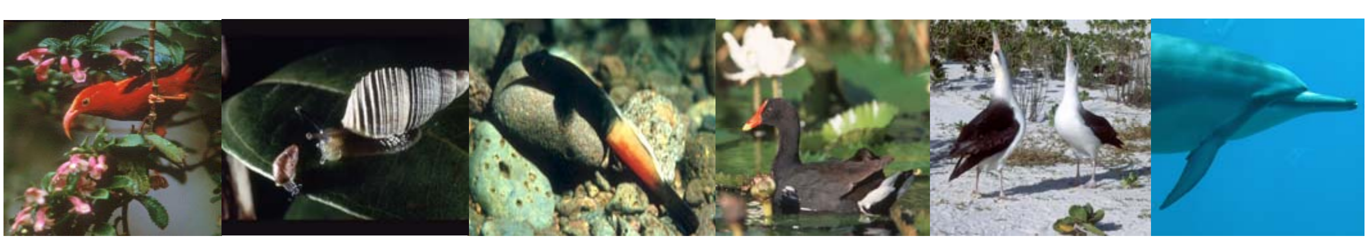
HAWAII'S COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

Effective October 1, 2005



HAWAII'S COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

As submitted to the National Advisory Acceptance Team
October 1, 2005

Department of Land and Natural Resources
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FOREWORD

Aloha! I am pleased to introduce Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS), a historic endeavor to address the conservation needs of over 10,000 species native to Hawai'i. Never before has the State attempted to outline a statewide strategy for native wildlife conservation that includes species from the mountains to the ocean, from the Northwestern Hawaiian Islands to the main Hawaiian Islands.

Much of Hawaii's unique wildlife is found nowhere else on earth, and these species and their habitats face tremendous challenges due to habitat loss and the introduction of non-native, invasive species. More than half of the native habitats have been lost and the introduction of non-native plants, animals, and diseases, like miconia, coqui frog, or West Nile virus, constitute an ongoing threat to species in restricted ranges. Hawaii's CWCS is an opportunity to turn the tide on the decline of our native species and habitats. By building on earlier conservation and research efforts, the CWCS uses the best possible science available to establish statewide objectives and strategies to address the challenges facing our native wildlife and habitats.

The CWCS is the result of the hard work of many people, and I offer a sincere *mahalo* to all who participated in its development. As we turn to the implementation of this ambitious strategy, I invite everyone to join in, working in partnership with and alongside management agencies, community groups, businesses, landowners, and citizens. Together, we can ensure these unique and rare Hawaiian species continue to exist for future generations.

Linda Lingle
Governor of Hawai'i

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List of Acronyms

BRA	Bottomfish Restricted Area
CI	Confidence Interval
CITES	Convention on International Trade of Endangered Species
CWCS	Comprehensive Wildlife Conservation Strategy
DAR	Division of Aquatic Resources (State)
DHHL	Department of Hawaiian Home Lands (State)
DLNR	Department of Land and Natural Resources (State)
DOFAW	Division of Forestry and Wildlife (State)
DOH	Department of Health (State)
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FMA	Fishery Management Area
GSN	Genetic Safety Net
HI-GAP	Hawaiʻi Gap Analysis Project
IUCN	International Union for the Conservation of Nature and Natural Resources
KIRC	Kahoʻolawe Island Reserve Commission
KS	Kamehameha Schools
MGD	Million gallons per day
MHI	Main Hawaiian Islands
MLCD	Marine Life Conservation District
MMA	Marine Managed Area
NAR	Natural Area Reserve
NGO	Non-governmental organization
NHP	National Historic Park
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWHI	Northwestern Hawaiian Islands
NWR	National Wildlife Refuge
SE	Standard Error
SD	Standard Deviation
SGCN	Species of Greatest Conservation Need
SOS	Save Our Shearwaters Program
SWG	State Wildlife Grant
TNC	The Nature Conservancy of Hawaiʻi
UH	University of Hawaiʻi
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey (Biological Resources Division)
WP	Watershed Partnership

EXECUTIVE SUMMARY

BACKGROUND

Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS) is a historic initiative that comprehensively reviews the status of the full range of the State's native terrestrial and aquatic species, over 10,000 of which are found nowhere else on earth. Hawaii's CWCS presents strategies for long-term conservation of these species and their habitats. The development of the CWCS built upon Hawaii's strong history of conservation and involved working with resource managers, biologists, and concerned individuals statewide. As a result, the CWCS has a broad level of support, increasing the likelihood that the conservation strategies identified will be implemented by multiple partners as well as the Hawai'i Department of Land and Natural Resources.

STRATEGY APPROACH AND DEVELOPMENT

The reason for developing a CWCS is to continue participation in the State Wildlife Grant (SWG) program administered by the U.S. Fish and Wildlife Service (USFWS). Every state in the nation and all the U.S. territories are preparing a CWCS by October 1, 2005 that contains the following eight required elements:

1) Information on the distribution and abundance of species of wildlife identified as "species of greatest conservation need," including low and declining populations, as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife;
2) Descriptions of the locations and relative condition of key habitats and community types essential to the conservation of species identified in (1);
3) Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats;
4) Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions;
5) Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions;
6) Descriptions of procedures to review the plan at an interval not to exceed ten years;
7) Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats;
8) Provisions to ensure public participation in the development, revision, and implementation of projects and programs.

The Hawai'i Department of Land and Natural Resources has taken the lead in preparing the CWCS and has gone beyond simply meeting mandated requirements by making the CWCS a useful document to guide conservation efforts across the State. The Strategy uses the best available science, and it integrates information from the many existing management, conservation, and recovery plans. The CWCS builds on and synthesizes information gathered from existing conservation partnerships and cooperative efforts, such that the development of this Strategy is based on collaboration with other local, State, and Federal agencies, non-governmental organizations, private landowners, and interested citizens. A combination of traditional outreach, such as public meetings and technical workshops, with ‘modern’ outreach, such as the development of a website and use of email, was used to invite and expand participation in the development of the CWCS. Chapter 2 of this document outlines the methods and approaches used to develop Hawaii’s CWCS.

Recognizing the effectiveness of taking conservation actions at a habitat-level in addition to a species-specific level, the CWCS emphasizes threats to species and their habitats and conservation needs at three levels: statewide, island-wide, and taxa-specific. Chapters 3 and 4 present an overview of Hawaii’s unique species and their habitats, identify the major threats to the long-term conservation of these species and habitats, and present seven conservation objectives to address these threats. Under each objective, strategies of highest priority are labeled; however, because conservation needs in Hawai‘i far exceed the resources available, implementation of any of the identified strategies will benefit native wildlife and habitats. Chapters 5 and 6 present more specific information for the marine environment (Chapter 5) and the individual islands and the Northwestern Hawaiian Islands (Chapter 6). Fact sheets on individual taxa or on groupings of taxa were developed to present information relating to elements one through five, and are compiled in Chapter 7. Finally, recognizing that monitoring is critical to the overall success of the CWCS, Chapter 8 discusses existing and needed monitoring programs for species and habitats as well as implementation and monitoring of Hawaii’s CWCS, including the 10-year revision.

HAWAII’S COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

Hawaii’s Species of Greatest Conservation Need (SGCN) include all native terrestrial animals, all endemic aquatic animals, additional indigenous aquatic animals identified as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. The SGCN includes: terrestrial mammal (1), birds (77), terrestrial invertebrates (~5,000), freshwater fishes (5), freshwater invertebrates (12), anchialine pond-associated fauna (20), marine mammals (26), marine reptiles (6), marine fishes (154), marine invertebrates (197), flora (over 600).

The major threats facing Hawaii’s native wildlife are common to most species groups and habitats and include:

- Loss and degradation of habitat resulting from human development, alteration of hydrology, wildfire, invasive species, recreational overuse, natural disaster, and climate change;
- Introduced invasive species (e.g., habitat-modifiers, including weeds, ungulates, algae and corals, predators, competitors, disease carriers, and disease);
- Limited information and insufficient information management;

- Uneven compliance with existing conservation laws, rules and regulations;
- Overharvesting and excessive extractive use;
- Management constraints; and
- Inadequate funding to implement needed conservation actions.

To address these threats, the CWCS identifies multiple strategies to implement the following seven priority conservation objectives for the State:

1) *Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive;*
2) *Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication;*
3) *Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs;*
4) *Strengthen existing and create new partnerships and cooperative efforts;*
5) *Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai'i;*
6) *Support policy changes aimed at improving and protecting native species and habitats; and*
7) *Enhance funding opportunities to implement needed conservation actions.*

Successful implementation of the CWCS will require an ongoing effort of local, State, and Federal agencies, non-governmental organizations, private landowners, and individual citizens working together. Though the magnitude and scope of the work needed to protect and recover Hawaii's unique native species are challenging, implementation of the identified strategies is critical if future generations are to see and experience the unique native wildlife of Hawai'i.

CHAPTER 1: PURPOSE AND VALUE

Mission Statement: *The mission of Hawaii's Comprehensive Wildlife Conservation Strategy is to guide conservation efforts across the State to ensure protection of Hawaii's wide range of native wildlife and the diverse habitats that support them.*

PURPOSE OF HAWAII'S COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

The purpose of developing Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS) is to provide the opportunity for resource managers to develop a comprehensive planning process to help manage all of Hawaii's unique native wildlife. Hawaii's CWCS is truly comprehensive in scope, going beyond the initial legislative mandate to fully recognize the interconnectedness of Hawaii's diverse flora and fauna to create an integrated, strategic blueprint for the protection and recovery of Hawaii's biodiversity. Although the magnitude and scope of the work needed to protect and recover Hawaii's unique species are challenging, the Strategy will improve the biological, cultural, and economic well-being of the islands and their people.

LEGISLATIVE MANDATE AND GUIDANCE

Historically, wildlife funding at the national level has been targeted towards species that were hunted or fished for sport and towards species federally listed as threatened or endangered. Declining populations of non-game, non-endangered species throughout the nation and the lack of stable funding to address the needs of these species led to the creation of the Wildlife Conservation and Restoration Program (WCRP) for fiscal year 2001 and the State Wildlife Grants (SWG) program (2002 to present) by the United States Congress. These programs provide funds to state agencies to begin the work needed to protect and secure viable populations of the full range of wildlife and their habitats in each state. The Hawaiʻi Department of Land and Natural Resources (DLNR) holds the constitutional and statutory authority to protect wildlife resources and administers the use of these funds.

As a condition for participation in these Federal aid programs, Congress required states to develop a Comprehensive Wildlife Conservation Strategy (CWCS) to remain eligible for SWG funding. Each CWCS must include the following eight elements:

1) Information on the distribution and abundance of species of wildlife identified as "species of greatest conservation need," including low and declining populations, as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife;
2) Descriptions of the locations and relative condition of key habitats and community types essential to the conservation of species identified in (1);
3) Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats;

4) Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions;
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7) Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats;
8) Provisions to ensure public participation in the development, revision, and implementation of projects and programs.

The Hawai‘i DLNR is leading the effort to collect the best available information from the many existing plans and programs and to coordinate with other local, State, and Federal agencies, non-governmental organizations, private landowners, and interested citizens to develop and implement the best approaches to ensure the long-term conservation of Hawaii’s native wildlife through Hawaii’s CWCS.

VALUE OF HAWAII’S CWCS

The value of Hawaii’s CWCS toward achieving its mission lies in its ability to integrate the needs of the full range of native species and habitats into a coordinated effort that enhances the effectiveness of broad cooperation among agencies and landowners toward the conservation of native species and habitats. Much of the groundwork for this collaboration exists in Hawai‘i in the form of numerous partnerships and existing management and species recovery plans. Although this conservation effort is characterized by working together and sharing information and responsibilities, no one document has synthesized all this information into a strategy for the entire State.

The value of having one document covering the needs of a diverse range of species groups makes Hawaii’s CWCS a historic endeavor. Additionally, by working with and soliciting information from a broad range of governmental agencies, non-governmental organizations, and citizens, Hawaii’s CWCS has helped to create consensus, excitement, support, and momentum to protect our native species. Whether or not our generation leaves a legacy of biodiversity to our grandchildren begins with the decisions and actions made today.

By identifying important species and habitats, key threats, and objectives and strategies for their conservation, and by creating a framework to measure the effectiveness of these strategies, Hawaii’s CWCS lays the foundation for conservation of native wildlife and their habitats. By taking a proactive approach, Hawaii’s CWCS takes a fiscally responsible stand. The CWCS focuses on actions to prevent species from reaching threatened or endangered status, providing a cost-effective alternative to recovering species after they have been listed as threatened or endangered. Additionally, by emphasizing measures that benefit multiple species groups and habitats in which they reside, the CWCS is a change from single species management. The true challenge, however, will come with the implementation of this CWCS.

HAWAII'S UNIQUE WILDLIFE RESOURCES AND THEIR VALUES

A CWCS is especially important to Hawai'i, the United States, and even the world, because of the unique biology, cultural importance, and economic value of native Hawaiian species. The Hawaiian Islands are the most isolated archipelago in the world, situated in the middle of the Pacific Ocean more than 3,200 kilometers (2,000 miles) from the nearest continent. Because of this extreme isolation, relatively few life forms survived the rigors of the ocean crossing and reached the islands. Fewer still were able to successfully establish populations in the archipelago over its 70 million year history. Those that did, however, found a diversity of climatic and geological features that provided an enormous range of habitat types. With extremely limited gene flow from their distant, original populations, colonists rapidly adapted to their novel environments. For many such colonists, unique adaptations occurred simultaneously among populations that were isolated from one another on an island and between islands. Hawai'i provides a text-book example of adaptive radiation, the process by which many new species evolved from a single common ancestor in a relatively short time span.

Although Charles Darwin never visited the Hawaiian Islands, he was aware of their unique biology. If he had visited the islands, he would have discovered that Hawai'i surpasses the Galapagos Islands in the number and variety of species that evolved from a small set of original colonizing ancestors. Scientists now recognize that the world's premier showcase of adaptive radiation is the Hawaiian archipelago. The diversity of unique species that have evolved in the islands is nothing less than astounding, with plants and animals that are so distinctive that the archipelago has been described as its own biogeographic province that possesses the world's highest degree of endemism – 90 percent for terrestrial species and 15 to 20 percent for marine species.

The arrival of Polynesians approximately 1,600 years ago, and increasingly with the arrival of Westerners in 1778, contributed to the destruction of native habitats and introduced many novel threats to which the island's species had never been exposed. For more than 70 million years, the evolution of new species vastly exceeded losses to extinction. Yet after the arrival of humans to the islands, within what is a blink of an eye in geological time, numerous species began precipitous declines to extinction. These losses include at least half of the native bird life, hundreds of unique plant species, and undoubtedly thousands of lesser known taxa such as terrestrial insects and spiders that were lost before they were ever described. Today, with less than 0.2 percent of the land area of the United States, the Hawaiian Islands hold more than 30 percent of the nation's imperiled species. These include 317 taxa of plants and animals listed by the U.S. Fish and Wildlife Service (USFWS) as endangered or threatened, 12 taxa proposed as endangered, and 105 taxa as candidates for listing.

Despite this, in present day Hawai‘i, the link between Native Hawaiian culture and native species has not been lost and continues to be practiced in belief systems as well as traditional practices such as gathering of native plants and animals for hula, traditional medicines, carving, weaving, tool making, jewelry, and ceremonies. The special role and relationship Native Hawaiians have with the native species and ecosystems in the islands is perhaps most reflected in their increasing role in natural resource management in places such as the island of Kaho‘olawe; Limahuli and Lumaha‘i valleys on Kaua‘i; Mo‘omomi, Moloka‘i; and Keauhou, Hawai‘i where traditional management practices such as *kapu* (taboo) and *ahupua‘a* (watershed)-scale thinking predominate.

Native wildlife is also important to all of Hawaii's residents. Based on a 2004 "Wildlife Values in the West" survey, a large majority of Hawaii's residents (71.4%) strongly agree that it is important to take steps to prevent the extinction of endangered species (Teel & Dayer, 2005). Economically, wildlife viewing opportunities are worth hundreds of millions of dollars to the State's $10 billion a year tourism industry (U.S. Department of Interior, 2003). Hawaii's native wildlife and their habitats also provide hundreds of millions of dollars in important goods and services to residents. A recent University of Hawai‘i study of the economic valuation of water quality, in-stream uses, species habitat, hunting, commercial harvest, ecotourism, and climate control estimated the value of services to be between $7.4 to $14 billion in the Ko‘olau Mountains of O‘ahu alone (Kaiser, 1999). Other examples of ecological services provided by native habitats include coral reefs that protect beaches, homes, and businesses from erosion, storms, and tsunami waves, and wetland habitats that filter the water supply. Finally, actions preventing the introduction of invasive species benefit people as well as native wildlife: invasive weeds increase the likelihood of wildfires that threaten homes and native habitats; introduced ungulates (hooved animals) denude native forest, causing soil erosion and sedimentation of streams and nearshore reefs and impacting fishing opportunities; plants such as *Miconia calvescens* provide much less erosion control than native trees, threatening billions of gallons of water provided by our watersheds; the coqui frog (*Eleutherodactylus coqui*) poses quality of life issues for residents while eating native invertebrates; and West Nile Virus and the brown tree snake raise public health and safety concerns.

ORGANIZATION AND FORMAT OF HAWAII'S CWCS

Hawaii's CWCS is organized in a way that addresses the required eight elements at multiple scales, from the statewide perspective to island-specific and taxa-specific levels. Chapter 2, **Approach and Methods**, describes the processes used to develop the Strategy and addresses elements 7 and 8. Chapters 3 and 4, **State of Hawai‘i Overview** and **Statewide Conservation Needs**, provide a statewide overview outlining the current condition of the State's natural resources, management activities, key threats to native species and habitats, and statewide conservation goals, objectives, and strategies. Chapter 5, **Marine Conservation Needs**, and Chapter 6, **Island Conservation Needs**, go beyond the statewide perspective to location-specific threats and strategies, including those for the Northwestern Hawaiian Islands. Chapter 7, **Species of Greatest Conservation Need**, provides details on all the listed wildlife taxa in fact sheets that contain information for one taxa, closely related groups of species, or species facing similar threats. These Chapters (3-7) address required elements 1 through 5. Chapter 8, **Monitoring, Implementation, and Adaptive Management,** discusses existing and needed monitoring programs for species and habitats as well as implementation and review of the CWCS itself, addressing elements 6 and 7. Finally, supporting sections consisting of **Appendices, Glossary,** and **References** are included to provide additional detail.

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CHAPTER 2: APPROACH AND METHODS

APPROACH

Given Hawaii's biological uniqueness on a global scale, the Comprehensive Wildlife Conservation Strategy (CWCS) recognizes the importance of protecting all native terrestrial animals, all endemic aquatic wildlife, other aquatic species threatened with decline, and a broad range of native flora. On the ecological level, the CWCS takes a habitat management approach, adopting a landscape view that takes into account the complex inter-relationships between species and their habitats and the need for change and adaptability. The CWCS builds on and synthesizes information gathered from existing conservation partnerships and cooperative efforts. Additionally, the CWCS highlights these partnerships and their efforts in Hawai‘i with a goal to enhance and expand existing and to create new partnerships, ultimately increasing support for implementing Hawaii's CWCS.

The Hawai‘i Department of Land and Natural Resources (DLNR) coordinated the development of Hawaii's CWCS, with joint cooperation by the Division of Forestry and Wildlife (DOFAW) and the Division of Aquatic Resources (DAR), the divisions primarily charged with protecting the State's terrestrial and aquatic resources. The CWCS core team consists of staff hired through the Pacific Cooperative Studies Unit (PCSU) of the University of Hawai‘i (UH). A broader CWCS team includes DOFAW and DAR staff that directly supported and assisted the development of the CWCS. In addition, other CWCS contributors include advisory groups and committees of representatives from government agencies and partner organizations, other internal and external stakeholders, and technical workshops and public meetings participants. For terrestrial wildlife, informal advisory groups were developed around species or geographic interests, building upon existing working groups (e.g., the Hawaiian Hoary Bat Research Cooperative). For aquatic wildlife, a Statewide Aquatic Wildlife Conservation Strategy Advisory Committee, with representatives from Federal and State agencies, resource user groups, and non-profit organizations was established. The Advisory Committee also assisted DAR in developing their CWCS products and a stand-alone Statewide Aquatic Wildlife Conservation Strategy to be published by PCSU.

METHODS

Multiple methods were used to develop and draft Hawaii's CWCS. The goal of each method was to engage different audiences and groups, garner information to meet the required eight elements, and build support for the strategy and its implementation. The following sections describe the planning process and methods utilized, addressing required elements 7 and 8.

OUTREACH

Public Participation

A variety of methods and opportunities were used to reach out to the public to introduce them to Hawaii's CWCS. The primary method used to engage the public as well as resource managers and technical experts was the CWCS website, www.state.hi.us/dlnr/dofaw/cwcs/index.html. The public was encouraged to comment at all stages of CWCS development, beginning with the draft list of species covered by the CWCS to taxa-specific fact sheets and the Final Draft Strategy. The website was updated monthly, and whenever new announcements, workshops or public meetings, or products for review were available. Three types of contact information were provided so that people could share information by email, phone, or mail. Each interested person was added to a CWCS Contact List, which was used to keep people updated and engaged in the process. This list was initially developed through an e-mail and a brochure mailing to over 600 individuals, agencies, and organizations.

DLNR also issued press releases between the fall of 2004 and 2005 that resulted in media coverage by the two statewide papers, individual island papers, and local radio stations. Hawaii's CWCS gained national attention when the Associated Press picked up a local article that resulted in coverage in the Washington Post and other major newspapers. During the month of April 2005, several outreach initiatives involving Earth Day celebrations were conducted where the distribution of informational brochures, games, and items such as bookmarks helped to raise public interest and support for Hawaii's CWCS. During the months of June and July, 2005, public meetings were held on six islands to engage the public in developing a Final Draft of Hawaii's CWCS. Following the public meetings, another opportunity to comment on a revised final draft was provided on the website and people were contacted by email, phone, and mail.

Resource Manager and Technical Expert Participation

Conservation and management of natural resources in Hawai‘i traditionally have involved strong collaborative efforts. Hawaii's CWCS benefited from this foundation of established partnerships and built upon existing species recovery plans, location-specific management plans, and other available related plans and documents.

The CWCS core team invited resource managers and technical experts to participate in the development of the CWCS through an initial outreach effort, sent both by mail and email, to a wide range of local, State, and Federal agencies, non-governmental organizations, researchers, and private landowners. The CWCS core team also identified existing partners and individually contacted them to introduce the strategy and invite their participation. Members of the CWCS core team attended several professional conferences where additional biologists and researchers were invited to participate in the development of the CWCS. Based on these outreach efforts, informal and formal advisory groups were developed on both a species and habitat level, providing information used to develop the Draft CWCS and reviewing of initial draft products. Technical workshops on four different islands were conducted once the Draft CWCS was complete, to provide a forum for managers and technical experts to review the CWCS, provide comments, and suggest additions for incorporation into the Final Draft of Hawaii's CWCS.

Current major collaborators include a wide range of agencies and organizations that have been integral in building support for the CWCS, sharing data and information, providing comments and recommendations, and assisting in the overall planning effort. Major contributors include the Hawai‘i Gap Analysis Program (HI-GAP), Bishop Museum, Nature Conservancy of Hawai‘i (TNC), the National Tropical Botanical Gardens (NTBG), Hawai‘i Invasive Species Council (HISC), UH, U.S. Fish and Wildlife Service (USFWS), U.S. National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), U.S. National Park Service (NPS), U.S. Army, and U.S. Marine Corps.

STRATEGY DEVELOPMENT

From the methods described previously, individuals and organizations were identified with information or expertise on species groups or islands and organized into informal reviewer groups. These groups along with the website, technical workshops, and public meetings were used to develop the following components of Hawaii's CWCS.

Identifying Species of Greatest Conservation Need and their Habitats

The Hawaiian Islands are biologically diverse, with fauna characterized by high levels of endemism. In addition, many migratory species spend key parts of their life cycles (e.g., breeding or wintering) in Hawaiʻi. To recognize the global rarity of these species or the importance of Hawaiʻi to these species, Hawaii's preliminary list of Species of Greatest Conservation Need (SGCN) was selected using the following criteria: 1) all terrestrial indigenous animals as identified by the Hawaiʻi list of indigenous species (Hawaiʻi Administrative Rules Title 13 Chapter 124); 2) all aquatic endemic animals; 3) any animal taxa on the Federal threatened, endangered, candidate, or species of concern list; 4) any animal protected by the U.S. Marine Mammal Protection Act; 5) any native animal on the International Union for the Conservation of Nature and Natural Resources' (IUCN) Threatened Red List or the Convention on International Trade in Endangered Species (CITES) appendices; and 6) additional animals suggested by the Statewide Aquatic Wildlife Conservation Strategy Advisory Committee or by the informal advisory groups as deserving of attention for other reasons. Migratory species with irregular or insignificant presence in the State were not included on the list; neither were introduced species, which by their nature do not represent the natural biodiversity of Hawaiʻi.

Hawaii's preliminary SGCN list was reviewed by partners, posted on the website for public consideration and comment, and discussed at technical workshops and public meetings. Given the large number of species, for organizational and management purposes, species were grouped into the following categories: terrestrial mammal, birds (forest birds, raptors, waterbirds, seabirds, migratory shorebirds and waterfowl, and Northwestern Hawaiian Islands passerines), terrestrial invertebrates, freshwater fishes, freshwater invertebrates, anchialine pond fauna, marine mammals, marine reptiles, marine fishes, and marine invertebrates.

A consistent theme during public review was the recommendation to include native flora on the list of SGCN for the following reasons: 1) native flora have a high degree of endemism; 2) native flora are in dire need of conservation attention with over 250 species federally listed as threatened or endangered; 3) native flora are highly important to native wildlife, as many native birds and native invertebrates rely upon native plants for food or for habitat.

After review of public comment, the CWCS core team developed a list of Flora Species of Greatest Conservation Need for inclusion in the CWCS using the following criteria: 1) plant species federally listed as threatened, endangered, or as a candidate for listing; 2) plant species identified as Genetic Safety Net (GSN) plants (i.e., plants with less than 50 individuals extant); 3) plant species identified as important elements of native habitats; 4) endemic aquatic plants; and 5) endemic terrestrial and aquatic algae. A plant species was considered an important element of native habitat if it was a dominant or co-dominant member of an identified natural community according to the *Manual of the Flowering Plants of Hawaiʻi* or if there was evidence that the plant was known to be a host for native wildlife, a food source for native wildlife, or habitat for native wildlife. The CWCS core team solicited the assistance of the Hawaiian botanical community to develop the list of Flora Species of Greatest Conservation Need, which was posted on the website for further public consideration and comment.

Together, the Fauna Species of Greatest Conservation Need and the Flora Species of Greatest Conservation Need compose Hawaii's SGCN. This broad approach of identifying Hawaii's SGCN recognizes the uniqueness and global rarity of Hawaii's natural environment. However, although this CWCS begins with SGCN, the CWCS focuses on habitats essential to these species, threats to these important habitats, and management strategies needed to preserve these habitats.

Identifying Threats, Conservation Objectives, Research Needs, Monitoring, and Priorities

Hawaii's CWCS core team identified the threats and needs of native wildlife and habitats by using multiple methods and at three levels. The first step was to review and analyze existing plans, policies, and scientific literature from local, State and Federal agencies, private landowners, non-governmental organizations, or academic researchers. The CWCS core team solicited additional information from resource managers and biologists through conversations, emails, and meetings. Based on this research and analysis, draft threats, conservation objectives, research needs, and monitoring issues for species and habitats were determined at a taxa-level, island-level, and statewide-level. At the statewide-level, major threats to and needs of Hawaii's SGCN and their important habitats were emphasized, and seven objectives were identified to address these threats. These seven objectives reflect the conservation priorities for the State without regard to the limitations of the State Wildlife Grants program, recognizing the need to comprehensively identify the State's conservation priorities to enhance the possibility of implementation. Under each objective, strategies of highest priority were labeled, but no further prioritization occurred as all strategies are important priorities and implementation of these strategies depends on several factors beyond relative ecological importance, such as funding, landowner interest, community support, or technological capacity. Because conservation needs in Hawai‘i far exceed the resources available, implementation of any of the identified strategies will benefit native wildlife and habitats. Important threats and conservation strategies were highlighted for each island, for the Northwestern Hawaiian Islands, for the marine environment, and for specific taxa.

Maps/Geographic Information System information

The CWCS core team worked closely with HI-GAP to develop spatial information and incorporate Geographic Information System (GIS) analysis into the Strategy. These products were reviewed not only by the HI-GAP team (which consisted of representatives from the Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program), TNC, Bishop Museum, UH, USGS, DOFAW, NPS, and USFWS), but also during the island technical workshops with local specialists. This collaboration was essential to Hawaii's CWCS process of identifying species distributions, management needs, information gaps, and potential new areas for conservation enhancement. In addition to HI-GAP, valuable spatial information was provided by the State of Hawaii's Division of Business and Economic Development, USFWS, USGS, NPS, NOAA, Hawai‘i Forest Bird Interagency Database Project, Hawai‘i

Biodiversity and Mapping Program (rare species database), and Bishop Museum (Invertebrates database).

The maps in Chapter 7 were based on data from two sources: incidental records and standardized surveys. Incidental records note were a species was located or collected, and provide limited information regarding a species' actual distribution. When the date was available, information post-1900 was utilized due to data limitations pre-1900. Maps based on standardized surveys represent occurrence data at survey or count stations. Density figures are available in Scott et al. (1986), and these figures are currently being updated. Distributions based on these surveys only provide distributional information in the areas surveyed (see Scott et al. 1986 for details). Distributions for the waterbirds are based on weighted occurrences of non-standardized count data (2000-2005). The distribution map for the nēnē was based on information from the USFWS recovery plan for that species. Long-term waterbird trend analyses are in preparation. Maps for certain widespread species were not provided because of a lack of systematic surveys. Maps for seabirds and migratory birds are not provided because many of these species have very limited ranges in Hawai‘i or because of a lack of systematic survey data.

Plan Review

Drafts of Hawaii's CWCS were shared through multiple venues including the website, technical workshops, public meetings, and the CWCS contact list. Availability of the Draft CWCS and the schedule of public meetings were publicized by email and direct mail to the CWCS contact list and additional parties, by press release, and on the website. Upon the conclusion of the technical workshops and public meetings, the comments were compiled, reviewed, evaluated, and incorporated as appropriate into the Revised Draft CWCS. In addition, new materials (e.g., fact sheets on terrestrial invertebrates) were made available for public review. This Revised Draft CWCS was posted on the website for review and both emailed and mailed to the CWCS Contact List, followed by another public comment period. Comments were again reviewed and incorporated as appropriate and Chapter 8 was substantially rewritten based on internal review and comment. The CWCS was then finalized and presented to the Board of Land and Natural Resources for approval.

CHAPTER 3: STATE OF HAWAI‘I OVERVIEW

Due to its extreme isolation and climactic conditions, Hawai‘i is characterized by high levels of endemism in both its native animals and plants, with over 10,000 species found nowhere else on earth. Unique and varied habitats are also found across the islands. As a result, Hawai‘i presents both an opportunity and challenge for conservation. While the threats to Hawaii’s native species persist, recent years have seen greater awareness of the need to take action to conserve biodiversity, more assertive political will to take steps to address the problems, and wider community involvement in projects. These changes have resulted in positive steps towards the recovery for Hawaii’s endangered species and towards the protection for those species that remain common so that they do not become endangered. Success stories include bringing the nēnē (*Branta sandvicensis* [Hawaiian goose]) from the edge of extinction, increasing populations of honu (*Chelonia mydas agassizi* [green sea turtle]), protection of important habitats such as that of Hanawī on Maui, and community-led restoration efforts of Waimānalo streams encouraging the return of the endangered ae‘o (*Himantopus mexicanus knudseni* [Hawaiian stilt]). However, despite these success stories, Hawai‘i continues to face major conservation challenges in protecting its over 10,000 native wildlife species. Chapter 3 provides both a social and biological overview, assessing the current status of natural resources in the State. This chapter, in combination with Chapter 4, addresses elements 1-4 at the statewide level.

SOCIAL OVERVIEW

HUMAN LANDSCAPE

The population of the State of Hawai‘i was estimated at 1,262,840 people in 2004, with the majority (70%) found on O‘ahu, in the City and County of Honolulu (899,593). The nearly seven million visitors in 2004 contributed an additional average of 170,000 people per day, mostly on O‘ahu and Maui.

Hawai‘i has four local governments: the City and County of Honolulu (island of O‘ahu and the Northwestern Hawaiian Islands), the County of Kaua‘i (islands of Kaua‘i and Ni‘ihau), the County of Maui (islands of Maui, Moloka‘i, Lāna‘i and Kaho‘olawe), and the County of Hawai‘i (island of Hawai‘i). Hawai‘i also has a fifth county, Kalawao County, which does not have a separate government unit. Kalawao County covers the former Hansen’s disease settlement at Kalaupapa (Moloka‘i) and is managed by the National Park Service (NPS) under a cooperative agreement with the State Department of Health.

Tourism is the primary economic activity in the State, with more than 6.9 million visitors and $10.3 billion in expenditures in 2004 alone. Agriculture, primarily pineapple cultivation and diversified agriculture, and military expenditures are important secondary economic drivers.

LAND AND WATER USE

Nearly half of Hawaii’s 1.66 million hectares (4.1 million acres) are managed by the State or Federal government. The largest landowner, the State of Hawai‘i, manages over 467,000 hectares (1,155,900 acres) for watershed protection, preservation of natural resources, agricultural use, recreation, transportation, and public safety. The State Department of Hawaiian Home Lands manages an additional 82,000 hectares (202,658 acres) in trust for the present and future use by Native Hawaiians. The Federal government (NPS, U.S. Fish and Wildlife Service (USFWS), and Department of Defense) owns or manages, through leases or cooperative agreements, more than 270,000 hectares (671,579 acres) for a variety of purposes, including conservation of natural and cultural features, protection of wildlife habitat, military support and training, and public safety. There are no lands managed by the U.S. Forest Service or the Bureau of Land Management in Hawaiʻi.

The remaining land is in private ownership. Much of this land is controlled by a few owners; seven private landowners own approximately 20 percent of the land in the State (Kamehameha Schools, Parker Ranch, Castle & Cooke, Inc., Alexander and Baldwin, Inc., James Campbell Estate, C. Brewer and Company, Ltd., and Dole Food Company, Inc.). Some of these lands are managed in cooperation with adjacent landowners for conservation purposes as part of a watershed partnership. Modeled after the first watershed partnership that began in East Maui in 1991, there are now nine watershed partnerships on six islands, involving more than 50 public and private partners and covering over 344,000 hectares (850,000 acres) of forested watershed. These voluntary partnerships are the primary vehicle for conservation on private lands in Hawaiʻi (as opposed to conservation easements, acquisition, or other methods).

Over the last decade, major land use trends include the transition from agriculture (e.g., sugar cane, pineapple cultivation) to resort-residential development and large-lot residential subdivisions on agricultural lots. Example areas include Mānele Bay (Lānaʻi), west Maui, central Oʻahu, and the Hāmākua Coast (island of Hawaiʻi). The dissolutions of the Campbell Estate and the Damon Estate private trusts are expected to result in additional land use changes. Increased military activity associated with the location of a U.S. Army Stryker Brigade and the possible stationing of an aircraft carrier group is anticipated to result in additional land use changes in the Urban District for housing and infrastructure and in the Conservation District for construction related to training.

Unlike many other states, Hawaiʻi has statewide land use classifications, with all land being zoned in one of four categories: Conservation, Agricultural, Urban, and Rural. About 48 percent of the State (798,702 hectares or 1,973,636 acres) is in the State Conservation District, a designation where development and commercial activity is generally limited with varying levels of restrictions based on the applicable subzone. While the State Department of Land Natural Resources (DLNR) manages land in the Conservation District, the counties have primary responsibility for land in the other three districts. Those Districts are subject to county land-use and development controls, including county community plans, zoning, and building code regulations which affect farm, residential, commercial, and industrial development and use. In addition, in Special Management Areas located along the shoreline, each county has an additional layer of regulation that provides special control of development, even for land already subject to Conservation District restrictions.

Hawaiʻi withdraws about two billion gallons per day of water, with just over 500 million gallons coming from groundwater sources, and the rest from surface water diversions and withdrawals. Water consumption is about 550 million gallons per day (mgd).

Freshwater resources are managed by a number of different State and Federal agencies. The DLNR-Division of Aquatic Resources (DAR) and the USFWS are responsible for managing freshwater animals. The Hawai‘i Department of Health and the U. S. Environmental Protection Agency are responsible for managing water quality and pollution under the Clean Water Act and other legislation. Coastal zone management, including development permits in Special Management Areas, is the joint responsibility of the State Department of Business, Economic Development, and Tourism Coastal Zone Management Program and the U. S. National Oceanic and Atmospheric Administration (NOAA).

A significant portion of the State (31%) has been designated for long-term resource protection and receives varying degrees of management: 260,267 hectares (643,134 acres) are in State Forest Reserves (DLNR), 147,710 hectares (365,000 acres) are within National Parks (NPS), 44,177 hectares (109,164 acres) are in State Natural Area Reserves (DLNR), 38,400 hectares (94,900 acres) are in State Wildlife Sanctuaries (DLNR), and 265,897 hectares (657,048 acres) of emergent and submerged land are in National Wildlife Refuges (USFWS). The Hawaiian Islands Humpback Whale National Marine Sanctuary (NOAA and DLNR) protects an additional 364,200 hectares (900,000 acres) of marine waters, while the Northwestern Hawaiian Islands (NWHI) Coral Reef Ecosystem Reserve protects submerged lands and waters in the NWHI.

CULTURAL SIGNIFICANCE OF NATIVE WILDLIFE

Native species in Hawai‘i play a significant role in Native Hawaiian culture. Historically, feathers from forest birds were used to make elaborate capes, leis, and helmets for the *ali‘i* (royalty). Whale ivory, shells, and shark’s teeth were used for necklaces and other adornments. Fish and sea turtle bones were used as kitchen implements, tools, and fishhooks, while sea turtle shells and scutes were used as containers. Koa (*Acacia koa*) trees were used for the ocean-voyaging canoes. Numerous other examples of the use of native plants and animals in both daily life and ritual exist. In present day Hawai‘i, the link between Native Hawaiian culture and native species has not been lost and continues to be practiced in belief systems, as well as in traditional practices such as gathering of native plants for hula, traditional medicines, carving, weaving, and ceremonies.

The belief system of the Native Hawaiians links people with all living and non-living things. Because all components of ecosystems were descended from *Wākea* (sky father) and *Papa-hanau-moku* (earth mother) and their offspring, *kini akua* (multitude of gods), both living and non-living elements possess spiritual qualities and *mana* (spiritual power). As such, Native Hawaiians, as *kanaka maoli* (native people), are guardians of these ecosystems and their well-being is directly related to the well-being of these ecosystems. For example, areas such as *wao akua* (upland forests) are sacred places, the realm of the gods. Native Hawaiian land ownership and resource management were often based on a unit called the *ahupua‘a*, which typically corresponded with what we today call watershed areas. This understanding of the link from uplands to the ocean was ahead of its time. *Kapu* (taboo) systems that limited certain classes or sexes from eating certain animals or fishing in certain places or at certain times may have aided in the conservation of some species (e.g., only men were allowed to eat honu (green sea turtle) and only royalty could eat certain fishes).

Native wildlife also play an important role in Native Hawaiian culture as many species such as the pueo (*Asio flammeus sandwichensis* [Hawaiian short-eared owl]), ʻio (*Buteo solitarius* [Hawaiian hawk]), ʻelepaio (*Chasiempis sandwichensis*), ʻalalā (*Corvus hawaiiensis* [Hawaiian crow]), sea turtles, and sharks are believed to be ʻ*aumakua* (ancestors or guardians) of certain Hawaiian families. Hawaiian names have been given to many of the native wildlife and they have been incorporated into *oli* (chants) and *moʻolelo* (legends). Today, Native Hawaiian teachings play an increasing role in natural resource management, especially in areas of cultural significance like Kahoʻolawe or Wao Kele o Puna (island of Hawaiʻi). The CWCS recognizes that the State and its agencies are obligated to protect the reasonable exercise of customarily and traditionally exercised rights of Native Hawaiians to the extent feasible, in accordance with *Public Access Shoreline Hawaii versus Hawaii County Planning Commission* and subsequent case law.

PUBLIC SUPPORT FOR CONSERVATION

Public Perspectives on Wildlife

Based on a 2004 "Wildlife Values in the West" survey, 71 percent of Hawaii's residents strongly agree that it is important to prevent the extinction of endangered species, 79 percent agree that in order to do this it is acceptable to eliminate introduced game animals from some areas, and 94 percent find it acceptable to close some areas to human use to protect wildlife (Teel & Dyer, 2005). In 2001, an estimated 20 percent of the population participated in some type of wildlife-associated recreation (e.g., fishing, hunting, wildlife watching), with expenditures for terrestrial wildlife watching activities in Hawaiʻi estimated at $132 million dollars. However, this is only a fraction of expenditures related to ocean wildlife viewing. A large proportion of the $10 billion dollar tourism sector is indirectly related to the viewing of marine wildlife, with one study estimating that snorkeling and diving alone generate $364 million dollars each year in added value for the State.

Funding for Conservation

Hawaiʻi ranks near the bottom (48th) in the nation for state spending on fisheries and wildlife, though the State forest reserve system ranks 11th in size and the State boasts the largest area of marine protected areas in the United States. In Fiscal Year 2006, the State Department of Land and Natural Resources was allocated approximately $76.8 million of the State's $8.9 billion dollar executive budget. With less than one percent (0.86%) of the State's budget, the Department must manage the State's marine and freshwater resources (e.g., commercial fisheries, aquaculture, aquatic resources protection, recreational fisheries), protect threatened and endangered species, manage State-owned lands (both those for lease and those set aside as forest reserves, natural areas, plant and wildlife sanctuaries, and parks), manage statewide ocean recreation and coastal areas programs (i.e., boating), oversee permitting associated with the Conservation District, implement the State's historic preservation mandates, maintain the statewide recording system for title to real property, and enforce the Department's rules and regulations.

A conservative estimate of the amount of State funds actually dedicated solely to conservation of native wildlife and their habitats is approximately $23 million dollars for Fiscal Year 2006. Though no comprehensive cost estimates exist for the protection and recovery of wildlife in Hawaiʻi, the inadequacy of current funding levels is obvious based on costs included in recovery plans for endangered species. For example, the recently published Draft Revised Recovery Plan for Hawaiian Forest Birds (2003) estimates the cost of recovering 21 species of forest birds at nearly $2.5 billion dollars over the next 30 years – an annual cost ($83 million) that exceeds the budget for the entire DLNR. Costs associated with the recovery for endangered whales, sea turtles, seabirds, waterbirds, and plants would add tens of millions more per year.

Funding levels from Federal sources are also inadequate and inequitably apportioned. With more than 30 percent of the nation's imperiled species, Hawaiʻi receives less than 15 percent of the national appropriation under the Endangered Species Act, Traditional Section 6 Program and only one percent of the national appropriation under the State Wildlife Grants Program. In recent years, through related competitive grant programs within the Section 6 program, additional funding for conservation on private lands and for land acquisition has become available. Though Hawaiʻi has been successful in securing a portion of these grants because of extensive and progressive partnerships with landowners, lack of sufficient overall funding to implement recovery programs, especially on State lands, leaves both critically endangered species and lesser known native species (e.g., terrestrial invertebrates) with little support.

Clearly, unprecedented efforts are needed to increase the funding base for the protection of Hawaii's wildlife and their habitats, and comprehensive and integrated strategies are needed to ensure that limited funding for wildlife conservation is used wisely and for maximal benefit.

BIOGEOGRAPHICAL OVERVIEW

The Hawaiian archipelago is comprised of eight main islands and approximately 124 smaller islands, reefs, and shoals spanning over 2,400 kilometers (1,500 miles) that vary in size from fractions of hectares to thousands of square kilometers. The archipelago was formed over the last 70 million years through volcanic eruptions from a relatively stationary hotspot beneath the slowly moving seafloor. The island of Hawaiʻi is the youngest island, with island age increasing to the northwest as the Pacific plate carries the older islands away from the hotspot. Millions of years of erosion, subsidence, and reef building resulted in the formation of the atolls which form the Northwestern Hawaiian Islands and the submersion under the sea surface of the seamounts which used to be islands.

Located over 3,200 kilometers (2,000 miles) from the nearest continent, Hawaiʻi is the most remote island chain in the world. Despite its relatively small area (less than 1.7 million hectares or 4.1 million acres), an elevation range from sea level to 4,205 meters (13,796 feet) results in Hawaiʻi containing all the major known ecological zones. With a wide temperature range due to the elevational gradient and with average annual rainfall ranging from less than 40 centimeters to over 1,200 centimeters (15 inches to over 480 inches) per year, Hawaiʻi displays most of the earth's variation in climatic conditions. Finally, Hawaiʻi possesses many natural wonders: the most active volcano in the world, the wettest place on earth, the tallest seacliffs, and extensive coral reefs.

HABITATS

The Hawaiian Archipelago possesses the full range of habitats, from wet forests to extremely dry coastal grasslands. Due to evolution and extreme isolation, these native habitats were characterized by high levels of plant endemism. With the arrival of humans and consequent introduction of invasive plants and animals and development, many of these habitats have declined. For example, 90 percent of Hawaii's dryland habitat, 61 percent of the mesic habitat, and 42 percent of the wetland habitat are estimated to be lost, with less than 40 percent of the land surface covered in native vegetation today. Similarly, much of the habitat for freshwater species has declined, with 58 percent of the perennial streams in the State having been altered in some way. The following section provides specific information on terrestrial, freshwater, and marine habitats, including associated wildlife and major threats.

Terrestrial Habitats

Distribution of terrestrial habitat in Hawai'i is heavily influenced by elevation, climate, and substrate. Five elevation zones are recognized: alpine (typically found over 3,000 meters (10,000 feet)); subalpine (typically found between 2,000 and 3,000 meters (6,500 to 10,000 feet)); montane (typically found between 1,000 and 2,000 meters (3,000 to 6,500 feet)); lowland (typically found between 0 and 1,000 meters (0 to 3,000 feet)); and coastal (typically found along the coast at low elevations). Further, three general moisture categories are recognized: dry (typically receive less than 125 centimeters (50 inches) of rainfall each year); mesic (typically receive between 125 to 250 centimeters (50 to 100 inches) of rainfall each year); and wet (generally receive over 250 centimeters (100 inches) of rain per year).

Using the elevation zones and moisture categories, the State can be classified roughly into nine terrestrial habitat types: alpine communities, subalpine communities; montane wet communities; montane mesic communities; montane dry communities; lowland wet communities; lowland mesic communities; lowland dry communities; and coastal communities. These nine habitat types can be refined further based on the dominant plants and structural characteristics of the vegetation. Although Hawaiian communities or habitats have been classified in a number of different ways, the *Manual of the Flowering Plants of Hawai'i* (Wagner, 1999) recognizes 33 native forest communities, 36 native shrubland communities, eight native grassland communities, and four native herbland communities. Subterranean systems form a tenth habitat type defined by geology rather than elevation zones and moisture. A short description of each of these habitats, associated wildlife, and primary threats is presented below.

Alpine communities

Alpine communities are found only on the islands of Hawai'i (Mauna Kea and Mauna Loa) and Maui (Haleakalā). Conditions are dry, vegetation is sparse, and the soil is predominantly cinder or barren gravel. Native species include terrestrial invertebrates, including the wekiu bug (*Nysius wekiuicola*), a candidate for Federal listing as endangered, spiders, and a few plants, most notably the 'āhinahina or silversword (*Argyroxiphium sandwicense*). There has been relatively little invasion by alien plants, but introduced alien insects, including the Argentine ant (*Linepithema humile*), are a growing problem.

Subalpine communities

Subalpine communities are found only on the islands of Hawai'i and Maui. Mainly located above the inversion layer, these communities are predominantly dry habitats, but subalpine mesic and wet habitats are found on East Maui and a subalpine mesic habitat is found on Mauna Loa, Hawai‘i. Dominant plants include māmane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), and ‘ōhi‘a (*Metrosideros polymorpha*) trees, ‘ōhelo (*Vaccinium* spp.) and pūkiawe (*Styphelia tameiameiae*) shrubs, and *Deschampsia nubigena* grass. Notable native species present include the palila (*Loxioides bailleui*), other endemic forest birds, ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]), ‘akē‘akē (*Oceanodroma castro* [band-rumped storm petrel]), nēnē (Hawaiian goose), and terrestrial invertebrates. Introduced ungulates, including mouflon sheep (*Ovis musimon*), pigs (*Sus scrofa*), goats (*Capra hircus*), sheep (*Ovis aries*), and cattle (*Bos taurus*), are the primary threat to these communities, browsing the native vegetation and spreading invasive plant species.

Montane wet communities

Montane wet communities occur on the islands of Kaua‘i, O‘ahu, Maui, Moloka‘i, and Hawai‘i. A diverse variety of montane wet communities exist, including bogs, densely vegetated shrublands and forests, cliff faces, and steep valley walls. These communities typically exhibit a richer understory development than montane dry or mesic systems. Important native plants include the ferns hāpu‘u (*Cibotium* spp.) and ‘ama‘u (*Sadleria* spp.), sedges (*Carex* spp.), *Oreobolus furcatus* (found in many bogs), and the ‘ōhi‘a tree. Notable native wildlife species include critically endangered forest birds such as the puaiohi (*Myadestes palmeri*) and po‘ouli (*Melamprosops phaeosoma*), Hawaii’s only land mammal, the ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* [Hawaiian hoary bat]), pueo (*Asio flammeus sandwichensis* [Hawaiian short-eared owl]), ‘io (*Buteo solitarius* [Hawaiian hawk]), and terrestrial invertebrates including *Megalagrion* spp. damselflies. Montane bog communities are particularly vulnerable to rooting pigs, and feral pigs contribute to the spread of habitat-modifying invasive plants such as strawberry guava (*Psidium cattleianum*) and kāhili ginger (*Hedychium gardnerianum*) in montane wet forest. Logging and then conversion to pastureland has also resulted in the loss of montane wet forest.

Montane mesic communities

Montane mesic communities occur on the islands of Kaua‘i, Maui and Hawai‘i. ‘Ōhi‘a, koa, olopua (*Nestegis sandwicensis*), and a‘e (*Sapindus saponaria*) are dominant trees, and the understory is composed of diverse trees, shrubs, sedges, and ferns. Notable native species include forest birds, ‘ōpe‘ape‘a, pueo, ‘io, and terrestrial invertebrates. Conversion to pastureland, the spread of introduced grasses, browsing by feral goats, sheep, and pigs, fires, and clearing for commercial tree planting have contributed to the loss and degradation of this habitat.

Montane dry communities

Montane dry communities are found on the leeward slopes of East Maui and of Hualālai, Mauna Loa, and Mauna Kea on Hawai‘i. Substrates are typically cinder or ash or weathered lava flows. Dominant plants include ‘ōhi‘a, ‘a‘ali‘i (*Dodonaea viscosa*), lovegrass (*Eragrostis atropioides*) and pili grass (*Panicum tenuifolium*). Notable native wildlife include terrestrial invertebrates, pueo, the ‘ōpe‘ape‘a (Hawaiian hoary bat), and forest birds. The primary threats to these communities are invasive plants, particularly fountain grass (*Pennisetum setaceum*), and grazing by feral ungulates, including goats, sheep, and mouflon.

Lowland wet communities
Lowland wet communities are generally found on the windward side of every island except Niʻihau and Kahoʻolawe. Dominant plants include ʻōhiʻa and koa trees, mamaki (*Pipturus albidus*) and uluhe (*Dicranopteris linearis*) shrubs, and hāpuʻu ferns are an important component of the native understory. Notable native wildlife includes terrestrial invertebrates, waterbirds, migratory shorebirds and waterfowl, pueo, ʻio, and the ʻōpeʻapeʻa. Threats include the establishment and spread of invasive plants, especially kāhili ginger and strawberry guava and degradation of the understory by feral pigs.

Lowland mesic communities
Lowland mesic communities are found on every island except Kahoʻolawe. Most lowland mesic communities have been converted to agricultural or ranching use or lost due to logging, and the remaining native communities are threatened by a number of invasive plant species, including guava (*Psidium guajava*), strawberry guava, molasses grass (*Melinis minutiflora*), firetree (*Morella faya*), Christmas berry (*Schinus terebinthifolius*), silk oak (*Grevillea robusta*), *Eucalyptus* spp., and beardgrasses (*Andropogon virginicus* and *Schizachyrium condensatum*). Wildfires, feral ungulates and introduced game animals, particularly goats, pigs, and axis deer, also contribute to the degradation of these communities. In the remaining lowland mesic communities, dominant plants include kāwelu (*Eragrostis variabilis*), pūkiawe, ʻaʻaliʻi, and ʻūlei (*Osteomeles anthyllidifolia*) shrubs, and koa, ʻōhiʻa, and lama (*Diospyros sandwicensis*) trees. Notable native wildlife species include waterbirds, migratory shorebirds and waterfowl, ʻōpeʻapeʻa, and terrestrial invertebrates.

Lowland dry communities
Lowland dry communities occur on the leeward sides of all eight of the Main Hawaiian Islands (MHI), as well as the windward side of Hawaiʻi in the Puna and Kaʻū districts. Dominant vegetation includes ʻōhiʻa, lama, olopua, and wiliwili (*Erythrina sandwicensis*) trees, ʻaʻaliʻi shrubs, and pili grass. Notable native wildlife includes terrestrial invertebrates, waterbirds, migratory shorebirds and waterfowl, and forest bird species which have apparently developed immunity to avian malaria and pox. Most lowland dry communities have been converted to urban and residential use or degraded by fire, grazing, and invasive plants, especially fountain grass, beardgrass, and natal redtop (*Rhynchelytrum repens*). These invasive plants now dominate some lowland dry areas and constitute a major fire threat.

Coastal communities
Coastal systems are communities subject to marine influences and include dry, mesic and wet communities. In addition, this habitat includes anchialine ponds, which are areas where fresh and saltwater mix through underground connections. These communities are found on coral atolls and island remnants in the NWHI, along coastlines of the major islands in the MHI, and on the many offshore islands in the MHI. Naupaka kahakai (*Scaevola sericea*) is an important native shrub throughout the coastal system. Notable

native wildlife includes seabirds, terrestrial invertebrates, migratory shorebirds, and marine animals that use the coastal area for basking and nesting, such as the Hawaiian monk seal (*Monachus schauinslandi*) and honu (green sea turtle). Primary threats include conversion to residential development, introduction of invasive plants (e.g., mangrove (*Bruguiera gymnorrhiza* and *Rhizophora mangle*), pickleweed (*Batis maritime*), and ironwood (*Casuarina equisetifolia*)), off-road vehicle activity, and arson.

Subterranean systems

Some of Hawaii's most unique native invertebrates are associated with lava tube and cave ecosystems. These habitats can be found from higher elevations down to the coast throughout the MHI. Cave ecosystems are divided into five distinct zones (entrance, twilight, transition, dark, and stagnant air zones) with each characterized by different vegetation and animals. Primary threats include loss of native vegetation above caves (roots provide food sources for species), degradation of habitat by human visitation and trampling as well as by non-native species (particularly non-native invertebrates), and habitat loss through development.

Aquatic Habitats

Aquatic habitats ecologically link together most of the terrestrial habitats. Over geologic time, the flow of water and wind have carved the topography of the mountains and valleys creating microhabitats in which many plants and animals have evolved and adapted. The flow of water that rains down on the high mountaintops transports nutrients, organic matter (energy), and water down through the various forested and shrubland habitats into estuaries and wetlands at low elevations and then finally into the sea. This organic energy from dead plants and animals fertilizes the growth of other plants and animals in lower elevation habitats, while the streams and groundwater flow play an important role in providing water for plants and animals throughout the ecosystem. Many of Hawaii's native freshwater aquatic animals migrate between the ocean, estuaries, and upper reaches of streams as part of their life cycle.

Streams

Small streams usually join together to form larger and larger streams and rivers until finally the largest stream in a system enters the ocean. A map of the smaller streams that are interconnected with the single bigger stream usually looks like the branches on a tree. This interconnected network of streams and the adjacent land areas share much of the same nutrients, energy, and water and often becomes the home area of populations of living things. This network and the habitat it encloses is called a watershed, similar to the traditional Hawaiian land division of the *ahupua'a*. Activities or threats that affect one part of this interconnected system will affect some other part or the whole of the system. Thus, to effectively protect watersheds, often the entire *ahupua'a* must receive adequate protection.

Hawaiian streams, or sections of streams, are either perennial or intermittent. Perennial streams flow year round; however, some flow continuously, discharging into the ocean, while others are interrupted, discharging into the ocean only seasonally. Perennial streams are important to most of Hawaii's freshwater fauna, because these species depend on the ocean for part of their larval life stage and would not survive without this connection to the sea. Perennial streams are habitat to all of Hawaii's freshwater fauna including five native stream fishes or ʻoʻopu, invertebrates including mollusks and shrimps, algae, and mosses. Intermittent streams, or sections of streams, flow only seasonally, typically with high rainfalls, when these streams may reach the ocean. These streams may have water in their upper sections year-round, while their lower sections are dry. Although some recent studies suggest that viable populations of stream animals can survive in intermittent streams, intermittent stream fauna primarily consists of oligochaete worms, several crustaceans, and algae.

The biology and ecology of stream systems also are defined by the "order" of a stream. First order streams are the smallest initial streams at the highest altitudes in an *ahupuaʻa*. They are often in the steepest gradient areas and have the coolest waters with least amounts of nutrients and energy. Many freshwater species cannot inhabit the upper parts of these streams in Hawaiʻi because of these limiting factors. Some native fishes, however, are highly evolved at climbing waterfalls. Second order streams are stream sections downstream from the junction of two first order streams and so on down to third or fourth order stream sections. Hawaiʻi does not have many streams higher than fourth order because of the steep terrain and short distance to the sea. Lower order streams in flatter areas have more nutrients and energy in them and are bigger and easier to inhabit for stream fishes and invertebrates. These areas also have the highest number of threats from sedimentation caused by grazing animals at higher elevations, nearby development, water diversions and dams, channelizing or concreting of the stream bottom and sides, and introduced gamefish. Streams in disturbed areas also do not typically have native vegetation along their banks, reducing shade, nutrient inputs from decaying plant matter, and shelter provided by tree roots. In some streams, non-native vegetation adjacent to streams provides excessive shading and nutrient input, leading to declines in native aquatic organisms. These threats are often most acute in the middle sections of streams as the areas nearest the ocean receive greater protection through zoning and coastal zone management requirements.

Estuaries

As streams near the ocean, the streambed often becomes dominated by finer grain sediments as salty seawater intrudes with the tides. The area where seawater from the ocean mixes with freshwater is an estuary. Estuaries in Hawaiʻi typically have a unique group of species that can tolerate the variable conditions and the large amount of sediments and sand in the water and on the bottom. Too much sediment, however, can be harmful even here. In addition, many marine animals also can inhabit these areas where the salinity is not too low, so the overall diversity of species is higher. Many of the same threats occurring in the middle sections of streams such as sedimentation, development, and invasive species occur in estuaries as well, though coastal zone regulations provide some degree of protection. Since estuaries are often calmer areas of water, boat harbors and other sources of human disturbance are often concentrated in these areas.

Sandy Bottom

The amount of sediment moving into the open ocean largely determines the presence of various types of marine habitats in Hawaiʻi. Too much sediment limits the presence of corals, so coral reefs can only occur away from estuaries. Instead of coral reefs, these areas close to estuaries are dominated by various sandy bottomed habitats that are rich in animals that live in the sand, like many worms or shelled animals, and in fishes like rays and flatfishes that feed in soft sediment.

Coral Reefs

Coral reefs develop in most of the rest of the shallow water fringe around the high islands. This results in the formation of "fringing reefs" that have coral growth near the surface of the water, very close to shore, with limited shallow water lagoons inshore of the reef. Reefs in areas with relatively recent lava flows, such as on the island of Hawai'i, have poorly developed fringing reefs. Kāne'ohe Bay on O'ahu and a small area of Kaua'i also have "barrier reefs," where the development of coral occurs further offshore. There is a more extensive shallow water lagoon inshore of the barrier reef that has a higher degree of development of what are called patch reefs, or small sections of coral interspersed in sandy habitat in waters of one to ten or 20 meters (three to 65 feet) deep. Many of the low islands in the Northwestern Hawaiian Islands are "atoll reefs." These reefs are the tops of drowned and submerged volcanic peaks that result in a ring of coral that can be many miles in circumference. They may or may not surround a small sandy island or islands somewhere inside a very extensive lagoon that also usually contains numerous patch reefs. Kure Atoll and Pearl and Hermes Reef are classic examples of atoll reefs. Coral reefs are threatened by human impacts, invasive species, disease and global climate change.

Bathypelagic, Mesopelagic, and Pelagic

Because the MHI are the tops of steep volcanic peaks, waters off these islands become very deep very quickly so that even within the three mile (five kilometer) boundary of State waters, the water is thousands of meters or feet deep. In this bathypelagic or deep zone, the waters are cold and dark, with many unusual fishes and invertebrates about which little is known. In the mesopelagic or middle realm (waters of only around 100 to 300 meters (330 to 1,000 feet) depth), there is some small amount of light and the species that occur here are often different from both the shallower and deeper species. Many species in this zone are important food sources for marine mammals in Hawai'i. The pelagic or nearshore waters on the surface above these deep water areas are home to some of the most desirable gamefishes including ono, mahimahi, 'ahi (tunas), and marlins, which increases the importance of this habitat. Offshore aquaculture is a potential new threat to these areas.

Additional Marine Habitats

Tidepools and rocky beaches provide important habitat for many of Hawaii's invertebrate species and larvae of many fishes. Desirable species including 'opihi (limpets) and some shelled invertebrates occur here. Some species are adapted to the strong wave action in these areas. Seagrass beds provide foraging areas for sea turtles as well as habitat for endemic invertebrates. Beaches are essential nesting grounds for sea turtles as well as areas where monk seals haul out, give birth, and protect and feed young. Threats to these habitats include direct and indirect human impacts due to proximity to the coast.

All of the marine ecosystems can be affected by pollution or other activities originating onshore so the conservation management of the terrestrial habitats has relevance to the health of the marine systems. Additional information on marine habitats is found in Chapter 5.

NATIVE TAXA

Because of the extreme isolation and distance, relatively few life forms successfully colonized the Hawaiian Archipelago over its 70 million year history. Those species that did, however, found habitats that varied enormously over very short distances. As a result, the archipelago displays some of the world's premier examples of evolution, with the creation of countless new lineages of plants and animals through natural selection and adaptive radiation. Rates of endemism (i.e., percent of species found nowhere else on earth) are typically 99 to 100 percent for terrestrial insects, spiders, and land snails, 90 percent for plants, more than 80 percent for breeding birds, and 15 to 20 percent for aquatic fauna.

Although thousands of Hawaiian species have yet to be described, the estimated number of indigenous species is thought to include more than 14,000 terrestrial, 100 freshwater, and 6,500 marine taxa. Among these are an estimated 10,000 species found nowhere else on the planet, and extreme examples of rapid evolution are found among Hawaii's birds (especially passerines), insects, spiders, land snails, plants, and fishes. The Hawaiian honeycreepers (family: Fringillidae) are often cited as a dramatic example of this process, with at least 40 species having evolved from a single common ancestor. This group of birds diversified to fill niches often occupied by separate families on continental environments and at first glance, bear little resemblance to one another.

Equally impressive radiations are seen in many other taxa. For example among the cosmopolitan family of drosophilid flies, there are nearly 500 described Hawaiian species, as well as hundreds of undescribed species, all of which evolved from perhaps two colonists. Many other explosive radiations are found among terrestrial arthropod groups: more than 400 species of *Hyposmocoma* moths, 180 species of *Sierola* wasps, and 177 species of *Proterhinus* beetles.

This rapid evolution produced many species with unusual characteristics or life-histories, including two dozen flightless birds (now extinct), mintless mints, flightless flies, stinkless stink bugs, blind big-eyed spiders, carnivorous caterpillars, diadromous fish that scale 300-meter (1,000-foot) waterfalls, and nectarivorous birds with bills superbly adapted to the corollas of particular flowering plant species.

Beginning with the arrival of Polynesians to Hawai'i around 1,600 years ago, and accelerating with the arrival of Westerners following Captain Cook's European discovery of the islands in the 1780s, humans have taken a dramatic toll on the biota of the Hawaiian Islands. With humans came the wholesale destruction of native habitats for agriculture, aquaculture, and development, and the introduction of perhaps thousands of alien species. The effects of these novel pressures on the native biota of the islands resulted in rapid declines and extinctions among hundreds if not thousands of native species. Some species were exterminated by Polynesians for food, especially species such as flightless birds which would have been relatively easy to capture. Some species were lost because of degradation or destruction of their unique habitats. Others persisted in more remote areas only to be weakened or overcome by non-native predators such as cats (*Felis silvestris*), rats (*Rattus* spp.), and mongooses (*Herpestes auropunctatus*). Native forest birds were virtually eliminated from lowland areas by the night-biting mosquito following its introduction in 1826. The mosquito spread avian malaria and avian poxvirus, diseases for which the native birds had no natural resistance.

As a result of the widespread and rapid changes brought by humans, an estimated half of the native bird species have been lost to extinction. Numbers among other taxa are far higher, including 90 percent of the native land snails, and thousands more terrestrial insects and spiders that were forever lost long prior to being described. The known extinctions alone in Hawaiʻi represent 75 percent of the recorded extinctions of plants and animals in the United States. Today, Hawaiʻi has the highest number of threatened and endangered species in the United States, accounting for more than 30 percent of the federally listed taxa. The decline in native species is also mirrored by the loss of native habitat, with less than 40 percent of the land surface covered with native-dominated vegetation today.

Of this great diversity, the following species or taxa are covered in the Comprehensive Wildlife Conservation Strategy (CWCS) as Species of Greatest Conservation Need (SGCN): one terrestrial mammal, 77 birds, over 5,000 known terrestrial invertebrates, over 500 plants, six species of endemic terrestrial algae, 12 freshwater invertebrates, five freshwater fishes, 24 species of endemic freshwater algae, 20 anchialine-pond associated fauna, 26 marine mammals, six marine reptiles, 154 marine fishes, 197 marine invertebrates, and 79 species of endemic marine plants or algae. A brief discussion of each species group is presented below, with more specific information presented in Chapter 7 (Species of Greatest Conservation Need).

Terrestrial Mammal
The ʻōpeʻapeʻa (Hawaiian hoary bat) is the only land mammal native to the Hawaiian archipelago and is an endemic subspecies of a bat found throughout North and South America. Historically, it is known from all of the MHI but Niʻihau. It is federally listed as endangered due to apparent population declines and a lack of information on its distribution, abundance, and habitat needs. Bats are affected by habitat loss, roost disturbance, and pesticides. The Hawaiian Bat Research Cooperative, a partnership composed of government agencies, non-profit organizations, and private landowners, was formed to prioritize and fund needed bat research.

Birds
The avifauna in Hawaiʻi are of national and global importance, as Hawaiʻi is home to the highest number of endemic forest birds in the United States and provides habitat for globally significant nesting populations of seabirds. Only about twenty bird species colonized Hawaiʻi. These represent just a few of the bird families known worldwide (19 out of 144). Most species are year-round residents, including forest birds, waterbirds, and two endemic seabirds, but many species of seabirds and migratory birds have breeding or wintering grounds in the State.

Forest birds
The ancestors of the forest passerines encountered different resource opportunities and limitations on different islands (e.g., foods and forest types). Because the distances between islands are formidable barriers to most small birds, inter-island isolation also

contributed to speciation and led to several island endemic species. As a result, within each of the five families of passerines found in Hawai‘i, there are related but distinct subspecies or species represented on different islands. Unfortunately, only one of five historic species of the family Corvidae is extant, and all members of the family Melephigidae are likely extinct.

There are only about 30 extant species of native Hawaiian forest birds--less than half the number known from historic and fossil records--and one third of those remaining are extremely rare or possibly extinct. More than half are endangered. A number of factors have contributed to this decline. Conversion of land from native forests to agricultural and other human use began with the arrival of Polynesians and accelerated with European contact. Remaining forests have been degraded by ungulates and invasive plant species. The introduction of the avian malaria virus and avian pox have proven catastrophic to Hawaii’s native bird species, especially the passerines. Rats, feral cats, and mongooses prey on bird nests, nestlings, and even on incubating adults. In addition, alien bird and arthropod species may compete with native forest birds for food or nest resources.

As a result of these changes, especially the introduction of mosquitoes, most remaining forest birds survive in montane mesic and wet native forests dominated by ‘ōhi‘a and koa or in subalpine forests dominated by māmane and co-dominated by māmane and naio where cooler temperatures limit mosquitoes. These include forests on Hawai‘i and Maui, as well as remnant forest patches at high elevations on Moloka‘i, Lāna‘i, O‘ahu and Kaua‘i. Thus, some species may be persisting in marginal habitats, further complicating their recovery. Critical conservation actions include protection of remaining native forest habitats from further degradation by ungulates and non-native plant species, control and eradication of introduced predators (primarily rodents and cats); captive propagation (‘alalā, puaiohi, ‘ākohekohe (*Palmeria dolei*), Maui parrotbill (*Pseudonestor xanthophrys*), Hawai‘i creeper (*Oreomystis mana*), Hawai‘i ‘ākepa (*Loxops coccineus coccineus*), ‘akiapōlā‘au (*Hemignathus munroi*), palila, ‘i‘iwi (*Vestiaria coccinea*), ‘amakihi (*Hemignathus virens*), and Hawai‘i ‘elepaio), and the prevention of the introduction of additional predators (e.g., snakes), disease (e.g., West Nile virus), or any other habitat-modifying plants or animals.

The Hawaiian Forest Bird Recovery Team, a cooperative effort involving multiple government agencies and non-profit organizations, guides forest bird conservation work, including the development of the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003) and five-year implementation plans for identified critical species, captive propagation, annual forest bird surveys, as well as other identified research and management projects.

Raptors

The ‘io (Hawaiian hawk) and the pueo (Hawaiian short-eared owl) are the only extant native raptors in Hawai‘i. The ‘io (Hawaiian hawk) is listed as endangered by both the USFWS and State and is restricted to the island of Hawai‘i. The pueo occurs on all the MHI and is listed by the State as endangered on O‘ahu only. Both birds are found from sea level to high elevations across most habitats. Primary threats include predation by introduced rodents and cats (particularly for the ground-nesting pueo) and habitat loss. Additional research on the distribution and abundance of these species as well as potential limiting factors (e.g., environmental contaminants and harassment by humans) is needed for both species.

Waterbirds
Six species of extant, endemic waterbirds occur in Hawai‘i: the Laysan duck (*Anas laysanensis*), nēnē (Hawaiian goose), koloa maoli (*Anas wyvilliana* [Hawaiian duck]), ‘alae ‘ula (*Gallinula chloropus sandvicensis* [Hawaiian moorhen]), ‘alae ke‘oke‘o (*Fulica alai* [Hawaiian coot]), and ae‘o (Hawaiian stilt). An additional indigenous species, ‘auku‘u (*Nycticorax nycticorax* [black-crowned night-heron]), is common throughout the MHI. All of the endemic species are listed as endangered by the USFWS and by the State. A Draft Revised Recovery Plan for the Laysan duck was published in 2004, a Revised Recovery Plan for the nēnē (Hawaiian goose) is currently in preparation, and a Draft Revised Recovery Plan covering the other four listed waterbird species was published in 1999. The ‘alae ke‘oke‘o (Hawaiian coot) and ae‘o (Hawaiian stilt) have been observed on every MHI except Kaho‘olawe, the distribution of the other three endemic waterbird species is more restricted within the MHI, and the Laysan duck is limited to Laysan island and Midway Atoll in the NWHI.

Three of the waterbird species (‘alae ‘ula (Hawaiian moorhen), ‘alae ke‘oke‘o (Hawaiian coot), and ae‘o (Hawaiian stilt)) inhabit wetland habitats including tidal flats and estuaries, playas and ephemeral basins, freshwater marshes, coastal ponds, taro patches, and human-constructed wetlands, such as irrigation ditches and sewage treatment ponds. The koloa maoli (Hawaiian duck) occurs in the above freshwater environments as well as montane streams and swamplands. Nēnē (Hawaiian goose) have been reintroduced to Kaua‘i, Maui, Hawai‘i, and Moloka‘i, where they can be found from sea level to 2,400 meters (7,900 feet) in elevation, predominantly in dry forest, shrubland, and grassland. The Laysan duck utilizes all available habitats with vegetation cover and fresh water, including upland vegetation, ephemeral wetlands, mudflats, and coastal areas. Historically found in the MHI as well as the NWHI, the Laysan duck was found only on Laysan island until last year when 20 birds were translocated to Midway Atoll.

The loss and degradation of wetland habitats negatively affects these species. Predation (primarily by feral cats, but also by mongooses and feral dogs (*Canis familiaris*)), hybridization between non-native mallards and the koloa maoli (Hawaiian duck), and disease also negatively affects these birds. Protecting and maintaining existing habitat, identifying and securing needed additional habitat, controlling or eradicating introduced predators, improving understanding of the use of non-breeding habitats (e.g., maintenance sites), captive propagation and reintroduction, and monitoring populations are priority conservation actions.

Seabirds
Forty different seabird species have been observed in the Hawaiian Islands, and at least 20 are known to breed in Hawai‘i. Two seabirds are endemic to Hawai‘i: ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]) and of the ‘a‘o (*Puffinus auricularis*

newelli [Newell's shearwater]). Many of these seabirds are of global or national importance: over 95 percent of the world's mōlī (*Phoebastria immutabilis* [Laysan albatross]) and ka'upu (*Phoebastria nigripes* [black-footed albatross]) populations nest in the Hawaiian Archipelago. Other seabirds of conservation concern include the 'akē'akē (band-rumped storm petrel), listed as endangered by the State, the short-tailed albatross (*Phoebastria albatrus*), listed as endangered by USFWS, and the Christmas shearwater (*Puffinus nativitatis*), the Tristram's storm petrel (*Oceanodroma tristrami*), and the blue-gray noddy (*Procelsterna cerulean*), identified as "high concern" in the U.S. Seabird Conservation Plan for the Pacific Region.

Historically, high densities of seabirds nested on all Hawaiian islands, but now most are restricted to the NWHI or to predator-free offshore islands within the MHI. A few birds, such as the 'ua'u (Hawaiian petrel) and 'a'o (Newell's shearwater), nest in high elevations or in inaccessible locations (e.g., sheer cliffs) in the MHI. Primary threats to seabirds while in Hawai'i include predation by feral cats, rodents, and mongooses, loss or degradation of habitat due to habitat-modifying invasive plants or animals, and human disturbance including coastal lighting. Threats at sea include fisheries bycatch and pollution (including oil spills). Needed conservation actions are protection of existing habitat, eradication of introduced predators (cats, rodents, and mongooses) from additional offshore islands and known breeding colonies, and additional surveys to locate additional breeding colonies and monitor population status and trends, particularly at sea.

Migratory shorebirds and waterfowl

Several species of migratory shorebirds and waterfowl winter in Hawai'i. Of these, the kōlea (*Pluvialis fulva* [Pacific golden plover]), the 'akekeke (*Arenaria interpres* [ruddy turnstone]), the 'ūlili (*Heteroscelus incanus* [wandering tattler]), and the kioea (*Numenius tahitiensis* [bristle-thighed curlew]) are regular migrants that have been identified as important (by the U.S. Shorebird Conservation Plan) because the populations in Hawai'i are hemispherically significant or relatively large. The habitats used by these migratory shorebirds and waterfowl generally overlap with those used by resident species, thus, protected wetland and coastal habitats often support both endemic waterbirds and migratory shorebirds and waterfowl. Primary threats to migratory shorebirds and waterfowl include loss or degradation of habitat and predation by feral cats and dogs. Protecting and maintaining existing habitat, identifying and securing needed additional habitat, controlling or eradicating introduced predators, improving understanding of the role of Hawaii's wintering habitats on global populations, and assessing population size and distributions are priority conservation actions.

Northwestern Hawaiian Islands passerines

Three species of passerines are found in the NWHI: the Laysan finch (*Telespiza cantans*), Nihoa finch (*Telespiza ultima*), and Nihoa millerbird (*Acrocephalus familiaris*). Found only on their respective named islands within the Hawaiian Islands National Wildlife Refuge in the NWHI, these three species are among the rarest birds in the world. Major threats include the introduction of habitat-modifying alien plants, the introduction of habitat-modifying or predaceous non-native animals, and environmental factors, including natural disaster, drought, and long-term climate change (e.g., sea level rise).

Priority conservation actions include maintaining the integrity of the islands' habitat by preventing and responding to non-native plant and animal introductions.

Terrestrial Invertebrates

Similar to native forest birds, Hawaii's native terrestrial invertebrates are characterized by high levels of endemism – over 90 percent of terrestrial invertebrates are found nowhere else on earth. Unique invertebrates include a carnivorous caterpillar, happy-face and no-eyed big-eyed spiders, and yellow-faced bees. Several invertebrates have been listed as endangered by the USFWS: Oʻahu tree snails of the genus *Achatinella*, the Kauaʻi cave wolf spider (*Adelocosa anops*), the Kauaʻi cave amphipod (*Spelaeorchestia koloana*), and the Blackburn's sphinx moth (*Manduca blackburni*), with Recovery Plans prepared for all four taxa and critical habitat designated for the sphinx moth and the Kauaʻi arthropods. Twelve species of *Drosophila* flies are currently proposed for listing as endangered, and two species of Lānaʻi tree snails (*Partulina* spp.), six species of *Megalagrion* damselflies, two species of *Drosophila* flies, one gall fly (*Phaeogramma* sp.), and the wekiu bug are candidates for listing by the USFWS. Many more native invertebrates are believed to be rare.

Native invertebrates play many critical roles in the ecosystem such as food for native birds and as pollinators for native plants. They can also be found in almost every habitat known throughout the Hawaiian Archipelago, including aeolian alpine summits, lava tube and lava cave systems, and strand and littoral habitats.

The main threats facing terrestrial invertebrates are loss and degradation of habitats, predation and competition by introduced species, and the loss of native host plants. The endemic koa tree is of particular importance as habitat for a wide range of native invertebrates, and extensive logging or the introduction of a pest or disease that attacks koa would have a significant impact on native invertebrate diversity. Further, funding to document new species or determine accurate populations or distributions of known species is insufficient; there are over 5,000 native terrestrial species currently known with new species discovered every year. Conservation actions needed for terrestrial invertebrates include improved information (e.g., species biology, population assessments, habitat needs and interactions), protection and restoration of native habitats, increased quarantine and inspection as well as assessment of pest-control and biocontrol measures to prevent further injurious alien introductions, establishment of long-term monitoring programs, and better education and outreach programs. In addition, research to gain a better understanding of the causes behind the decline in native ground-dwelling arthropods such as jumping bristletails, bees, and wasps is needed.

Plants and algae

Over 1,000 distinct flowering plant species evolved from approximately 295 successful flowering plant colonist species. In addition, Hawaiʻi supports over 150 recognized taxa of native ferns and fern allies. Total species richness is concentrated on older islands, primarily in mesic and wet habitats and at relatively low elevation (700 to 800 meters; 2,100 to 2,400 feet), as a function of evolutionary and ecological processes acting within the constraints of geologic history. Richness of endangered plant species is highest in mesic and dry habitats of the Waiʻanae mountains of Oʻahu, with somewhat high concentrations in the mesic habitats of western Kauaʻi and the wet habitats of the Koʻolau mountains on Oʻahu. Plant species that are naturally rare (those projected to have had a restricted range prior to human impact) are concentrated in the mesic habitats of the Waiʻanae mountains (Oʻahu), the Alakaʻi swamp region (Kauaʻi), and other wet summit regions (e.g., Koʻolau mountains, Oʻahu). Plant species that have suffered the greatest percentage of habitat loss are concentrated in very low elevation mesic habitats on Kauaʻi mesic to dry habitats in the Waiʻanae mountains (Oʻahu), very low elevation mesic habitats in the Koʻolau mountains (Oʻahu), and low elevation dry to mesic habitats on Molokaʻi, Maui and Lānaʻi. Critical habitat has been designated on every island in the MHI and on Nihoa, Necker, and Laysan in the NWHI for over 100 listed plants.

Feral ungulates, such as cattle, pigs, goats, deer (*Odocoileus hemionus* and *Axis axis*), and mouflon sheep, pose a major threat to native plants by consuming and trampling native understory plants, creating conditions favoring non-native plant infestation and establishment, preventing the establishment of ground-rooting native plants, and disrupting soil nutrient cycling. Introduced invertebrates and disease weaken and kill native plants and compete with native pollinators, and invasive habitat-modifying plants outcompete native plants within the habitat. Conservation actions needed include protection of existing native habitats from feral animals, invasive plant control and eradication, monitoring of populations, and additional research on methods to address the role of invertebrates and disease. Extremely rare plants require additional *ex situ* (off site) conservation actions (e.g., seed banking, *in vitro* propagation, and cryopreservation).

Hawaiʻi also has an endemic marine plant, the seagrass *Halophila hawaiiana*, which is host to an endemic snail. Threats to seagrass include limited habitat, as it occurs in discrete patches on sandy substrate off a few islands, limited sexual reproduction as male and female flowers occur on separate plants and male plants are seldom found, and nearshore disturbance (e.g., dredging or sedimentation).

Little is known about Hawaii's endemic algae and its role in the ecosystem, beyond the importance of marine algae as a food source for marine fishes, invertebrates, and green sea turtles. Over 100 species of endemic terrestrial, freshwater, and marine endemic algae have been identified.

Freshwater Species

Streams in Hawaiʻi have a relatively small number of native species. There are five native fishes or ʻoʻopu, that occur in freshwater streams and evolved from two families of marine fishes. These ʻoʻopu are mostly small herbivores or omnivores. There are twelve freshwater invertebrates of conservation need, including two omnivorous shrimps, at least eight species of herbivorous snails, one endemic worm species, and one endemic sponge species. Some of these invertebrates spend a brief part of their larval stage in the ocean before returning to the freshwater streams as juveniles. Threats include insufficient instream flow standards, stream diversions, dams, and channelizations, and sedimentation and pollution of streams. Needed actions include reversing or mitigating these destructive impacts and organizing management for stream animals along continuous stream corridors from the mountain to the ocean.

Anchialine-pond Fauna

Anchialine ponds are home to numerous animals. Eight species of anchialine shrimps are hypogeal, which means they live in subterranean aquatic habitats in the water that occurs in cracks and slits between rocks. Six of these species are candidates for listing under the Endangered Species Act. These shrimps can be found in anchialine ponds where the subterranean water system reaches the surface through natural or man-made connections and where the salinity of seawater intrudes to at least some degree. It is not clear whether anchialine ponds are necessary for the survival of any of the eight shrimp species, as one shrimp has also been found in the open ocean, and many species have been found in artificially created ponds, some many miles from the nearest naturally formed pond. However, the importance of the little-understood hypogeal system is clear, and the anchialine ponds may greatly increase the amount of energy in the hypogeal systems because of the access to photosynthetic organisms in the pools. Anchialine ponds are also home to eleven species of amphipods, two of which have also been found in the open ocean. Little is known about their biology or ecology. One snail species is also often commonly found in anchialine ponds and other estuarine habitats. Some *Megalagrion* damselflies are also found in anchialine ponds, but require vegetation that is often removed from the ponds. Many other marine species can be occasionally found in anchialine ponds. Threats to the ponds themselves include excessive use, filling in or alteration of ponds for alternate use or development, and the introduction of invasive predatory fishes and invertebrates. Needed conservation actions include better management of human access, protection of pond habitats, and development of effective methods to prevent and control invasive species.

Marine Species

Marine ecosystems in Hawai‘i support over 1,200 species of fishes, with around 500 species adapted to live on coral reefs, and the rest adapted to the open ocean waters, deep habitats, estuaries, or areas characterized by sandy bottoms. These fishes occupy a range of niches from herbivores to carnivores that specialize on microscopic plankton, seashells, crabs, shrimp, or other fishes. At the top of the food chain are the apex predators such as the many sharks of Hawai‘i. Over 5,000 marine invertebrates are known from Hawai‘i, including over 100 species of hard, soft and precious corals, as well as hundreds of types of seashells, crabs, and shrimps and small numbers of worms, jellyfish, sponges, starfish, and tunicates. Many commercially or recreationally fished species are protected by Fishery Management Plans developed under the U.S. Magnuson-Stevens Fishery Conservation and Management Act. Stony corals, black corals, seahorses, and some sharks are protected by the Convention on International Trade in Endangered Species (CITES) Appendix II.

A small number of marine reptiles occur in Hawai‘i. Two sea turtles are common residents here, and three others are more occasional visitors. All sea turtles are listed as threatened or endangered by the USFWS. The honu (green sea turtle) is an herbivore and the hawksbill sea turtle (*Eretmochelys imbricata*) specializes on eating sponges. Both lay eggs on Hawaii’s beaches. There are two species of sea snake reported from Hawaiian waters, although these are rarely seen.

About 26 species of marine mammals are resident or occasional visitors to Hawai‘i. All are protected by the Marine Mammal Protection Act. These include the popular spinner (*Stenella longirostris*) and bottlenose dolphins (*Tursiops truncatus*), resident year-round, and the migratory humpback whales (*Megaptera novaeangliae*) which spend a few months each year in Hawaiian waters to birth and breed. Humpback whales and the Hawaiian monk seal (*Monachus schauinslandi*) are the more commonly occurring marine mammals in Hawaiʻi that are listed as endangered under Federal and State law. Many of the resident whales and dolphins feed on fishes and squids that occur in the moderately deep waters off Hawaii's coasts.

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CHAPTER 4: STATEWIDE CONSERVATION NEEDS

Based on the overview provided in Chapter 3, Chapter 4 discusses the major threats affecting species statewide, followed by seven objectives and priority strategies to address the major threats outlined. The adoption of these seven objectives and priority strategies by the people and institutions of Hawai‘i will continue to build on the success stories and conservation achievements to ensure that a legacy of healthy biodiversity is left for future generations. This chapter addresses elements 3 and 4 at the statewide level.

OVERVIEW OF THREATS

CURRENT THREATS

The major threats to Hawaii's native wildlife are widespread and common to most species groups and habitats. Major threats include:

- Loss and degradation of habitat resulting from human development, alteration of hydrology, wildfire, invasive species, recreational overuse, natural disaster, climate change, and other factors;
- Introduced invasive species (e.g., habitat-modifiers, including weeds, ungulates, algae and corals, predators, competitors, disease carriers, and disease);
- Limited information and insufficient information management;
- Uneven compliance with existing conservation laws, rules and regulations;
- Overharvesting and excessive extractive use;
- Management constraints; and
- Inadequate funding.

Loss and Degradation of Habitat

Loss, fragmentation, and degradation of habitat have been primary contributors to extinction and rarity of native bird species and are suspected to play an important role in the decline of native invertebrate populations. Historically, logging, agriculture, grazing, military use, fire, and urban and residential development have claimed more than half of Hawaii's native habitats. At low elevations where development pressures are highest, less than ten percent of native vegetation remains. Alterations of streams, non-point source pollution, sedimentation, and storm water runoff have decreased, fragmented, or degraded freshwater habitats. Marine systems downstream are affected by changes in stream systems, especially by any increase in sediment load. Corals, in particular, are susceptible to both pollution and excessive sedimentation. Anchialine ponds are threatened by the filling and trampling of the ponds, and the photosynthetic organisms (algae) that form the base of their food chain are easily disturbed. For other sensitive areas such as subterranean systems or nearshore reefs, the increase in human visitation, particularly by tourists, cumulatively impacts habitat quality and is a growing cause for concern.

Populations of many species are limited by the amount of suitable habitat available. This results in multiple problems that increase the probability of future extinction. Because many of the Hawaiian plant and animals co-evolved with one another, extinction of one species could lead to cascading extinctions of other species. While the current land use zoning of the Conservation District limits further loss of forested habitat to development, this designation confers only the coarsest protection. Without active management, these lands remain threatened by invasive plants and animal species or require restoration to support native wildlife. In addition, zoning does not protect all of the remaining quality habitat from being converted to another land use.

Development and shoreline alterations

Many important wetland and coastal habitats are threatened by residential development. The limited amount of shoreline and the constant demand for beach-front housing has resulted in the division and conversion of formerly open coastal areas to homes and residential landscaping. The closure of sugar plantations resulted in the loss of irrigation ponds used by waterbirds, and many former fields are being subdivided for residential use. As housing demand increases, development constitutes a threat away from the coast as well in areas formerly considered "remote," such as Ka'ū. Shoreline alterations, including the building or expansion of harbors, seawalls, and other structures, damages marine habitats for corals and other species directly or indirectly by changing water flows or sediment deposition.

Alteration of hydrology

Alteration of hydrology, which includes watershed development, stream diversions, channelizations, and excessive water withdrawals that lower the aquifer, degrades or destroys habitat used by native fishes and invertebrates. Such activities indirectly affect terrestrial wildlife where these changes alter plant communities or the availability of drinking water. Insufficient instream flows with lack of set standards threaten many streams that have diversions or alterations. Inadequate zoning in riparian zones threatens aquatic ecosystems by allowing agriculture, grazing, or development to occur too close to streams.

Fire

Unlike many continental ecosystems, Hawaiian plants and animals are not adapted to periodic fires, most likely because of few natural ignition sources like lightning. Today, invasive plants have increased the fuel loads in some areas, and most fires are caused by human activities. Fires are more likely to occur on the dry leeward side of the islands, destroying existing habitat and providing invasive species with an opportunity to displace native vegetation.

Recreational Overuse and Tourism Effects

The cumulative impact of human interaction with native species and habitats is a growing concern. Most attention recently has centered on marine activities, and the potential for dolphin and whale watching and shark feeding tours to change the behavior of these species. Turtle feeding is another area where increased human-interactions may change behaviors. Excessive trampling of coral reefs, tidepools, and other shoreline areas by recreational users directly kill many marine organisms or indirectly kill their algal or invertebrate food sources. On land, recreational overuse is also an emerging concern. An increase in the popularity of guidebooks and Internet sites that reveal the locations of sensitive habitats to more people has increased visitation in these areas. Many sensitive habitats such as anchialine ponds, lava tube and cave systems, coral reefs, and offshore islands are compromised or outright destroyed by the presence of people. Off-road vehicles in coastal dune ecoystems degrade habitat for native plant communities and nesting seabirds.

Natural Disaster

Because many Hawaiian plant and animal species persist in low numbers or in restricted ranges, natural disasters, such as hurricanes, volcanic eruptions, or tsunamis can be particularly devastating. For example, several species of forest birds endemic to Kaua‘i suffered significant declines in population or have not been seen since Hurricanes Iwa (1982) and Iniki (1992) and volcanic eruptions from Mauna Loa on the island of Hawai‘i in 1984 destroyed quality habitat for island endemic forest birds.

Climate Change

Global climate change is anticipated to have multiple and disastrous effects on Hawaiian wildlife. First, sea level rise will inundate the Northwestern Hawaiian Islands (NWHI), reducing habitat for nesting seabirds, monk seals, and sea turtles, and alter coastal habitats throughout Hawai‘i. Second, temperature increases will allow avian disease pathogens and vectors to expand their ranges to higher elevations, areas which currently support the last remaining populations of many forest bird species. Third, Hawai‘i could experience increased frequency of El Nino/Southern Oscillation (ENSO) events, meaning more drought periods that could impact both wildlife and habitat. ENSOs may have implications for marine wildlife as well. Fourth, increases in ocean temperatures could impact invertebrate and fish populations, which would in turn impact seabird populations. Increases in seawater temperature also contributes to the phenomenon of coral bleaching, in which corals temporarily or permanently lose their symbiotic algae, potentially resulting in the death of the corals. Although Hawai‘i was spared the reef bleaching events of the 1980s and 1990s, some bleaching in the NWHI has recently been documented. Increased carbon dioxide has caused the acidity of the ocean to increase, making it more difficult for corals and mollusks to form skeletons and shells. Finally, increased ultraviolet radiation could also harm native wildlife. Many of the above mentioned impacts are known or currently anticipated effects of global climate change; additional impacts that are not currently anticipated or understood may also occur.

Introduced Invasive Species

Due to their evolutionary history and high levels of endemism, Hawaii’s native plants and animals are particularly susceptible to the threats posed by the introduction and spread of introduced invasive species and pathogens. Invasive species are species whose introduction does or is likely to cause environmental or economic harm or harm to human health. Virtually no native habitat is free from the threat of introduced (also called “non-native,” “alien,” or “exotic”) species, and most native habitats experience some negative effects related to non-native species. Non-native species may outcompete native species or may directly harm native species through predation or infection. Non-native species may also threaten native species through interbreeding and hybridization, leading to the loss of the native species as a unique species. No other region of the United States has experienced a similar invasion of non-native competitors, predators, habitat-modifiers, vectors of infectious disease, and pathogens.

No longer isolated, Hawai‘i is highly vulnerable to human-assisted alien introductions due to its role as a central military, trade, and tourist hub. The establishment of non-native species is facilitated by Hawaii’s benign climate, year-round growing season, the range of habitats, and the number of “open niches.” Before human arrival, the estimated rate of successful new colonizations was one species every 25,000 years. Over the last two centuries alone, the rate of plant introductions alone has been more than 40 species per year. It is estimated that over 6,000 introduced terrestrial and aquatic species are now established, and that of all the species currently in Hawai‘i, approximately 26 to 30 percent are non-native. While many introductions do not pose a threat to native habitats, approximately ten percent of the established non-native species are highly invasive or pose significant threats to Hawaiian ecosystems.

In addition to the already established introduced species, numerous species currently not found on the islands are poised to invade island ecosystems. Over a nine-month period, a Pest Risk Assessment conducted at Kahului Airport by the State Department of Agriculture discovered over 100 alien species entering via air cargo. Because the establishment of additional invasive species poses such a risk to Hawaii’s native wildlife, ecosystem, economy, and public health, preventive measures have been established for a few identified threats, such as the brown treesnake (*Boiga irregularis*) and West Nile virus. Many other potential introduced species, such as the red-imported fire ant, Africanized honey bee, biting flies, marine organisms, and “lethal yellows” (palm disease) pose such high risk of damage that similar preventive planning is needed, but prevention is expensive and requires continual vigilance. Finally, the rise of the genetically modified organisms (GMO) industry in Hawai‘i is an emerging issue as the impacts of GMOs to native flora and fauna, such as through inter-species transfer of genes, is under research.

Habitat Modifiers: Invasive Plants and Ungulate Grazers and Browsers

One of the major threats to Hawaii's native species and forests is the uncontrolled spread of many invasive non-native plants. These plants displace Hawaii's distinctive native flora, resulting in a loss of species diversity and eventually in more pronounced and permanent changes to ecosystem function such as alteration of primary productivity and nutrient cycling. Many invasive species completely replace native vegetation resulting in total loss of native habitats. Invasive plants such as fire-adapted fountain grass (*Pennisetum setaceum*) and orchard grass (*Dactylis glomerata*) provide fuels for fires and often increase in abundance after fires. A short list of invasive plant species that pose a significant threat to native plant communities and require aggressive management include miconia (*Miconia calvescens*), firetree (*Morella faya*), fountain grass (*Pennisetum setaceum*), banana poka (*Passiflora tarminiana*), blackberry (*Rubus argutus*), mangrove (*Bruguiera gymnorrhiza* and *Rhizophora mangle*), strawberry guava (*Psidium cattleianum*), and golden crown-beard (*Verbesina encelioides*); there are many other invasive plants that degrade and destroy native habitat. Because the seeds of many invasive plants persist for years, eradication is exceedingly difficult after the plant is established and control requires an ongoing effort to prevent further spread. However, control operations are expensive; for example, the current expenditures to control miconia on Maui alone are $1 million dollars a year.

Established ungulates (hooved animals) are another major threat to native habitat. Ungulates in Hawaiʻi include pigs (*Sus scrofa*), goats (*Capra hircus*), sheep (*Ovis aries*), mouflon sheep (*Ovis musimon*), deer (*Odocoileus hemionus* and *Axis axis*), and to a lesser extent, feral cattle (*Bos taurus*). Ungulates directly and indirectly affect native ecosystems in a variety of ways. These effects include damaging vegetation by grazing and browsing, trampling seedlings and aquatic invertebrates, spreading non-native plant seeds, disturbing soil, and increasing erosion. These activities can affect the amount of light and moisture levels within forests, as well as nutrient cycling, and result in modified or destroyed plant and animal communities, decreased water retention of soils, erosion, and decreased water quality. In addition, pigs have been observed destroying the nests of ground-nesting birds (e.g., nēnē) and have been linked to the spread of mosquito-borne avian disease (i.e., pig wallows creating mosquito breeding habitat).

Because Hawaiian plants only recently have been exposed to the effects of grazing, they lack common defenses such as thorns or toxins. Thus, grazing and browsing animals often prefer native plants over non-native plants. Grazing and browsing can result in the extirpation of native plant populations, but even low intensity browsing can affect the species composition of habitats and encourage a shift in dominance from native towards non-native species. Non-ungulate herbivores, such as rabbits (*Oryctolagus cuniculus*), can have the same impact.

Soil disturbance by rooting animals (typically pigs) occurs throughout Hawaiʻi and favors the germination and establishment of alien plant species, many of which are adapted to such disturbances and may require disturbance to complete their life cycle. Conversely, native species are not adapted to such disturbances and tend to be negatively affected. This in turn affects the composition of plant communities, which indirectly affects the animals that depend on the community; effects on native invertebrates may be particularly acute. Removal of ungulates is often the first step in ecosystem restoration and usually results in the recovery of native habitat, as well as the decline of particular alien plants.

The distribution of ungulates varies across the landscape. Subalpine communities have been and continue to be affected by feral goats, mouflon sheep, and feral pigs. Montane and lowland mesic forests on Kauaʻi and Maui are impacted by the spread of axis deer. Dryland forests have suffered greatly because of cattle and goats. Feral pigs typically affect wetter communities, and their effects are widespread throughout the islands. Control of animal populations is difficult and expensive, given high rates of reproduction and the ability of these animals to hide.

Invasive algae species have become a threat in recent years. These organisms can outcompete and overgrow native algae species and kill corals, altering the structure of local coral reef communities. Nearshore eutrophication (water pollution caused by excessive nutrients that stimulate excessive plant growth) from non-point source pollution or leaking cesspools and sewage systems may contribute to the explosive growth of these algae. Leeward areas of Maui and areas in Kāneʻohe Bay, Oʻahu and Waikīkī, Oʻahu have experienced algal blooms or have growing invasive algae populations. Another marine invasive, snowflake coral (*Carijoa* sp.), outcompetes and overgrows native coral species, possibly including the precious black corals found in deeper waters off Maui.

Introduced Predators

Hawaiian terrestrial animals evolved in the total absence of mammalian predators and are extremely vulnerable to predation by these introduced species, especially rats (*Rattus* spp.) and feral cats (*Felis silvestris*), and to a lesser extent, mongooses (*Herpestes auropunctatus*). All of these species prey on eggs, nestlings, and adult birds, limiting populations. Rats have been implicated in the decline in native bird populations in the early 1900s. Rats are ubiquitous throughout Hawaiian habitat and while rats are commonly known to prey on seabirds, waterbirds, and forest birds, even climbing into trees to prey upon canopy-nesting species, they are also known predators of native tree snails and other native invertebrates. Rats also eat the seeds of a large number of native plant species, limiting their regeneration. Feral cats are extremely skilled predators and have been responsible for the extinction of birds on other islands. In Hawai‘i, cats are widely distributed and are found throughout bird habitat on all of the Main Hawaiian Islands (MHI) from sea level to high elevation. While a single cat can have a devastating effect on a breeding seabird colony, “cat colonies” pose an even greater threat to bird populations because of their concentrated sheer numbers. Although less arboreal than rats, mongooses are efficient predators. With few rare exceptions, populations of nēnē (Hawaiian goose), waterbirds, and seabirds do not persist long in areas where mongooses are present. Presently, high densities of feral cats, rodents, and mongooses are a major cause of mortality among native birds and may place similar pressures on native terrestrial invertebrates. In general, Hawaiian bird species have low reproduction rates, so increased predation can be particularly problematic.

Other predators that pose ongoing threats to native bird species include feral and unleashed dogs (*Canis familiaris*), cattle egrets (*Bubulcus ibis*), barn owls (*Tyto alba*), frogs, and pigs. Fortunately, snakes have yet to become established in the islands. Given that the brown treesnake (*Boiga irregularis*) effectively caused the extinction of Guam’s avifauna, it is expected that the successful establishment of predatory snakes in Hawai‘i would have equally devastating consequences.

Introduced fishes have been documented to prey on native freshwater fishes and invertebrates, while introduced frogs, such as the coqui, prey on aquatic and terrestrial invertebrates. Anchialine ponds are threatened by introduced fishes and shrimps that prey on the native shrimp and alter the habitat structure. Over the last 200 years, introductions of invertebrates, including ants, snails, and wasps, have been extensive throughout the archipelago. Many of these species prey on or parasitize native invertebrates. Biologists have long suspected that these introductions caused declines in native insects and snails and had indirect community-level effects. Scientists in the last century, for example, noted extensive declines in native moths after introductions of predatory arthropods. These declines were followed by declines in native birds that preyed on the native moths. More recently, studies have documented the effects of introduced ants and vespid wasps on native arthropod fauna and on nesting birds; for example, introduced ants have been documented killing nestlings.

Disease carriers, Disease, and Pathogens

The introduction of mosquitoes (*Culex quinquefasciatus*) to the Hawaiian Islands in 1826 had a profound effect on native forest birds and continues to affect the distribution and abundance of many bird species. By serving as vectors for avian malaria (*Plasmodium relictum*) and avian poxvirus (*Poxvirus avium*), mosquitoes effectively spread these diseases throughout lowland areas. Many species of introduced birds now present in Hawai‘i may provide effective reservoirs for these diseases, allowing them to persist and spread widely. For Hawaiian birds that had evolved in the absence of these diseases for millions of years, the impacts were severe. Over the next 150 years, many bird species became extinct. Today, most of the remaining native forest birds persist at elevations above 1,600 meters (5,000 feet), where few mosquitoes can survive.

In recent years, a few species have begun to recolonize lower elevations where avian malaria and poxvirus are common, indicating that at least some species may have developed resistance to these diseases. However, global warming could enable transmission of poxvirus and malaria to higher elevations, threatening remaining populations of endangered birds. New vectors of such diseases are also of concern. On the island of Hawai‘i, the recent establishment of *Aedes japonicus*, the State’s first truly temperate mosquito, may extend the range of mosquito-borne disease into currently mosquito-free high elevation forests.

Other diseases impact native wildlife; for example, avian botulism is the most prevalent disease in Hawai‘i for native waterbirds and the introduction of West Nile virus could have even more devastating impacts. Threat by disease is not limited to terrestrial fauna, however. Recent work has shown that many species of corals have diseases that, in some cases, are on the increase and may be caused by introduced species. Honu (*Chelonia mydas agassizi* [green sea turtles]) in most areas suffer from fibropappiloma, which may also be caused by an introduced disease. With little natural resistance to disease, the Hawaiian fauna is expected to be highly susceptible, and prevention of the establishment of new diseases is a top priority need.

Limited Information and Insufficient Information Management

Resource managers must typically make decisions based on incomplete data and information. Data on the effects of different threats to native species is often lacking, as is information on the effects of different management techniques or actions on natural resources. Management decisions based on inadequate data can result in a misallocation of extremely limited conservation dollars.

For example, Hawaii’s forest birds have been systematically surveyed for the past 25 years, yet current information on population size or distribution in certain areas remains poorly known for some species. Limited funds restrict surveys mainly to currently managed lands and may not accurately reflect a population’s full distribution or abundance. Accurate population estimates for many Hawaiian waterbirds, seabirds, fishes, and for most non-threatened or endangered invertebrate populations are not available. Large numbers of native invertebrates have not even been described, making assessment of their populations and consideration of the consequences of proposed management actions problematic at best.

Huge gaps in knowledge exist for many native species. Population censuses cannot provide data on basic demographic parameters or determine threats to specific species. Such information is often necessary to direct management, especially for those species persisting at low populations. For example, for many Hawaiian forest birds, virtually nothing is known about their reproductive behavior, demography, survival, or dispersal tendencies.

Gaps in information are often magnified by the challenges inherent in sharing information across institutions. Multiple agencies and organizations in Hawai‘i collect and manage data on a variety of species and habitats. This information is often collected in different formats and for different purposes. There are no comprehensive computerized spreadsheets or databases that list even the names of all known Hawaiian species. Building on existing efforts to centralize information storage in a spatial database could better identify data gaps, provide a more comprehensive view of the status of a particular species or habitat, and allow management decisions to be made using the most up-to-date and accurate information.

Uneven compliance with existing conservation laws, rules and regulations

Uneven compliance with existing conservation laws stems from two sources: limited capacity for enforcement and lack of respect for the value of protecting native wildlife. Limited funding restricts the State’s capacity to enforce existing laws, rules, and regulations protecting native wildlife and habitat. The Department of Land and Natural Resources Division of Conservation and Resource Enforcement is understaffed and underfunded. At the same time, the Division is tasked with additional duties beyond resource conservation (e.g., participation in marijuana eradications and in Homeland Security actions). Consequently, public perception is that the State is not able to effectively respond to or enforce laws relating to the conservation of Hawaii’s natural resources, such as regulations prohibiting fishing in a certain area. As a result, voluntary compliance with conservation laws and regulations decreases as the public sees few consequences for violations. Poaching of native wildlife and other non-compliance with conservation laws, rules, and regulations is a direct threat to native wildlife and their habitat.

The success of voluntary compliance depends heavily on local community involvement. Peer pressure is one form of this involvement. In addition, community based education and management give the local community an understanding of the importance and values of native wildlife and their habitat and a sense of pride and ownership that encourage voluntary compliance. In many locations, this level of community involvement is absent.

Overharvesting and Excessive Extractive Use

Bottomfishes, as defined by the Federal government to include the ulua (*Caranx* spp.) as well as ‘ōpakapaka (*Pristipomoides filamentosus*), onaga (*Etelis coruscans*), and hāpu‘u (*Epinephelus quernus*), have been declared in a state of “overfishing,” a technical and legal condition in which there is too much fishing effort that will soon lead to a critical drop in the populations of these fishes. As a result, fisheries managers have one year under Federal law to determine how to reduce fishing effort to return these bottomfishes to a healthy state. Other fishes in the State also may be in a state of overfishing, but solid data is lacking to make these technical determinations.

Excessive extractive use constitutes a threat to other wildlife as well. Certain reef fishes are harvested for sale in the aquarium trade. Freshwater and marine fishes and invertebrates are collected for subsistence, recreation, and commercial purposes. Native plants and snails that may be important food sources or habitat for native birds and invertebrates are illegally collected for lei making, flower arrangements, jewelry, or herbal use. Logging of native koa (*Acacia koa*), ‘ōhi‘a (*Metrosideros polymorpha*), and hāpu‘u tree ferns (*Cibotium* spp.) removes important components of a native forest. These activities are not sustainable on a large scale and impact native wildlife.

Management Constraints

While more than 31 percent of the land in Hawai‘i has been set aside for protection by the State or Federal government or is managed as part of a watershed partnership, these lands are subjected to differing levels of conservation or management effort. Regardless of their jurisdiction and management goals, land managers face similar constraints, such as multiple use mandates, insufficient funds for day-to-day management, infrastructural challenges, regulatory hurdles, high numbers of visitors, and increasing demands for public access.

The Department of Land and Natural Resources (DLNR), the State agency charged with managing the State’s lands and waters, has multiple management responsibilities. For example, DLNR is charged with documenting and preventing illegal activities on public lands, conducting auctions to lease public lands, protecting and recovering indigenous wildlife and their habitats, preserving natural areas and protecting watershed resources, promoting public hunting, establishing and regulating public fishing areas, harvesting forest products, providing public lands for agricultural purposes, and generating revenue from the lease of State lands. While generally consistent, these multiple uses may not always facilitate strategic native wildlife conservation objectives. For example, a State lease for pasture use may degrade remnant native habitat or public hunting rules may not adequately control ungulate populations to meet the management needs for forest bird recovery and native plant protection. Efforts to identify inconsistencies in management guidelines and policies can be delayed by a lack of resources (technical, human, and financial) and the lack of effective working relationships with different resource user groups to jointly identify areas for dedicated conservation and areas for multiple use.

DLNR also is limited by infrastructural challenges; for example, the difficulty in filling existing vacant positions on a timely basis and the near impossibility of adding personnel to coordinate new conservation actions is a significant constraint on management. Procurement rules and contracting procedures can delay the State’s ability to coordinate and carry out needed conservation actions. Other governmental agencies and non-governmental organizations face similar infrastructural challenges.

Unclear or lengthy regulatory processes constitute another management constraint. Research, response and control of invasive non-native species (particularly animal species) is delayed by the existing regulatory process. Current State and Federal regulations require more review and approvals of techniques to control invasive non-native species than are required before introduction of the non-native species into the State. As a result, non-native plants and animals too often gain entry and become established because similar burdens of proof and screening requirements are not placed upon key industries, such as shipping and horticulture. Other management actions such as invasive plant species removal or ungulate-proof fence construction can trigger State permitting and environmental review processes. Finally, at least 117 Hawaiian species qualify for listing as threatened or endangered by USFWS, however most are not likely to receive additional regulatory protection in the near future due to understaffing and political considerations.

Inadequate funding
Limited funding to implement identified priority management actions to protect or restore wildlife and their habitats on Federal, State and private lands, to hire staff to coordinate these projects, or to conduct research and monitoring is a significant constraint on effective wildlife conservation in Hawai‘i. This is complicated by grant programs that have varying eligibility requirements (such as private land ownership or former farm land). These factors contribute to "opportunistic" conservation on a piecemeal basis based on funding availability, rather than addressing needs in order of biological priority.

The largest landowner of important habitat for native plants and animals is the State of Hawai‘i. However, as discussed earlier in Chapter 3, the amount of State funds dedicated to conservation of native wildlife and their habitats is conservatively estimated at $23 million dollars annually, while annual funding requirements estimated for the recovery of forest birds alone is four times this amount. Although much of the State funding is matched by Federal funds (e.g., Endangered Species Act Section 6 grants and State Wildlife Grant funds) to increase the overall conservation budget, it still is inadequate to address the wildlife conservation needs in Hawai‘i, let alone effectively prevent the introduction of new invasive species. Moreover, limited State funding can prevent the State from meeting match requirements needed to receive Federal funds that may become available to states for conservation management in the future.

STATEWIDE CONSERVATION OBJECTIVES

The goal of this CWCS is to guide conservation efforts across the State to ensure protection of Hawaii's Species of Greatest Conservation Need and the diverse habitats that support them. Given limited conservation dollars, management of habitats to benefit multiple species is the focus of the CWCS. Hawaii's CWCS development process sought to identify major threats affecting native wildlife and their habitat throughout the State and then defined major objectives and strategies to respond to these threats and improve native wildlife conditions. The following seven objectives have been identified as elements necessary for the long-term conservation of Hawaii's native wildlife:

1) *Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive;*

2) *Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication;*

3) *Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs;*

4) *Strengthen existing and create new partnerships and cooperative efforts;*

5) *Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai'i;*

6) *Support policy changes aimed at improving and protecting native species and habitats;*

7) *Enhance funding opportunities to implement needed conservation actions.*

Implementation of these seven objectives will allow resource managers and landowners to address the major conservation needs of Hawaii's native wildlife. The objectives relating to the protection and restoration of habitats and the prevention and control of introduced species address many of the most direct biological threats to native wildlife. The other objectives address somewhat more indirect needs arising from a lack of information, the need for improved coordination of efforts and funding, and management constraints. Because ecological problems are complex, there is overlap among these objectives. For example, much of habitat protection in the State involves invasive species control; more effective invasive species control requires more aggressive policies, cooperation among landowners, and public support. This overlap underscores the necessity for a landscape-level, multiple-species approach to conservation of Hawaii's wildlife. These seven objectives address the overall goal and the legislative mandate of the CWCS. Future assessment of their effectiveness as conservation tools is discussed in Chapter 8 (Monitoring, Implementation, and Adaptive Management).

Under each objective are listed specific strategies that encompass multiple direct conservation actions that must be applied in areas currently managed for wildlife conservation and in potential areas for future conservation management. All of the strategies are high priorities; however, those that are the highest priority are identified. Additional conservation strategies and actions are identified in Chapters 5 (Marine Conservation Needs), 6 (Island Conservation Needs), and 7 (Species of Greatest Conservation Need).

1. Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.

Protection of the remaining native ecosystems and restoration of additional native habitats are necessary to conserve Hawaii's native wildlife for future generations.

<u>Highest Priority</u>

- Adequately support the implementation of conservation management plans, guidelines, and actions within currently managed areas (e.g., National Parks, National Wildlife Refuges, National Marine Sanctuaries, Natural Area Reserves, Natural Area Partnership Preserves, Forest Reserves, Watershed Partnership areas, Marine Protected Areas,

landowner preserves, and other areas committed to native habitat and species conservation);
- For habitats on private land not currently protected and/or receiving management attention (e.g., middle reaches of stream corridors or coastal areas), encourage protection using appropriate tools, including acquisition, grant agreements, conservation easements, leases, technical assistance, development of safe harbor agreements or habitat conservation plans, and other tools;
- Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations.

<u>High Priority</u>
- Remove introduced mammals (e.g., goats, pigs, deer, mouflon, rats, feral cats, mongooses) from important habitats to establish ungulate and predator free areas on each island;
- Develop recovery and management plans where needed to guide management, including short-term implementation plans, for species, species groups, or habitats;
- Implement effective habitat management through a variety of activities: landscape-level predator management; invasive plant control, fencing and ungulate removal, predator control, wetland enhancement, riparian restoration, native species outplanting, fire threat mitigation, and management of human activity in sensitive areas;
- Support the development and implementation of statewide programmatic Safe Harbor Agreements;
- Decrease in number of stream diversions and channelized streams;
- Review the status of all Marine Managed Areas (MMAs) and consider altering boundaries or adding new MMAs;
- Develop a handbook on restoration specific to Hawai‘i;
- Support development of an expanded CWCS that more fully integrates plants and algae;
- Develop plans to respond to natural disasters and climate change.

2. Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
Invasive alien species have the capacity to degrade and destroy remaining native habitat and eliminate native species. Continual monitoring and responsive management is needed to prevent the establishment of invasive plants, algae, marine invertebrates, predators, parasites and pathogens in priority areas and to control or remove invasive plant and animal species from areas managed for natural resources protection. Prevention and rapid response to novel threats is critical to preventing the establishment of new threats into the State.

<u>Highest priority</u>
- Increase inspection and implement other “prevention” measures to identify and prevent high-risk invasive species and diseases (e.g., brown treesnake, West Nile virus) from entry into the State or between islands. This must include implementation of appropriate measures for the pet, poultry, agriculture, aquaculture, and horticulture industries, for domestic and international mail and shipments, especially from Asia, for military transport, and for the tourism industry.

High priority

- Continue coordination of invasive species prevention, management, and control programs for county, State, Federal, and private sector entities through existing mechanisms, including the Hawai‘i Invasive Species Council, the Coordinating Group on Alien Pest Species, individual island invasive species committees, the Aquatic Invasive Species Management Plan, and topic-specific working groups (e.g., the West Nile Virus Prevention Group and the Brown Treesnake Rapid Response Team);
- Review and revise existing screening procedures for the introduction of non-native plants and animals to move from a prohibition on specific listed taxa to a general prohibition on introduction except for identified taxa;
- Strengthen quarantine and treatment of imported plants, especially known vectors for non-native invertebrates (e.g., Christmas trees);
- Provide adequate funding for effective statewide early detection and rapid response to new introductions of invasive species;
- Control already established priority invasive plants, such as fountain grass, miconia, kāhili ginger, Australian tree fern, mangrove, and others, to prevent the spread into pristine habitats;
- Decrease the number of invasive species or the total area of invasive species coverage in aquatic and marine ecosystems;
- Continue research on effective management methods and tools (e.g., control methods for introduced vertebrates (e.g., mongooses, rats, cats, mallards), invertebrates (e.g., *Vespula* spp., wasps, ants, and carnivorous snails [*Euglandina rosea*]), and for introduced predatory fish;
- Support a coordinated statewide invasive species public outreach program with shared resources and responsibilities among cooperating entities;
- Continue to support research on biocontrol (including prescreening to limit unintentional secondary impacts) as one method that addresses priority invasive species.

3. Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.

Existing knowledge on the statewide distribution, abundance, population trends, and limiting factors of native wildlife is inadequate for all species. Similarly, detailed information on vegetation structure and composition is lacking for many native habitats. Funding to adequately maintain and analyze data is frequently insufficient. Addressing these shortfalls in monitoring, research, and information management is critical if resource managers and landowners are to take effective steps to conserve native wildlife.

Highest priority

- Identify priorities for research and monitoring to document distribution, abundance, population trends, limiting factors, demography, and behavior of native species in order to guide conservation management and recovery programs.

High priority

- Establish and implement information collection and data sharing protocols through interagency cooperative efforts, building upon existing resources such as the Hawai‘i

Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program), the Pacific Basin Information Node, the Western Pacific Fisheries Information Network, the Coral Reef Information System, the Bishop Museum Hawaiʻi Biological Survey, and the HI-GAP and Hawaiʻi Marine GAP projects;
- Development and linkage of existing databases to create a central repository for use by resource managers containing biological information on native species and habitats and corresponding management-relevant information;
- Complete HI-GAP and Marine GAP analyses and integrate into the decision-making processes of Federal, State, and local agencies, non-governmental organizations, and private landowners that manage significant tracts of land in the State;
- Develop a stream GAP analysis program that quantifies stream habitats and organisms and adjacent land uses and management;
- Develop standards for data collection for projects funded by conservation grants, through partnership and collaboration among funding agencies, to facilitate monitoring of progress and success across landscapes and across funding programs.

4. Strengthen existing and create new partnerships and cooperative efforts.
Several species of Hawaii's native wildlife owe their continued existence to formal and informal partnerships among natural resource agencies, military agencies, other Federal, State, and county agencies, non-governmental organizations, academic researchers, private landowners, community organizations, and individuals. From watershed partnerships covering thousands of acres of land to single-species working groups, these cooperative efforts are valuable ways to share information, coordinate management actions, and pool resources for the benefit of Hawaii's native wildlife.

<u>Highest priority</u>
- Expand and strengthen existing partnerships (e.g., by increasing communication, formalizing partnerships, or adding new partners).

<u>High priority</u>
- Establish new partnerships with private landowners, non-traditional partners, and with community groups to share information and facilitate implementation of identified conservation actions;
- Increase the scope of community involvement in local conservation efforts by identifying areas for community based management (e.g., West Hawaiʻi Regional Fisheries Management Council);
- Maintain the partnership between government agencies and the University of Hawaiʻi (e.g., through the Pacific Cooperative Studies Unit or the Hawaii-Pacific Islands Cooperative Ecosystems Studies Unit) to implement many on-the-ground conservation and research projects;
- Explore areas of common ground and future collaboration with agricultural industries and research facilities (e.g., University of Hawaiʻi College of Tropical Agriculture and Human Resources);
- Collaborate with the Federal government to implement coordinated protections for marine species in a marine protected area in the NWHI and resolve fishing issues there;

- Enhance partnerships with Federal enforcement agencies including the U.S. Marine Corps, U.S. Coast Guard, and NOAA Office for Law Enforcement;
- Coordinate with inter-state agencies and stakeholders in the U.S. Pacific Islands (Commonwealth of Northern Mariana Islands, Guam, American Samoa) and with Alaska to develop and support population goals for migratory shorebirds and seabirds;
- Improve coordination among and within funding agencies to strategically select projects for funding based on their contribution to overall native species and habitat conservation needs;
- Support and emphasize voluntary and incentive-based programs for native wildlife and habitat conservation on private lands.

5. Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai'i.

Comprehensive education, outreach, and information services programs contribute to a sense of responsibility for native wildlife conservation among the public and help to ensure voluntary compliance with conservation rules, regulations, and laws. Public support is critical to successful conservation management as well as to the continued protection of all of Hawaii's natural resources. Education and outreach is vital to providing residents and visitors with the information needed to take action to protect Hawaii's native wildlife for future generations.

Highest priority

- Increase public understanding of native wildlife by developing and implementing a strategic and comprehensive conservation education program (particularly for Hawaii's lesser known species) that would include public awareness campaigns and working with potential partners (e.g., Department of Education and non-governmental organizations).

High priority

- Secure permanent dedicated funding for native wildlife conservation education and outreach;
- Provide lawmakers and citizens with the information necessary to effectively legislate and provide funding for the conservation of native species and their habitats;
- Encourage public participation and stewardship by expanding volunteer opportunities to contribute to native wildlife conservation, including invasive species control and participation in monitoring;
- Continue support for the Youth Conservation Corps, the Hawaiian Internship Program, and other youth programs, recognizing the value of these programs in teaching students about conservation in Hawai'i;
- Build upon existing efforts to develop conservation management curricula for kindergarten through twelfth grade, compatible with current statewide educational requirements, and conduct training for teachers on how to use curricula in the classroom;
- Encourage and support business sector-led initiatives to incorporate native wildlife considerations into their business models, with a focus on agriculture, forestry, horticulture, aquaculture, fisheries, and tourism industries;
- Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas;

- Collaborate to increase compliance with existing laws through outreach and educational programs and support for increased enforcement capacity.

6. Support policy changes aimed at improving and protecting native species and habitats.
Adequate protection of native wildlife may require changes to existing policies. The changes range from enforcing existing rules that have a direct impact on the overall state of Hawaii's native wildlife to developing new policies to address emerging threats.

<u>Highest priority</u>

- Increase conservation enforcement efforts on all State-owned land and waters through increased funding for trained enforcement officers;
- Collaborate with the Department of Agriculture on needed policy changes to prevent the introduction of non-native plant and animal species by air or water and to prevent spread of non-native species instate and beyond Hawaii's borders;
- Evaluate current management of State lands and waters and identify priority areas for changes in current use (e.g., unencumbered State lands of conservation quality or restoration potential).

<u>High priority</u>

- Review and evaluate existing State policies and Administrative Rules for gaps in protection;
- Review and revise existing rules and regulations dealing with extractive uses of aquatic animals, plants, and terrestrial snails;
- Review and revise existing DOFAW management guidelines regarding game management to ensure consistency with existing management plans and recovery plans and to reflect native species and habitat conservation needs;
- Support development and implementation of a comprehensive coastal policy;
- Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
- Identify species, particularly invertebrates, in need of additional protection and evaluate for inclusion on the State threatened and endangered species list;
- Collaborate with the Office of Conservation and Coastal Lands to update Conservation District rules to encourage conservation management activities while ensuring continued protection of Conservation District;
- Administer and award State Wildlife Grant funds through a joint partnership of DOFAW and DAR;
- Explore opportunities to streamline the EPA label process for new control methods for invasive species;
- Identify constraints on research and management actions to control non-native pests in remote field operations and develop appropriate policies to minimize response time delay.

7. Enhance funding opportunities to implement needed conservation actions.
Without sufficient, sustained, and long-term funding, the actions outlined in this CWCS cannot be implemented for the benefit of native species and their habitats.

Highest priority

- Develop new sources of funding to support and expand conservation management in the State, particularly on State lands and waters.

High priority

- Organize an interagency and stakeholder task force to examine and implement market-based conservation funding solutions, including review of recreational gear taxes, visitor taxes, airport landing fees, new or expanded license or user fees, and targeted tax breaks for conservation activities;
- Explore cooperative opportunities to accomplish needed conservation actions with existing funding, such as by training Transportation Security Administration inspectors to recognize priority invasive species;
- Support lobbying efforts to increase Federal funds to states and to change the formula used to allocate Federal funds to reflect the conservation realities of each State;
- Secure additional funding dedicated to recovery priorities for listed species.

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CHAPTER 5: MARINE CONSERVATION NEEDS

Due to the large number and the varied geology of the islands, Hawai‘i has diverse marine habitats, which range from estuaries, tidepools, sandy beaches, and seagrass beds to nearshore deep waters, extensive fringing and atoll reef systems, and smaller barrier reef systems. However, introduced mangroves have altered native habitat in a number of places. Because of Hawaii's geographical isolation, many of its coastal and marine species are endemic. Approximately 15 to 20 percent of the marine species are endemic, one of the largest proportions of marine endemism for any island chain in the world. Yet because of the isolation, Hawai‘i has relatively low marine species richness, with approximately 580 different shallow reef fish in contrast to areas of the Pacific further west with thousands of species. In total though, Hawai‘i still has over 6,000 marine species.

The distribution of marine ecosystems in Hawai‘i is a result of island age, reef growth, water depth, exposure to wave action, geography, and latitude. The marine habitats found on each island depend on the type of island: large and young, mature, or drowned islands. Large and young islands such as the island of Hawai‘i have recent lava flows and few, living structural coral reefs. Beaches are rocky except around bays, and drowned reefs may be found in deep waters or off parts of the east coast of Maui. Mature islands, such as O‘ahu and Kaua‘i in the Main Hawaiian Islands (MHI) and Nihoa and Necker in the Northwestern Hawaiian Islands (NWHI) are the most diverse, with habitat types ranging from estuaries and sandy beaches to rocky beaches and fringing and barrier reefs to lagoons with patch or pinnacle reefs. Drowned islands, such as atolls in the rest of the NWHI, are the remains of volcanic islands with habitats ranging from coral islets and benches to caves and terraces along the slope of the atoll.

OVERVIEW

Geology

The Hawaiian Archipelago consists of eight large islands and approximately 124 small islands. Many smaller sandy islands in the northwest are intermittent, depending on storms, waves, and currents for their existence and are now threatened by climate change and associated rising sea levels. The MHI are high islands, meaning they are mountainous with rocky headlands, narrow coastal plains, and ringed by beaches or rocky coastline. These high islands are often surrounded by fringing coral reefs with barrier-like reefs off small sections of the coast of O‘ahu and Kaua‘i. The NWHI are low islands, worn down by subsidence and erosion. They remain only as rings of reef that encircle a lagoon. Although the State of Hawai‘i is forty-ninth in size, it has approximately 1,336 kilometers (830 miles) of coastline, giving it the fourth highest length of coastline among all the coastal states in the United States. Coastline length for each of the islands is as follows: Hawai‘i 428 kilometers (266 miles), Maui 193 kilometers (120 miles), Kaho‘olawe 47 kilometers (29 miles), Lāna‘i 76 kilometers (47 miles), Moloka‘i 142 kilometers (88 miles), O‘ahu 180 kilometers (112 miles), Kaua‘i 145 kilometers (90 miles), Ni‘ihau 72 kilometers (45 miles), and NWHI 50 kilometers (30 miles).

Climate and Oceanography

The waters surrounding Hawai‘i are affected by seasonal variations in climate and ocean circulation. The surface temperature of the oceans around Hawai‘i follow a north-south gradient and range from 24 ˚C (75 ˚F) in the MHI to 20 ˚C (68 ˚F) to 22 ˚C (72 ˚F) in the NWHI in winter and spring to 26 ˚C (79 ˚F) to 27 ˚C (81 ˚F) throughout all the islands in the late summer and fall. The depth of the thermocline, where water temperature reaches ten degrees Celsius (50 ˚F), is 450 meters (1,500 feet) northwest of the islands and 300 meters (1,000 feet) off the island of Hawai‘i. Surface currents generally move east to west and increase in strength moving southward. The seas are rougher between islands than in the open ocean, because wind and water are funneled through the channels. Waves are larger in the winter months than in the spring and are generally bigger on the northern shores of the islands than the southern shores. Marine organisms have adapted to these general climatological and oceanographic conditions.

Land and Water Use

Most waters and submerged land from the shore out to at least three miles (five kilometers) are technically owned by the State with some authority exercised by the Federal government. Offshore waters out to 12 to 200 miles (19 to 322 kilometers) are regulated by a variety of Federal agencies. The Hawai‘i Department of Land and Natural Resources (DLNR) Division of Conservation and Resource Enforcement is responsible for enforcing many of the State's marine laws while Federal enforcement authority is granted to the U. S. Coast Guard, the U. S. Navy, the U. S. Marines, and the National Oceanic and Atmospheric Administration (NOAA) Office for Law Enforcement. The DLNR Division of Boating and Ocean Recreation regulates boating and commercial tourism activity.

Management authority for the nearshore marine waters is the responsibility of a variety of State and Federal agencies including the Hawai‘i DLNR, the Hawai‘i Department of Transportation (DOT), the Hawai‘i Department of Health (DOH), NOAA's National Marine Sanctuaries Program, U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and the U. S. Military. Much of the water surrounding Maui County and smaller areas off Kīlauea Point National Wildlife Refuge on Kaua‘i, parts of the north and southeast coast of O‘ahu, and the northwest coast of the island of Hawai‘i are protected as a part of the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). The Hawaiian Islands National Wildlife Refuge protects marine species generally out to ten fathoms (18 meters) of depth off the NWHI. The USFWS helps manage hawksbill sea turtle nesting off the Keālia Pond National Wildlife Refuge (NWR) on Maui. The NPS manages marine habitats off Kalaupapa National Historic Park (NHP), Kaloko-Honokōhau NHP, and Hawai‘i Volcanoes National Park. The U.S. Navy is responsible for Pearl Harbor and waters near Kāne‘ohe Marine Corps Base on O‘ahu, the Pacific Missile Range Facility off Kaua‘i, and other smaller training areas. Waters under military jurisdiction provide de-facto protection of species and habitats, because public access is often restricted. The DLNR Division of Aquatic Resources (DAR) manages 11 Marine Life Conservation Districts, 19 Fish Management Areas, nine Fish Replenishment Areas, two Wildlife Sanctuaries, 18 Bottomfish restricted areas, and the South Kona ‘Ōpelu fishing area in addition to implementing general, statewide fishing regulations. The DLNR Division of Forestry and Wildlife (DOFAW) manages the waters of ‘Āhihi Kīna‘u Natural Area Reserve (NAR) on Maui. The Kaho‘olawe Island Reserve Commission manages waters from the shores of Kaho‘olawe out to two miles (three kilometers). The DOT-Harbors Division controls access to the ten commercial harbors in the State and numerous recreational harbors.

Human Landscape

Much of the State's economy is based on the island's coastal and marine resources. Tourism accounts for the majority of the State's economy, with a significant portion of the tourist activities associated with beaches and marine wildlife. Coastal development and land values have both increased with the growth in tourism. In 2002, the Coral Reef Initiative funded a study regarding the economic valuation of the coral reefs of Hawai'i, where the value of coral reefs to the Hawai'i economy was estimated to be $380 million dollars a year. Fishing also contributes to the State's economy and commercial landings increased greatly in the 1990s.

The military has a significant presence in Hawai'i with large Naval installations located on estuarine and coastal areas such as Pearl Harbor and Kāne'ohe Bay on O'ahu and the Pacific Missile Range Facility on the south shore of Kaua'i. Point source pollution in the marine environment originates from a variety of sites including: Pearl Harbor, Hickam Air Force Base, ten oil refineries and terminals, 25 power plants, 1,860 storm drain wells, and 100,000 cesspools. Discharges from cruise ships and tour boats are of current public concern. Hawaii's DOH lowered their permit standards for injection wells, contributing to nutrient increases and algal blooms in some areas. Non-point source pollution from the agricultural sector has decreased as agriculture has declined; however, domestic non-point source pollution has increased.

SPECIES AND HABITATS OF IMPORTANCE

All marine habitats in Hawai'i are considered important for conservation, because each habitat has characteristic fish and invertebrate assemblages unique to that habitat. The marine habitats that are represented in Hawai'i include: tidepools, rocky beaches, sandy beaches, estuaries where fresh and salt waters mix, seagrass beds, fringing reefs, barrier reefs, atolls, deep reefs, sand, pelagic (open near-surface water), mesopelagic (middle depths with some light and vertical migration of organisms living there), bathypelagic (deeper waters with no light), and deep bottom. A more detailed classification of habitats can be found in Maragos and Gulko (2002). Although outside the marine habitat, adjacent terrestrial habitats along the coast or within *ahupua'a* (watersheds) impact the ocean and play a large role in the health of marine habitats and species.

Appendices A and B provides information on the marine fauna and flora Species of Greatest Conservation Need (SGCN), with more specific taxa information found in Chapter 7. Marine species in Hawai'i include over 1,200 species of fishes, with around 500 species adapted to live on coral reefs, and the rest adapted to the pelagic open surface waters, mesopelagic or bathypelagic zones (middle or deep waters), estuaries, or sandy bottoms. At the top of the food chain are the apex predators such as the many sharks of Hawai'i. The SGCN list includes 154 marine fishes. Over 5,000 marine invertebrates are known from Hawai'i and include over 100 species of hard, soft, and precious corals as well as hundreds of types of snails, crabs, shrimps and small numbers of worms, jellyfish, sponges, starfish, and tunicates. One-hundred and ninety seven species of marine invertebrates are listed in the SGCN list. Six marine reptiles occur in Hawai'i. Two sea turtles are common residents that nest here and three others are more occasional visitors. All sea turtles are listed as threatened or endangered under the Endangered Species Act and are listed on the SGCN list. Approximately 26 species of marine mammals are resident or occasional visitors to Hawai'i. All are protected by the Marine Mammal Protection Act and are on the SGCN list. These include the migratory humpback whales or koholā (*Megaptera noveangliae*) that breed and give birth during the few months each year they spend in Hawaiian waters, as well as the popular spinner dolphins (*Stenella longirostris*) and bottlenose dolphins (*Tursiops truncatus*). Koholā (humpback whales) and Hawaiian monk seals (*Monachus schauinslandi*) are the only common marine mammals in Hawaiʻi listed as endangered by the USFWS. Many of the resident whales and dolphins feed on fishes and squids that occur in the moderately deep waters off Hawaii's coasts. There are 78 species of endemic marine algae, 24 species of endemic freshwater algae, and two aquatic plants on the flora SGCN list.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife and habitats are discussed in Chapter 4 (Statewide Conservation Needs) including a discussion on threats common to both the terrestrial and marine environment. Threats that are more acute or specific to the marine environment are listed below.

- Localized excessive extractive use: technical "overfishing" (i.e., too much fishing effort in the fishery) has been declared for bottomfishes by the Federal government. Data to meet technical determination of overfishing is lacking for most other species, but there are concerns about aquarium species, ʻopihi (limpets), uhu (parrotfishes), and other species. Extraction for research purposes may also lead to localized excessive extractive use;
- Fisheries bycatch, including reef fishes, sea turtles, Hawaiian monk seals (*M. schauinslandi*), other marine mammals, and seabirds caused by actively fished lay (gill) nets, ulua slide-bait fishing, and ghost nets, lines, and traps;
- Urbanization and coastal alteration including harbors, seawalls and other structures, land reclamation, and commercial and residential development too close to streams and beaches;
- Recreational overuse including trampling, anchor damage, watercraft disturbance, and SCUBA;
- Alien species including algae, fishes, and invertebrates as outlined in Hawaii's Aquatic Invasive Species Management Plan;
- Hull fouling of recreational boats and ballast water in commercial vessels that acts as a source of alien species;
- Pollution from upstream sources, as well as oil spills, nearshore sewage, cruise ship wastes, tour boat discharge, and other marine users;
- Sedimentation and eutrophication (water pollution due to too many nutrients) from upstream or coastal land use;
- Noise from boats, sonars, drilling, experiments such as the Acoustic Thermometry of Ocean Climate (ATOC) experiment, and other sources that may disturb or harm marine mammals and other wildlife;
- Light pollution from coastal developments can cause disorientation and fatality for both nesting sea birds (birds fall out of nests) and sea turtles (newly hatched turtles make their way toward light sources, often roadways, instead of to the ocean);
- Marine debris such as nets and plastics that can entangle and harm animals as well as be ingested by them;
- Dolphin and sea turtle watching that may alter species' behavior or habitat use. Shark watching in federal waters may alter gamefish or shark behavior and distribution;
- Feeding wildlife that may sicken or alter behavior of native wildlife;
- Offshore aquaculture that may harm marine organisms through entanglement, habitat loss, pollution, and escape of genetically modified organisms. Includes deep water

species that may be threatened by new Federal proposal to lease areas in U.S. territorial waters;
- Increased interactions with monk seals which are more abundant and now birth on all the MHI;
- Ship strikes that may kill or injure marine mammals or sea turtles;
- Ship groundings that can harm or destroy corals and can result in oil or toxic spills;
- Lack of enforcement of existing regulations and appropriate penalties for violations;
- Lack of adequate funding for conservation and research.

MARINE STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet below) and throughout Chapter 6 (Island Conservation Needs), additional strategies for marine species and habitats include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in 'Management Needs' section;
    - Develop and implement conservation programs for federally protected marine species in coordination with NOAA and USFWS;
    - Obtain and implement the plans of an Incidental Take Permit for sea turtles and monk seals;
    - Ensure marine noise, ocean-user disturbance, and fish feeding are adequately managed;
    - Review the status of all Marine Managed Areas (MMAs) and consider altering boundaries or adding new MMAs;
    - Develop access and monitoring plans for MMAs;
    - Expand current capability to respond to protected species strandings;
    - Increase efforts to remove marine debris in the MHI;
    - Support development of an expanded CWCS that fully integrates aquatic algae and plants;
    - Collaborate to better manage development and coastal alteration; oil, boat, and land-based sewage and pollution; light pollution; aquarium fish and invertebrate exports; offshore aquaculture; shark watching; and ship groundings and strikes.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Support implementation of Hawaii's Aquatic Invasive Species Management Plan and other identified actions;
    - Increase inspection and other "prevention" measures to prevent high-risk invasive species and diseases from entry into the State, or to islands where they are not currently found;
    - Implement rapid response teams to detect and eradicate invasive species;
    - Monitor for non-native marine algae and respond if detected;
    - Decrease the number of invasive species or the total area of invasive species coverage in aquatic and marine ecosystems;

    - Encourage compliance with upcoming ballast water regulations and support development of similar regulations for hull fouling;
    - Research and employ methods to mitigate threats from invasive species;
    - Support a coordinated statewide invasive species public outreach program with shared resources and responsibilities among cooperating entities.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Develop database of all aquatic species in order to track information on biology, ecology, threats, monitoring and conservation actions;
    - Continue the MHI RAMP (Research and Monitoring Program) cruise and other collaborations between NOAA and DAR to monitor windward MHI reefs;
    - Complete Marine Gap Analysis Program (GAP) analysis and integrate into decision-making process of Federal, State, and local agencies, and non-governmental organizations that manage Hawaii's waters;
    - Improve information sharing among agencies, non-governmental organizations, and academia through support of programs such as the Hawai‘i Marine GAP, the Western Pacific Fisheries Information Network, the Pacific Basin Information Node, and the Bishop Museum Hawai‘i Biological Survey;
    - Seek to expand funding for monitoring of other habitats (e.g., deep waters, sandy habitats, shallow water, and tidepools, etc.).
- Strengthen existing and create new partnerships and cooperative efforts.
    - Expand and strengthen existing partnerships and cooperative efforts by formalizing partnerships or by adding new partners;
    - Collaborate with the U.S. government to implement coordinated protections for marine species in a marine protected area in the NWHI and resolve fishing issues there;
    - Enhance partnerships with federal enforcement agencies including the U.S. Marine Corps, U.S. Coast Guard, and NOAA Office for Law Enforcement;
    - Support the Local Action Strategies projects in Honolua Bay, Maui; Kawela to Kapualei, Moloka‘i; and Hanalei Bay, Kaua‘i and other watershed management partnerships and groups that seek to decrease non-point source pollution;
    - Increase the scope of community involvement in local conservation efforts by consulting with *kupuna*;
    - Support community based management programs like the West Hawai‘i Regional Fisheries Management Council;
    - Collaborate with other land managers to utilize the *ahupua‘a* approach to better manage freshwater and marine systems in recognition of their connectedness;
    - Collaborate with DOH to protect other sensitive marine ecosystems by improving water quality;
    - Collaborate to decrease the number of coastal stations listed as impaired for water quality by DOH;
    - Continue and enhance partnership among DLNR, HIHWNMS, National Marine Fisheries Service (NMFS) Pacific Island Regional Office and Pacific Islands Fisheries Science Center for marine wildlife conservation.
- Expand and strengthen outreach and educational efforts to improve understanding of our native wildlife resources among the people of Hawai‘i.

    - Seek to expand current educational programs to provide the public a sense of individual stewardship responsibility through ocean user's workshops, newsletters, brochures, posters, school and community group visits, and public service announcements;
    - Include issues of incidental take of marine protected species in educational and outreach programs;
    - Encourage public participation and stewardship by expanding volunteer opportunities to contribute to native wildlife conservation;
    - Encourage and support business sector-led initiatives to effectively incorporate native wildlife considerations into their business models, with a focus on aquaculture, fisheries, and tourism industries;
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas;
    - Collaborate to increase compliance with existing laws through outreach and educational programs and support for increased enforcement capacity.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Increase the number of species protected in the HIHWNMS by collaborating with NOAA in the ongoing review process;
    - Review fishing regulations to insure they adequately protect game and non-game species;
    - Encourage regulation requiring permits for take of all marine species;
    - Encourage regulation for blanket extractive limits for non-game species extracted for research, recreation, and commerce purposes;
    - Improve management of lay (gill) nets in State waters;
    - Implement new or revised MMA rules and/or boundaries;
    - Collaborate to revise and implement policies on anchor damage and use, watercraft disturbance, recreational overuse, marine debris, use of biodiesel fuels, and boat pump-out stations;
    - Support development and implementation of a comprehensive coastal policy;
    - Increase conservation enforcement efforts on all State-owned waters through increased funding for trained enforcement officers;
    - Strengthen regulations for import and export of aquatic, non-native species that rely on the precautionary principal.
- Enhance funding opportunities to implement needed conservation actions.
    - Develop new sources of State funding to support and expand conservation management in State waters including identified management actions;
    - Support increased funding for enforcement.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section. Many apply to the entire marine ecosystem.

- The Ocean Resources Management Plan was developed by a multi-agency effort in order to guide management of ocean resources. There are plans to update it in the near future. (Hawai‘i Department of Business, Economic Development, and Tourism (DBEDT) 1991);

- The Western Pacific Fisheries Management Council has Fisheries Management Plans that guide fishing for Bottomfish and Seamount Fisheries; Precious Corals, Crustaceans, Coral Reef Ecosystems, and Pelagic species. Available at: www.wpcouncil.org;
- The Aquatic Invasive Species Management Plan of DAR addresses prevention and eradication of marine invasive species. Available at: http://www.hawaii.gov/dlnr/dar/pubs/ais_mgmt_plan_final.pdf;
- The Hawaiian Islands Humpback Whale National Marine Sanctuary has a five year management plan. Available at: http://www.hihwnms.nos.noaa.gov/planreview/hihw/sanctuaryrevised.html;
- The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve has an operations plan. Available at: http://www.hawaiireef.noaa.gov/documents/welcome.html;
- The Hawaiʻi Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program) initiated the Marine Gap Analysis Program (Marine GAP) for DAR. This program was originally established to identify key areas for protection based on a variety of variables such as biodiversity. Information available at: http://www.hinhp.org/mgap/;
- The Hawaii Biological Survey (HBS) is an ongoing natural history inventory of the Hawaiian Archipelago. It was created to locate, identify, and evaluate all native and non-native fauna and flora within the State, and to maintain the reference collections of that biota for a wide range of uses. It is managed by the Bishop Museum. Information and data available at: http://hbs.bishopmuseum.org/;
- The Western Pacific Fishery Information Network (WPacFIN) is a Federal and State partnership for collecting, processing, analyzing, sharing, and managing fisheries data from American island territories and states in the Western Pacific. Information and data available at: http://www.nmfs.hawaii.edu/wpacfin/;
- NOAA Coastwatch uses a variety of satellite remote sensing datasets in an effort to better monitor and analyze the central Pacific Ocean. Information and data available at: http://coastwatch.nmfs.hawaii.edu/;
- NOAA's Coral Reef Information System (CoRIS) is designed to be a single point of access to NOAA coral reef information and data products, especially those derived from NOAA's Coral Reef Conservation Program. Information and data available at: http://www.coris.noaa.gov/.

MANAGEMENT NEEDS

Current Management of Species and Habitats

Under Hawaiʻi Revised Statutes 190-1, all marine waters of the State are a "marine conservation area." Although this legislation provides no additional protection (beyond authorizing the establishment of MLCDs), it recognizes the importance of marine waters to the well-being of the State and provides DLNR with the authority to manage ocean resources. The following segment addresses the current management actions and future needs of key habitats of Hawaii's marine environment. The discussion of future management needs is highlighted within each current managed area.

Future activities regarding ocean management are being considered by all agencies with management authority over marine wildlife. Revisions to catch limits, areas, and methods are being considered by DAR. The entire system of State marine managed areas is also being reviewed to ensure consistency in designated use and purpose and to consider additions or modifications to current marine managed areas. The Hawaiian Islands National Wildlife Refuge in the NWHI is updating their management plan. Hawaii's DLNR is moving forward with plans to manage State waters in the NWHI as a Marine Refuge. The NWHI Coral Reef Ecosystem Reserve is being considered for conversion to a National Marine Sanctuary by NOAA that could include co-management with DLNR in State waters there. A bill in Congress proposes setting aside the entire NWHI area as a new form of federal managed area called a National Marine Refuge. Chapter 4 (Statewide Conservation Needs) and Chapter 6 (Island Conservation Needs) address upstream actions that affect coastal water and habitat quality.

***General Fishing Regulations*, DAR**

Species: Marine fishes and invertebrates including black corals.
Habitats: Marine ecosystems.
***Current Management*:** Limited take, gear, size, season, and area restrictions on some reef, bottom, and pelagic fishes, mollusks, crustaceans, and corals.
***Future needs*:** Reevaluate size limits to ensure species have sufficient reproductive potential to ensure species survival in Hawai'i. Review regulations dealing with non-game species, research, and other commercial uses.

***Fishing Regulations in Federal Waters,* Western Pacific Fishery Management Council and NOAA**

Species: Marine fishes and invertebrates including black and other precious corals.
Habitats: Marine ecosystems.
***Current Management*:** Limited take, gear, size, season, and area restrictions on some coral reef organisms, bottomfish, pelagic fishes, crustaceans, and precious corals as outlined in Fishery Management Plans for these groups.
***Future needs*:** Collaborate on management of fisheries in the NWHI; fully comply with Federal regulations and guidelines on developing and implementing Fishery Management Plans; establish workshop to evaluate management needs for precious corals; and respond to the declaration of bottomfish as being in a state of "overfishing."

***Hawaiian Islands Humpback Whale National Marine Sanctuary* (about 900,000 acres), Co-Managed by NOAA and DLNR**

***Species*:** Humpback whale.
Habitats: Marine ecosystems.
***Current Management*:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
***Future needs*:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

***Hawaiian Islands National Wildlife Refuge* (610,000 acres of marine habitat), USFWS**

Species: 18 seabirds, Hawaiian monk seals, green sea turtles or hōnu (*Chelonia mydas*), endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins, and other marine mammals.
Habitats: Marine and coastal ecosystems (please refer to Chapter 6 Northwestern Hawaiian Islands for more detail).
Current Management: Limited access, limited take, reef monitoring, and turtle monitoring; collaboration with other marine researchers; and research and education.
Future needs: Update management plan. Coordinate actions with the State and the Coral Reef Reserve or Sanctuary, and additional monitoring.

***NWHI Marine Refuge,* DAR <u>Proposed</u>**
Species: Hawaiian monk seals, green sea turtles, endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins and other marine mammals.
Habitats: Marine ecosystems.
Current Management: Limited access and take; no anchoring or any other activities that can damage coral; and no discharge from boats.
Future needs: Create refuge, develop and implement a management plan.

***NWHI Coral Reef Ecosystem Reserve*, NOAA**
Species: Hawaiian monk seals, green sea turtles, endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins and other marine mammals.
Habitats: Marine ecosystems.
Current Management: Operation plan in place. Limited access and take; no anchoring or any other activities that can damage coral; and no discharge from boats.
Future needs: Potential transition to a National Marine Sanctuary.

***Marine Life Conservation Districts,* DAR (11 Areas – O‘ahu: Hanauma Bay, Pūpūkea, Waikīkī; Lāna‘i: Mānele-Hulopo‘e; Maui: Honolua-Mokulē‘ia, Molokini Shoal; Hawai‘i: Kealakekua Bay, Lapakahi, Old Kona Airport, Wailea Bay, Wai‘ōpae Tidepools)**
Species: Species associated with shallow coral reef, sandy beach, and rocky habitats, Hawaiian monk seals, green sea turtles, spinner dolphins and other marine mammals.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, rocky habitats.
Current Management: Limited access in most MLCDs, eight MLCD include at least some No Take areas; Mānele, Old Kona Airport, and Waialea Bay all allow fishing throughout the MLCD; and fish monitoring.
Future needs: Evaluate all MLCDs for purpose and management effectiveness and consider need for new marine protected areas.

***Fishery Management Areas,* DAR (19 Areas – Kaua‘i: Hanamā‘ulu Bay, Nāwiliwili Harbor, Port Allen, Waimea Bay; O‘ahu: He‘eia Kea Wharf, Honolulu Harbor, Pōka‘i Bay, Waialua Bay; Waikīkī-Diamond Head Shoreline; Moloka‘i: Kaunakakai Harbor; Lāna‘i: Mānele Harbor; Maui: Kahului Harbor; Hawai‘i : Hilo Harbor, Kailua Bay, Kawaihae Harbor, Keauhou Bay, Kīholo Bay, Kona Coast Puakō Bay and Reef)**
Species: Some or all regulated fish species.

Habitats: Marine and estuary ecosystems.
***Current Management*:** Waikīkī-Diamond Head Shoreline is no take. Limited take, gear, size, season, and/or area restrictions in other Fishery Management Areas (FMAs).
***Future needs*:** Evaluate the purpose and management effectiveness for all FMAs and consider need for new marine protected areas.

***Bottomfish Restricted Areas,* DAR (18 Areas – Ni'ihau (1), Kaua'i (2), O'ahu (4), Penguin Banks (2), Moloka'i (1), Maui (2), Maui Nui (1), Hawai'i (5). See references for resource listing exact coordinates)**
***Species*:** Seven bottomfish species.
Habitats: Marine ecosystems.
***Current Management*:** No take of bottomfish.
***Future needs*:** Evaluate the purpose and management effectiveness for all Bottomfish Restricted Areas and consider need for new or revised protected areas.

***Wildlife Sanctuaries,* DAR (2 Areas – O'ahu: Coconut Island, Paikō Lagoon)**
***Species*:** Species associated with shallow coral reef, sandy beach, and rocky habitats.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, and rocky habitats.
***Current Management*:** Limited access and no take.
***Future needs*:** Evaluate the purpose and management effectiveness for all Sanctuaries and consider need for new marine protected areas.

***Ke'ehi Lagoon*, State Department of Health**
***Species*:** All resident aquatics.
Habitats: Estuary.
***Current Management*:** Phytoremediation (a plant based clean-up method) to remove nutrients and pollutants.
***Future needs*:** Additional monitoring and expansion to other areas if successful.

***Kalaupapa National Historic Park* (10,779 acres), NPS**
***Species*:** Invertebrates and fishes associated with shallow coral reef and rocky habitats, monk seals, and sea turtles.
Habitats: Shallow coral reefs, sandy beaches, and rocky habitats.
***Current Management*:** 'Opihi and reef monitoring and research, marine fish inventory, monk seal monitoring and protection, and coral recruitment project. Planning underway for expanded marine biological monitoring (of benthic invertebrates, fish, and fisheries) and water quality monitoring.
***Future needs*:** Establish monitoring program for nesting sea turtles, establish program to study oceanographic currents and marine water quality, and continue monitoring coral reef fishes and benthic fishes and invertebrates.

***Keālia Pond National Wildlife Refuge* (700 acres), USFWS**
***Species*:** Hawksbill sea turtle.
Habitats: Sandy beach (used for nesting by sea turtle).

Current Management: Support monitoring and protection for nesting hawksbill turtles on Sugar Beach; fencing to prevent turtles from moving onto major roadway; and dune restoration.
Future needs: Maintain existing management.

***ʻĀhihi-Kīnaʻu Natural Area Reserve* (2,045 acres), DOFAW**
Species: Species associated with shallow coral reef, sandy beach, and rocky habitats, spinner dolphins, and green sea turtles.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, and rocky habitats.
Current Management: Limited access and no take.
Future needs: Additional enforcement capacity, additional research and monitoring, evaluate purpose and management effectiveness and consider need to integrate aquatic components with other DAR marine protected areas.

***Kahoʻolawe Island Reserve*, Kahoʻolawe Island Reserve Commission**
Species: Species associated with shallow coral reef, sandy beach, and rocky habitats, pelagic fishes, Hawaiian monk seals, green sea turtles.
Habitats: Marine ecosystems including shallow and deep coral reef, sandy beach, and rocky habitats.
Current Management: Limited access and take, no commercial activity, monitoring, and water quality improvements.
Future needs: Additional monitoring, marine debris removal.

***Fishery Replenishment Areas*, DAR (9 Areas - all on the Kona Coast of Hawaiʻi and part of the West Hawaiʻi Regional Fishery Management Area)**
Species: Species associated with shallow coral reef, sandy beach, and rocky habitats.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, and rocky habitats.
Current Management: No aquarium fish fishing or fish feeding.
Future needs: Evaluate the purpose and management effectiveness for all Fishery Replenishment Areas and consider need for new marine protected areas.

***South Kona ʻŌpelu Fishing Area,* DAR**
Species: ʻŌpelu.
Habitats: Marine ecosystems.
Current Management: No take of ʻōpelu.
Future needs: Evaluate purpose and management effectiveness and consider need for new marine protected areas.

***Koloko-Honokōhau National Historic Park* (1,161 acres), NPS**
Species: Species associated with shallow coral reef and rocky habitat species, green sea turtle.
Habitats: Shallow coral reef and rocky habitats and sandy beach (used for basking by turtles).

***Current Management*: ** Reef and sea turtle monitoring and research; underwater sounds inventory.
***Future needs*: ** Continue existing management, implement biological and water quality monitoring.

***Hawai'i Volcanoes National Park* (323,431 acres), NPS**
***Species*: ** Species associated with shallow coral reef and rocky habitat, hawksbill sea turtle.
Habitats: Shallow coral reef and rocky habitats and sandy beach (used for nesting hawksbill sea turtle).
***Current Management*: ** Sea turtle research, monitoring, education, and protection.
***Future needs*: ** Continue existing management, secure stable funding for sea turtle work, increase understanding of adjacent nearshore marine habitat to better evaluate impacts occurring adjacent to the park on the park.

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CHAPTER 6: ISLAND CONSERVATION NEEDS

Moving from a statewide perspective to an island region perspective, Chapter 6 addresses individual islands with regard to native wildlife and habitat priorities and strategies. Each island discussion will provide an overview section, identify habitats and species of importance, summarize key threats of particular importance to the island, outline island strategies linked with the seven statewide objectives, identify plans and tools to aid management, and finally, discuss existing management actions and highlight potential new areas for increased conservation management. The Northwestern Hawaiian Islands (NWHI), also included in this chapter, will be treated as an entire region and follow a similar format for discussion. This chapter addresses elements 1-5 at the island level.

KAUA‘I

Kaua‘i is the northernmost and oldest of the eight Main Hawaiian Islands (MHI) and is characterized by deep eroded canyons and valleys and steep cliffs. There is a wide diversity of unique natural communities, from montane bogs, montane wet forest, lowland mesic forest, lava tube caves, long stretches of sandy beach, and many streams and rivers. Because of the age of the island and its relative isolation, levels of endemism are higher on Kaua‘i than elsewhere in the State. Hurricanes Iwa (1982) and Iniki (1992) damaged forest cover and encouraged the spread and establishment of introduced invasive weeds. As the only island where the mongoose (*Herpestes auropunctatus*) has not become established, Kaua‘i hosts greater populations of several ground-nesting birds than other islands.

OVERVIEW

Geology and Hydrology

Most of the island was formed from the eruptions of a single shield volcano between 3.6 million and 5.6 million years ago. Since that time, rain, streams, and waves have eroded the 143,226 hectares (353,920 acres) island, creating steep sea cliffs, deep canyons and valleys that extend from the interior of the island to the coast, a mountainous interior, and a broad coastal plain with deep soil and extensive beaches. Approximately 35 percent of the island is below 150 meters (500 feet) in elevation, and approximately 24 percent is above 610 meters (2,000 feet) in elevation. Kaua‘i has 61 perennial streams, 45 of which are continuous. Wailua and Hanalei have the largest discharges, 200 and 140 million gallons per day (mgd), respectively. Kaua‘i also has three offshore islets.

Climate

Elevation ranges from sea level to 1,598 meters (5,243 feet). Kaua‘i is directly exposed to the prevailing tradewinds that deliver rain, conditions which make Mount Wai‘ale‘ale one of the wettest spots on earth, with an average 1,120 centimeters (444 inches) of rainfall per year. However, not all the island is wet: average rainfall in Kekaha on the leeward side is only 52 centimeters (20 inches) per year.

Land and Water Use

Approximately 38 percent of the island remains dominated by native vegetation, and approximately 15 percent of the island has been designated as critical habitat for Kaua‘i plants.

More than half the island (56% or 156,619 acres) is located in the State Conservation District, approximately 40 percent is in the State Agricultural (128,839 acres) or State Rural District (1,253 acres), and the remaining is in the State Urban District (100,730 acres). Twenty-five streams are diverted and 12 have altered channels. Kaua'i has 11 impaired streams under the Environmental Protection Agency (EPA) Clean Water Act standards. The Wailua canal system is the largest man-made stream system. Waita Reservoir is a significant man-made lake that is seven meters (23 feet) deep and 171 hectares (424 acres) in size.

Human Landscape

In 2003, the County of Kaua'i had a population of nearly 61,000 residents. The total County population amounted to almost five percent of the State population, the smallest of the four counties. Most residents live in towns around the perimeter of the island, primarily along the east and south sides of Kaua'i, with smaller populations living in towns on the north shore. The principal economic driving forces are tourism, agriculture, and defense expenditures. Tourism counts declined during the 1990s, due largely to the destruction caused by Hurricane Iniki in 1992, but visitor numbers have since increased, with Kaua'i hosting nearly one million visitors in 2003. Visitor accommodations are located throughout the island, but are primarily at Poipu, Princeville, and Waimea/Kapaa. Agriculture has shifted recently from primarily sugarcane, with the closure of four of five plantations, to diversified agriculture and aquaculture. Defense expenditures stem from the Pacific Missile Range Facility, located in the southwest corner of the island.

SPECIES AND HABITATS OF IMPORTANCE

Habitats on Kaua'i are composed of montane wet communities, montane mesic communities, lowland wet communities, lowland mesic communities, lowland dry communities, and coastal communities, resulting in a diverse range of natural vegetation. While just over one-third of the island remains dominated by native vegetation, many native-dominated areas contain smaller pockets of non-native invasive species that became established following Hurricanes Iwa and Iniki. The island has a network of perennial and intermittent streams and several rivers. Unique habitat types and major associated landscapes for wildlife include the montane bogs located in the Alaka'i Wilderness Preserve, montane wet forest, lowland mesic forest, lava tube caves, steep sea cliffs, wetlands, coastal zones, and long stretches of mountain streams. Two offshore islands, Lehua and Kaula, are particularly important for nesting seabirds. In addition, 21,266 hectares (52,549 acres) have been designated as critical habitat for 83 endangered plants on Kaua'i. Partially overlapping with the plant critical habitat designation are the 110 hectares (272 acres) designated for the Kaua'i cave wolf spider (*Adelocosa anops*) and Kaua'i cave amphipod (*Spelaeorchestia koloana*) and the 20 kilometers (12 miles) of stream segments and 1,812 hectares (4,479 acres) of adjacent riparian area designated as critical habitat for the Newcomb's snail (*Erinna newcombi*). Recovery habitat has been identified for the puaiohi (*Myadestes palmeri*), 'akikiki (*Oreomystis bairdi* [Kaua'i creeper]), and the presumed extinct Kaua'i 'akialoa (*Hemignathus procerus*), Kaua'i nuku pu'u (*Hemignathus lucidus hanapepe*), Kaua'i 'ō'ō (*Moho braccatus* ['ō'ō 'ā'ā]), kāma'o (*Myadestes myadestinus* [large Kaua'i thrush]), and 'ō'ū (*Psittirostra psittacea*). Three offshore islands support more than 15 species of breeding seabirds, including the largest 'ā (*Sula leucogaster* [brown booby]) colony in the State.

Appendix A provides information on what wildlife Species of Greatest Conservation Need are present on Kaua'i and its associated offshore islands. Species endemic to Kaua'i include the puaiohi, ‘akikiki (Kaua‘i creeper), ‘anianiau (*Hemignathus parvus* [lesser ‘amakihi]), ‘akeke‘e (*Loxops caeruleirostris* [Kaua‘i ‘ākepa]), Newcomb’s snail, the Kaua‘i cave wolf spider, and the Kaua‘i cave amphipod. Other forest birds include the ‘i‘iwi (*Vestiaria coccinea*), ‘apapane (*Himatione sanguinea*), and Kaua‘i ‘elepaio (*Chasiempis sandwichensis sclateri*). Waterbirds and migratory shorebirds utilize remnant wetlands, with 80 percent of the State’s koloa maoli (*Anas wylvilliana* [Hawaiian duck]) population, and 50 percent of the State’s nēnē (*Branta sandvicensis* [Hawaiian goose]) population found on Kaua‘i. Two Hawaiian endemic seabirds, the ‘a‘o (*Puffinus auricularis newelli* [Newell’s shearwater]) and ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]), and the ‘akē‘akē (*Oceanodroma castro* [band-rumped storm-petrel]) are believed to nest on upper elevation sea cliffs. Kaua‘i is also home to a diverse number of terrestrial invertebrates, most of which have been poorly studied. Notable invertebrates include several endemic species of native bees in the genus *Hylaeus* and of native damselflies in the genus *Megalagrion*. In addition, diversity within most families of beetles (Coleoptera) is among the highest in the State. In recent years, the number of ‘īlio-holo-i-ka-uaua, or Hawaiian monk seals (*Monachus schauinslandi*), basking on Kauai’s beaches has increased. Finally, Kaua‘i is believed to have historically supported populations of the endangered Blackburn’s sphinx moth (*Manduca blackburni*).

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats more acute or specific to Kaua‘i are listed below.

- Populations of feral pigs (*Sus scrofa*) and goats (*Capra hircus*) that distribute introduced invasive plants (such as strawberry guava [*Psidium cattleianum*]) and eat, trample, or uproot native plants, degrading habitat, contributing to soil erosion, and impairing stream quality;
- Habitat-modifying invasive plants, including kāhili ginger (*Hedychium gardnerianum*), Australian tree fern (*Sphaeropteris cooperi*), and strawberry guava;
- Populations of feral cats (*Felis silvestris*) that kill waterbirds and ground-nesting seabirds;
- Introduced smallmouth bass, a predatory fish that eat a number of native stream fishes and invertebrates and may also compete with some of them;
- Potential introduction of non-established pests, such as the mongoose;
- Restricted mosquito-free habitat, making Kauai’s forest birds highly vulnerable to habitat degradation;
- Stream diversions, dams, or channelizations;
- Insufficient in-stream flows to insure the biological integrity of many stream systems;
- Development of formerly undeveloped areas and increased urbanization leading to loss and degradation of terrestrial, freshwater, and marine habitat (e.g., increased nutrients in coastal areas leads to non-native algal blooms which affect fish populations and coral habitats, sedimentation from development near stream corridors);
- Hybridization between koloa maoli (Hawaiian duck) and introduced mallards;
- Limited information on genetically modified organisms (GMO) research by private agricultural engineering firms on State and private lands and the possible interaction of GMOs with native wildlife;
- Recreational overuse in some areas along the Nā Pali Coast and in the Po‘ipū area;

- Human interactions with monk seals which are much more common off Kaua‘i than off the other Main Hawaiian Islands.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Kaua‘i include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Implement conservation actions identified in the ‘Potential Areas for Enhanced Conservation Management’ subsection;
    - Develop and/or implement recovery plans for threatened and endangered species on Kaua‘i;
    - Protect remaining lava tube and cave habitats;
    - Increase active management in, or acquisition of, extremely rare habitats on Kaua‘i;
    - Increase the total acreage of ungulate-free and predator-free areas;
    - Implement fire suppression measures and protocols for post-fire restoration;
    - Decrease in number of stream diversions and channelized streams;
    - Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations;
    - Collaborate in efforts to reduce pollution threats from recreational boats and cruise ships;
    - Develop management plans for all Marine Managed Areas;
    - Support the Local Action Strategies project to deal with non-point source pollution in Hanalei Bay and support expansion of successful methods to other areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on Kaua‘i (e.g., mongooses);
    - Increase efforts to prevent establishment of priority invasive plants in pristine areas (e.g., kāhili ginger, Australian tree fern) and to eradicate from areas with recovery potential;
    - Decrease in the overall number of streams negatively impacted by invasive species;
    - Support efforts to strengthen marine alien species prevention and control.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;

    - Assess impact of eco-tourism activities on terrestrial and aquatic native wildlife and associated habitats.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Continue implementation of the successful Save Our Shearwaters (SOS) program and complete and implement the SOS Procedures Plan;
    - Continue development of an island-wide Habitat Conservation Plan (HCP) addressing the take of seabirds on Kaua‘i;
    - Expand partnership with hunting community to reduce ungulate population;
    - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i.
    - Maintain existing outreach and educational programs at managed conservation areas;
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
    - Assess ways to support increased enforcement capacities, including cross-deputization between agencies;
    - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
    - Improve integration of policies to address linkages between terrestrial and marine habitats and their shared conservation threats and needs.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Nēnē (Hawaiian goose) (2004), the Draft Recovery Plan for the Kaua‘i Cave Arthropods (2004), the Draft Recovery Plan for the Newcomb’s Snail (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), the Hawaiian Endangered Bird Partnership for Captive Propagation Five Year Workplan (2002), the Draft Revised Recovery Plan for Hawaiian waterbirds (1999), and the Recovery Plan for the Hawaiian Hoary Bat (1998);
- Critical habitat designations by the USFWS for the Kaua‘i cave arthropods, for Newcomb’s snail, and for threatened and endangered plants on Kaua‘i.
- Management Plans for the State Natural Area Reserves (NAR): Kuia NAR (1989) and Hono o Na Pali NAR (1989);
- The Division of Forestry and Wildlife’s (DOFAW) Draft Management Guidelines, which coarsely rate vegetation quality and provide guidelines for land use (public hunting, recreation, and forest products) for State lands managed by DOFAW;
- The Kaua‘i Watershed Alliance Management Plan (2005);
- The National Tropical Botanical Gardens (NTBG) have developed a master plan for Limahuli Garden and Preserve;

- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawaiʻi Implementation Plan for Polluted Runoff Control (2000), Hawaiʻi Unified Watershed Assessment (1998);
- Hawaii's Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;
- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawaiʻi;
- The Hawaiʻi Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Kauaʻi. The discussion of future management needs is highlighted within each current managed area. Some areas on Kauaʻi are already under active management or protection through designation as a State Natural Area Reserve (NAR), State Wilderness Preserve, or National Wildlife Refuge (NWR). The Kauaʻi Watershed Alliance (KWA) was recently formed to identify and implement conservation actions needed to preserve Kauai's watershed resources on both public and private land, and the natural and cultural resources within these watersheds. In addition, other partnerships, such as the Save Our Shearwaters program, the Kauaʻi Endangered Bird Recovery Team (KEBRT), the Kauaʻi Invasive Species Committee (KISC), and the partnership formed to develop a Seabird Habitat Conservation Plan have been formed to address specific species conservation needs.

***Hono o Na Pali NAR* (3,150 acres), DOFAW**

***Species*:** Forest birds, pueo, seabirds, ʻōpeʻapeʻa (Hawaiian hoary bat), terrestrial invertebrates, freshwater fishes, freshwater invertebrates, 46 rare plant taxa.
Habitats: Montane wet communities, lowland mesic communities, lowland wet communities, coastal communities, continuous perennial streams (Hanakāpīʻai, Hanakoa, Waiahuakua streams).
***Current Management*:** Management plan exists. Ungulate control through public hunting year-round, invasive weed species removal, monitoring.
Future Needs: Update management plan. Increased ungulate (particularly goat) control, increased invasive weed monitoring and control, rare plant monitoring, baseline survey work in Waiahuakua stream.

***Kuʻia NAR* (1,636 acres), DOFAW**

Species: Forest birds, pueo, seabirds, ʻōpeʻapeʻa, terrestrial invertebrates, 28 rare plant taxa.

Habitats: Montane mesic system, lowland mesic system.
Current Management: Management plan exists. Small-scale fencing, ungulate control through public hunting seasons, invasive weed species removal, monitoring.
Future Needs: Construction of proposed fencing, increased ungulate control, increased invasive weed species removal, outplanting, monitoring. Identify areas of intact lowland mesic forest for protection.

Alaka'i Wilderness Preserve **(9,939 acres*)*, DOFAW**
Species**:** Forest birds, pueo, koloa maoli, terrestrial invertebrates, rare plant taxa.
Habitats: Montane wet communities.
Current Management**:** Ungulate control through public hunting, invasive weed (including kāhili ginger, Australian tree fern) control.
Future Needs: Fencing and ungulate control, increased invasive weed species removal, monitoring.

Kaua'i Watershed Alliance **(142,000 acres), Public-Private Partnership (County of Kaua'i Department of Water, DLNR-DOFAW, DLNR-State Parks, DLNR-Land, Kamehameha Schools, McBryde Sugar Company, Ltd., Grove Farm Company, Inc., Līhu'e Land Company, Kealia Ranch, LLC, B.A. Dyer, and Princeville Development, LLC)**
Species: Forest birds, seabirds, pueo, 'ōpe'ape'a, terrestrial invertebrates, freshwater fishes, freshwater invertebrates, rare plant taxa.
Habitats: Montane wet communities, lowland wet communities, lowland mesic communities, lowland dry communities.
Current Management: Management plan exists. Planned management includes fencing, ungulate control through variety of methods, suppression, containment, and eradication of priority and secondary weeds, monitoring (ungulate activity, weed distribution, vegetation cover, stream turbidity).
Future Needs: Adequate funding to implement management plan.

Hanalei NWR **(917 acres), USFWS**
Species: Waterbirds, 'ōpe'ape'a.
Habitats: Lowland wet communities (wetlands).
Current Management: Management plan in development. Endangered species management (habitat enhancement, predator control, invasive weed control, monitoring).
Future Needs: Continued management for wildlife needs.

Hulē'ia NWR **(241 acres), USFWS**
Species: Waterbirds, 'ōpe'ape'a.
Habitats: Lowland wet communities (wetlands).
Current Management: Management plan in development. Endangered species management (habitat enhancement, predator control, invasive weed control, monitoring).
Future Needs: Continued management for wildlife needs.

Kīlauea Point NWR **(199 acres), USFWS**
Species: Waterbirds, seabirds, nēnē, migratory shorebirds.
Habitats: Coastal communities.

Current Management: Management plan in development. Feasibility study underway regarding acquisitions to Refuge. Endangered species management (habitat enhancement, predator control, invasive weed control, monitoring), outreach and education.
Future Needs: Acquire and manage additional habitat once Feasibility Study complete.

***Kawaiele Wildlife Sanctuary* (37 acres), DOFAW**
***Species*:** Waterbirds, migratory shorebirds, seabirds, migratory waterfowl.
Habitats: Coastal communities.
***Current Management*:** Eliminate tilapia from ponds, habitat restoration through native plantings, public education, and monitoring of bird and plant populations.
Future Needs: Complete addition of adjacent 105 acres (Mānā Plains Wetland Sanctuary) to create Mānā Plains Forest Reserve, continued habitat restoration and management, monitoring.

***Limahuli Preserve* (1,005 acres), NTBG**
Species: Forest birds, seabirds, pueo, rare plants.
Habitats: Lowland wet communities.
Current Management: Outplanting of native plants, fencing and ungulate removal, predator control.
Future Needs: Continue existing management.

***State Seabird Sanctuary* (3 offshore islets: Lehua, Ka‘ula, and Moku ‘Ae‘ae), DOFAW**
Species: Nesting seabirds: ‘ua‘u kani (wedge-tailed shearwater), ‘ou (Bulwer’s petrel), ‘ā (red-footed booby), ‘ā (brown booby),‘ā (masked booby), mōlī (Laysan albatross), ka‘upu (black-footed albatross), noio (black noddy), noio-kōhā (brown noddy), manu-o-Kū (fairy tern), Christmas shearwater, ‘a‘o (Newell’s shearwater), koa‘e ‘ula (red-tailed tropicbird), koa‘e kea (white-tailed tropicbird), ‘iwa (great frigatebird), ‘akē‘akē (band-rumped storm petrel).
Habitats: Coastal communities.
Current Management: Surveys and monitoring, planned eradication of rats and rabbits on Lehua, and habitat restoration.
Future Needs: Continued monitoring of seabird populations, follow-up monitoring of predator populations to prevent re-establishment.

***Kaua‘i Resource Conservation Program*, Public-Private Partnership**
***Species/Habitats*:** All species and habitats present in Kōke‘e State Park and surrounding State lands affected by invasive species issues.
***Current Management*:** Invasive species removal and control.
Future Needs: Adequate funding for ongoing control actions.

***Kaua‘i Endangered Bird Recovery Team*, DOFAW, USFWS, UH**
Species/Habitats: Montane-nesting forest birds and seabirds, particularly endangered and critically endangered species and their habitats.
Current Management: Implementation of Draft Revised Recovery Plan for Hawaiian Forest Birds, Draft Five-year Implementation Plan for puaiohi and ‘a‘o (Newell’s Shearwater).

Future Needs: Adequate funding to implement endangered species recovery plan and implementation plans.

***Kaua‘i Invasive Species Committee*, Public-Private Partnership**
***Species/Habitats*:** All species and habitats affected by invasive species issues.
***Current Management*:** Invasive species prioritization, control, and removal island-wide.
***Future Needs*:** Increased invasive plant and animal prevention capacity, improved detection and rapid response capacity, and additional resources to address established threats to native habitats.

***Save Our Shearwaters*, DOFAW, USFWS, Kaua‘i Island Utility Cooperative**
***Species*:** **‘**A‘o (Newell’s Shearwater), ‘ua‘u (Hawaiian petrel), ‘akē‘akē (band-rumped storm-petrel).
***Current Management*:** Recovery and release into the wild of downed seabirds. During its first 26 years the program recovered more than 29,000 Newell’s shearwaters, 220 Hawaiian petrels, and 15 band-rumped storm petrels, as well as a few wedge-tailed shearwaters and white-tailed tropicbirds. Overall, 92 percent of the birds have been released back into the wild.
Future Needs: Finalize and implement Save Our Shearwaters Implementation Guidelines and Operation Manual.

***Hawaiian Islands Humpback Whale National Marine Sanctuary* (about 900,000 acres), Co-Managed by NOAA and DLNR**
***Species*:** Humpback whale.
Habitats: Marine ecosystem.
***Current Management*:** Management plan exists. Humpback whale 100-yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
***Future Needs*:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary, and increase research, education, and enforcement actions.

***Four Fishery Management Areas (FMA),* DAR** (Hanamā‘ulu Bay, Nāwiliwili Harbor, Port Allen, Waimea Bay).
***Species*:** Some or all regulated fish species.
Habitats: Marine and estuary ecosystems.
***Current Management*:** Limited take, gear, size, season, and/or area restrictions.
***Future needs*:** Evaluate all FMAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

***Two Bottomfish Restricted Areas (BRA),* DAR**
***Species*:** Seven bottomfish species.
Habitats: Marine ecosystem.

*Current Management***:** No Take of bottomfish.
*Future needs***:** Evaluate all BRAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Potential Areas for Enhanced Conservation Management

In addition to maintaining and enhancing existing conservation actions, additional efforts are needed for the long-term conservation of Kauai's native wildlife. The following section identifies areas where enhanced conservation management would significantly benefit native species or their habitats. Areas are discussed in habitat order from the mountains to the sea.

Montane Wet Forest

*Species***:** Puaiohi, ʻakikiki, ʻiʻiwi, Kauaʻi ʻelepaio, ʻanianiau, Kauaʻi ʻamakihi, ʻakekeʻe (Kauaʻi ʻākepa), ʻapapane, pueo, ʻaʻo (Newell's shearwater), terrestrial invertebrates, freshwater invertebrates, rare plants.
*Basis for Priority Designation***:** Identified in Forest Bird Recovery Plan as core area for conservation; DOFAW Management Guidelines recognized as highest quality native vegetation; identified for protection in Kauaʻi Watershed Alliance Management Plan. Last remaining suitable habitat for puaiohi, ʻakikiki; last known habitat for Kauaʻi ʻakialoa, Kauaʻi nuku puʻu, Kauaʻi ʻōʻō, kāmaʻo, and ʻōʻū; habitat for ʻakekeʻe (Kauaʻi ʻākepa) and ʻapapane.
Potential Conservation Actions: Coordinate and implement existing management plans (Draft Revised Recovery Plan for Hawaiian Forest Birds, Draft Five-year Implementation Plan for Puaiohi and Newell's Shearwater, Kauaʻi Watershed Management Plan, DOFAW Management Guidelines). Increase funding and staffing for implementation of identified actions, fencing, ungulate (pig and goats) removal, predator control, invasive weed control, habitat restoration through native plantings, and monitoring.

***Wetland Habitat* (including Kīlauea River, Hanalei River Valley and taro fields, Lumahaʻi Valley, Wainiha River Valley and taro fields, Haʻena State Park wetlands and loʻi, Mānā Plains, Waimea River and taro fields, Hanapēpē Coastal Ponds (Hanapēpē Salt Ponds, Kaumakani Gulch Ponds, Olokele Settling Ponds), Lāwaʻi Kai Estuary, Kōloa district reservoirs (Waita Reservoir), Waiopili Stream, Hulēʻia stream and associated watershed, Līhuʻe area wetlands (including Nāwiliwili wetlands, Pualu wetlands), Hanamāʻulu wetlands, Wailua River and associated watershed (including Opaekaʻa wetlands), Kapaʻa area wetlands)**

*Species***:** Aeʻo (Hawaiian stilt), ʻalae keʻokeʻo (Hawaiian coot), ʻalae ʻula (Hawaiian moorhen), koloa maoli (Hawaiian duck), nēnē (Hawaiian goose), shorebirds, including the kōlea (Pacific golden plover), ʻakekeke (ruddy turnstone), hunakai (sanderling), freshwater fishes, freshwater invertebrates.
*Basis for Priority Designation***:** Identified in Hawaiian Waterbird Draft Revised Recovery Plan as core or supporting wetlands or identified by biologists as important potential wetland habitat. With demise of sugar, wetland habitat is being reduced as former irrigation ditches are no longer maintained.
Needed Conservation Actions: Implement Waterbird Recovery Plan. Protect, restore, and manage additional wetland habitat through coordination with private or public landowners, removal of invasive plants, and institution of predator control. Remove

threat of feral mallard and kola maoli (Hawaiian duck) hybridization by supporting research, outreach, regulation/legislation, and control of feral mallards. Research on ecosystem function of taro *lo'i* to identify management actions that support both taro growth and quality wildlife habitat. Expand outreach efforts to neighboring landowners to encourage voluntary protection (conservation easements) or implementation of best management practices. Continue existing waterbird surveys.

Kōloa Lava Tube/Cave Ecosystem

Species: Kaua'i cave wolf spider, Kaua'i cave amphipod.

Basis for Priority Designation: Designated as critical habitat for endangered cave wolf spider and cave amphipod, may be only known habitat. Areas near these caves are under consideration for development.

Potential Conservation Actions: Support for current protection of existing inhabited cave on private land, continued monitoring of population.

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NIʻIHAU

Niʻihau is a small, privately owned island located approximately 27 kilometers (17 miles) west of Kauaʻi. The island's highest point is 390 meters (1,281 feet). Among Niʻihau's most unique natural features are several intermittent lakes, which provide habitat for ʻalae keʻokeʻo (*Fulica alai* [Hawaiian coot]), aeʻo (*Himantopus mexicanus knudseni* [Hawaiian stilt]), and koloa maoli (*Anas wyvilliana* [Hawaiian duck]). Due to restricted access, there is limited biological information available about Niʻihau (e.g., the percent cover of native vegetation, the distribution and abundance of native species, and the condition of habitats used by wildlife species). While the seasonal lakes are known to be an important natural wetland feature for waterbirds, the use and importance of this island by other species groups, such as seabirds or invertebrates, is largely unknown.

OVERVIEW

Geology and Hydrology

Niʻihau was formed from a single shield volcano approximately 4.89 million years ago, making it slightly younger in age than Kauaʻi. It is approximately 18,130 hectares (70 square miles or 44,800 acres), and sea cliffs are a prominent feature of the eastern coast. Approximately 78 percent of the island is below 150 meters (500 feet) in elevation. Niʻihau has no perennial streams. Halulu Lake is a natural freshwater lake covering approximately 74 hectares (182 acres) and Halāliʻi Lake is an intermittent lake covering approximately 340 hectares (841 acres).

Climate

Located inside Kauai's rain shadow, Niʻihau receives only about 50 to 100 centimeters (20 to 40 inches) of rain per year.

Land and Water Use

The entire island is located in the State Agricultural District. The primary economic activities are cattle and sheep ranching, commercial game hunting, and limited military training exercises.

Human Landscape

Part of the County of Kauaʻi, Niʻihau is privately owned. A Native Hawaiian community of approximately 160 people lives there in relative isolation. There are no resorts, and public access is allowed only with permission of the owners.

SPECIES AND HABITATS OF IMPORTANCE

Habitat on Niʻihau includes only lowland dry systems and coastal systems. It is thought that Niʻihau may have some of the best coastal habitats in the State.

Information on species' distribution on Niʻihau is limited. Appendix A provides information on the wildlife Species of Greatest Conservation Need present on Niʻihau. There are no wildlife species known to be endemic to Niʻihau. Known species present are primarily waterbirds, seabirds, and migratory shorebirds. The U.S. Fish and Wildlife Service has designated critical habitat for one plant, *Brighamia insignis.*

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats more acute or specific to Ni‘ihau are listed below. Because Ni‘ihau has no perennial streams, there are no identified threats specific to freshwater species on Ni‘ihau.

- Lack of permanent conservation status for known wetland habitat;
- Habitat degradation (loss of vegetation and subsequent erosion) caused by domestic and feral ungulates;
- Limited information on species presence or abundance, habitat conditions, or the importance of existing habitat for wildlife.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Ni‘ihau include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Develop and/or implement recovery plans for threatened and endangered species on Ni‘ihau;
    - Encourage long-term protection and management of known wetland habitat (including ephemeral playa lakes) for nesting waterbirds;
    - Encourage long-term protection of remaining native-dominated coastal or lowland vegetation from degradation by ungulates;
    - Develop management plans for all Marine Managed Areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Inventory existing terrestrial and aquatic invasive species and prioritize control actions.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Complete an inventory of native wildlife and plants;
    - Determine population estimates for rare or unique species of native wildlife;
    - Coordinate research to assess threats and conservation needs of species.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Establish a partnership with the private landowner to protect the wetland habitat and improve knowledge about native species and their habitats;
    - Explore opportunities for partnership with local community.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i.
    - Explore opportunities for community-based wildlife surveys and monitoring.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Assess ways to support increased enforcement capacities, including cross-deputization between agencies;

- Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas.

PLANS AND TOOLS TO AID MANAGEMENT

No management plans and tools specific to Ni‘ihau exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Ni‘ihau. The discussion of future management needs is highlighted within each current managed area. Unlike other islands, Ni‘ihau is entirely privately owned and has no State or Federal management presence. There are no formalized or long-term conservation management actions currently occurring on terrestrial Ni‘ihau. In the marine waters surrounding Ni‘ihau, there is one Bottomfish Restricted Area (BRA).

Bottomfish Restricted Area, DAR

***Species*:** Seven bottomfish species.
Habitats: Marine ecosystem.
***Current Management*:** No Take of bottomfish.
Future Needs: Evaluate all BRAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

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O‘AHU

O‘ahu is the most developed and populated island in the Hawaiian chain. As a result of the pressures of population and economics, native forest is found primarily along mountainous ridges unsuitable for development. These mountain ridges are highly dissected by erosion, resulting in a rich array of habitats (from montane wet forest to lowland dry forest) with localized distributions of many species, particularly of native invertebrates. O‘ahu contains several wetlands important to waterbirds and migratory shorebirds, including the Kawai Nui and Hāmākua Marsh complex. Thanks to grassroots support and community involvement, the Kawai Nui and Hāmākua Marsh complex was designated a Wetland of International Importance under the Ramsar Convention of Wetlands in 2005, the 22nd such designation in the United States and the first in Hawai‘i. Several offshore islands and several protected and managed coastal sites support seabird colonies. O‘ahu also has a number of large estuaries and bays and one of only two barrier reef complexes in the State. Many areas managed for wildlife conservation are accessible to the public, giving residents and visitors the opportunity to view and appreciate examples of the native wildlife of the State.

OVERVIEW

Geology and Hydrology

The island of O‘ahu was created by two large shield volcanoes, the younger Ko‘olau volcano to the east and the older Wai‘anae volcano to the west. Subsequent extensive erosion has since fashioned these volcanoes into long, narrow, ridge-like mountain ranges, connected by the Schofield Plateau. Nearly half (45%) of the island is below 150 meters (500 feet) in elevation, and for the most part, the island is surrounded by coastal plain and sandy beaches, rather than steep sea cliffs. Just under five percent of the island is over 610 meters (2,000 feet) in elevation; Mt. Ka‘ala in the Wai‘anae range, is the highest point on the island at 1,220 meters high (4,003 feet) high. The island has 57 perennial streams, 29 of which are continuous. Kahana and Waikele streams have the largest discharges, 35 and 27 million gallons per day (mgd), respectively. Wahiawā Reservoir (including Lake Wilson) and Nu‘uanu Reservoir are significant freshwater lakes on the island.

Climate

The Wai‘anae and Ko‘olau mountain ranges combine to produce distinctive windward and leeward climates. Average annual rainfall exceeds 635 centimeters (250 inches) per year on the crest of the Ko‘olau Range. In contrast, some areas on the leeward coast, located in the rain shadow of the Ko‘olaus, receive less than 50 centimeters (20 inches) per year. The Ko‘olau Mountains form the primary watershed for the island, providing approximately 133 mgd of recharge to the Pearl Harbor aquifer.

Land and Water Use

O‘ahu is the third largest island at 156,284 hectares (386,188 acres). The island’s land area is almost evenly divided between the Conservation District (41%; 63,381 hectares or 156,619 acres), Agricultural District (33%; 52,139 hectares or 128,839 acres), and the Urban District (26%; 40,764 hectares or 100,730 acres). The Conservation District encompasses most of the Ko‘olau and Wai‘anae mountain ranges. About 13,853 hectares (34,232 acres), primarily in the Conservation District, are managed by the DLNR Division of Forestry and Wildlife (DOFAW)

(9% of the total land area). Approximately 35,942 hectares (88,817 acres) of conservation-zoned forest land is under private ownership or management. The Agricultural District covers primarily the plateau between the two mountain ranges. The Urban District covers the primary urban center of Honolulu, extending west along the leeward coast, east to include the developed areas of Kāneʻohe and Kailua, and north to include the developments along the H-2 Highway, such as Mililani.

Approximately 36,853 hectares (91,066 acres, 24% of the total land area) is under the control (through ownership or lease) of the military. The largest private landowners are Kamehameha Schools, Dole Food Company, Damon Estate, Campbell Estate, and Amfac.

Thirty-one streams are diverted and 31 have altered channels. The largest altered stream is Waikele, and the Waiāhole Ditch system is the largest man-made stream system. Oʻahu has 34 impaired streams under Environmental Protection Agency Clean Water Act standards.

Human Landscape

In 2004, the total resident population of Oʻahu was estimated at 899,593, accounting for 72 percent of the State's population. This number is supplemented by an average daily visitor population of 82,121. The population is spread around the island, with most residents living on the south side, east of Pearl Harbor on the coastal plain, valleys, and lower mountain ridges. Oʻahu is the State's governmental, service, commercial, and transportation center, and accounts for about 80 percent of the State's economic output. The large visitor industry, military activities, and to a lesser extent, agriculture contribute to this output. Oʻahu's sugar industry closed in 1996, and many former sugar lands have been converted to residential communities. The recent decision to base one of the six U.S. Army Stryker Brigades in Hawaiʻi will likely result in increased military activity on Oʻahu, involving purchase of additional land, construction of range complexes, and improvement of roads.

SPECIES AND HABITATS OF IMPORTANCE

Habitats on Oʻahu are composed of montane wet communities, lowland wet communities, lowland mesic communities, lowland dry communities, and coastal communities. The island has a network of perennial and intermittent streams, many of which have been altered. Habitat types include ʻakiʻaki (*Sporobolus virginicus*) coastal dry grassland, naupaka (*Scaevola sericea*) mixed coastal dry shrubland, ʻuki (*Cladium jamaicense*) lowland wet sedgeland, ʻōhiʻa (*Metrosideros polymorpha*) lowland wet and mesic forest, and wet cliffs. The dry to mesic habitats located in the Waiʻanae mountains are considered to contain high concentrations of federally endangered plant species, including both species that are naturally rare as well as species exhibiting human-induced rarity. A system of wetlands situated along the windward coast south to Pearl Harbor provide important habitat for endemic waterbirds and migratory shorebirds and waterfowl. Many of the seventeen offshore islands are important for nesting seabirds, with Moku Manu and Mānana supporting the greatest diversity of species and the highest number of individuals. Ulupaʻu Wildlife Management Area (at Kāneʻohe Marine Corps Base) supports one of the two colonies of ʻā (*Sula sula* [red-footed booby]) in the Main Hawaiian Islands. Approximately 22,274 hectares (55,040 acres) have been designated as critical habitat for 99 endangered plants on Oʻahu, which partially overlaps with the 26,661 hectares (65,879 acres) designated as critical habitat for the O‘ahu ‘elepaio (*Chasiempis sanwichensis ibidis*). Habitat essential for the recovery of the O‘ahu tree snails (*Achatinella* spp.) has also been identified.

Appendix A provides information on what wildlife Species of Greatest Conservation Need are present on O‘ahu and its associated offshore islands. Known taxa endemic to O‘ahu include the O‘ahu ‘elepaio (endemic at the subspecies level), O‘ahu ‘alauahio (*Paroeomyza maculata* [O‘ahu creeper], potentially extinct), O‘ahu ‘amakihi (*Hemignathus flavus*), the damselfly *Megalagrion leptodemas*, several endemic bees (*Hylaeus* spp.), and the O‘ahu tree snails (*Achatinella* spp.). The endangered ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* [Hawaiian hoary bat]) occurs on the island, as do the following birds: ‘apapane (*Himatione sanguinea*), ‘i‘iwi (*Vestiaria coccinea*) (State listed as endangered on O‘ahu), and pueo (*Asio flammeus sandwichensis* [Hawaiian short-eared owl]) (State listed as endangered on O‘ahu). Significant populations of endangered waterbirds occur on O‘ahu, including the ae‘o (*Himantopus mexicanus knudseni* [Hawaiian stilt]), ‘alae ke‘oke‘o (*Fulica alai* [Hawaiian coot]), ‘alae ‘ula (*Gallinula chloropus sandvicensis* [Hawaiian moorhen]), and the koloa maoli (*Anas wyvilliana* [Hawaiian duck]). The seabird, ‘a‘o (*Puffinus auricularis newelli* [Newell’s shearwater]), is believed to nest in the Ko‘olau mountains, mōlī (*Phoebastria immutabilis* [Laysan albatross]) nest at Ka‘ena Point Natural Area Reserve, and eight species of seabirds nest on the offshore islands. O‘ahu is also home to a diverse number of terrestrial invertebrates, most of which have been poorly studied. Several species of land snails from the genera *Auriculella*, *Leptachatina*, and *Amastra* have been observed, while diversity within most families of beetles (Coleoptera) is among the highest in the State. ‘Ōpae‘ula (*Holocaridina rubra*) occur in natural and man-made anchialine and aquaculture ponds. Native freshwater fishes, including several species of ‘o‘opu, native freshwater invertebrates, including *Oahuhawaiian kazukolinda*, and several species of crustaceans, are found within several stream systems. Finally, honu (*Chelonia mydas agassizi* [green sea turtles]) are regularly observed around the island.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife and habitats are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats that are more acute or specific to O‘ahu are listed below.

- Primary entry point for new invasive species into the State;
- Insufficient acreage of managed wetland habitat to support expansion of waterbird populations;
- Wildfire, especially in drier leeward areas, due to humans and exacerbated by invasive non-native plants (increasing fuel loads);
- Recreational use of offshore islets, deterring seabird nesting or destroying existing nests and habitats;
- Predation by introduced animals (e.g., feral cat colonies and mongooses preying on waterbirds, shorebirds, and seabirds; introduced fish preying on native freshwater species and terrestrial invertebrates; introduced snails preying on native land snails);
- Disturbance of forested habitat and rare plants by feral pigs;
- Stream diversions, dams, or channelizations;
- Development of formerly undeveloped areas and increased urbanization leading to loss and degradation of terrestrial, freshwater, and marine habitat (e.g., increased nutrients in

coastal areas leads to non-native algal blooms which affect fish populations and coral habitats, sedimentation from development near stream corridors);
- Insufficient in-stream flows to insure the biological integrity of many stream systems;
- Human impacts on anchialine ponds;
- Localized excessive recreational use at places like Hanauma Bay and Waikīkī;
- Localized point source pollution originating from recreational boats and cruise ships;
- Fisheries bycatch of green sea turtles and seabirds;
- Introduction of invasive marine species in ports and harbors;
- Human and boat interactions with marine mammals along the Wai‘anae Coast;
- Land-based sources of pollution.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for O‘ahu include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Implement conservation actions identified in the ‘Potential Areas for Enhanced Conservation Management’ subsection;
    - Develop and/or implement recovery plans for threatened and endangered species on O‘ahu;
    - Enhance resources to expand management capacity at existing protected wetland habitat (e.g., Kawai Nui and Hāmākua Marsh);
    - Increase active management in, or acquisition of, extremely rare habitats on O‘ahu;
    - Protect remaining intact native forest, wetland habitat, and coastal areas from development through a combination of acquisition, conservation easements, or cooperative agreements with landowners;
    - Increase the total acreage of ungulate-free and predator-free areas;
    - Decrease in number of stream diversions and channelized streams;
    - Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations;
    - Implement fire suppression measures and protocols for post-fire restoration;
    - Protect remaining anchialine ponds;
    - Collaborate in efforts to reduce pollution threats from recreational boats and cruise ships;
    - Develop management plans for all Marine Managed Areas;
    - Support ongoing projects to deal with non-point source pollution in Kāne‘ohe Bay and other watersheds and support expansion of successful methods to other areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve prevention capacity through increased airport inspection and containment barriers around cargo unloading areas;

- Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on O‘ahu;
    - Increase efforts to prevent establishment of priority invasive plants in pristine areas (e.g., miconia) and to eradicate from areas with recovery potential (e.g., mangrove in tidal flats);
    - Expand control of mammalian predators (e.g., feral cats, rats) in waterbird, seabird, and ‘elepaio habitat;
    - Decrease in the overall number of streams negatively impacted by invasive species;
    - Support efforts to strengthen marine alien species prevention and control.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;
    - Assess impact of eco-tourism activities on terrestrial and aquatic native wildlife and associated habitats.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Formalize partnerships with military agencies to manage areas (including State land) for habitat conservation;
    - Encourage additional landowner participation and involvement in Ko‘olau Mountains Watershed Partnership to facilitate conservation actions on these lands;
    - Develop new partnerships with non-traditional partners such as smart growth initiatives to address loss of habitat through development;
    - Expand partnership with hunting community to reduce ungulate populations;
    - Expand current firefighting capacity through greater interagency cooperation (e.g., sharing equipment, training, and fighting capacity);
    - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i.
    - Maintain existing outreach and educational programs at managed conservation areas (e.g., National Wildlife Refuges, Wildlife Sanctuaries);
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas;
    - Expand and broaden public education and outreach to take advantage of the large science and management community on the island;
    - Improve education regarding the destructive impact of nesting seabird disturbance and reef trampling;
    - Develop and provide technical support for the implementation of pilot or demonstration projects by citizen groups, small businesses, or landowners, in areas close to where people live to provide an opportunity to connect residents with O‘ahu’s native wildlife and their needs.
- Support policy changes aimed at improving and protecting native species and habitats.

- Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
- Assess ways to support increased enforcement capacities, including cross-deputization between agencies;
- Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
- Review other species and habitat for inclusion in Hawaiian Islands Humpback Whale National Marine Sanctuary, increase research, education, and enforcement.
- Obtain and implement the plans of an Incidental Take Permit for sea turtle and Hawaiian monk seal bycatch;
- Improved integration of policies to address linkages between terrestrial and marine habitats and their shared conservation threats and needs;
- Develop and implement strategies and policies to encourage proper management of coastal dune system.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Nēnē (Hawaiian goose) (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), the Hawaiian Endangered Bird Partnership for Captive Propagation Five Year Workplan (2002), the Draft Revised Recovery Plan for Hawaiian waterbirds (1999), the Recovery Plan for the Hawaiian Hoary Bat (1998), and the Recovery Plan for the Oʻahu Tree Snails of the Genus Achatinella (1992);
- Critical habitat designations by the USFWS for the Oʻahu ʻelepaio and for threatened and endangered plants on Oʻahu;
- Management Plans for the State Natural Area Reserves (NAR): Kaʻena Point NAR (1989) and Mt. Kaʻala NAR (1990);
- Integrated Natural Resources Management Plans have been developed by the U.S. Army, U.S. Marine Corps, and U.S. Navy to cover their respective installations on Oʻahu;
- The Division of Forestry and Wildlife's (DOFAW) Draft Management Guidelines, which coarsely rate vegetation quality and provide guidelines for land use (public hunting, recreation, and forest products) for State lands managed by DOFAW;
- The Koʻolau Mountains Watershed Partnership Management Plan (2002);
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawaiʻi Implementation Plan for Polluted Runoff Control (2000), Hawaiʻi Unified Watershed Assessment (1998);
- Hawaii's Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;

- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawai‘i;
- The Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on O‘ahu. The discussion of future management needs is highlighted within each current managed area. Some areas on O‘ahu are already under active management or protection through designation as a State Natural Area Reserve (NAR), State Wildlife Sanctuary, National Wildlife Refuge (NWR), or Marine Corps Wildlife Management Area. The Ko‘olau Mountains Watershed Partnership (KMWP) was formed to identify and implement conservation actions needed to preserve the watershed resources of the Ko‘olau mountains, and initial steps are underway to establish a similar partnership in the Wai‘anae mountains. In addition, other partnerships, such as the O‘ahu Invasive Species Committee (OISC) have been formed to address specific species conservation needs.

***Ko‘olau Mountains Watershed Partnership* (97,760 acres), Public-Private Partnership (DLNR-DOFAW, DLNR-State Parks, Department of Hawaiian Home Lands, U.S. Army, USFWS, Honolulu Board of Water Supply, Agribusiness Development Corporation, Queen Emma Foundation, Kamehameha Schools, Bishop Museum)**

> ***Species*:** Forest birds, pueo, terrestrial invertebrates, including land snails, damselflies, bees, beetles, spiders, freshwater fishes (‘o‘opu), freshwater invertebrates, rare plants.
> ***Habitats:*** Lowland wet communities, lowland mesic communities.
> ***Current Management*:** Management plan exists. Fencing, ungulate control, invasive weed control.
> ***Future needs*:** Funding to implement management plan, fencing, ungulate control, invasive weed control, predator control, outplanting.

***O‘ahu Forest NWR* (4,525 acres), USFWS**

> ***Species*:** Forest birds, pueo, terrestrial invertebrates, including land snails, rare plants.
> ***Habitats:*** Lowland wet communities, lowland mesic communities.
> ***Current Management*:** Invasive weed control, ungulate control, predator control.
> ***Future needs*:** Continued management including ungulate and predator control, forest restoration.

***Pahole Natural Area Reserve* (658 acres), DOFAW**

> ***Species*:** Forest birds, terrestrial invertebrates, including land snails, spiders, rare plants.
> ***Habitats:*** Lowland communities.
> ***Current Management*:** No management plan exists. Fencing, ungulate removal from fenced areas, predator control, invasive plant removal, outplanting.

***Future Needs*:** Completion of proposed Kapuna fencing, develop management plan, formalize partnership with U.S. Army for habitat and rare plant management, continue existing management.

***Mt. Ka'ala Natural Area Reserve* (1,100 acres), DOFAW**

***Species*:** Forest birds, terrestrial invertebrates, including land snails, spiders, rare plants.
Habitats: Montane wet communities, lowland wet communities, lowland mesic communities, lowland dry communities.
***Current Management*:** Management plan exists. Fencing, invasive plant removal, maintenance of fencing.
***Future Needs*:** Formalize partnership with U.S. Army for habitat and rare plant management, continue existing management, ungulate and predator control.

***Honouliuli Preserve* (3,582 acres), The Nature Conservancy**

***Species*:** Forest birds, terrestrial invertebrates, rare plants.
Habitats: Lowland communities.
***Current Management*:** Fencing, fire prevention, predator (rat) control, invasive weed removal, ungulate control, habitat restoration, monitoring, research.
***Future Needs*:** Continue existing management.

***Kawailoa Training Area*, U.S. Army**

Species: Birds, snails, rare plants.
Habitats: Lowland wet communities, lowland mesic communities.
Current Management: Management plan exists, ungulate control, fencing.
Future Needs: Implement Integrated Natural Resources Management Plan.

***Kawai Nui and Hāmākua Marsh Complex* (850 acres), DOFAW**

***Species*:** Waterbirds, migratory shorebirds, ʻoʻopu, ʻōpae kalaʻole (shrimp).
Habitats: Lowland communities.
***Current Management*:** Hydrologic studies, habitat restoration, including invasive plant removal and native wetland planting, predator control.
***Future Needs*:** Continue existing management, secure adequate funding to support expanded management (increased predator control, invasive weed removal, habitat restoration, educational opportunities).

***Nu'upia Pond Wildlife Management Area* (482 acres), U.S. Marine Corps Base Hawai'i**

***Species*:** Waterbirds, migratory shorebirds, seabirds, particularly ʻuaʻu kani (wedge-tailed shearwater).
Habitats: Wetlands and ponds.
***Current Management*:** Implementation of Integrated Natural Resources Management Plan (INRMP): predator control, invasive plant (e.g., mangrove) removal, wetland improvements, monitoring.
Future Needs: Continue existing management.

***James Campbell NWR* (222 acres), USFWS**

***Species*:** Waterbirds, migratory birds, terrestrial invertebrates, anchialine pond fauna.

Habitats: Lowland communities, coastal communities.
Current Management**:** Habitat restoration and endangered species protection: predator control, weed control, monitoring.
Future Needs**:** Continue existing management. Increase the area protected and managed in order to accommodate growing populations of endangered waterbirds and migratory birds. Restoration of lowland wet and other coastal plant species.

***Pearl Harbor NWR* (62 acres), USFWS**
Species**:** Waterbirds, migratory birds, terrestrial invertebrates, ‘ōpae‘ula (anchialine pond shrimp).
Habitats: Lowland communities, anchialine pools.
Current Management**:** Habitat restoration and endangered species protection: predator control, weed control, monitoring.
Future Needs**:** Continue existing management.

***Paikō Lagoon* (40 acres), DOFAW**
Species**:** Migratory shorebirds.
Habitats: Coastal communities.
Current Management**:** Volunteer opportunities to participate in non-native plant (e.g., mangrove) control, trash removal, predator control, outplanting.
Future Needs**:** Continue existing management.

***Pouhala Marsh Wildlife Sanctuary* (70 acres), DOFAW**
Species**:** Waterbirds, particularly Hawaiian stilt.
Habitats: Lowland communities.
Current Management**:** Habitat management: predator control, trash removal, mangrove removal, pond restoration.
Future needs**:** Continue existing management.

***Ka‘ena Point Natural Area Reserve* (36 acres), DOFAW**
Species**:** Seabirds, particularly nesting mōlī (Laysan albatross) and ‘ua‘u kani (wedge-tailed shearwater), migratory shorebirds, monk seal, rare plants.
Habitats: Coastal communities.
Current Management**:** Management of human access and activities, invasive weed removal, predator control, outplanting, monitoring, research.
Future Needs**:** Continue existing management, increase monitoring and visitor education.

***Ulupa‘u Wildlife Management Area* (23 acres), U.S. Marine Corps Base Hawai‘i**
Species**:** Seabirds, particularly ‘ā (red-footed booby).
Habitats: Coastal communities.
Current Management**:** Implementation of INRMP: fire risk reduction, habitat enhancement.
Future Needs: Continue existing management.

***State Seabird Sanctuary* (13 offshore islets), DOFAW**

Species**:** Seabirds: ‘ua‘u kani (wedge-tailed shearwater), Christmas shearwater, ‘ewa‘ewa (sooty tern), pākalakala (gray-backed tern), noio (black noddy), noio-kōhā (brown noddy), manu-o-Kū (white tern), bonin petrel, ‘iwa (great frigatebird), ‘ā (red-footed booby), ‘ā (brown booby), ‘ā (masked booby), koa‘e ‘ula (red-tailed tropicbird), koa‘e kea (white-tailed tropicbird), mōlī (Laysan albatross), ka‘upu (black-footed albatross), ‘ou (Bulwer’s petrel), migratory shorebirds.
Habitats: Coastal communities, marine ecosystems.
Current Management**:** Ongoing surveys, predator removal, invasive weed control
Future Needs**:** Continue existing management, identify priority islands for predator eradication and implement, include offshore waters as part of Marine Managed Area.

O‘ahu Invasive Species Committee**, Public-Private Partnership**
Species/Habitats**:** All species and habitats affected by invasive species.
Current Management**:** Identification of priority invasive species, then implementation of control and/or eradication. Current priority species include: miconia, Caribbean frogs, Himalayan blackberry, fountain grass, fire tree, bushy beardgrass, manuka, Indian rhododendron, smoke bush.
Future Needs**:** Adequate funding to support priority OISC actions.

Hawaiian Islands Humpback Whale National Marine Sanctuary **(about 900,000 acres), Co-Managed by NOAA and DLNR.**
Species**:** Humpback whale.
Habitats: Marine ecosystems.
Current Management**:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
Future needs**:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

Three Marine Life Conservation Districts (MLCD), **DAR: Hanauma Bay, Pūpūkea, Waikīkī**
Species**:** Species associated with shallow coral reef, sandy beach, and rocky habitats, Hawaiian monk seals, green sea turtles, spinner dolphins, and other marine mammals.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, rocky habitats.
Current Management**:** Limited access in most MLCDs, eight MLCD include at least some No Take areas, and fish monitoring.
Future needs**:** Evaluate all MLCDs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Five Fishery Management Areas (FMA), **DAR*:* He‘eia Kea Wharf, Honolulu Harbor, Pōka‘i Bay, Waialua Bay, Waikīkī-Diamond Head Shoreline**
Species**:** Some or all regulated fish species.
Habitats: Marine and estuary ecosystems.

Current Management**:** Waikīkī-Diamond Head Shoreline is No Take. Limited take, gear, size, season, and/or area restrictions in other FMAs.
Future needs**:** Evaluate all FMAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Nearshore waters surrounding Kāne'ohe Marine Corps Base, **U.S. Marine Corps Base Hawai'i**
Species: Marine invertebrates, coral reef fishes, and sea turtles.
Habitats: Marine ecosystems: seagrass bed, coral reef.
Current management: 500 foot (150 meter) safety buffer around Kāne'ohe Marine Corps Base enforced for public safety due to proximity to firing range.
Future needs: None at this time.

Coconut Island Wildlife Sanctuaries, **DAR**
Species**:** Marine species.
Habitats: Marine ecosystems: shallow coral reef, sandy beach, and rocky habitats.
Current Management**:** Limited access. No Take.
Future needs**:** Evaluate all Sanctuaries for purpose and management effectiveness and consider need for new Marine Managed Areas.

Four Bottomfish Restricted Areas (BRA), **DAR**
Species**:** Seven Bottomfish species.
Habitats: Marine ecosystems.
Current Management**:** No Take of bottomfish.
Future needs**:** Evaluate all BRAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Potential Areas for Enhanced Conservation Management
In addition to maintaining and enhancing existing conservation actions, additional efforts are needed for the long-term conservation of O'ahu's native wildlife. The following section identifies areas where enhanced conservation management would significantly benefit native species or their habitats. Areas are discussed in habitat order from the mountains to the sea.

Ko'olau Forested Watershed
Species**:** Forest birds, terrestrial invertebrates, rare plants.
Basis for Priority Designation**:** Habitat for rare species, significant acreage of intact lowland wet forest, tracts of remnant lowland dry forest, opportunities for partnership with numerous private landowners.
Potential Conservation Actions: Expand participation in KMWP, facilitate conservation on private lands through technical assistance and funding opportunities, increased ungulate management through fencing and control, invasive weed control and removal, rodent control.

Manoa stream riparian corridor
Species: *Oahuhawaiiana kazukolinda*.
Basis for Priority Designation**:** Few intact stream corridors remaining statewide.

Potential Conservation Actions: Secure additional protection, fencing, support voluntary and incentive based programs for conservation on private lands.

Wai'anae Forested Watershed

Species: Forest birds, native invertebrates, rare plant taxa.
Basis for Priority Designation: Habitat for rare species, intact lowland mesic forest, emerging public-private partnership currently encompassing 5,800 acres involving DOFAW, Board of Water Supply, non-governmental organizations, community. Opportunities for expanded partnerships. Multiple planning efforts underway (U.S. Army Mākua Mitigation Plan; Board of Water Supply watershed plans).
Potential Conservation Actions: Expand and strengthen emerging partnership, integrate existing conservation management, ungulate control, invasive weed control, fire prevention.

Wetland Habitats

Species: Waterbirds, migratory shorebirds and waterfowl, terrestrial invertebrates, freshwater fishes, freshwater invertebrates.
Basis for Priority Designation: Insufficient number of protected and managed wetlands to support growth of endangered waterbird populations.
Potential Conservation Actions: Increase active management of areas currently used by waterbirds using predator control, invasive plant removal, and wetland restoration, identify priority areas for protection and management, secure adequate funding for management and restoration of wetlands, develop emerging partnership of landowners (DLNR, Hawai'i Community Development Authority, Kamehameha Schools) at He'eia into model for cooperative management across an *ahupua'a* (from the mountains to the ocean).

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MOLOKAʻI

Molokaʻi is the fifth largest of the Main Hawaiian Islands. While fairly small in geographic size, the island supports a wide-range of native habitats and a diversity of native wildlife. The mountains of eastern Molokaʻi are cut into deep valleys by perennial streams, and due largely to their inaccessibility, these valleys contain high-quality native habitat for stream fauna, forest birds, and native snails and insects. The coastal strand along the island's northwest coast contains one of the State's last intact dune systems and is important to nesting seabirds and marine animals. Habitat community types found on Molokaʻi include lava tube caves, montane bogs, and wet forests. Important geographic features include the State's third largest perennial stream, and the highest sea cliffs in the world.

OVERVIEW

Geology and Hydrology

Molokaʻi is approximately 1.8 million years old and 68,000 hectares (170,240 acres) in size. Three shield volcanoes comprise most of the island, with the East Molokaʻi Mountains making up half of the island area. The highest point on the island is 1,515 meters (4,970 feet), and steep cliffs characterize the northern windward coast with inaccessible deep valleys dissecting the coastal area. The leeward slopes descend to a narrow coastal plain fronting an extensive shallow offshore reef flat. The terrain of western Molokaʻi was formed by an older volcano, and has a maximum elevation of 421 meters (1,351 feet). This side of the island is typically dry and windy. The Kalaupapa peninsula, formed by the third volcano, extends from the north-central coast, below the steep sea cliffs of eastern Molokaʻi. Approximately 37 percent of the island is below 150 meters (500 feet) in elevation, and about 18 percent of the island is above 610 meters (2,000 feet) in elevation. Molokaʻi has 36 perennial streams, 16 of which are continuous. Wailau-Pulena and Pelekunu have the largest discharges, 27 and 25 million gallons per day (mgd), respectively. Molokaʻi has nine offshore islets.

Climate

Annual rainfall ranges from 406 centimeters (160 inches) at the top of the East Molokaʻi Mountains, to 38 centimeters (15 inches) along the coasts of the leeward side of the island.

Land and Water Use

The majority of land on the island is in the State Agricultural District (67% or 44,651 hectares/111,627 acres). Approximately 30 percent (or 19,907 hectares/49,768 acres) is in the State Conservation District, primarily covering the East Molokaʻi Mountains and the coastlines. The remaining land is either in the Urban (2% or 1,016 hectares/2,539 acres) or Rural (1% or 746 hectares/1,866 acres) Districts. Ten percent of the island (6,412 hectares/16,030 acres) is in Forest Reserve. There are also 10,308 hectares (25,769 acres) of Department of Hawaiian Home Lands (16% of the island). Within native dominated landscapes, major landowners include the State of Hawaiʻi and private entities such as The Nature Conservancy of Hawaiʻi, Kamehameha Schools, Puʻu O Hoku Ranch, and Molokaʻi Ranch. One stream (Kamalo) has an altered channel. The Waikolu canal in the northeast is the largest man-made stream system at five mgd. Kualapuʻu Reservoir is a significant man-made lake at 15 meters (50 feet) deep and 40 hectares (100 acres) in area.

Human Landscape
Total resident population on the island is estimated at 7,500, with an average daily visitor count of 955. A majority of the population is centered in the Kaunakakai and Hoʻolehua areas in central Molokaʻi. Molokaʻi has the second highest percentage of Native Hawaiians in the State, and many of these residents engage in traditional practices of subsistence gathering. In 1999, the island was named an "Enterprise Community" through the USDA Empowerment Zone program, a designation which provides Federal funds to support economic growth and community development. The major industries are agriculture, ranching, and flower cultivation.

SPECIES AND HABITATS OF IMPORTANCE
Molokaʻi is home to a variety of habitats. Major habitat types include montane wet forests and shrublands, coastal system (including dunes and grasslands), perennial streams, lava tubes and caves, cliffs, bog communities, and nine offshore islets. Molokaʻi contains recovery habitat identified by the USFWS for the Maui parrotbill (*Pseudonestor xanthophrys*) and ʻākohekohe (*Palmeria dolei* [crested honeycreeper]). Additionally, 1,242 hectares (3,105 acres) in East Molokaʻi has been designated by the USFWS as critical habitat for the Blackburn's sphinx moth (*Manduca blackburni*), which partially overlaps with 9,733 hectares (24,333 acres) designated as critical habitat for 41 endangered plants on Molokaʻi.

Appendix A provides information on what wildlife Species of Greatest Conservation Need are present on Molokaʻi and its associated offshore islands. Most of Molokai's endemic forest birds are likely extinct; however ʻiʻiwi (*Vestiaria coccinea*), ʻamakihi (*Hemignathus virens*), and ʻapapane (*Himatione sanguinea*) still persist at low numbers. In addition, Molokaʻi supports populations of several endangered and threatened species, such as ʻōpeʻapeʻa (*Lasiurus cinereus semotus* [Hawaiian hoary bat]), the nēnē (*Branta sandvicensis* [Hawaiian goose]), aeʻo (*Himantopus mexicanus knudseni* [Hawaiian stilt]), ʻalae keʻokeʻo (*Fulica alai* [Hawaiian coot]), ʻuaʻu (*Pterodroma sandwichensis* [Hawaiian petrel]), ʻaʻo (*Puffinus auricularis newelli* [Newell's shearwater]), and the Blackburn's sphinx moth. Other species groupings that can be found on Molokaʻi are terrestrial invertebrates, freshwater fishes, freshwater invertebrates, seabirds, migratory birds, and raptors.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS
Many general threats to native wildlife and habitats are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats that are more acute or specific to Molokaʻi are listed below.

- Large numbers of goats (*Capra hircus*) occur at mid-elevations on the south slope of east Molokaʻi, denuding vegetation, pushing back the forest line, and contributing to soil erosion and runoff onto the nearshore reefs, thereby affecting both forest and marine species;
- Range expansion by invasive plants threatens the native-dominated core of east Molokaʻi;
- The presence of pigs (*Sus scrofa*) and axis deer (*Axis axis*) in areas of pristine, high-quality native forest degrades important habitat for the remaining arthropods, forest birds, and snails;
- The relative isolation and small size of forest bird populations makes these species extremely vulnerable to disturbances and unexpected disasters such as hurricanes or

wildfires that could lead to their extinction. The degree to which this is also true for arthropods and snails is unknown;

- Development of formerly undeveloped areas (especially along the southeastern coast) leading to loss and degradation of terrestrial, freshwater, and marine habitat (e.g., increased nutrients in coastal areas leads to non-native algal blooms which affect fish populations and coral habitats, sedimentation from development near stream corridors);
- Introduced predators (vertebrate and invertebrate) in native landscapes that prey on native birds, snails, and other invertebrates either directly, or indirectly, through competition for food and other resources;
- Nest burrow usurpation, or trampling by ungulate and human traffic, and disease by arthropod vectors for seabirds;
- Wildfire;
- Lack of enforcement for existing rules and regulations;
- Expanding eco-tourism activities that disrupt animal behaviors and habitats.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Molokaʻi include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ʻManagement Needs' section;
    - Implement conservation actions identified in the ʻPotential Areas for Enhanced Conservation Management' subsection;
    - Develop and/or implement recovery plans for threatened and endangered species on Molokaʻi;
    - Increase active management in, or acquisition of, extremely rare habitats on Molokaʻi;
    - Increase DOFAW capacity to support on-site management and coordination with Molokaʻi partners;
    - Implement fire suppression measures and protocols for post-fire restoration;
    - Increase the total acreage of ungulate-free and predator-free areas;
    - Assess potential reintroduction of native birds historically found on Molokaʻi;
    - Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations;
    - Develop management plans for all Marine Managed Areas;
    - Support Local Action Strategies project to deal with non-point source pollution off the south coast and support expansion of successful methods to other areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on Molokaʻi (e.g., *Tibouchina herbacea* and *Miconia calvescens*);

  - Increase efforts to prevent establishment of priority invasive plants in pristine areas and to eradicate from areas with recovery potential;
  - Support efforts to strengthen marine alien species prevention and control.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
  - Improve dissemination of research and data regarding native species populations and habitat condition;
  - Conduct surveys and inventories for invertebrates in currently managed areas;
  - Increase bat surveys to better assess bat distribution;
  - Assess impact of eco-tourism activities on terrestrial and aquatic native wildlife and associated habitats.
- Strengthen existing and create new partnerships and cooperative efforts.
  - Support ongoing and future projects to deal with Non-Point Source Pollution;
  - Support community based management of terrestrial and aquatic habitats;
  - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawaiʻi.
  - Maintain existing outreach and educational programs at managed conservation areas;
  - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas.
- Support policy changes aimed at improving and protecting native species and habitats.
  - Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
  - Assess ways to support increased enforcement capacities, including cross-deputization between agencies;
  - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
  - Improve integration of policies to address linkages between terrestrial and marine habitats and their shared conservation threats and needs.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Nēnē (Hawaiian goose) (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), the Hawaiian Endangered Bird Partnership for Captive Propagation Five Year Workplan (2002), the Draft Revised Recovery Plan for Hawaiian waterbirds (1999), and the Recovery Plan for the Hawaiian Hoary Bat (1998), the Draft Recovery Plan for the Blackburn’s sphinx moth (2003);
- Critical habitat designations by the USFWS for the Blackburn’s sphinx moth and for threatened and endangered plants on Molokaʻi;
- Management Plans for the State Natural Area Reserves (NAR): Olokui NAR (1991), Puʻu Aliʻi NAR (1991);

- Long-Range Management Plans for Natural Area Partnership Preserves (NAPP): Mo‘omomi NAPP (2000); Kamakou NAPP (2000); Pelekunu NAPP (2003);
- The Division of Forestry and Wildlife’s (DOFAW) Draft Management Guidelines, which coarsely rate vegetation quality and provide guidelines for land use (public hunting, recreation, and forest products) for State lands managed by DOFAW;
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawai‘i Implementation Plan for Polluted Runoff Control (2000), Hawai‘i Unified Watershed Assessment (1998);
- Hawaii’s Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;
- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawai‘i;
- The Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Moloka‘i. The discussion of future management needs is highlighted within each current managed area. Some areas on Moloka‘i are already under active management or protection through designation as a State Natural Area Reserve (NAR), Natural Area Partnership Preserve, National Park, or National Wildlife Refuge (NWR). The East Molokla‘i Watershed Partnership (EMoWP) extends similar management over private lands, resulting in the protection of a contiguous 760 hectare (19,000 acre) block of the most intact portion of the native-dominated landscape. The Moloka‘i subcommittee of the Maui Invasive Species Committee (MoMISC) addresses high priority invasive species on an island-wide basis. Additional conservation management benefiting native wildlife occurs on a more localized basis, based on funding availability and landowner or community support. Examples include nēnē re-introduction on private lands and Mo‘omomi coastal strand restoration. Finally, DOFAW working with USFWS has a programmatic Safe Harbor Agreement for nēnē on Moloka‘i, allowing the agency to enroll individual landowners who enhance, restore, or maintain habitat to benefit nēnē, protecting them from Endangered Species Act requirements if nēnē numbers increase due to their conservation actions.

***East Moloka‘i Watershed Partnership (EMoWP)* (19,000 acres), Public-Private Partnership (NPS, TNC, DOFAW, Kamehameha Schools, Kapualei Ranch, Kawela Plantation, Ke Aupuni Lōkahi Enterprise Community Governance Board, individual private landowners, Hawai‘i Department of Health, Maui County, Maui County Department of Water Supply,**

Molokaʻi-Lānaʻi Soil and Water Conservation District, USDA, USGS, U.S. Environmental Protection Agency)

> ***Species:*** All species found on partner lands listed below.
> ***Habitats*****:** Montane wet communities, lowland communities, coastal communities, marine systems.
> ***Current Management***: Management plan exists. Phase I fencing along the south slope of the East Molokaʻi Mountains.
> ***Future Needs***: Continue fencing excluding ungulates and predators from upper south slope of East Molokaʻi mountains in cooperation with private landowners, maintain fences.

Kalaupapa National Historic Park **(10,779 acres, in addition 2 offshore islets), NPS**

> ***Species:*** ʻAmakihi, ʻapapane, ʻiʻiwi, ʻuaʻu (Hawaiian petrel), ʻaʻo (Newell's shearwater), koaʻe kea (white-tailed tropicbird), koaʻe ʻula (red-tailed tropicbird), ʻā (brown bobby), ʻou (Bulwer's petrel), ʻuaʻu kani (wedge-tailed shearwater), cave invertebrates, Hawaiian monk seal, hōnu (green and hawksbill), five native diadromous fish (goby) species, native snails, shrimp.
> ***Habitats:*** Montane wet communities, lowland communities, coastal communities. Kauhakō Crater contains only known low elevation dryland forest known in the State.
> ***Current Management***: Management plan exists. One-time inventories for bats, herptofauna, vascular plants, anchialine pond fauna, and marine fishes. Invasive plant control, fencing, ungulate control, water quality monitoring. Marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bat, terrestrial invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality). ʻOpihi and reef monitoring and research, monk seal monitoring and protecting, and coral recruitment project.
> ***Future Needs***: Continue existing management. Establish monitoring program for nesting sea turtles, establish program to study oceanographic currents and marine water quality, and continue monitoring of coral reef fishes, benthic fishes, and invertebrates.

Kamakou Preserve **(2,774 acres), TNC**

> ***Species:*** ʻAmakihi, ʻapapane, ʻiʻiwi, five rare native land snails, native insects.
> ***Habitats***: Montane wet communities, lowland mesic communities.
> ***Current Management***: Management plan exists. Fence maintenance, ungulate control through trapping, invasive plant control and eradication, fire prevention, monitoring, rare species outplanting, community outreach.
> ***Future Needs***: Continue existing management.

Pelekunu Preserve **(5,714 acres), TNC**

> ***Species:*** ʻIʻiwi, ʻapapane, ʻamakihi, ʻaukuʻu (black-crowned night-heron), ʻūlili (wandering tattler), koaʻe kea (white-tailed tropicbird), *Partulina mighelsiana, P. tessellata*, *Megalagrion santhomelas, M. pacificum*, beetles, five native freshwater fishes, freshwater snail, hihiwai, two native crustaceans, ʻopae kalaʻole, ʻopaeʻoheaʻa, rare aquatic insects, *Campsicnemus ridiculus.*

Habitats: Montane wet communities, lowland communities, coastal communities. Free-flowing streams.
Current Management: Management plan exists. Ungulate control, invasive plant monitoring and control, natural resource and water quality monitoring.
Future Needs: Continue existing management.

Oloku‘i NAR **(1,620 acres), DOFAW**

Species: ‘Apapane, ‘amakihi, ‘i‘iwi, koa‘e kea (white-tailed tropicbird), ‘a‘o (Newell’s shearwater), ‘ua‘u (Hawaiian petrel), native insects (crickets, katydid, flies, spiders), rare tree snails (*Achatinella* spp., *Partulina mighelsiana*, *P. tessellata, P. dwightii, Newcombia cinnamomea*).
Habitats: Montane wet communities, montane mesic communities, lowland wet communities, coastal communities, perennial streams.
Current Management: Management plan exists. Aerial and ground monitoring for feral ungulates and invasive plants.
Future Needs: Continuation of existing efforts to maintain Olokui in pristine condition.

Pu‘u Ali‘i NAR **(1,330 acres), DOFAW**

Species: Oloma‘o, ‘i‘iwi, pueo, ‘apapane, ‘amakihi, ‘a‘o (Newell’s shearwater), ‘ua‘u (Hawaiian petrel), native invertebrates (crickets, drosophilid flies, happyface spiders, Tornatellinid snails, Succinid snails, four species of *Achatinella* land snails, *Partulina tessellata, P. redfieldii, P. proxima, P. mighelsiana*).
Habitats: Perennial streams, montane wet shrublands and forests, upper half has most intact communities.
Current Management: Management plan exists. Ungulate control, fence maintenance, invasive plant control.
Future Needs: Fencing to restrict ungulate movement in a larger portion of the NAR, ungulate removal, continuation of existing efforts.

Kakahai‘a NWR **(45 acres), USFWS**

Species: Ae‘o (Hawaiian stilt), ‘Alae ke‘oke‘o (Hawaiian coot), migratory shorebirds.
Habitats: Contains 15-acre freshwater pond, seven-acre impoundment, and marshy thicket of bulrushes.
Current Management: Environmental education, habitat restoration, invasive species removal.
Future Needs: Continue existing management.

Mo‘omomi Preserve **(921 acres), TNC**

Species: Pueo, hunakai (sanderling), kōlea (Pacific golden plover), ‘iwa (great frigatebird), mōlī (Laysan albatross), Hawaiian monk seal, honu (green sea turtle).
Habitats: Coastal communities.
Current Management: Management plant exists. Nonnative species control, weed control, resource monitoring and research, community outreach, and rare species protection.
Future Needs: Continue existing management.

***State Seabird Sanctuary* (Seven offshore islands), DOFAW**

Species: ʻAukuʻu (black-crowned night-heron), ʻuaʻu kani (wedge-tailed shearwater), ʻou (Bulwer's petrel), koaʻe kea (white-tailed tropicbird), koaʻe ʻula (red-tailed tropicbird), ʻā (brown booby), kōlea (Pacific golden plover), ʻūlili (wandering tattler), ʻakekeke (ruddy turnstone), yellow-faced bees (*Hylaeas* spp.).
Habitats: Coastal communities.
Current Management: Monitoring, surveys.
Future Needs: Removal of small mammalian predators and native vegetation habitat restoration.

***Molokaʻi Invasive Species Committee*, Public-Private Partnership**

Species/Habitats: All species and habitats affected by invasive species.
Current Management: Invasive species prevention and control.
Future Needs: Continued support to identify, control, and eradicate high priority invasive species, increase prevention surveillance.

***Hawaiian Islands Humpback Whale National Marine Sanctuary* (about 900,000 acres), Co-Managed by NOAA and DLNR.**

***Species*:** Humpback whale.
Habitats: Marine ecosystems.
***Current Management*:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
***Future needs*:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

***One Fishery Management Area (FMA),* DAR*:* Kaunakakai Harbor**

Species: Some or all regulated fish species.
***Habitats*:** Marine and estuary systems.
***Current Management*:** Limited take, gear, size, season, and/or area restrictions.
***Future needs*:** Evaluate all FMAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

***One Bottomfish Restricted Area (BRA),* DAR**

Species: Seven bottomfish species.
***Habitats*:** Marine ecosystems.
***Current Management*:** No Take of bottomfish.
***Future needs*:** Evaluate all BRAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Potential Areas for Enhanced Conservation Management

In addition to maintaining and enhancing existing conservation actions, additional efforts are needed for the long-term conservation of Molokai's native wildlife. The following section identifies areas where enhanced conservation management would significantly benefit native species or their habitats. Areas are discussed in habitat order from the mountains to the sea.

***Moloka'i Forest Reserve* (16,030 acres), DOFAW**

***Species*:** Forest birds, terrestrial invertebrates.

***Basis for Priority Designation*:** Good quality native forest, lowland mesic shrubland, part of EMoWP adjacent to core forested areas, little active management for native wildlife conservation.

Potential Conservation Actions: Control of invasive plants (biocontrol was introduced to halt spread of *Clidemia* to pristine areas), more intensive management for conservation in upper Waimanu and Mokomoko sections, review management policies to bring in line with quality of habitat.

Watershed area east of Kapualei

***Species*:** Forest birds, terrestrial invertebrates.

***Basis for Priority Designation*:** Relatively intact native habitat, protection against browsing by feral goats would reduce vegetation loss and soil erosion, thereby reducing sedimentation onto nearshore reefs.

Potential Conservation Actions: Assess future partnership opportunities and create incentives for conservation management.

Stream corridors (*Wailau*)

***Species*:** Freshwater fishes, freshwater invertebrates, terrestrial invertebrates.

***Basis for Priority Designation*:** One of the major stream corridors on the island not impacted by ungulates and invasive plants.

Potential Conservation Actions: Monitor stream health, assess for future management needs.

***Cave Ecosystems* (Kalaupapa and montane rain forest on the slopes of Kawela)**

***Species*:** Invertebrates.

***Basis for Priority Designation*:** Unique ecosystems – only habitat for certain endemic invertebrates.

Potential Conservation Actions: Protection from human intrusion, invasive alien species, invasive microorganisms, wild fires, and ungulates.

***Coastal Wetlands* (Paialoa Pond**, Pālaau wetlands, **Kaunakakai** Sewage Treatment Plant, **'Ōhi'apilo** Playa, coastal fishponds, **Kualapu'u** Reservoir, Ho'olehua wetlands)

***Species*:** Waterbirds, migratory birds.

***Basis for Priority Designation*:** These areas have been identified by the USFWS and the Pacific Coast Joint Venture as core (bolded) and supporting areas for waterbird recovery.

Potential Conservation Actions: Restoration and management: increase and create open water surface, establish permanent water sources, control weeds, and restore native vegetation, conduct predator control.

North and West Shore Coastal Strand

***Species*:** Seabirds, Hawaiian monk seal, honu (sea turtle).
***Basis for Priority Designation*:** Important, heavily used habitat for seabirds and marine animals.
Potential Conservation Actions: Restoration of native vegetation, limit human disturbance, predator control.

***ʻĪlio Point,* State Land**

***Species*:** Seabirds.
***Basis for Priority Designation*:** Lithified sand dunes support quality intact mixed coastal shrubland. Used by nesting seabirds. Threatened by axis deer, invasive plants, feral cats, and pigeons. High restoration potential for coastal strand ecosystem and seabird habitat.
Potential Conservation Actions: Presence of unexploded ordnance limits conservation activities. Deer-proof fencing and predator control needed.

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LĀNA‘I

Lāna‘i is the third smallest of the Main Hawaiian Islands. Because of the history of overgrazing by cattle, goats, and axis deer, most of the island has suffered from extensive soil erosion and few native-dominant natural communities remain. Though many species once native to Lāna‘i are now gone, the last major remnant of the olopua/lama dryland forest that once covered large portions of the lowlands of Maui Nui (composed of Maui, Lāna‘i, Moloka‘i, and Kaho‘olawe) occurs on Lāna‘i. This forest is habitat to several taxa of native invertebrates. The upland area surrounding the island's highest point, Lāna‘ihale, contains most of the remaining native-dominated mesic forest and is habitat for the ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]), ‘apapane (*Himatione sanguinea*), and rare land snails. Waterbird species rely primarily on man-made reservoirs (e.g., the Lāna‘i Sewage Treatment Plant), rather than natural wetlands.

OVERVIEW

Geology and Hydrology

Lāna‘i was formed from a single dome-shaped shield volcano that last erupted over one million years ago. Only 29 kilometers (18 miles) long and 21 kilometers (13 miles) wide, the island is approximately 36,520 hectares (90,500 acres). The highest point is Lāna‘ihale, at 1,027 meters (3,370 feet). The northeastern coast is fringed with broad sandy beaches, while the southwestern coast is marked by sea cliffs. Approximately 25 percent of the island is below 150 meters (500 feet) in elevation; only 6 percent of the island is above 610 meters (2,000 feet) in elevation. Lāna‘i has five offshore islets. There are no perennial streams or lakes.

Climate

Located in the rain shadow of Maui, Lāna‘i is generally dry, with an average rainfall of 75 to 100 centimeters (30 to 40 inches) over Lāna‘ihale and less than 25 centimeters (ten inches) on the southwestern (leeward) side of the island. A large portion of the water in the island's aquifer comes from "fog drip," moisture pulled from clouds by trees and ferns in upper elevations. Strong tradewinds funneled from Maui and Moloka‘i increase evaporation of moisture and contribute to soil erosion, particularly on the western side of the island.

Land and Water Use

Approximately 42 percent (15,457 hectares or 38,197 acres) of the island is in the Conservation District, located primarily around Lāna‘ihale and on the western end of the island. This area partly overlaps the Lāna‘i Cooperative Game Management Area. Most of the remaining acreage is in the Agricultural District (52%), with about four percent in the Urban District (concentrated around Lāna‘i City, Mānele Bay and the airport) and two percent in the Rural District (located primarily along remote coastlines). Nearly the entire island (98%) is privately owned by Castle and Cooke, Inc. Four of the five offshore islands are in the State Seabird Sanctuary. Approximately 12,140 hectares (30,000 acres) are leased by State Division of Forestry and Wildlife (DOFAW) for use as the Lāna‘i Cooperative Game Management Area.

Human Landscape

In 2000, the residential population of the island was estimated at 3,193 persons. A majority of the population is centered in Lānai City. In the early 1990s, with the closure of a large pineapple plantation and opening of two resorts at Kō‘ele and Mānele Bay, the island's economic base shifted from agriculture to tourism and resort-residential development. The number of annual visitors grew from 46,052 in 1990 to a high of 106,036 in 1997.

SPECIES AND HABITATS OF IMPORTANCE

Habitats on Lānaʻi are primarily lowland dry communities and coastal communities. While few areas of native-dominant vegetation remain, there are opportunities for habitat restoration through a combination of fencing to exclude ungulates (hooved animals), outplanting of native species, and invasive plant control.

Appendix A provides information on the wildlife Species of Greatest Conservation Need present on Lānaʻi and its associated offshore islands. Species endemic to Lānaʻi include several species of Lānaʻi tree snail (*Partulina* spp.). Although once abundant, these species are currently near extinction due to loss of habitat, recreational collecting, and predation by non-native carnivorous snails. Waterbirds and migratory shorebirds use remnant wetlands, and the ʻuaʻu (*Pterodroma sandwichensis* [Hawaiian petrel]) is believed to nest on the sea cliffs. Historically, Lānaʻi was home to eight species of forest birds. Although several are now extinct, the possibility exists for re-introduction of ʻiʻiwi (*Vestiaria coccinea*), ʻamakihi (*Hemignathus virens*), and ʻōʻū (*Psittirostra psittacea*). The U.S. Fish and Wildlife Service (USFWS) has designated critical habitat for two plants: *Tetramolopium remyi* and *Bidens micrantha kalealaha*.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats more acute or specific to Lānaʻi are listed below. Because Lānaʻi has no perennial streams, there are no identified threats specific to freshwater species on Lānaʻi.

- Habitat degradation caused by feral ungulates, specifically axis deer (*Axis axis*), sheep (*Ovis aries*), and goats (*Capra hircus*), which contributes to erosion and sedimentation of near-shore reefs;
- Introduction of invasive species via the ferry from Maui;
- Degradation of habitat by introduced plant species, with kāhili ginger (*Hedychium gardnerianum*), strawberry guava (*Psidium cattleianum*), fountain grass (*Pennisetum setaceum*), and molasses grass (*Melinis minutiflora*) among the most important;
- Threat of fire, exacerbated by non-native grasses;
- Predation of nesting ʻuaʻu (Hawaiian petrel) by feral cats (*Felis silvestris*), dogs (*Canis familiaris*), barn-owls (*Tyto alba*), cattle egrets (*Bubulcus ibis*), and rodents (e.g., *Rattus* spp.);
- Predation of endemic tree snails by alien carnivorous snails (e.g., *Euglandina rosea*);
- Localized excessive recreational use (e.g., Mānele Bay);
- Human and boat interactions with marine mammals.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Lānaʻi include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.

- Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Develop and/or implement recovery plans for threatened and endangered species on Lānaʻi;
    - Increase active management in, or acquisition of, extremely rare habitats on Lānaʻi;
    - Increase the total acreage of ungulate-free and predator-free areas;
    - Assess potential reintroduction of native birds historically found on Lānaʻi;
    - Institute landscape-level predator management (primarily rodent and feral cat) around suspected ʻuaʻu (Hawaiian petrel) nesting colonies;
    - Evaluate methods to maintain old plantation roads as firebreaks;
    - Support restoration efforts on the island, particularly of native habitats and areas adjacent to watershed;
    - Erosion control and restoration/reforestation of northeast portion of island to minimize sedimentation and runoff into coastal area and ocean;
    - Develop management plans for all Marine Managed Areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on Lānaʻi; explore the feasibility of inspection of persons and materials arriving via the ferry from Maui;
    - Inventory existing terrestrial and aquatic invasive species and prioritize control actions.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;
    - Conduct forest bird survey to update information on populations.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Support efforts to develop community-based management;
    - Support projects to deal with Non-Point Source Pollution;
    - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawaiʻi.
    - Explore opportunities for community-based wildlife surveys and monitoring;
    - Maintain existing outreach and educational programs at managed conservation areas;
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
    - Review other species and habitat for inclusion in Hawaiian Islands Humpback Whale National Marine Sanctuary, increase research, education, and enforcement.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Long-range management plan for Natural Area Partnership Preserve: Kānepuʻu Preserve (2004);
- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), and the Draft Revised Recovery Plan for Hawaiian waterbirds (1999);
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawaiʻi Implementation Plan for Polluted Runoff Control (2000), Hawaiʻi Unified Watershed Assessment (1998);
- Hawaii's Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;
- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawaiʻi;
- The Hawaiʻi Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Lānaʻi. The discussion of future management needs is highlighted within each current managed area. In comparison to other islands, Lānaʻi has few areas managed for the long-term conservation of native wildlife. There are no National Parks or Wildlife Refuges, State Forest Reserves, Natural Area Reserves, or Wildlife Sanctuaries, and no on-island Invasive Species Committee.

***Kānepuʻu Preserve* (590 acres), TNC and ʻIke ʻĀina**

> ***Species:*** ʻApapane, pueo, kōlea (Pacific golden plover).
> ***Habitats:*** Lowland dry communities, particularly olopua/lama dryland forest.
> ***Current Management***: Management plan exists. Maintenance of fencing; deer control, invasive plant control, outplanting of native plants as part of Natural Area Partnership Program.
> ***Future Needs***: Maintenance of existing fencing, weed control, community involvement.

***Lāna‘i Watershed Partnership* (20,000 acres), Public-Private Partnership (Castle & Cooke, DOFAW, USFWS, NRCS, TNC, County of Maui Department of Water Supply, Bishop Museum)**

Species: ‘Apapane, ‘ua‘u (Hawaiian petrel), tree snails.
Habitats: Lowland mesic communities, lowland dry communities.
Current Management: Management strategy exists but no formalized plan. Fencing of 1,450 hectare (3,600 acres) at Lāna‘ihale summit, ungulate (primarily deer) removal, native outplanting and reforestation.
Future Needs: Funding to complete fencing and ungulate removal, reforestation.

***State Seabird Sanctuary* (4 offshore islets), DOFAW**

Species: Nesting seabirds, primarily noio (black noddy), koa‘e ‘ula (red-tailed tropicbird).
Habitats: Coastal community.
Current Management: No management plan exists. Surveys and monitoring of seabird populations.
Future Needs: Continue surveys, predator control.

***Hawaiian Islands Humpback Whale National Marine Sanctuary* (about 900,000 acres), Co-Managed by NOAA and DLNR.**

***Species*:** Humpback whale.
Habitats: Marine ecosystems.
***Current Management*:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
***Future needs*:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

***Mānele-Hulopo‘e Marine Life Conservation District (MLCD),* DAR**

***Species*:** Species associated with shallow coral reef, sandy beach, and rocky habitats, Hawaiian monk seals, green sea turtles, spinner dolphins, and other marine mammals.
Habitats: Marine ecosystems, including shallow coral reef, sandy beach, and rocky habitats.
***Current Management*:** Allow fishing throughout MLCD and fish monitoring.
Future Needs: Evaluate all MLCDs for purpose and management effectiveness and consider need for new Marine Managed Areas.

***Mānele Harbor Fishery Management Area (FMA),* DAR**

***Species*:** Some or all regulated fish species.
Habitats: Marine and estuary ecosystems.
***Current Management*:** Limited take, gear, size, season, and/or area restrictions.

Future Needs: Evaluate all FMAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

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MAUI

Maui is the second largest island in the State of Hawai'i and is known as the Valley Isle. Thirty percent of the island is dominated by native vegetation with most of this habitat in east Maui. The upper elevation slopes and summits of both east and west Maui are typically native dominated, with coastal and lower elevation areas dominated by non-native vegetation. Three notable areas contain continuous native vegetation spanning a range of habitats, forming a landscape with a high diversity of total species: summit and leeward west Maui (wet forests and bogs transitioning to lowland mesic communities), windward east Maui (subalpine shrubland transitioning to wet forest), and leeward east Maui (subalpine community transitioning to remnant montane mesic then lowland and coastal dry communities). In addition, large tracts of intact native-dominated montane forests remain, with a canopy composed primarily of 'ōhi'a (*Metrosideros polymorpha*) and koa (*Acacia koa*) and a well-developed sub-canopy layer of mixed native understory trees and shrubs. Habitat types are highly diverse, including coastal and wetland habitats, lava tube caves, aeolian habitats, and bogs. Maui also has ten offshore islets that are significant habitats for seabirds. Anchialine ponds, which host a unique fauna of amphipods and shrimp, are found in young lava fields. As a result of the range of habitats, a diversity of species can be found including cave insects, endangered forest birds, marine mammals, and endemic freshwater fishes.

OVERVIEW

Geology and Hydrology

At 186,163 hectares (465,408 acres), Maui was formed between 750,000 and 1.3 million years ago, as first west Maui then east Maui emerged from two large shield volcanoes (West Maui and Haleakalā). Haleakalā is the tallest peak at 3,055 meters (10,023 feet), with Pu'u Kukui in West Maui coming in second at 1,764 meters (5,788 feet). Maui is the only island (other than Hawai'i) containing alpine and subalpine communities. Approximately 25 percent of the island is below 150 meters (500 feet) in elevation; just over 40 percent is above 610 meters (2,000 feet) in elevation. Major streams include Palikea (the second largest perennial stream in the State), Kalialinui-waialae gulch (the State's second longest stream), Honokohau stream (the longest stream channel in west Maui), and 'Īao stream. Maui has 90 perennial streams, 56 of which are continuous. Waihe'e and 'Īao streams have the largest discharges - 60 and 43 million gallons per day (mgd) respectively. Many streams are diverted; Maui has the highest diversion of natural stream flows in the State. Kanahā Pond, historically a natural freshwater lake, is approximately one meter (three feet) in depth and 16 hectares (41 acres) in size and is located wholly within the Kahului Airport boundary area. Maui has ten offshore islets.

Climate

Because of the size and elevation range of Haleakalā, climate and vegetation communities vary dramatically. Warm trade winds meet the windward side of the volcano and leave most of their moisture behind as rain or cloud drip on the windward side. At high elevations and on the leeward slopes of Haleakalā, dry conditions predominate. The geologically older West Maui mountains receive an average rainfall of 1,016 centimeters (400 inches) per year, making it the second wettest spot in the State.

Land and Water Use

Land use designations according to the State Land Use Commission are 53 percent Agricultural District, 42 percent Conservation District, five percent Urban District, and less than one percent Rural District. Major land owners in West Maui include the State of Hawaiʻi, Maui Land and Pineapple, Inc., C. Brewer, Inc., AMFAC/JMB Hawaiʻi, Kamehameha Schools, and Maui County (Department of Water Supply). In East Maui, major land owners are the State of Hawaiʻi (including the Department of Hawaiian Home Lands), the National Park Service, Alexander and Baldwin, and Haleakalā Ranch. Fifty-seven streams are diverted and seven have altered channels. ʻĪao is the largest altered stream. Maui has ten impaired streams under EPA Clean Water Act standards. The East Maui canal system in Central Maui is the largest man-made stream system at 164 million gallons per day.

Human Landscape

Estimated human population for the island is 117,000 with most of the island's population located in central, south, and west Maui in areas such as Kahului and Wailuku, Kīhei, and Lahaina and Kaʻanapali. The average daily visitor population is approximately 44,000. Major industries are tourism, agriculture, ranching, and flower cultivation.

SPECIES AND HABITATS OF IMPORTANCE

Given the five elevation zones present on Maui, the island has a diversity of habitats for native wildlife. Particular habitats associated with native wildlife include alpine deserts, subalpine and montane forests and bogs, lowland forests, coastal communities, anchialine pools, and lava tube caves. Additionally, parts of East Maui have healthy freshwater aquatic systems on the slopes of ridges, in the streams of lower Hanawī, and the streams of the Kipahulu and Kaupō area. These habitats support a diversity of native species including forest birds, invertebrates, ʻōpeʻapeʻa (*Lasiurus cinereus semotus* [Hawaiian hoary bat]), pueo (*Asio flammeus sandwichensis* [Hawaiian short-eared owl]), waterbirds, freshwater species, and seabirds. Plant endemism for Maui is estimated at 20 percent. Beaches provide habitat for a few nesting sea turtles. Offshore islets provide important habitats for seabirds, migratory birds, raptors, invertebrates, and marine fauna. Approximately 9,398 hectares (23,496 acres) of critical habitat has been designated by the USFWS for Blackburn's sphinx moth (*Manduca blackburni*) and 50,612 hectares (126,531 acres) for 59 endangered plants on Maui. Recovery habitats for the Maui parrotbill and ʻākohekohe have also been identified by the USFWS.

Appendix A provides information on what wildlife Species of Greatest Conservation Need are present on Maui and its associated offshore islands. Maui is important habitat for several native forest birds, including the following Maui endemic species: ʻākohekohe (crested honey creeper), Maui ʻalauahio (creeper), poʻouli, and Maui parrotbill. Maui is also home to the second largest population of nēnē (Hawaiian goose) in the State. Other federally listed species include the ʻalae keʻokeʻo (Hawaiian coot), aeʻo (Hawaiian stilt), koloa maoli (Hawaiian duck), ʻuaʻu (Hawaiian petrel), ʻōpeʻapeʻa (Hawaiian hoary bat), Hawaiian monk seal, hawksbill turtle, and green sea turtle. For invertebrates, in general, Maui is characterized by high levels of endemism and diversity representing many orders. For example, along with the federally endangered Blackburn's sphinx moth, Maui also hosts several endemic native bees (*Hylaeus* spp.), tree snails, and high levels of diversity within most families of beetles (Coleoptera). Maui also has endemic anchialine amphipods. Other species groupings that can be found on Maui are freshwater fishes, freshwater invertebrates, migratory birds, and raptors.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife and habitats are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats that are more acute or specific to Maui are listed below.

- The population of axis deer is slowly spreading across east Maui into west Maui, causing habitat degradation and loss;
- High pig densities in upper remote watershed degrade sensitive bog communities and wet forest, habitat for endemic birds and invertebrates;
- Presence of habitat-modifying invasive plants, including miconia;
- Introduction of invasive species at airports, ports, and harbors;
- Invasive algae in Lahaina and Kīhei areas;
- Introduced reptiles and amphibians, such as coqui frog and veiled chameleons, prey on native invertebrates and likely compete with native birds for food resources;
- Populations of feral cats and cat colonies kill waterbirds and seabirds across the island;
- Avian disease transmitted by mosquitoes restricts forest birds to habitat located above the mosquito-line;
- Wildfire, particularly for low elevation dry habitats and exacerbated by non-native invasive plants that increase fuel loads;
- Hybridization between koloa maoli (Hawaiian duck) and introduced mallards;
- Development of formerly undeveloped areas and increased urbanization leading to loss and degradation of terrestrial, freshwater, and marine habitat (e.g., increased nutrients in coastal areas leads to non-native algal blooms which affect fish populations and coral habitats, sedimentation from development near stream corridors);
- Stream diversions, dams, or channelizations;
- Insufficient in-stream flows to insure the biological integrity of many stream systems;
- Localized point source pollution originating from recreational boats and cruise ships;
- Fisheries bycatch of green sea turtles and seabirds;
- Human disturbance of sensitive ecosystems such as lava tube caves or anchialine pools;
- Localized excessive recreational use at places like ‘Āhihi Kīna‘u Natural Area Reserve, Honolua Bay, and Molokini Shoal;
- Human and boat interactions with marine mammals and sea turtles along the leeward coast.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Maui include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Implement conservation actions identified in the ‘Potential Areas for Enhanced Conservation Management’ subsection;
    - Develop and/or implement recovery plans for threatened and endangered species on Maui;

- Increase active management in, or acquisition of, extremely rare habitats on Maui;
- Protect remaining intact native forest, wetland habitat, and coastal areas from development through a combination of acquisition, conservation easements, or cooperative agreements with landowners;
- Implement fire suppression measures and protocols for post-fire restoration;
- Increase the total acreage of ungulate-free and predator-free areas;
- Decrease in number of stream diversions and channelized streams;
- Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations;
- Protect remaining anchialine ponds and lava tube and cave habitats;
- Collaborate in efforts to reduce pollution threats from recreational boats and cruise ships;
- Support ongoing projects to deal with non-point source pollution like those in the watershed partnerships and Honolua Bay and support expansion of successful methods to other areas;
- Develop management plans for all Marine Managed Areas.

- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve prevention capacity through increased airport inspection and containment barriers around cargo unloading areas;
    - Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on Maui;
    - Increase efforts to prevent establishment of priority invasive plants in pristine areas (e.g., miconia) and to eradicate from areas with recovery potential;
    - Revive and fund the Maui Axis Deer Group or similar partnership to address the need to fence existing populations of axis deer and to control deer outside of fenced areas;
    - Expand control of mammalian predators (e.g., feral cats, rats) in waterbird and seabird habitat;
    - Decrease in the overall number of streams negatively impacted by invasive species;
    - Support efforts to strengthen marine alien species prevention and control.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;
    - Assess impact of eco-tourism activities on terrestrial and aquatic native wildlife and associated habitats;
    - Expand surveys to monitor population status and trends of under-researched species groups such as seabirds, pueo (Hawaiian short-eared owl), ‘ōpe‘ape‘a (Hawaiian Hoary bat), Blackburn’s sphinx moth, Maui *Partulinid* spp. and other native invertebrates;
    - Survey native wildlife community in koa-dominated forests in East Maui;

    - Research role of alien bird (cattle egret and barn owl) predation and best control strategies.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Encourage additional landowner participation and involvement in East Maui Watershed Partnership, West Maui Mountains Watershed Partnership, and Leeward Haleakalā Watershed Restoration Partnership;
    - Work with interested communities to address conservation threats and needs and develop appropriate actions;
    - Expand partnership with hunting community to reduce ungulate population;
    - Collaborate in efforts to reduce pollution threats from recreational boats and cruise ships;
    - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawaiʻi.
    - Maintain existing outreach and educational programs at managed conservation areas;
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas;
    - Expand and broaden public education and outreach to take advantage of the large science and management community on the island.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
    - Assess ways to support increased enforcement capacities, including cross-deputization between agencies;
    - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
    - Review and revise DOFAW management guidelines to better reflect habitat conservation needs, followed by review and revision of game animal hunting regulations;
    - Improve integration of policies to address linkages between terrestrial and marine habitats and their shared conservation threats and needs;
    - Obtain and implement the plans of an Incidental Take Permit for sea turtle and monk seal bycatch.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Nēnē (Hawaiian goose) (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), the Draft Recovery Plan for the Blackburn's sphinx moth (2003), the Hawaiian Endangered Bird Partnership for Captive Propagation Five Year Workplan (2002), the Draft Revised Recovery Plan for Hawaiian Waterbirds (1999), and the Recovery Plan for the Hawaiian Hoary Bat (1998);

- Critical habitat designations by the USFWS for the Blackburn's sphinx moth (*Manduca blackburni*) and for threatened and endangered plants on Maui;
- Management Plans for the State Natural Area Reserves (NAR): ʻAhihi-Kīnaʻu NAR (Draft 1992), Kanaio NAR (1993), West Maui NAR (1988), and Hanawī NAR (1989);
- Long-range management plans for Natural Area Partnership Preserves (NAPP): Kapunakea NAPP (2003), Waiakamoi NAPP (2000), Puʻu Kukui NAPP (2005);
- The Division of Forestry and Wildlife's (DOFAW) Draft Management Guidelines, which coarsely rate vegetation quality and provide guidelines for land use (public hunting, recreation, and forest products) for State lands managed by DOFAW;
- The East Maui Watershed Partnership Management Plan and the West Maui Mountains Watershed Partnership Management Plan;
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawaiʻi Implementation Plan for Polluted Runoff Control (2000), Hawaiʻi Unified Watershed Assessment (1998);
- Hawaii's Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;
- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawaiʻi;
- Fleming Arboretum is in the process of compiling an electronic database reflecting native dryland forest species that can be found at www.flemingarboretum.org;
- The Hawaiʻi Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Maui. The discussion of future management needs is highlighted within each current managed area. Many areas on Maui are already under active management or protection through designation as State Natural Area Reserves (NAR), a National Wildlife Refuge (NWR), a State Wildlife Sanctuary, a National Park (NP), land trusts, and several public-private partnerships in the form of watershed partnerships, and natural area preserve partnerships. Each of these managed areas receives some level of agency or other support, including field teams composed of staff personnel or specific mission-oriented teams such as the Maui Invasive Species Committee and the Maui Forest Bird Recovery Project. Management of most of these areas is guided by existing management plans. These plans strongly emphasize conservation and restoration with a focus on controlling ungulates, predatory small mammals, and invasive alien species (both flora and fauna). In total, approximately 79,315 hectares (198,288 acres) or 43 percent of the island is under some form of conservation management (e.g., management plan exists) or protection.

***East Maui Watershed Partnership* (100,000 acres), Public-Private Partnership (NPS, DOFAW, TNC, Hanā Ranch Partners, LLC, East Maui Irrigation, Haleakalā Ranch, County of Maui Department of Water Supply)**

Species: ʻŌpeʻapeʻa (Hawaiian hoary bat), forest birds, pueo, kōlea (Pacific golden plover), nēnē (Hawaiian goose), ʻuaʻu (Hawaiian petrel), endemic land snails and hundreds of endemic terrestrial, aquatic, and semi aquatic arthropods, rare plants. Outstanding invertebrates include one of only nine species of flightless flies found worldwide, and several species of rare long-horned beetles.
Habitats: Montane wet communities. Largest intact native forest on the island (20%) and recovery habitat for 21 species of rare forest birds.
Current Management: Management plan exists. Continue fencing across East Maui, ungulate control, invasive weed control, monitoring (particularly for stream and water quality), education and outreach.
Future Needs: Secure funding to implement management plan. Expand management into other native-dominated forests within the partnership boundaries (e.g., Makawao Forest Reserve).

***Haleakalā NP* (30,183 acres), NPS**

Species: Highly significant for ʻuaʻu (Hawaiian petrel), nēnē (Hawaiian goose), and cave invertebrates. Forest birds, ʻōpeʻapeʻa (Hawaiian hoary bat), rare plants.
Habitats: Alpine communities, subalpine communities, montane communities, lowland communities, subterranean communities.
Current Management: Management plan exists. Maintains high level of staff support for predator, ungulate, and alien vegetation control and removal, fencing, vegetation sampling transects, yearly surveys for threatened and endangered species, nest protection and monitoring for nēnē and ʻuaʻu. One-time inventories for bats and herptofauna, marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bat, terrestrial invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality).
Future Needs: Continue existing management.

***Hanawī NAR* (7,500 acres), DOFAW**

Species: Supports one of the highest number and densities of endangered forest birds in the State. Core populations of poʻouli, Maui ʻākepa, Maui parrotbill, ʻākohekohe, Maui nuku puʻu, and ʻōʻō. Other forest birds, pueo, native invertebrates, rare plants.
Habitats: Subalpine communities, montane wet communities, perennial streams.
Current Management: Management plan exists. Control of pig populations, weed-control activities, fencing, resource monitoring, public education and volunteer program, Maui Forest Bird Recovery Project activities.
Future Needs: Predator control. Continue existing management as this area is critical for native forest birds.

***Waiakamoi Preserve* (5,230 acres), TNC**

Species: ʻŌpeʻapeʻa (Hawaiian hoary bat), forest birds, native invertebrates, rare plants.
Habitats: Montane wet communities.

Current Management: Management plan exists. Ungulate control, invasive plant species control and eradication, research and monitoring, outreach.
Future Needs: Continue existing management.

***Leeward Haleakalā Watershed Restoration Partnership* (43,175 acres), Public-Private Partnership (DOFAW, DHHL, NPS, James Campbell, Haleakalā Ranch, Ka'ono'ulu Ranch, Kaupō Ranch, 'Ulupalakua Ranch, Nu'u Mauka Ranch, Living Indigenous Forest Ecosystems (LIFE), individual private landowners, Hawai'i Community Foundation, Trust for Public Land (TPL), USFS, USGS, USFWS, NRCS, County of Maui Department of Water Supply**)

Species: 'Ōpe'ape'a, forest birds, possibly 'ua'u (Hawaiian petrel), terrestrial invertebrates, including Blackburn's sphinx moth, rare plants.
Habitats: Montane mesic communities, montane dry communities. Priority recovery habitat for endangered forest birds.
Current Management: Management plan for resource management from Makawao Forest Reserve to Kaupō above 3,500 feet (1,067 meters) in development, to include monitoring, fencing, ungulate removal, and koa reforestation. Related projects include fencing of Kahikinui Forest Reserve (DOFAW) and adjacent DHHL lands.
Future Needs: Develop and implement partnership management plan for reforestation. Continue fencing. Expand management into other areas within the partnership boundaries (e.g., Kula Forest Reserve).

***Kanaio NAR* (876 acres), DOFAW**

Species: 'Ōpe'ape'a (Hawaiian hoary bat), pueo, kōlea (Pacific golden plover), nēnē (Hawaiian goose), 'ua'u (Hawaiian petrel), terrestrial invertebrates, including Blackburn's sphinx moth, yellow-faced bees, endemic wasps *Odynerus spp*. and *Ectemnius spp*., potentially cave invertebrates, rare plants.
Habitats: Lowland dry communities. Significant remaining tract of dryland forest and shrubland.
Current Management: Management plan exists. Fencing, invasive plant removal, ungulate control.
Future Needs: Complete proposed addition of adjacent unencumbered land to NAR, complete proposed boundary fencing of upper section. Continue existing management.

***West Maui Mountains Watershed Partnership* (52,940 acres), Public-Private Partnership (DOFAW, TNC, Maui Land and Pineapple, Inc., Amfac, C. Brewer, Kahoma, Kamehameha Schools, Makila land, County of Maui Department of Water Supply)**

Species: 'Ōpe'ape'a, forest birds, pueo, nēnē (Hawaiian goose), koloa maoli (Hawaiian duck), 'ua'u (Hawaiian petrel), 'a'o (Newell's shearwater), terrestrial invertebrates, including Blackburn's sphinx moth, *Megalagrion spp*., rare achatinellid land snails, freshwater fishes, freshwater invertebrates, rare plants.
Habitats: Montane wet communities, lowland wet communities, lowland mesic communities.
Current Management: Management plan exists. Fencing, ungulate and predator control, reduction of invasive alien weeds. The Hawai'i Unified Watershed Assessment proposed the West Maui Mountains as a Tier 1 Watershed in Need of Restoration under

the EPA Clean Water Act.
Future Needs: Secure funding to implement management plan. Identification of areas in need of active management and/or fencing to protect quality native forests. Expand management into other native-dominated forests within the partnership boundaries (e.g., West Maui Forest Reserve).

West Maui NARS **(6,702 acres-3 parcels), DOFAW**
Species: Forest birds, migratory birds, terrestrial invertebrates, including rare land snails, freshwater fishes, freshwater invertebrates, rare plants.
Habitats: Montane wet communities, perennial streams.
Current Management: Management plans exist. Fencing, ungulate control, resource monitoring, non-native plant control, public education, and volunteer recruitment.
Future Needs: Continue existing management.

Pu'u Kukui Preserve **(8,661 acres), Maui Land and Pineapple, Inc.**
Species: 'Ōpe'ape'a (Hawaiian hoary bat), forest birds, pueo, nēnē, migratory birds, seabirds, terrestrial invertebrates, including rare land snails, freshwater fishes, freshwater invertebrates, rare plants.
Habitats: Montane wet communities, lowland wet communities, lowland mesic communities.
Current Management: Management plan exists. Fencing, ungulate removal, small mammal and non-native invertebrate control, weed control monitoring, and rare species protection.
Future Needs: Continue existing management.

Kapunakea Preserve **(13,000 acres), TNC**
Species: Forest birds, pueo, seabirds, terrestrial invertebrates, including rare tree snails.
Habitats: Montane wet communities, lowland mesic communities, lowland dry communities.
Current Management: Management plan exists. Ungulate control, invasive plant control, small mammal control, resource monitoring, community outreach, rare species protection and research.
Future Needs: Continue existing management.

Kanahā Wildlife Sanctuary **(235 acres), DOFAW**
Species: Seabirds, waterbirds, migratory birds, terrestrial invertebrates.
Habitats: Lowland wet community including saline wetland.
Current Management: Currently developing a management plan. Habitat restoration through invasive weed removal, predator control, surveys and monitoring.
Future Needs: Continue existing management, install perimeter predator-proof fencing and eradicate predators within.

Old Waihe'e Dairy **(277 acres), Maui Coastal Land Trust**
Species: Migratory birds, terrestrial invertebrates.
Habitats: Coastal communities.
Current Management: Developing management plan.
Future Needs: Implement management plan.

***Mū'olea Point* (70 acres), Trust for Public Land**

Species: Seabirds, migratory birds, invertebrates, marine fauna, raptors.
Habitats: Coastal communities.
Current Management: Recent acquisition for permanent protection.
Future Needs: Develop and implement management plan.

***Keālia National Wildlife Refuge* (700 acres), USFWS**

Species: Waterbirds, migratory birds, turtles.
Habitats: Coastal communities including saline wetland habitat.
Current Management: Beach patrol, dune restoration, environmental education, fencing to keep turtles away from road, nest monitoring and protection.
Future Needs: Continue existing management.

***Maluaka and Paniaka Wetlands*, State Parks**

Species: Endangered waterbirds, migratory birds.
Habitats: Coastal communities.
Current Management: Maluaka wetland is being fenced for predator control management and revegetated with native vegetation after alien plant removal. However, Paniaka remains unmanaged.
Future Needs: Fence Paniaka ponds with predator-proof fencing, enhance native vegetation, continue collaboration with State Parks on species management and support DOFAW's yearly waterbird counts and breeding season monitoring of the waterbirds.

***'Āhihi Kīna'u NAR* (2,045 acres including marine), DOFAW**

Species: Migratory birds, waterbirds, terrestrial invertebrates, anchialine pond fauna, marine mammals, marine fishes, marine invertebrates.
Habitats: Coastal communities, marine systems, includes unusual communities associated with recent lava flows including anchialine pools, subterranean lava tubes, and aeolian systems on the surface of the flows.
Current Management: Management plan exists. Resource monitoring (particularly for any illegal takings), rangers hired for enforcement and education, public education and sign postings, restricting certain areas from public over use. Fencing of anchialine pools has been proposed but not implemented. No Take of terrestrial or marine resources.
Future Needs: Management of human activity, monitoring, education, and outreach.

***State Seabird Sanctuary* (8 offshore islands), DOFAW**

Species: Seabirds, migratory birds.
Habitats: Coastal communities.
Current Management: Removal of small mammalian predators and native vegetation habitat restoration.
Future Needs: Increase surveys and monitoring.

***Maui Invasive Species Committee*, Public-Private Partnership**

Species/Habitats: All species and habitats affected by invasive species.
Current Management: Invasive species prevention and control.

Future Needs: Increased invasive plant and animal prevention capacity, improved detection and rapid response capacity, and additional resources to address established threats to native habitats.

***Maui Forest Bird Recovery Project*, USFWS, DOFAW, UH**
Species/Habitats: Endemic forest birds, particularly endangered and critically endangered species and their habitats.
Current Management: Research and conservation management implementation of Draft Revised Recovery Plan for Hawaiian Forest Birds, development and implementation of five-year implementation plans.
Future Needs: Adequate funding to implement recovery plan and implementation plans.

***Hawaiian Islands Humpback Whale National Marine Sanctuary* (about 900,000 acres), Co-Managed by NOAA and DLNR.**
***Species*:** Humpback whale.
Habitats: Marine ecosystems.
***Current Management*:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
***Future needs*:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

***Two Marine Life Conservation Districts (MLCD),* DAR: Honolua-Mokuleia, Molokini Shoal**
Species: Species associated with shallow coral reef, sandy beach, and rocky habitats. Hawaiian monk seals, green sea turtles, spinner dolphins, and other marine mammals.
***Habitats*:** Marine ecosystems.
***Current Management*:** Limited access in most MLCDs, eight MLCD include at least some No Take area, fish monitoring.
***Future needs*:** Evaluate all MLCD's for purpose and management effectiveness and consider need for new Marine Managed Areas.

***One Fishery Management Areas (FMA),* DAR*:* Kahului Harbor**
Species: Some or all regulated fish species.
***Habitats*:** Marine and estuary ecosystems.
***Current Management*:** Limited take, gear, size, season, and/or area restrictions.
***Future needs*:** Evaluate all FMA's for purpose and management effectiveness and consider need for new Marine Managed Areas.

***Three Bottomfish Restricted Areas (BRA),* DAR**
Species: Seven bottomfish species.
***Habitats*:** Marine ecosystems.
***Current Management*:** No Take of bottomfish.

***Future needs*: Evaluate all BRAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Potential Areas for Enhanced Conservation Management

In addition to maintaining and enhancing existing conservation actions, additional efforts are needed for the long-term conservation of Maui's native wildlife. The following section identifies areas where enhanced conservation management would significantly benefit native species or their habitats (previously identified areas of the Makawao Forest Reserve and Kanaio can be found under the future needs discussion in the management needs section). Areas are discussed in habitat order from the mountains to the sea.

***Kīpahulu Forest Reserve (Upper portion above 3,500 feet between Kaupō Gap and Kīpahulu Valley)*, DOFAW**

Species: Forest birds, invertebrates, rare plants.

***Basis for Priority Designation*:** Remnant native forests still intact, but high densities of feral goats are rapidly destroying the understory, clearing their way into wet forests. Habitats include, from west to east, drier koa-dominated into wet ʻōhiʻa dominated. Mesic koa forest is highly rare on Maui.

Potential Conservation Actions: Fencing of the most-intact areas, removal of feral goats, and developing public hunting access (currently no public hunting access allowed) through adjacent landowners (e.g., the national park Kaupō trail).

***Dryland habitats* (leeward Haleakalā down to coast of southern Maui)**

Species: Wiliwili (*Erythrina sandwichensis)* forests, koa (*Acacia koa*) forests, diverse dryland forests, terrestrial invertebrates, rare plants.

Basis for Priority Designation: Low elevation dryland forest is highly imperiled and significantly reduced from historic range. Tracts of native wiliwili groves remain primarily in undeveloped private parcels in the coastal areas of Makena and the *ahupuaʻa* of Maluaka, Kaʻeo, Papaʻanui, Waipao, and Keauhou. Remnant diverse dryland forest remains in the Auwahi area. Threatened by the potential for development. The full impacts of the recent introduction of the *Erythrina* gall wasp are not yet known. Wiliwili are a keystone species in native dryland forest and are host to several species of native terrestrial invertebrates, while in general, the dryland forest hosts many rare plant species.

Potential Conservation Actions: Fencing intact tracts of dryland forest, removal of deer and goats, invasive plant removal, fire suppression, outplanting.

***Wetland habitats (*Kīhei Coast, Ukumehamehe, North Shore, Cape Hanamanioa, Nuʻu, Pauwalu Point, Keʻanae Peninsula, East Maui stream, loʻi)**

***Species*:** Waterbirds, migratory birds.

***Basis for Priority Designation*:** These areas have been identified by the USFWS and the Pacific Coast Joint Venture as areas for waterbird recovery.

Potential Conservation Actions: Small mammal predator control, invasive species control; where private lands occur, support voluntary and incentive based programs for potential conservation.

Coastal Areas on State Lands in the North and Northwest Portions of West Maui; other intact coastal areas (South, East Maui)

***Species*: Wetland birds, migratory shorebirds and waterfowl, seabirds, native invertebrates, native plants.

***Basis for Priority Designation*: Hawai‘i has few native coastal vegetation areas still left intact and these areas have a diverse coastal vegetation system. However, it is being threatened by ungulates (mostly cattle).

Potential Conservation Actions: Identify best intact areas and assess for appropriate conservation measures including fencing, removal and control of ungulates, and redesignation of coastal area for conservation purposes.

***Kanahā Beach,* Maui County**

***Species*: Native invertebrates, native plants.

***Basis for Priority Designation*: An area that is rich with native plants and native invertebrates, but is faced with immediate threats by human activities such as off-road vehicles. Existing actions have been removal of invasive plants, restoration of native plants, public education, and construction of a vehicle barrier to protect quality areas. This area could serve as a public education model for the need to protect and restore coastal areas.

Potential Conservation Actions: Continue existing management.

Anchialine Pond Habitat

***Species*: Anchialine shrimp, endemic anchialine amphipods (*Grandidierella palama, Paramoera rua, Rotomelita ana*).

***Basis for Priority Designation*: Anchialine pool habitats are experiencing degradation as a result of invasive species and human disturbance leading to decreasing populations of anchialine species in these habitats.

Potential Conservation Actions: Prevent introduction of non-native fish (tilapia), manage human disturbance.

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KAHOʻOLAWE

Kahoʻolawe is the smallest of the eight Main Hawaiian Islands. The island was historically inhabited by several hundred Native Hawaiians who farmed and fished for subsistence. Kahoʻolawe also was important as a religious center where the navigators and *kahuna* (priests) responsible for guiding the ocean voyages of early Hawaiians were trained. Consequently, Kahoʻolawe is listed on the National Register for Historical Places, containing 544 archaeological and historical sites with over 2,000 features including some of the largest and oldest *heiau* (Hawaiian shrines) in the State. After the arrival of Europeans, the island was used as a penal colony, for ranching, and for military training, including extensive bombing practice. These activities resulted in severe ecological degradation, and much of the soil (particularly on the eastern side and along the ridge crests) is exposed and lost to strong, easterly winds. Alien-dominated vegetation covers most of the island and includes kiawe forest and buffel grasslands. Remaining native habitats include coastal dry shrubland dominated by maʻo (*Gossypium tomentosum* [Hawaiian cotton]), ʻilima (*Sida fallax*), and ʻakiʻaki (*Sporobolus virginicus*), lowland dry grassland, mixed shrub coastal dry cliff, a high salinity anchialine pool, intermittent streams, and ephemeral pools. Nearshore marine resources include substantial coral reefs and intertidal natural communities. Native wildlife species on the island include an endangered moth, seabirds, and monk seals.

OVERVIEW

Geology and Hydrology

Kahoʻolawe is 11,520 hectares (28,800 acres) in total area, 17.6 kilometers (11 miles) long and 11.2 kilometers (seven miles) wide at its broadest point. The island is gently sloped with a diagonal ridge running across it. Steep sea cliffs mark the southern and eastern coastlines while sloping ridges with bays and beaches characterize the northern and western coasts. The highest point of the island is on the northeast end, at 450 meters (1,477 feet). Approximately 39 percent of the island is below 150 meters (500 feet) in elevation. Kahoʻolawe has two offshore islands. There are no perennial streams.

Climate

Located in Maui's rain shadow, Kahoʻolawe is very dry and arid, receiving no more than 65 centimeters (25 inches) of rain annually with most occurring on the eastern side of the ridge.

Land and Water Use

The Navy had used Kahoʻolawe for several decades of military bombing exercises which ceased in 1990. The following ten year Navy clean-up resulted in approximately ten percent subsurface clearance of the island and 69 percent surface clearance of unexploded ordnance from the island. In 2003, management and ownership of the island was officially transferred from the U.S. Navy to the Kahoʻolawe Island Reserve Commission (KIRC), a State agency administratively attached to DLNR, for management. The entire island is designated Conservation District under the State Land Use Code.

The island of Kahoʻolawe and the waters two miles from the shoreline are designated as the Kahoʻolawe Island Reserve, owned by the State of Hawaiʻi. KIRC manages Kahoʻolawe in trust for a future Native Hawaiian sovereign entity. Access to the island is restricted due to unexploded ordnance, and commercial use is strictly prohibited. The island is managed and maintained in perpetuity for the following purposes: 1) preservation and practice of all rights customarily and traditionally exercised by the Native Hawaiians for cultural, spiritual, and subsistence purposes; 2) preservation and protection of its archaeological, historical, and environmental resources; 3) rehabilitation, revegetation, habitat restoration, and preservation; and 4) education. Overall activities on the island are guided by the following principles: traditional ecological knowledge, ecosystem succession, strategic restoration, keeping practices in line with the island's geography and natural systems, and integrated research and action.

Human Landscape
Although the island has no permanent residents, barracks provide accommodations for about 50 workers who are flown in for conservation and management activities or visitors coming to volunteer for conservation activities or participate in cultural practices.

SPECIES AND HABITATS OF IMPORTANCE
Historically, Kaho‘olawe was home to a range of vegetation communities that included dry forest and shrublands, grasslands, coastal vegetation, and possibly a mesic forest. However, due to 200 years of grazing by introduced ungulates, followed by decades of military bombings, the habitat on the island has been reduced to over 80 percent barren or hardpan soil and/or alien-dominated vegetation. In addition to the two islets, the western coastal area is the only area where native vegetation remains. Despite this, Kaho‘olawe is still home to 14 rare plants as well as a new species, *Kanaloa kahoolawensi*s, in a new genus. Under the island's management plan, five native terrestrial communities have been identified: ‘Aki‘aki Coastal Dry Grassland, the Hawaiian Mixed Shrub Coastal Dry Cliff, the ‘Ilima Coastal Dry Shrubland, the Ma‘o Coastal Dry Shrubland, and the Pili Lowland Dry Grassland. Most of the rare plant populations that are known can be found on the southern and eastern seacliffs.

For wildlife in particular, important areas on the island include coastal areas such as Honokanai‘a, Kūheia, Lae o Kuikui, Hakioawa, and the uplands. In addition, the USFWS designated 1,701 hectares (4,252 acres) of critical habitat for Blackburn's sphinx moth (*Manduca blackburni*). Vegetation within this area consists of mixed-species, mesic and dry grass and shrubland communities with a high percentage of non-native vegetation interspersed with native vegetation. There are also several wetland areas on the island (e.g., Lua Keālialalo, Lua Keālialuna, Lua Makika) that can provide habitat for migratory shorebirds and waterbirds. Kaho‘olawe is also home to two islets, Pu‘u koae and ‘Ale‘ale, both of which are significant habitats for nesting seabirds (e.g., ‘ua‘u [*Pterodroma sandwichensis* or Hawaiian petrel], ‘akē‘akē [*Oceanodroma castro* or band-rumped storm petrel]) and migratory birds (e.g., kioea [*Numenius tahitiensis* or bristle-thighed curlew]) and contain native shrub coastal dry cliff communities.

Appendix A provides information on the wildlife Species of Greatest Conservation Need present on Kaho‘olawe and its associated offshore islands. KIRC has plans to also reintroduce species such as birds, invertebrates, ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* [Hawaiian hoary bat]), and marine reptiles.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats more acute or specific to Kahoʻolawe are listed below. Because Kahoʻolawe has no perennial streams, there are no identified threats specific to freshwater species on Kahoʻolawe.

- Feral cats (*Felis silvestris*), barn owls (*Tyto alba*), and rodents that prey on ground nesting seabirds;
- Established populations of alien ants, wasps, and parasites that negatively affect native invertebrates;
- Wide-spread non-native vegetation and soil erosion threaten habitat restoration (an estimated 1.9 million tons of soil is lost each year);
- Unexploded ordnance that limit conservation activities;
- Fire that can exacerbate the distribution of alien vegetation and disrupt current native vegetation restoration efforts;
- Marine debris accumulation;
- Sedimentation due to historic grazing and land degradation;
- Lack of compliance with fishing regulations.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for Kahoʻolawe include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ʻManagement Needsʼ section;
    - Develop and/or implement recovery plans for threatened and endangered species on Kahoʻolawe;
    - Secure permanent, long-term funding for KIRC;
    - Eradication of mammalian predators, particularly feral cats, and avian predators (e.g., barn owls, cattle egrets) from the island;
    - Enhance existing wetlands (e.g., fencing, restoration, control of alien vegetation);
    - Reintroduce appropriate native species (e.g., waterbirds, Laysan duck, native passerines, native invertebrates, Hawaiian hoary bat, native plants);
    - Implement fire suppression measures and protocols for post-fire restoration;
    - Increase marine debris removal capacity and collaborate with experts on marine debris issues;
    - Suppress fires and implement fire management protocols.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Improve prevention measures and early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on Kahoʻolawe;
    - Support efforts to strengthen marine alien species prevention and control.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Support ongoing projects to address Non-Point Source Pollution.

- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i.
    - Maintain existing outreach and educational programs at managed conservation areas.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
    - Increase enforcement capacity and education on the value of the Reserve.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Specific management plans developed by KIRC, including the Kaho‘olawe Use Plan (1995), the Kaho‘olawe Ocean Management Plan (1997), the Kaho‘olawe Environmental Restoration Plan (1998), and the Draft Access and Risk Management Plan (2001);
- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Recovery Plan for Blackburn's sphinx moth (2003);
- Critical habitat designations by the USFWS for the Blackburn's sphinx moth;
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- Bishop Museum has a comprehensive database of invertebrates;
- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawai‘i;
- The Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on Kaho‘olawe. The discussion of future management needs is highlighted within each current managed area. Unlike other islands (except Ni‘ihau), Kaho‘olawe is managed by one entity, the Kaho‘olawe Island Reserve Commission (KIRC).

***Kaho‘olawe Island Reserve* (28,800 terrestrial acres-entire island), KIRC**

Species: Native invertebrates including Blackburn's sphinx moth and koa butterfly, seabirds, migratory birds.
Habitats: Coastal dry grasslands, dry cliff, dry shrublands, anchialine pool, wetlands.
Current Management: Management plans exist. Erosion control, revegetation and habitat restoration, predator control.
Future Needs: Continue existing management. Adequate funding to implement management plan. Eradication of cats.

***Kaho'olawe Island Reserve* (marine waters up to two miles from shoreline), KIRC**

Species: Hawaiian monk seals, coral reef organisms, pelagic and bottomfishes, green sea turtles.

***Habitats*:** Marine ecosystems including shallow coral reef, deeper reefs, sandy beach, and rocky habitats.

***Current Management*:** Limited access and take, no commercial activity, monitoring, water quality improvements.

***Future needs*:** Additional monitoring, increased enforcement.

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HAWAIʻI

The island of Hawaiʻi is the largest, highest, and youngest in the Hawaiian Archipelago. It has two mountains over 4,000 meters (13,000 feet), three active volcanoes, and twice the area of all the other islands combined. Hawaiʻi is also climatically diverse: Kawaihae, on the leeward Kohala coast, averages less than 26 centimeters (10 inches) of rain each year, while mid-elevation forests on the windward side of the island receive over 700 centimeters (270 inches) of rain. The highest mountains are usually snow-capped through the winter. In spite of this, they are host to a suite of endemic arthropods in an aeolian ecosystem. Lava flows from the active volcanoes isolate patches of forest called kīpuka, leading to genetic divergence between isolated populations, and ultimately, speciation. Young lava flows are colonized quickly and become habitat for specialized arthropod fauna. Lava tubes in older flows host a diverse and unique cave fauna. Wet forests are home to a spectacular radiation of endemic birds as well as many unique invertebrates such as happy-face spiders and carnivorous caterpillars. Most of the original lowland habitat on the island has been transformed by human habitation, and whole suites of bird and snail species have been extirpated and are known only from fossils. In addition, honeycreeper and honeyeater species that were adapted to low-elevation forests have disappeared, both from the loss of forests and the introduction of alien insects and diseases such as avian pox and malaria. The extent of the missing native arthropod fauna can only be guessed, but one assumes it is extensive, and that the loss of arthropod pollinators and seed dispersers likely affects forest health in the remaining habitats.

OVERVIEW

Geology and Hydrology

The island of Hawaiʻi is comprised of five shield volcanoes, all of which are less than a million years old. The youngest three of these (Hualālai, Mauna Loa, and Kīlauea) are active; therefore, the landscape includes extensive areas of seemingly barren lava flows. Continuously changing forest boundaries and interesting succession patterns are the result. The two older volcanoes (Mauna Kea and Kohala) are marked by the cinder cones characteristic of late-stage eruptions, and by deep, stream-eroded valleys on the windward side. Only 12 percent of the island is below 150 meters (500 feet) in elevation; nearly 70 percent of the island is above 610 meters (2,000 feet) in elevation. The island of Hawaiʻi has 132 perennial streams, 70 of which are continuous. Wailuku River has the largest discharge at 250 million gallons per day (mgd). Anchialine ponds, which host a unique fauna of amphipods and shrimp, are found in young, coastal lava fields. Waiākea Pond is a natural freshwater lake that is over 2.3 meters (seven feet) deep and 11 hectares (27 acres) in area, and Lake Waiau, at 4,300 meters (13,020 feet), is the only alpine lake in the State. Hawaiʻi has three offshore islets.

Climate

Because of its size and elevation range, Hawaii's climate and vegetation communities vary dramatically. Warm trade winds meet the island and leave most of their moisture behind as rain or cloud drip on the windward side. At high elevations and on the Kona side, dry or even arid conditions predominate. Convection-driven onshore breezes on the leeward side create upslope showers most afternoons, resulting in a broad band of mesic forest. The peaks of Mauna Loa and Mauna Kea have permanent frost.

Land and Water Use
Hawaii's 1,042,000 hectares (2,573,400 acres) include 80 percent of the State's remaining native habitat. About 51 percent of the land is in the State Conservation District, and 47 percent is in the Agricultural District. About 520,000 acres are managed by the Division of Forestry and Wildlife (DOFAW), part of the State Department of Land and Natural Resources (DLNR). Over 465,000 acres are managed by Federal agencies (three-fourths of this is managed by the National Park Service (NPS) or U.S. Fish and Wildlife Service (USFWS), and about one-fourth by the U.S. Army). Thus, approximately 38 percent of the total land area of the island is under State or Federal management. Approximately 105,000 acres of conservation-zoned forest land is under private ownership or management. The largest private landowners on the island are Kamehameha Schools, Parker Ranch Trust, and C. Brewer and Co. An additional 13 of the State's 40 largest landowners manage at least some areas that are in the conservation zone and that likely support some native wildlife populations. Seventy-four streams are diverted and four have altered channels. The largest altered stream is Wailoa. The island of Hawai'i has 15 impaired streams under EPA Clean Water Act standards. The Lower Hāmākua Ditch system in Kohala is the largest man-made stream system at 32 million gallons per day (mgd).

Human Landscape
There are 158,000 residents on the island of Hawai'i. This number is supplemented by an average daily visitor population of about 22,000. The island's population is centered in Hilo on the windward side and Kailua-Kona on the leeward side, with additional concentrations in Waimea and the Puna region. Tourism, agriculture, and government services are the main economic drivers. Primary agricultural products on the island include beef, coffee, macadamia nuts, papaya, and tropical flowers. Sugarcane production on Hawai'i ended in 1996 and many former sugar lands have since been converted to lands for forestry products or for large-lot residential development. Ranching, sugar, and forestry shaped the landscape. Hawai'i Volcanoes National Park counts over 1.2 million annual visitor days. In addition, about 50,000 visitors each year purchase tours to areas where they encounter at least some native habitat and might see terrestrial wildlife. Over half of these are visitors to Mauna Kea.

SPECIES AND HABITATS OF IMPORTANCE
Major native habitat types on the island include wet montane forest, mesic montane forest, subalpine mesic forest and shrubland. Additional but smaller areas support alpine shrubland and alpine desert, dry montane and dry lowland forests, wet lowland forest, coastal forest and coastal shrub and grasslands. Eighty percent of the known worldwide anchialine pools are on Hawai'i. Despite this diversity of habitat types, 42 percent of the island is considered "converted" to human use. The USFWS has designated critical habitat for palila (*Loxioides bailleui*) and Blackburn's sphinx moth (*Manduca blackburni*) (nearly 146,000 acres) with much of it overlapping with critical habitat for 41 endangered plant species (208,000 acres). Over 90 percent of land designated critical habitat is managed by State or Federal agencies.

Appendix A provides information on what wildlife Species of Greatest Conservation Need are present on the island of Hawai'i. The island of Hawai'i supports a great number of endemic species, including forest birds (palila, 'akiapōlā'au (*Hemignathus munroi*), 'ōma'o (*Myadestes obscurus* [Hawai'i thrush]), and Hawai'i 'ākepa (*Loxops coccineus coccineus*)) and terrestrial invertebrates, including several species of land snails, the wekiu bug (*Nysius wekiuicola*), and bees. Because of its size and the loss of habitat on other islands, Hawai‘i also provides abundant habitat for species such as the ‘io (*Buteo solitarius* [Hawaiian hawk]), ‘i‘iwi (*Vestiaria coccinea*), nēnē (*Branta sandvicensis* [Hawaiian goose]), and anchialine pond fauna. Other federally listed species include the ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* [Hawaiian hoary bat]), ‘alae ke‘oke‘o (*Fulica alai* [Hawaiian coot]), ae‘o (*Himantopus mexicanus knudseni* [Hawaiian stilt]), and koloa maoli (*Anas wyvilliana* [Hawaiian duck]), ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]), Blackburn's sphinx moth, and sea turtles. For terrestrial invertebrates, in general, Hawai‘i is characterized by high levels of endemism and diversity within many orders. Hawai‘i supports rare species of stink bugs, damsel bugs, plant hoppers, and kissing bugs (Heteroptera), lacewings (Neuroptera), beetles (Coleoptera), moths (Lepidoptera), flies (Diptera), yellow-faced bees (Hymenoptera), and damselflies (Odonata). Many other species, including migratory birds, seabirds, freshwater fishes, freshwater invertebrates, marine reptiles, marine fishes, and marine invertebrates are found on the island or in the near-shore waters.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife and habitats are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats that are more acute or specific to the island of Hawai‘i are listed below.

- Alien grass domination in former dry forest and coastal habitats. These grasses (e.g., fountain grass (*Pennisetum setaceum*)) are fire-adapted and fire-prone which makes them particularly threatening to conservation of the remaining rare dry habitats in Kona. In addition, alien grasses in montane mesic and wet forests inhibit seedling recruitment among native forest plants, so that mechanical removal is required for native reforestation;
- Expanding populations of feral sheep-mouflon hybrids (*Ovis aries- Ovis musimon*) at high elevations on Mauna Loa, on Mauna Kea, and on Hualālai threaten native vegetation and regeneration, thereby indirectly affecting forest species. They may also be directly affecting nesting resources for ‘ua‘u (*Pterodroma sandwichensis* [Hawaiian petrel]) and ‘akē‘akē (*Oceanodroma castro* [band-rumped storm petrel]);
- Wide-ranging populations of pigs (*Sus scrofa*), sheep (*Ovis aries*), and goats (*Capra hircus*) continue to pose significant management challenges for habitat and species management, contributing to losses of forest cover that adversely affect groundwater retention and stream quality, ultimately increasing marine sedimentation and decreasing coral reef viability;
- Invasions of wet forests by alien plants, notably firetree (*Morella faya*), guava (*Psidium guajava*), blackberry (*Rubus* spp.) and banana poka (*Passiflora tarminiana*) change forest composition and likely affect arthropod and snail communities. Over 44,500 hectares (110,000 acres) are infested with miconia (*Miconia calvescens*);
- *Vespula* and other predatory wasps are known to affect invertebrate communities in Hawai‘i Volcanoes National Park and in palila habitat at Pu‘u Lā‘au. In addition to negative impacts on native arthropods, food availability for this and other bird species may be affected as a result. Other invasive animal species of concern are ants (*Solenopsis invicta, Wasmannia auropunctata*), carnivorous snails (*Euglandina rosea*), coqui frogs (*Eleutherodactylus coqui*), and Jackson's chameleon (*Chamelaeleo jacksonii*);
- ‘Alalā (*Corvus hawaiiensis*) recovery has been hampered by habitat degradation and fragmentation and hostile habitat, i.e., the presence of disease and both native and introduced predators in release areas;

- The small size and isolation of forest bird populations have likely contributed to the decline and disappearance of some of these populations. The degree to which this is also true for arthropods and snails is unknown;
- Anchialine pond fauna are threatened by human activity, especially intentional release of alien fish and shrimp into these ponds and human disturbance;
- Introduced freshwater fish and invertebrates have adverse effects on native stream species;
- Stream alterations and inadequate instream flows have negative effects on native freshwater species;
- Increased stream sediment load resulting from forestry, urban development, and pasture agriculture contributes to sedimentation impacts on near-shore marine habitats;
- Management priorities are not consistent with quality of habitat across agencies;
- Current regulations require more review and approvals for control of invasive non-native species than for introduction of the non-native species into the State, causing delays and reducing effectiveness of response and control actions;
- Overharvesting for marine aquarium trade.

ISLAND STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional island-specific strategies for the island of Hawai‘i include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
    - Implement conservation actions identified below in the ‘Potential Areas for Enhanced Conservation Management’ subsection;
    - Develop and/or implement recovery plans for threatened and endangered species on Hawai‘i;
    - Increase active management in, or acquisition of, extremely rare habitats such as the dry forest patches, caves, anchialine ponds, and summits of the high mountains;
    - Increase the total acreage of ungulate-free and predator-free areas;
    - Protect remaining intact native forest, wetland habitat, and coastal areas from development through a combination of acquisition, conservation easements, or cooperative agreements with landowners;
    - Develop management plans for all Marine Managed Areas;
    - Implement fire suppression measures and protocols for post-fire restoration;
    - Protect remaining anchialine ponds and lava tube and cave habitats;
    - Collaborate in efforts to reduce pollution threats from recreational boats and cruise ships;
    - Support projects to deal with non-point source pollution and support expansion of successful methods to other areas.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.

- Improve early detection and rapid response capacity for species not yet established in the islands (e.g., brown treesnake, West Nile virus, Argentine fire ant) or present in the MHI but not yet established on the island of Hawai‘i;
    - Increase efforts to prevent establishment of or eradicate priority invasive plants in pristine areas (e.g., miconia), to control spread of fountain grass (*P. setaceum*) and other dry grasses, and to eradicate priority invasive species from areas with recovery potential;
    - Expand control of mammalian predators (e.g., feral cats, rats) in waterbird (including nēnē (Hawaiian goose)), seabird, and forest bird habitat;
    - Decrease the overall number of streams negatively impacted by invasive species;
    - Support efforts to strengthen marine alien species prevention and control.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;
    - Assess impact of eco-tourism activities on terrestrial and aquatic native wildlife and associated habitats;
    - Sampling of Ichnuemonidae in the Kohala, Kona, and Ka‘ū areas.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Formalize partnerships with military agencies to manage areas (including State land) for habitat conservation;
    - Encourage additional landowner participation and involvement in ‘Ōla‘a-Kīlauea Partnership and Kohala Mountains Watershed Partnership;
    - Establish partnership covering the lands of Mauna Loa;
    - Expand current firefighting capacity through greater interagency cooperation (e.g., sharing equipment, training, and fighting capacity);
    - Collaborate with NOAA to ensure the protection of marine mammal populations.
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i.
    - Maintain existing outreach and educational programs at managed conservation areas;
    - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats and areas;
    - Expand and broaden public education and outreach to take advantage of the large science and management community on the island.
- Support policy changes aimed at improving and protecting native species and habitats.
    - Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
    - Assess ways to support increased enforcement capacities, including cross-deputization between Federal (including military) and State agencies;
    - Evaluate all current Marine Managed Areas for purpose and management effectiveness and consider need for new Marine Managed Areas;
    - Review and revise DOFAW management guidelines to better reflect habitat conservation needs, followed by review and revision of game animal hunting regulations;

- Improve integration of policies to address linkages between terrestrial and marine habitats and their shared conservation threats and needs;
- Obtain and implement the plans of an Incidental Take Permit for sea turtle bycatch.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section and include the following:

- Species Conservation Plans prepared by the USFWS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Nēnē (Hawaiian goose) (2004), the Draft Revised Recovery Plan for Hawaiian Forest Birds (2003), the Draft Recovery Plan for the Blackburn's sphinx moth (2003), the Draft Revised Recovery Plan for the ʻalalā (Hawaiian crow) (2003), the Hawaiian Endangered Bird Partnership for Captive Propagation Five Year Workplan (2002), the Draft Revised Recovery Plan for Hawaiian waterbirds (1999), the Recovery Plan for the Hawaiian Hoary Bat (1998);
- Critical habitat designations by the USFWS for the palila, the Blackburn's sphinx moth, and for threatened and endangered plants on the island of Hawaiʻi;
- The U.S. Army has developed an Integrated Natural Resources Management Plan and Implementation Plan for the Pōhakuloa Training Area (2005);
- Management Plans for the State Natural Area Reserves (NAR): Kahaualeʻa NAR (1992), Kīpāhoehoe NAR (2002), Laupāhoehoe NAR (1989), Manukā NAR (1992), Puʻo o Umi (1989), and Puʻu Makaʻala (1989);
- DOFAW and State Parks jointly developed a management plan for the ahupuaʻa of Puʻu Waʻawaʻa and the makai lands of Puʻu Anahulu;
- The Division of Forestry and Wildlife's (DOFAW) Draft Management Guidelines, which coarsely rate vegetation quality and provide guidelines for land use (public hunting, recreation, and forest products) for State lands managed by DOFAW;
- The ʻŌlaʻa-Kīlauea Partnership Plan is updated on a regular basis as new projects are developed; the Kohala Mountains Watershed Partnership is currently finalizing a management plan (2005);
- A draft Programmatic Safe Harbor Agreement for endangered waterbirds is under development for private landowners participating in Natural Resources Conservation Service Farm Bill programs;
- The Cave Conservancy of Hawaiʻi has developed a management plan for the Kīpuka Kanohina Cave Preserve (2003);
- A summary of research and information on individual offshore islands, prepared by the Offshore Island Restoration Committee, and found at http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/;
- The Interim State Strategic Plan for Invasive Species Prevention, Control, Research, and Public Outreach;
- Coastal Zone Management plans, including Hawaiʻi Implementation Plan for Polluted Runoff Control (2000), Hawaiʻi Unified Watershed Assessment (1998);
- Hawaii's Local Action Strategy to Address Land-based Pollution Threats to Coral Reefs (2004);
- Bishop Museum has a comprehensive database of invertebrates;

- The Audubon Society maintains a Sightings database of bird species observed in the State;
- The Pacific Basin Information Node maintains a database of information on species and habitats in Hawai‘i;
- The Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program) maintains a database of rare species and habitats.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key habitats on the island of Hawai‘i. The island of Hawai‘i has numerous areas managed in part for long-term conservation of native wildlife. These include five National Park units (NP/NHP), two units comprising a National Wildlife Refuge (NWR) complex, eight Natural Area Reserves (NAR), two Watershed Partnerships, State Forest Reserve lands, and a number of additional private and public efforts. In addition, other partnerships, such as the Big Island Invasive Species Committee (BISC) have been formed to address issues or species specific conservation needs.

***Mauna Kea Ice Age NAR* (3,886 acres), DOFAW**

Species: Possibly ‘ua‘u (Hawaiian petrel), terrestrial invertebrates, including rare insects, rare plants.
Habitats: Alpine communities.
Current Management: Wekiu bug surveys and research. Education and on-site management of recreational and cultural users is provided by the Office of Mauna Kea Management ranger staff. Public hunting for ungulate (mouflon sheep) control in surrounding Mauna Kea Forest Reserve.
Future Needs: Complete management plan. Continue collaboration with Office of Mauna Kea Management.

***Pōhakuloa Training Area* (PTA) (109,811 acres), U.S. Army**

Species: ‘Ōpe‘ape‘a (Hawaiian hoary bat), forest birds (including palila critical habitat), ‘io (Hawaiian hawk), nēnē (Hawaiian goose), terrestrial invertebrates, rare plants.
Habitats: Subalpine communities.
Current Management: Management plan exists. Primary purpose of PTA is military training, management of natural resources and endangered species limited to exclosures and “intensive management areas.” Monitoring, fire prevention, and control.
Future Needs: Review of impact of Stryker Brigade relocation on current natural resource management activities.

***Big Island NWR* Complex, USFWS**

<u>Hakalau Forest NWR (32,700 acres)</u>
Species: Forest birds, ‘io (Hawaiian hawk), koloa maoli (Hawaiian duck), nēnē (Hawaiian goose), terrestrial invertebrates, including rare snails, rare plants.
Habitats: Montane wet communities.

Current Management: Habitat restoration via koa reforestation, fencing and ungulate control, alien plant species control, and propagation and outplanting of understory and endangered plant species. Annual forest bird surveys. Vegetation monitoring.
Future Needs: Continue existing management, avian disease monitoring, control of non-native mynah, Japanese white-eye, mallard, and mallard-koloa hybrids; accelerated planting of bird food resources such as ʻōhiʻa (*Metrosideros polymorpha*).

Kona Forest Unit of Hakalau Forest NWR (5,341 acres)
Species: Forest birds, ʻio (Hawaiian hawk), historically ʻalalā (tract was acquired as ʻalalā habitat).
Habitats: Montane mesic communities.
Current Management: Intermittent forest bird surveys have been completed.
Future Needs: Continue existing management. Plans include fencing, ungulate removal, and habitat restoration.

***ʻŌlaʻa -Kīlauea Watershed Partnership* (420,000 acre, of which 14,000 acres jointly managed), Public-Private Partnership (NPS, USFWS, DLNR, Biological Resources Division of the U.S. Geological Survey (USGS), U.S. Forest Service, Kūlani Correctional Facility, Kamehameha Schools)**

Species: Forest birds, ʻio, highly diverse terrestrial invertebrates, including rare snails and insects, rare plants.
Habitats: Subalpine communities, montane wet communities, montane mesic communities.
Current Management: Management plan exists. Nearly 14,000 acres are currently under joint management. Habitat restoration via fencing and ungulate removal, propagation and outplanting of native endangered species, control of incipient alien weed invasions. Fencing along Keauhou Ranch boundary creates additional 30,000 acres of protected habitat connecting Kūlani with Mauna Loa Strip of Hawaiʻi Volcanoes NP.
Future Needs: Continue existing management. Secure funding to implement identified priority projects (e.g., North Kona fencing, Kūlani reforestation), effectively implement expansion of partnership boundaries to "Three-Mountains."

***Hawaiʻi Volcanoes National Park* (323,431 acres), NPS**

Species: Bat, forest birds, ʻio (Hawaiian hawk), nēnē (Hawaiian goose), seabirds (including ʻuaʻu (Hawaiian petrel) and ʻakēʻakē (band-rumped storm-petrel)), diverse terrestrial invertebrates, rare plants, marine species associated with shallow coral reef and rocky habitat, hawksbill and green sea turtles.
Habitats: Alpine communities, subalpine shrubland, montane communities, lowland communities, coastal communities, cave habitat, marine ecosystems.
Current Management: Management plan exists. Fencing and ungulate control, habitat restoration, eradication of priority non-native plants, propagation and outplanting of native plant species, monitoring and predator control for endangered birds (nēnē (Hawaiian goose) and ʻuaʻu (Hawaiian petrel)), sea turtle research, monitoring, education. One-time inventories for bats, herptofauna, anchialine pond fauna, shoreline birds. Marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bat, terrestrial

invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality).
Future Needs: Continue existing management. Expand partnerships for complementary monitoring and management of adjacent habitat for native wildlife, especially for rare species including forest birds, seabirds, and invertebrates.

***Pu'u Maka'ala NAR* (12,106 acres), DOFAW**
Species: Forest birds, 'io (Hawaiian hawk), terrestrial invertebrates, including rare snails and insects, rare plants.
Habitats: Montane wet communities.
Current Management: Management plan exists. Feral pig control, control of invasive non-native plants, monitoring.
Future Needs: Continue existing management. Fence remaining forest above 1,000 meters (3,000 feet), ungulate and weed control.

***Kīpuka 'Āinahou Nēnē Sanctuary* (11,157 acres), DOFAW**
Species: Nēnē (Hawaiian goose), forest birds, terrestrial invertebrates, rare plants.
Habitats: Montane wet communities. Montane mesic communities.
Current Management: Public hunting.
Future Needs: Review of DOFAW management guidelines, identification of high-quality native habitat needing protection.

***Waiākea 1942 Lava Flow NAR* (644 acres), DOFAW**
Species: Forest birds, terrestrial invertebrates, including rare insects, rare plants.
Habitats: Montane wet communities, subterranean communities.
Current Management: Recent insect survey by Bishop Museum.
Future Needs: Complete management plan.

***Kahauale'a NAR* (16,726 acres), DOFAW**
Species: Forest birds, 'io (Hawaiian hawk), terrestrial invertebrates, including rare insects, rare plants.
Habitats: Montane wet communities, lowland wet communities.
Current Management: Management plan exists. Trail management only. Limited invasive species control.
Future Needs: Continue existing management and expand management to include fencing and ungulate removal focusing on most intact areas, control of alien weed invasions, other non-native species control to reduce impacts of alien invertebrates.

***Manukā NAR* (25,550 acres), DOFAW**
Species: 'Ōpe'ape'a (Hawaiian hoary bat), forest birds, 'alalā (Hawaiian crow) known historically, 'io (Hawaiian hawk), terrestrial invertebrates, including rare insects, rare plants, anchialine pond fauna.
Habitats: Subalpine communities, montane mesic communities, lowland dry communities, coastal communities, anchialine ponds.

Current Management: Management plan exists. Removal of feral pigs and goats, invasive non-native plant (e.g., fountain grass) control, fencing around rare communities, coqui frog control, monitoring, *Vespula* eradication.
Future Needs: Continue existing management. Fence entire upper boundaries, removal ungulates, biocontrol for fountain grass, Christmas berry, strawberry guava, eradication of *Clidemia hirta*, coqui frog.

Kīpāhoehoe NAR (5,583 acres), DOFAW
Species: Forest birds, seabirds, ʻio (Hawaiian hawk), terrestrial invertebrates, including rare snails and insects, rare plants.
Habitats: Montane wet communities, montane mesic communities, lowland mesic communities, lowland dry communities.
Current Management: Management plan exists. Fencing and ungulate removal in most pristine habitats, weed control in intact native communities (upper elevation forests and pili grasslands).
Future Needs: Continue existing management. Expand fencing to include entire NAR, biocontrol for Christmas berry, strawberry guava, *Clidemia hirta*.

Kaʻū Preserve (3,491 acres), TNC
Species: Forest birds, ʻio (Hawaiian hawk), terrestrial invertebrates, rare plants. Possibly ʻōpeʻapeʻa.
Habitats: Lowland wet communities, lowland mesic communities.
Current Management: Management plan exists. Ungulate control, invasive non-native plant control, community outreach.
Future Needs: Acceptance into the Natural Area Partnership Program. Implement management plan.

Kona Hema Preserve (8,061 acres), TNC
Species: Forest birds, ʻio (Hawaiian hawk), terrestrial invertebrates, rare plants.
Habitats: Montane mesic communities, lowland mesic communities.
Current Management: Management plan exists. Restoration via fencing and ungulate control. Research on koa reforestation.
Future Needs: Continue existing management, ungulate eradication from fenced units.

Puʻu Waʻawaʻa Wildlife Sanctuary (3,806 acres), DOFAW
Species: ʻŌpeʻapeʻa (Hawaiian hoary bat), forest bird, ʻio (Hawaiian hawk), pueo, nēnē (Hawaiian goose), recovery habitat for ʻalalā, terrestrial invertebrates, including rare moths and insects, rare plants.
Habitats: Montane mesic communities, montane dry communities, lowland dry communities.
Current Management: Management plan exists. Removed livestock, curtailed illegal logging. Limited fencing, ungulate and invasive species control.
Future Needs: Implement Puʻu Waʻawaʻa Management plan, DOFAW Management guidelines, revise wildlife sanctuary rules to reflect conservation status, complete fence repairs and remove all ungulates, implement fire threat mitigation, implement outplanting program.

***Kohala Mountains Watershed Partnership* (>30,000 acres), Public-Private Partnership (Parker Ranch, Inc., Kahua Ranch, Ltd., Ponoholo Ranch, Ltd., The Queen Emma Foundation, Kamehameha Schools, Laupāhoehoe Nui, LLC, DLNR, State Department of Hawaiian Home Lands (DHHL), Hawai‘i County Department of Water Supply, The Nature Conservancy (TNC))**

Species: Forest birds, koloa maoli (Hawaiian duck), migratory shorebirds and waterfowl, kōlea (Pacific golden plover), terrestrial invertebrates, including rare snails and insects, rare plants.
Habitats: Montane wet communities.
***Current Management*:** The partnership formed in 2004, and a management plan for the partnership is currently being developed.
Future Needs: Secure funding to implement management plan.

***Pu‘u O ‘Umi NAR* (10,142 acres), DOFAW**

Species: Forest birds, ‘io (Hawaiian hawk), koloa maoli, (Hawaiian duck), ‘a‘o (Newell's shearwater) possible, terrestrial invertebrates, including rare snails and insects, rare plants.
Habitats: Montane wet communities.
Current Management: Management plan exists. Fencing, ungulate removal, monitoring.
Future Needs: Continue existing management. Extend fencing to protect most intact bogs and forests from ungulates. Increase control of priority weed species such as banana poka.

***Laupāhoehoe NAR* (7,894 acres), DOFAW**

Species: Forest birds, ‘io (Hawaiian hawk), koloa maoli (Hawaiian duck), terrestrial invertebrates, rare plants.
Habitats: Montane wet communities, lowland wet communities.
Current Management: Management plan exists.
Future Needs: Increase active management. Fencing, feral pig control, weed control, monitoring to assess management effectiveness.

***Cooperative Nēnē Sanctuaries*, Public-Private Partnership**

Species: Nēnē (Hawaiian goose).
Habitats: Forested areas and shrublands.
Current Management: There are two cooperative nēnē sanctuaries: Keauhou (Ka‘ū) (KS) and Keauhou II (Hualālai) (KS). Predator control (small mammals) during breeding seasons. Release of captive bred birds. Supplemental food and water. Exclosures for nesting birds and goslings.
Future Needs: Continue existing management.

***Wetlands Restoration*, Public-Private Partnership**

Species: Koloa maoli (Hawaiian duck), nēnē (Hawaiian goose), other waterbirds and migratory birds.
Habitats: Wetland areas island-wide.

Current Management: Restoration or creation of 28 montane ponds on private lands, including fencing to exclude ungulates and feral dogs and predator control. Development of programmatic Safe Harbor Agreement to cover future participating landowners (Safe Harbor Agreement completed with one landowner).
Future Needs: Approval of programmatic Safe Harbor Agreement, technical assistance for private landowners.

***Kaloko-Honokohau National Historic Park* (1,161 acres), NPS**
Species: ʻŌpeʻapeʻa (Hawaiian hoary bat), aeʻo (Hawaiian stilt), ʻalae keʻokeʻo (Hawaiian coot), migratory birds, anchialine pond fauna, species associated with shallow coral reef and rocky habitat, green sea turtle.
Habitats: Coastal communities, anchialine ponds, marine ecosystem (including shallow coral reef and rocky habitats and sandy beach).
Current Management: Management plan exists. One-time inventories for bats, herptofauna, native plants, shoreline birds. Habitat restoration at ʻAimakapā (alien weed removal), protection of wetland and anchialine habitats, reef monitoring, and research. Marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bat, terrestrial invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality).
Future Needs: Continue existing management, predator control. Expanded partnerships for complementary monitoring and management of adjacent habitat for native terrestrial and marine species.

***Puʻuhonua O Honaunau NHP* (182 acres), NPS**
Species: Migratory birds, green sea turtles.
Habitats: Coastal communities, marine ecosystems.
Current Management: Management plan exists. One-time inventories for bats, herptofauna, native plants, shoreline birds. Turtle protection via public education. Marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bat, terrestrial invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality).
Future Needs: Continue existing management. Expanded partnership for complementary monitoring and management of adjacent habitat for native wildlife.

***Puʻukoholā Heiau NHP* (83 acres), NPS**
Species: Migratory birds.
Habitats: Coastal communities, nearshore marine ecosystems.
Current Management: Management plan exists. One-time inventories for bats, herptofauna, native plants, shoreline birds. Marine and terrestrial monitoring protocols are under development (covering fishes, fisheries, marine benthos, freshwater animals, selected birds, bats, terrestrial invertebrates, vegetation, land use changes in and adjacent to park, invasive species, and water quality). Research on grassland habitat restoration.
Future Needs: Continue existing management.

***State Seabird Sanctuary* (3 offshore islands), DOFAW**
Species: Seabirds, migratory birds.

Habitats: Coastal communities.
Current Management: Surveys and monitoring.
Future Needs: Continue surveys, develop and implement management plan.

Big Island Invasive Species Committee **(BISC), Public-Private Partnership**
Species/Habitats: All species and habitats affected by invasive species.
Current Management: Prevention of incipient invasions, invasive species control, public education.
Future Needs: Adequate funding to support priority BISC actions.

Hawaiian Islands Humpback Whale National Marine Sanctuary **(about 900,000 acres), Co-Managed by NOAA and DLNR.**
Species**:** Humpback whale.
Habitats: Marine ecosystems.
Current Management**:** Management Plan exists. Humpback whale 100 yard (91 meter) approach rule and other regulations protecting humpback whales and their habitat, increased fines for violating provisions of the Endangered Species Act, lead agency for the MHI component of the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) project to determine population size, volunteer whale counts and other community events, and other educational activities, research support, and enforcement.
Future needs**:** Review other marine species, including seabirds, and habitats for inclusion in Sanctuary and increase research, education, and enforcement actions.

Five Marine Life Conservation Districts (MLCD), **DAR: Kealakekua Bay, Lapakahi, Old Kona Airport, Wailea Bay, Wai'opae Tidepools**
Species**:** Species associated with shallow coral reef, sandy beach, and rocky habitats, Hawaiian monk seals, green sea turtles, spinner dolphins, and other marine mammals.
Habitats: Marine ecosystems including shallow coral reef, sandy beach, rocky habitats.
Current Management**:** Limited access in most MLCDs, eight MLCD across the islands include at least some No Take areas, Old Kona Airport allows fishing throughout the MLCD, and fish monitoring.
Future needs**:** Evaluate all MLCDs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Six Fishery Management Areas (FMA), **DAR: Hilo Harbor, Kailua Bay, Kawaihae Harbor, Keauhou Bay, Kīholo Bay, Kona Coast, Puako Bay and Reef**
Species**:** Some or all regulated fish species.
Habitats: Marine and estuary ecosystems.
Current Management**:** Limited take, gear, size, season, and/or area restrictions.
Future needs**:** Evaluate all FMAs for purpose and management effectiveness and consider need for new Marine Managed Areas.

Five Bottomfish Restricted Areas (BRA), **DAR**
Species**:** Seven bottomfish species.
Habitats: Marine ecosystems.

Current Management: No Take of bottomfish.
Future needs: Evaluate all BRAs for purpose and management effectiveness and consider need for new or revised Marine Managed Areas.

Potential Areas for Enhanced Conservation Management

In addition to maintaining and enhancing existing conservation actions, additional efforts are needed for the long-term conservation of the native wildlife of the island of Hawaiʻi. The following section identifies areas where enhanced conservation management would significantly benefit native species or their habitats. Areas are discussed in habitat order from the mountains to the sea.

Greater Mauna Loa Landscape Conservation Area

This is a multi-unit priority area comprised of the next five specific regions, as well as land already managed by the NPS, NARS, TNC and the ʻŌlaʻa-Kīlauea Partnership. Because much of the land in this area is currently managed for preservation or is conservation-zoned, there is an opportunity to prioritize management objectives under a broad goal of wildlife conservation. This area has intact or largely native ecosystems nearly from sea to summit and provides an opportunity to conserve wildlife on a landscape scale. The contiguous forests across elevation and moisture gradients in Kaʻū district might provide habitat even under changing climate and weather conditions. On the north side of the Southwest Rift Zone, the forest landscape is patchier, but still rich in places. Additionally, the economics of ranching have changed so that some landowners are pursuing sustainable koa forestry and ecotourism as a means of generating income from the land. Both of these are compatible with enhancing wildlife habitat across a landscape scale.

Kaʻū Forest Reserve (DOFAW) and adjacent State parcels at Kiolakaʻa, Waiʻōhinu and Kaʻalāiki

Species: Forest birds include five common (ʻamakihi, ʻapapane, ʻelepaio, ʻiʻiwi, ʻōmaʻo) and three endangered (ʻakiapōlāʻau, ʻākepa, Hawaiʻi creeper) species, ʻio (Hawaiian hawk), potential habitat for release of ʻalalā. The native arthropod community is known to be diverse in some areas at lower elevations. Hawaiian hoary bat (ʻōpeʻapeʻa) is present.
Basis for Priority Designation: This is one of the most diverse and least invaded forests on the island. It supports the highest known densities of common and rare forest birds in the State. Forest supports one of the highest known vegetation biomass profiles in the State due to high stature closed canopy forests. Lower portions of the reserve are known to harbor a diverse native insect fauna. As part of a broader area which would include Kapāpala Forest Reserve and the recently expanded Hawaiʻi Volcanoes NP, it provides an elevational and moisture gradient that would allow wildlife populations to move in response to changing climate or weather conditions. The southeast sections and State parcels named above, in addition to State parcels adjacent to TNC lands along Hilea Gulch support diverse and nearly weed-free lowland forest down to about 1,750 feet.
Potential Conservation Actions: Designated as highest quality native vegetation and ungulate control in DOFAW's Management Guidelines, but presently no ungulate control ongoing. Remoteness precludes adequate control through public hunting. Maintain high quality of forest through fencing and ungulate control, prevent weed invasion, and

implement monitoring for ungulate damage and incipient invasions to facilitate adaptive management.

Kapāpala Forest Reserve (DOFAW) and Kapāpala Koa Management Area (existing and proposed)
Species: Five common and four endangered birds, ʻakiapōlāʻau, nēnē, ʻio, ʻuaʻu, possibly ʻakēʻakē, ʻōpeʻapeʻa. Invertebrate populations may be substantial. *Micromus* sp., a rare undescribed flightless lace-wing, is known from the forest reserve.
Basis for Priority Designation: As part of a broader area including Kaʻū Forest Reserve, Mauna Loa Forest Reserve, ʻŌlaʻa -Kīlauea Watershed Partnership and Hawaiʻi Volcanoes National Park, this area has potential for implementing landscape-level conservation. Koa (*Acacia koa*) kīpuka here provide habitat for a geographically distinct population of endangered ʻakiapōlāʻau, which could become important if other populations decline. Continuous and concentrated diversity in vegetation may indicate the same diversity for invertebrate populations. This is a unique mesic habitat. The western portion of the reserve has a limited degree of alien plant species invasion thus reducing the degree of management necessary.
Potential Conservation Actions: Fencing and ungulate control. At higher elevations, mouflon sheep may be inhibiting koa forest regeneration, revisit DOFAW management guidelines, establish koa regeneration throughout.

Mauna Loa Forest Reserve between Pōhakuloa and Hawaiʻi Volcanoes NP (DLNR, U.S. Army, DOFAW)
Species: ʻŌpeʻapeʻa, ʻuaʻu and ʻakēʻakē, nēnē. Diverse and rare invertebrate communities including *Hylaeus* spp., Lepidoptera, Heteroptera, and Coleoptera species known from adjacent Puʻu Waʻawaʻa. Rare *Leptachatina* sp. (snail), *Helicoverpa confusa* (moth), *Rhyncogonus stellarius* (weevil) known from adjacent Pōhakuloa Training Area.
Basis for Priority Designation: Two State endangered seabird species probably have nesting colonies in this area. Dry tropical montane and subalpine shrub is rare world-wide. The saddle between Mauna Kea, Mauna Loa, and Hualālai includes numerous endangered and endemic plant species and a completely unique habitat type on this island. Some of the insect fauna is likely to be endemic to this region. Much of the region is prone to fire as alien grasses dominate the areas below and military training exercises can start fires. Inclusion of this area would extend landscape-scale wildlife conservation management to the north side of Mauna Loa. There are also numerous caves in the area, some of which support native invertebrates and/or have pools of water at their entrances where nēnē and ʻōpeʻapeʻa have been seen.
Potential Conservation Actions: More proactive predator (e.g., feral cat) control to protect nesting seabirds. Fire prevention. Fencing in areas where plant communities are rare or largely intact. Research rare invertebrates, determine limiting factors affecting them, and conservation actions that might enhance populations.

***Mesic montane forests and parklands in South Kona*. (NPS, USFWS, KS, NARS (Manukā and Kīpahoehoe), DOFAW Forest Reserves (South Kona FR), State land**

in Waiea, private lands (Yee-Hop, McCandless Ranch, Kapua Mauka, Kealakekua Ranch, TNC, Kealia Ranch, Hokukano Ranch))
Species: Common forest birds: ʻākepa, ʻakiapōlāʻau and Hawaiʻi creeper in a few locations, ʻio, last known range of ʻalalā. Likely provides habitat for native invertebrate fauna, particularly in less degraded forest patches and in lava tubes. Rare insect species in the region include two undescribed damsel bugs, stink bug, koa bug, kissing bug, lacewing, weevil, two moths and two candidate *Drosophila* species. Snails found recently in Kapua include *Pronesopupa* sp., *Elasmias fuscum,* and *Tornatellides/Tornatellaria* species.
Basis for Priority Designation: This area includes habitat ranging from intact forests to open degraded parkland and rangeland. Possible economic futures for this contiguous region include sustainable koa forestry, which has been shown to create foraging and nesting habitat for some forest species. Forest patches and young koa forest could harbor native invertebrates as well. There is a possibility for economic drivers related to diminishing returns on ranching and increased interest in koa forestry and ecotourism in this region to enhance wildlife habitat.
Potential Conservation Actions: Sustainable koa forestry. Restoration of degraded and unprofitable rangelands. Exotic ungulate control through guided private hunting. Possible ecotourism activities. Fencing and ungulate control of State lands at higher elevations where native forest communities are intact (including South Kona FR, NARs, Waiea tract), where private lands occur, support voluntary and incentive based programs for potential conservation.

Coastal strand communities at Kaʻaluʻalu (State), Manukā (DOFAW/Land), Kapua (private), and Okoe (State)
Species: Presence of seabirds and migratory waterfowl and shorebirds. Unknown, but it is assumed native arthropod communities would be associated with these diverse native vegetation communities. There may be turtles nesting in some sections. A Hawaiian monk-seal pupped at Kaʻaluʻalu a few years ago. Anchialine species.
Basis for Priority Designation: In addition to a diverse coastal vegetation community, these areas contain anchialine ponds, archeological resources, and may harbor nesting turtles. There is a high probability that there is a diverse native arthropod community associated with this uniquely diverse, and therefore rare, coastal strand community. Kapua and Okoe are contiguous with protected coastal area of Manukā NAR, presenting an unusual opportunity to protect a large section of coastal strand.
Potential Conservation Actions: Where private lands occur, support voluntary and incentive based programs for potential conservation, public/private partnerships to protect rare habitat. Predator control (rats and mongooses) to protect turtle nests and enhance arthropod populations.

***Habitat corridor between Hāmākua and ʻŌlaʻa-Kīlauea Watershed Partnership*. This would include upper elevation sections of Hilo Watershed and Upper Waiākea Forest Reserves, the Waiākea 1942 Lava Flow NAR, and Mauna Loa Kīpuka Mosaic areas. Could be extended to include Kīpuka ʻĀinahou Nēnē Sanctuary (DOFAW)**

Species: Forest birds including two endangered species. Diverse arthropod communities recently documented in some areas. Diverse snail community historically, present extent unknown. Cave communities.
Basis for Priority Designation: Habitat degradation due to feral ungulates and invasive forest plants in this area may be limiting populations of all species known from this area. A corridor of aggressively managed habitat between the forest bird "hot spots" of Hāmākua and Ka'ū might allow greater migration (and genetic exchange) among populations as well as expansion of existing populations. Particularly diverse arthropod communities are known to exist in the kīpuka area and along the Stainback Highway in Upper Waiākea Forest Reserve. The integrity of these areas should be preserved. Emesine Cave underlies this area and is important for numerous cave-adapted species.
Potential Conservation Actions: More aggressive management for wildlife conservation including fencing, ungulate and alien weed control. Protection of habitat integrity to ensure continued survival of invertebrates.

Pīhā tract of Hilo Forest Reserve **(DOFAW)**
Species: Forest birds including five common and three locally abundant endangered species, 'io.
Basis for Priority Designation: Create buffer zone around key habitat at Hakalau Forest NWR; Pīhā divides this important habitat and is not currently managed for conservation. Habitat degradation by ungulates and invasive plant species in Pīhā threatens efforts at Hakalau Forest as well.
Potential Conservation Actions: Explore cooperative management with USFWS, possibly through conveyance of land or conveyance of management. Fencing, ungulate eradication, invasive weed eradication.

Kanakaleonui Corridor (State land between Mauna Kea Forest Reserve and Hakalau Forest NWR) **(Department of Hawaiian Home Lands (DHHL))**
Species: Common forest birds - especially 'i'iwi, 'apapane, 'amakihi. Possibly 'elepaio and 'akiapōlā'au, 'io.
Basis for Priority Designation: Forest birds migrate with 'ōhi'a and māmane phenology. These species (and juveniles of these) are known to travel between wet forests and subalpine māmane forests during the bloom. DHHL lands are a corridor for this travel.
Potential Conservation Actions: Create corridors for this movement through koa and māmane reforestation. Discontinue koa logging so some native corridor remains. Discontinue reforestation with sugi pine (*Cryptomeria japonica*) as this is a known invader in koa forests. Explore potential of cooperative management with USFWS and DOFAW. Encourage planting of native species for cultural and economic benefits, in line with DHHL mission, via partnerships with schools, universities, and conservation-oriented and Hawaiian cultural groups.

Puna low elevation forests, including those in Nānāwale, Puna, Keauohana, and Malama-Kī Forest Reserves (DOFAW), and Pu'u Kali'u (KS)
Species: Forest birds, especially 'apapane and 'amakihi , unknown invertebrate populations.

Basis for Priority Designation: These are the last native lowland forest areas on the island. Native bird populations within them appear to have developed resistance to avian malaria, so these populations are important from a conservation and biological perspective even though they are common species.
Potential Conservation Actions: Establish partnership or lease agreement to facilitate reforestation. Protect old growth ʻōhiʻa (*Metrosideros polymorpha*) and lama (*Diospyros sandwichensis*). Fencing and ungulate control of "best" forest areas. Alien plant species eradication to allow regeneration of native forest species.

Dry Forest Areas including Puʻu Waʻawaʻa (DOFAW), Kaʻūpūlehu (KS), Hualālai summit area (KS), Palama Nui (Hiluhilu), State land north of Palama Nui
Species: Snails: *P. confusa, Tornatellaria spp., Lamellidea spp., Elasmius fuscum*, eight other genera collected at Pōhakuloa in 1990's. Diverse native arthropod community with numerous Lepidoptera, Heteroptera, and Coleoptera. Spiders from seven families. Rare taxa include a stink bug, plant bug, planthoppers, lacewing, beetles, moths, *Hylaeus* spp., a candidate endangered *Drosophila* species, endangered Blackburn's sphinx moth. Birds include nēnē, ʻio, pueo, common and endangered forest species.
Basis for Priority Designation: Tropical dry forests are extremely rare worldwide and are one of the most endangered habitats in Hawaiʻi. ʻUmi Manu cave system and Henahena lava tubes support many species of rare subterranean invertebrates. Habitat types in the area include subalpine and dry montane forest and shrubland, montane mesic and lowland dry forests. Many arthropods known from here are associated with specific host plants that are also only found here. Possible release area for endangered ʻalalā.
Potential Conservation Actions: Conservation partnerships. Implementation of 2003 Management Plan for the *Ahupuaʻa* of Puʻu Waʻawaʻa. Fencing and mammal control (ungulates and rats) in "best" forest areas to allow regeneration. Develop control methods for alien grasses and fire mitigation measures.

Unprotected Wetlands: Waipiʻo and Waimanu Valley, Kīholo Springs Pond and Marsh, Opaeʻula Pond, Kealakekua Bay Pond, Lokoaka Pond, Waiākea Pond, Keʻanae Pond
Species: Aeʻo (Hawaiian stilt), ʻalae keʻokeʻo (Hawaiian coot), koloa maoli (Hawaiian duck), migratory waterfowl and shorebirds, associated native invertebrates.
Basis for Priority Designation: These are core or supporting wetland areas identified in USFWS Waterbird Recovery Plan. Waipiʻo and Waimanu have extensive wetlands and taro *loʻi* which require long-term protection. Habitat for wetland bird species.
Potential Conservation Actions: Where private lands occur, support voluntary and incentive based programs for potential conservation, in all areas, enhance waterbird habitat by removing invasive vegetation. Provide technical assistance to private landowners to affect this. Control predators (rat, cat, mongooses) during nesting season, especially where endangered aeʻo and ʻalae keʻokeʻo occur. Coordinate pesticide use with DAR. Remove feral mallards to prevent potential hybridization with koloa maoli.

***Anchialine areas* (DLNR, KS, NPS, NARS, private)**
Species: Anchialine amphipods and shrimp, aeʻo (Hawaiian stilt), migratory shorebirds.
Basis for Priority Designation: There are only about 700 anchialine pools worldwide, 80 percent of which are on Hawaiʻi. Anchialine ponds support a unique fauna which is

threatened by human activities ranging from coastal development and subsequent changes in hydrology to "biological pollution" by those who intentionally dump alien fish (mosquito fish and tilapia) and shrimp into ponds. Also, *Holocaridina rubra* potentially threatened by commercial harvesting.
Potential Conservation Actions: Where private lands occur, support voluntary and incentive based programs for potential conservation, improved public education regarding fragility of anchialine ecosystems. Development and implementation of ichthyocide methods to control alien fish in salt water. Divert human use away from these features.

***Streams originating in more protected areas*: below Hakalau, Wailuku River, Honolii, Pahaoehoe, Kapue, Kolekole, Kilau, Haakoa, Kaiwilahilahi, Pahale, additional protection below Kohala Watershed, and others**

Species: ʻOʻopu, *Megalagrion spp,* damselflies, koloa maoli (Hawaiian duck).
Basis for Priority Designation: Protect native freshwater fish species. Alien fish in these streams may prey on native *Megalagrion* species.
Potential Conservation Actions: Implement additional fencing and removal of ungulates to improve stream water quality and reduce erosion, benefiting stream and ocean fish.

***Caves:* Kipuka Kanohina (near Ocean View, 800-1400'), ʻUmi Manu and Henahena systems (Puʻu Waʻawaʻa), Kaʻū and Kapāpala (tubes are unsurveyed), Emesine Cave (Upper Waiākea FR), Wao Kele O Puna, Kīholo Bay, Kaʻūpūlehu and Puʻu Waʻawaʻa ahupuaʻa between Mamalahoa and Queen Kaahumanu Highways**

Species: Endemic cave-adapted fauna. A unique species is known from coastal tubes at Kīholo (*Oliarus lorettaei*). In Emesine Cave, species include *Nesidiolestes ana* (blind, cave-adapted thread-legged bug), ten other cave-adapters including planthopper *Oliarus polyphemus*, moth *Schrankia sp.*, rock crickets *Caconemobius varius* and related species, tree cricket *Thaumatogryllus cavicola,* millipede *Nannolene sp.,* rock centipede *Lithobius sp.*, springtails *Collembola* spp. At higher elevations in Kaʻūpūlehu and Puʻu Waʻawaʻa, there are planthoppers, moths, centipedes, spiders and crickets.
Basis for Priority Designation: Hawaii's cave fauna is globally unique. To protect the cave systems, land above them must be managed for conservation. Some of the caves already listed are included in other sections of this document.
Potential Conservation Actions: Protect habitat above caves as cave-adapted ecosystems depend on tree roots and moisture. Construct gates to manage human access.

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NORTHWESTERN HAWAIIAN ISLANDS

The Northwestern Hawaiian Islands (NWHI) extend approximately 1,600 kilometers (1,000 miles) from Niʻihau and Kauaʻi to Kure Atoll in the north. They consist of ten main atoll systems, each of which has one or more islands. The total number of islands varies as storms and climate change affect the presence of some small, sandy islands. These islands and atolls are remnants of earlier volcanic high islands in the Hawaiian chain that pre-date the Main Hawaiian Islands (MHI) in the southeast. Most of the NWHI islands, except those in the extreme southeast, have little vertical relief and only sandy soils with little forest development. This reduced habitat variability means there are far fewer natural habitats and lower species diversity than found in the MHI. However, there is a high abundance of endemic species and other significant animal populations in the region because of the less intensive historical human impact. Six species of plants in the NWHI are federally protected under the Endangered Species Act (ESA). The rocky islands in the southeast make excellent nesting areas for some cliff-nesting and other seabirds. Laysan Island has a large euryhaline lake that helps support the endemic and endangered Laysan ducks as well as some possibly unique aquatic fauna. Laysan and Nihoa also have extant populations of three other endemic birds that are endangered (Laysan finch, Nihoa finch, and Nihoa millerbird).

All of the islands support large nesting populations of various seabird species. In total, approximately 14 million individuals from 18 species of seabirds nest in the NWHI (ʻakēʻakē (*Oceanodroma castro* [band-rumped storm petrel]), noio (*Anous minutus* [black noddy]), kaʻupu (*Phoebastria nigripes* [black-footed albatross]), blue-gray noddy (*Procelsterna cerulean)*, Bonin petrel (*Pterodroma hypoleuca*), ʻā (*Sula leucogaster* [brown booby]), noio-kōhā (*Anous stolidus* [brown noddy]), ʻou (*Bulweria bulwerii* [Bulwer's petrel]), Christmas shearwater (*Puffinus nativitatis*), ʻuaʻu (*Pterodroma sandwichensis* [Hawaiian petrel]), pākalakala (*Sterna lunata* [gray-backed tern]), ʻiwa (*Fregata minor* [great frigatebird]), mōlī (*Phoebastria immutabilis* [Laysan albatross]), ʻā (*Sula dactylatra* [masked booby]), ʻā (*Sula sula* [red-footed booby]), koaʻe ʻula (*Phaethon rubricauda* [red-tailed tropicbird]), ʻewaʻewa (*Sterna fuscata* [sooty tern]), ʻuaʻu kani (*Puffinus pacificus* [wedge-tailed shearwater]), manu-o-Kū (*Gygis alba* [white tern]), and koaʻe kea (*Phaethon lepturus* [white-tailed tropicbird])). The area is significant for having the majority of the worldwide breeding population of Laysan albatross (93%), black-footed albatross (95%), Bulwer's petrels and Bonin petrels, and 25 percent of the worldwide population of wedge-tailed shearwaters. Many endemic terrestrial arthropods and land snails also occur in the NWHI. Many of the islands serve as nesting or pupping grounds for honu (*Chelonia mydas agassizi* [green sea turtles]) and ʻīlio-holo-i-ka-uaua (*Monachus schauinslandi* [Hawaiian monk seals]), both of which are protected by the ESA. Marine habitat here is dominated by atoll reef systems and thus differs from the MHI, which mostly have fringing coral reefs. The NWHI have extensive atoll formations with large lagoons and patch reef complexes separated from the open ocean in many areas. Many endemic marine species occur only in the NWHI. The communities here are also less impacted by humans and invasive species and are dominated by large numbers of predatory sharks and jacks and a higher diversity of stony corals than in the MHI. Significant cultural resources in the form of Native Hawaiian archaeological sites and historic ship and airplane wrecks occur in the area.

OVERVIEW

Geology and Oceanography

The total coastline of all islands in the NWHI measures approximately 50 kilometers (30 miles) and total land area, excluding Midway Atoll, is about 8 square kilometers (3.1 square miles). The age of the various islands and atolls ranges from 7.2 million year old Nihoa to 27.7 million year old Midway Atoll. Because of the age of the islands, they have undergone extensive erosion and subsidence of their basaltic rock foundations. Only Mokumanamana Island (Necker), Nihoa, La Perouse Pinnacle, and Gardner Pinnacles have substantial exposed basaltic rock substrate. Further to the northwest, the islands consist of sandy substrates derived from reef formations overlaying the original basalt. There are about 2,220 square kilometers (860 square miles) of coral reefs in State waters around the NWHI, and about 6,300 square kilometers (2430 square miles) of reef in Federal Exclusive Economic Zone waters around the atolls and reefs that are part of Hawai‘i (i.e., not including Midway Atoll and the submerged banks). Therefore, approximately 26 percent of the coral reefs of these areas are under State jurisdiction and management.

Climate

Rainfall and temperature are more consistent across and within these islands because of their small size. The winter season brings much larger sea swell. Precipitation averages about 50 to 75 centimeters (20 to 30 inches) per year.

Land and Water Use

All of the land in the NWHI is part of the Hawaiian Islands National Wildlife Refuge (HINWR), except Midway Atoll, which is managed as a separate National Wildlife Refuge, and Kure Atoll which is managed by the Hawai‘i Department of Land and Natural Resources as a State Seabird Sanctuary. All the islands are part of the County of Honolulu, except Midway Atoll which is not part of the State of Hawai‘i at all as it is a territory of the U.S. government. Waters out to ten fathoms (18.3 meters) deep around most of the islands (except to 20 fathoms deep around Mokumanamana Island (Necker)) are also part of the HINWR, so there is unique Federal-State co-management of the inshore waters. Federal waters from three miles (five kilometers) offshore to 50 miles (80 kilometers) offshore are part of the NWHI Coral Reef Ecosystem Reserve managed by the National Oceanic and Atmospheric Administration (NOAA).

Human Landscape

There is no real resident population besides a few HINWR staff on Sand Island at Midway, Laysan Island, and Tern Island at French Frigate Shoals. Historical occupation of Tern Island and Green Island at Kure Atoll by the Coast Guard, and Midway Atoll by the Navy, ended in the past 20 years, but left various environmental problems. Archaeological sites point to pre-historical occupation of Mokumanamana Island (Necker) and Nihoa. The principal economic driving forces in the NWHI today are bottomfishing (one-third of the State's bottomfish come from the NWHI), the Wildlife Refuge and Coral Reef Ecosystem Reserve operations, and scientific research.

ISLAND AND ATOLL SUMMARIES

The following are brief summaries of the various island and atoll systems, from north to south.

Kure Atoll, at the northwestern end of the archipelago, is the world's northernmost coral atoll. About ten kilometers (six miles) in diameter and one square kilometer (0.4 square miles) in land area, Kure is a typical atoll comprising one major island, Green Island, and one or more smaller, intermittent sand spits. Maximum elevation is six meters (20 feet). It has about 32,375 hectares (80,000 acres) of reef habitat. Kure is approximately 2,100 kilometers (1,300 miles) northwest of Honolulu. The U.S. Coast Guard closed the LORAN navigation station on Green Island and left the site in 1992. Since then, the atoll has only been occupied during National Marine Fisheries Service (NMFS) and State of Hawaiʻi summer field camps. Kure Atoll is managed as a State of Hawaiʻi Seabird Sanctuary. Bird and dolphin surveys, marine debris removal, and invasive vegetation control and native plant species replanting are the main management actions. Rats were eradicated from the island in the past. Introduced big-headed ants and scale insects are a potential threat as are introduced invasive plants. Toxic chemicals have been detected that are likely from the Coast Guard occupation. Hawaiian grouper are more abundant here in shallow water than in other parts of the NWHI. A large group of spinner dolphins lives in the atoll.

Midway Atoll, located approximately 2,040 kilometers (1,270 miles) northwest of Honolulu, consists of two major islands (Sand and Eastern), small sand islets, and a fringing coral reef. It is about ten kilometers (six miles) in diameter and 6.5 square kilometers (2.5 square miles) in land area. Maximum elevation is four meters (12 feet). It has about 36,000 hectares (89,000 acres) of reef habitat. Midway was discovered in 1859 and claimed by the United States. Since that time, there have been considerable activities that have resulted in significant alteration of the physical environment. Projects have included blasting a ship channel through the coral reef, the installation in 1902 of a cable station (which led to the introduction of various species of plants and animals and the importation of an estimated 9,000 tons of topsoil for use in gardening), and the construction of an airport in 1935 by Pan American Airways. Midway also played a critical role in WWII. USFWS established the Midway Atoll National Wildlife Refuge as an overlay refuge in 1988 through a cooperative agreement with the U.S. Navy, and the atoll was transferred from the Navy to USFWS in 1996. Midway is managed as the Midway Atoll National Wildlife Refuge and is not technically part of the State of Hawaiʻi. The world's largest breeding colony of mōlī (Laysan albatross) nests here, as does the second largest colony of kaʻupu (black-footed albatross). The Refuge also contains important habitat for the monk seal, green sea turtle, large numbers of migratory seabirds, and a variety of coastal strand plants. The Refuge waters support numerous species of nearshore and other coral reef species, as well as pelagic fish, marine mammals, and sea turtles. The Refuge is currently closed to visitation.

Pearl and Hermes Reef, is a low coral atoll made up of as many as eight islets, five of which are permanent. The reef encloses an elliptical lagoon, approximately 32 kilometers by 18 kilometers (20 miles by 11 miles) in size and has 0.3 square kilometers (0.1 square miles) of land area. Maximum elevation is three meters (ten feet). It has about 121,400 hectares (300,000 acres) of reef habitat. The reef was unknown prior to 1822 when two British whaling ships, the *Pearl* and the *Hermes*, ran aground there on the same day. These wrecks were likely discovered in 2004. Beginning in 1902, Japanese feather poachers came to the NWHI and illegally took thousands of albatross, but the true extent of their poaching is not known. From 1926 to 1930, fishing operations for pearl oysters led to the construction of several buildings on the atoll's Southeast Island. This base was abandoned in October 1931 and U.S. forces destroyed the buildings during World War II. The atoll is unoccupied except for NMFS and USFWS summer field camps. Significant seabird, green sea turtle, and monk seal nesting or pupping occur here. About 160,000 seabirds from 17 species nest here, including about 20 percent of the world population of ka'upu (black-footed albatross). The Atoll is also an important nesting site for Tristram's storm-petrels. NMFS has removed over 300 tons of marine debris from the beaches and reefs over the past few years. Pearl oysters were historically far more common here than anywhere else in Hawai'i and have recovered somewhat from the overfishing. The HINWR is currently trying to remove invasive *Verbesina* weed here. Populations of Laysan finch introduced to provide another population to reduce the risk of extinction of the species on its native island of Laysan do well here, but have evolved different anatomy to deal with different food sources.

Lisianski Island, is a low, sandy island measuring approximately 1.6 kilometers (one mile) long and one kilometer (0.6 mile) wide, with a land area of 1.5 square kilometers (0.6 square miles). Maximum elevation is 12 meters (40 feet). It lies near the north edge of Neva Shoal, a large area varying in depth to 18 meters (60 feet). It has about 125,400 hectares (310,000 acres) of reef habitat. The island was discovered in 1805 by Capt. Urey Lisianski, a Russian explorer. During the same period, Lisianski was visited by expeditions harvesting fish, turtles, guano, bêche-de-mer (sea cucumbers), and sharks, as well as monk seals. More concentrated exploitation of the island took place during the period 1904-10 by Japanese feather poachers, but this activity was apparently halted by 1911. Mice and rabbits denuded the island of vegetation. Subsequent visits to Lisianski appear to have been limited. The atoll is unoccupied except for NMFS and USFWS summer field camps. There is significant seabird nesting including the largest bonin petrel colony in the world.

Laysan Island, the largest land area in the NWHI at four square kilometers (1.6 square miles), is a coral-sand island enclosing a hyper-saline lake of about 0.5 square kilometers (0.2 square miles) in area. The island is about three kilometers (two miles) long and 1.6 kilometers (one mile) wide and is partially surrounded by a fringing reef. Maximum elevation is 12 meters (40 feet). It has about 40,500 hectares (100,000 acres) of reef habitat. The first well-documented visit was by the Russian ship *Moller* in 1828. The biota of the island remained relatively undisturbed until the late 19th century. By the turn of the century, the activities of sealers and guano miners had seriously affected the Laysan monk seal population, nearly eliminating it. These activities were followed in

1909 to 1910 by intensive harvesting of bird skins and feathers by the Japanese, who carried out an additional poaching raid in 1915. Since that time, visits to Laysan have primarily been those of survey parties and scientific expeditions. The island has been occupied continuously since 1991 by USFWS volunteers attempting to eradicate invasive weeds and during the summer months by a NMFS field camp. The whole island is designated as critical habitat for endangered plants. Endangered and endemic Laysan ducks and finches occur naturally only on the island (though a group of Laysan ducks was recently introduced outside its native range to Midway Atoll, and Laysan finches were introduced to Pearl and Hermes Atoll). About two million individuals from 17 seabird species nest on the island. Laysan has the State's biggest nesting colonies of mōlī (Laysan albatross) and ka'upu (black-footed albatross) (Midway has the largest colonies in all of the NWHI). Laysan also has the largest colonies of 'ua'u kani (wedge-tailed shearwaters) and Christmas shearwaters and a significant colony of koa'e 'ula (red-tailed tropicbirds). Revegetation with native plants is currently occurring as well as efforts to remove invasive *Verbesina* and *Cenchrus* weeds. It is the northernmost area where *Acropora* corals occur in the NWHI.

Maro Reef is an irregular reef network with no distinct atoll or fringing reef. It is approximately 19 kilometers by ten kilometers (12 miles by six miles) in size. It has about 202,300 hectares (500,000 acres) of reef habitat. There is only a small awash rock and no terrestrial wildlife. Marine areas have unique reef development with no consistent fringing reef, only intertwined reef spurs radiating out and encompassing several relatively isolated lagoons. High vertical relief and algal cover on the reefs are also atypical for the NWHI. Few monk seals or sea turtles occur or give birth here because of the lack of haul-out spots. There are unusually large populations of galapagos and other sharks that seem to occupy some of the predatory niche occupied by ulua at the other atolls.

French Frigate Shoals, a crescent shaped coral atoll about 19 kilometers by 28 kilometers (12 miles by 18 miles) in size, is open to the west and partially enclosed by a crescent-shaped reef to the east. The largest land area in the shoals is Tern Island; a number of smaller islets are scattered along the westerly reef of the crescent. There are two exposed volcanic rocks called La Perouse Pinnacles. Total land area is about 0.3 square kilometers (0.1 square miles); maximum elevation is 36 meters (120 feet) at La Perouse Pinnacle. It has about 93,000 hectares (230,000 acres) of reef habitat. The shoals were discovered by the French in 1786 and claimed by the United States in 1859. In 1882, a vessel chartered by a U.S. company visited the atoll and departed with a cargo of shark (flesh, fins, and oil), turtle (shells and oil), bêche-de-mer (sea cucumber), and bird down. During the 1930s, the U.S. Navy used the area extensively for training exercises. Following the Battle of Midway during World War II, an airbase was established on Tern Island, and construction of a LORAN navigation station was begun in 1944 on East Island. When the airbase was closed in 1946, fishermen from Hawai'i began to use the facilities. The East Island LORAN navigation station was in operation until 1952. At that time a new LORAN navigation station at Tern Island was activated and was operated by the USCG until mid-1979. The USFWS have occupied the facility since that date with a small staff, which is augmented by other agencies and private projects throughout the year. It has the highest breeding populations of monk seals and green sea turtles and the highest coral diversity in the NWHI. There is a landfill that is contaminated with Poly-Chlorinated Biphenols (PCBs) and lead that has been proposed for removal from Tern Island. Reconstruction of the seawall is a priority ongoing project as the dilapidated wall can trap and harm seals and other wildlife. This is the only spot in the NWHI where all 18 species of seabirds known to nest in the NWHI nest.

Gardner Pinnacles has a total land area of 0.03 square kilometers (0.01 square miles) and a maximum elevation of 57 meters (190 feet). It has about 242,800 hectares (600,000 acres) of reef habitat. The two volcanic rocks serve as roosting and breeding sites for smaller populations of 12 species of seabirds, including blue-gray noddies. A few monk seals haul out there. Coral diversity is high but abundance is low because of the lack of shallow water habitat and the predominance of high wave energy from the exposure to the open sea on all sides.

Mokumanamana Island (Necker Island), about 1.4 kilometers (0.7 miles) long by 0.2 kilometers (0.2 miles) wide, is a rocky, J-shaped island consisting of two parts connected by a low isthmus. Total land area is 0.6 square kilometers (0.07 square miles) and maximum elevation is 82 meters (276 feet). It has about 153,800 hectares (380,000 acres) of reef habitat. Its European discovery is credited to a French navigator, La Perouse, in 1786, but prehistoric habitation of the island was noted about 1879 by one of the early landing parties. Ships periodically visited the island during the mid- and late-1800s, but heavy seas often thwarted landings. During the period of feather poaching by the Japanese early in the 20th century, patrol vessels visited Mokumanamana Island, but no evidence of harassment of the birdlife was seen. The whole island is designated as critical habitat for three endemic endangered plants. Nine insects are endemic to the island as are one trap-door spider and one land snail. About 60,000 seabirds from 16 species nest or roost on the island. There is a large colony of blue-gray noddies. Observations of seals at the island suggest that the species has occurred there regularly for at least a century, although likely for much longer. Mokumanamana Island is uninhabited and only rarely visited by humans. Both Mokumanamana and Nihoa have low coral diversity (less than 20 species) because of high wave action and scour.

Nihoa Island, the easternmost point of the NWHI, is a precipitous remnant of a volcanic peak, about 450 meters (1,500 feet) long and ranging in width from roughly 90 to 320 meters (300 to 1,000 feet). Total land area is 0.6 square kilometers (0.3 square miles); maximum elevation is 269 meters (903 feet). It has about 57,500 hectares (142,000 acres) of reef habitat. Nihoa was discovered by Europeans in 1779, though, like Necker Island, there is evidence of prehistoric human occupation. Over the years, difficulties in landing on the steep slopes of Nihoa have restricted visits and may explain why feather poachers did not attempt to exploit the island. During the 1960s, military personnel occupied Nihoa briefly. This island is rarely visited and only by USFWS staff, other researchers, and Native Hawaiians on cultural expeditions. The whole island is designated as critical habitat for endangered plants including three species endemic to the island. Endemic Nihoa millerbird and endemic Nihoa finch are both ESA listed. Over 500,000 seabirds nest on the island. The island supports the largest known colony of ‘ou

(Bulwer's petrel) in the world. It also supports the largest Hawaiian colonies of ‘iwa (great frigatebirds), ‘ā (brown boobies), ‘ā (red-footed boobies), noio (black noddies), blue-gray noddies, noio-kōhā (brown noddies) and manu-o-Kū (white terns). There are at least 17 insects, six ticks and mites, a trap-door spider, and six land snails endemic to just this island. Recent outbreaks of the grasshopper *Schistocerca* are a concern for endangered plants and the birds and invertebrates that rely on this habitat.

SPECIES AND HABITATS OF IMPORTANCE

Laysan, Lisianski, Necker, and Mokumanamana Islands are the most important islands for arthropods, seabirds, the endangered passerines (Laysan finch, Nihoa finch, and Nihoa millerbird), and Laysan duck. Data on seabird numbers is available through the Federal Pacific Seabird Monitoring Database. Green sea turtles and monk seals have their largest reproductive groups at French Frigate Shoals. Data are maintained by NMFS Pacific Islands Fisheries Science Center. Critical habitat for the monk seal was designated by NMFS in 1988 out from shore to 20 fathoms around the named islands (from Nihoa to Kure).

For marine species there is a peak in diversity of species in the middle of the NWHI, near French Frigate Shoals. The extreme north has cooler water temperatures that may limit some coral species and geographic isolation that may limit dispersal and recruitment of some species. The middle islands are also closer to Johnston Atoll and other Central Pacific Islands that may serve as stepping stones for recruitment of species from the south. In particular, some fishes and acroporid corals appear to exist in the NWHI for this reason. Abundance of species is good in most places, and historical damage from recent human occupation on Kure, Midway, and French Frigate Shoals is now reduced with the removal of military and Coast Guard facilities. A few endemic marine species only occur in the NWHI. They are: *Synchiropus kinmeiensis* (a dragonet fish) which has been collected from Maro Reef through Kure Atoll; *Scorpaenopsis pluralis* (a scorpionfish), known only from the holotype (original described specimen) collected off Laysan; *Epigonius devaneyi* (a deep water cardinalfish) which has been found from Necker Island to Maro Reef; and *Nerita plicata*, a shallow water snail that is found only in the NWHI. Biological data are gathered by USFWS, NMFS, National Ocean Service, and DAR research programs as well as collaborative research cruises among these agencies.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife are discussed in Chapter 4 (Statewide Conservation Needs) and Chapter 5 (Marine Conservation Needs). Threats more acute or specific to the NWHI are listed below.

- Habitat degradation from non-native vegetation (*Cenchrus*, *Verbesina*);
- Unknown factors leading to decline in monk seals, especially at French Frigate Shoals, possibly related to changes in ocean productivity;
- Pollution (PCB and lead contamination on Tern Island; PCB's, pesticides, and copper at Kure);
- Marine debris;

- Introduced species on land or in water (historically, rabbits on Laysan and rats on Kure; currently, *Schistocerca* grasshoppers on Nihoa, along with at least 80 other introduced insect species);
- Seabirds and marine mammals are threatened by longline fishery interactions outside State jurisdiction;
- Climate change leading to loss of islands from storms and sea-level change and alteration to food webs;
- Natural disasters.

NWHI STRATEGIES

In addition to the statewide strategies identified in association with the seven conservation objectives in Chapter 4 (Statewide Conservation Needs) (main bullet), additional NWHI specific strategies include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
    - Implement Recovery Plans for honu (green sea turtle) and monk seal;
    - Collaborate with Federal government and encourage residents to take steps that would reduce factors leading to climate change;
    - Develop and/or implement recovery plans for threatened and endangered species on NWHI;
    - Establish year round presence on Kure with expanded research, management, and education activities;
    - Develop access and monitoring plan for the Marine Managed Areas (MMAs);
    - Mitigate pollution at Kure atoll.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
    - Decrease acres dominated by invasive, non-native vegetation and insects;
    - Monitor for non-native marine algae and respond if detected.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
    - Improve dissemination of research and data regarding native species populations and habitat condition;
    - Conduct surveys and inventories for invertebrates in currently managed areas;
    - Better understand the population dynamics and important ecological factors explaining declines in Hawaiian monk seals in some areas, especially at French Frigate Shoals. Research feeding ecology, distribution, life history and threats.
- Strengthen existing and create new partnerships and cooperative efforts.
    - Coordinate with U.S. government to implement coordinated protections for marine species in an MMA in the NWHI and resolve fishing issues there;
    - Enhance partnerships with Federal enforcement agencies including the USCG and NOAA Office of Law Enforcement.

- Support policy changes aimed at improving and protecting native species and habitats.
    - Determine whether the marine areas are best protected by a Federal refuge, State refuge, and/or National Marine Sanctuary designation;
    - Secure adequate funding for management of the MMA(s);
    - Assess ways to support increased enforcement capacities, including cross-deputization between Federal (including military) and State agencies.

PLANS AND TOOLS TO AID MANAGEMENT

Management plans and tools exist to address some of the threats listed in the Summary of Key Threats to Species and Habitats section. Many apply to the entire marine ecosystem and thus are placed here.

- The Hawaiian Islands National Wildlife Refuge. Management Plan. Fish and Wildlife Service (1986);
- The Western Pacific Fisheries Management Council has Fisheries Management Plans that guide fishing for Bottomfish and Seamount Fisheries, Precious Corals, Crustaceans, Coral Reef Ecosystems, and Pelagic species. Available at: www.wpcouncil.org;
- Species Conservation Plans prepared by the USFWS and NMFS, including the Regional Seabird Conservation Plan (2005), U.S. Pacific Islands Regional Shorebird Conservation Plan (2004), the Draft Revised Recovery Plan for the Laysan Duck (2004); the Northwestern Hawaiian Islands Passerines Recovery Plan (1984); Recovery Plan for the Hawaiian Monk Seal (2004); and Recovery Plans for the U.S. Pacific populations of the green sea turtle, hawksbill sea turtle, leatherback turtle, loggerhead turtle, and olive ridley turtle (1998);
- The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve has an operations plan. Available at: http://www.hawaiireef.noaa.gov/documents/welcome.html;
- NOAA Coastwatch uses a variety of satellite remote sensing datasets in an effort to better monitor and analyze the central Pacific Ocean. Information and data available at: http://coastwatch.nmfs.hawaii.edu/;
- NOAA's Coral Reef Information System (CoRIS) is designed to be a single point of access to NOAA coral reef information and data products, especially those derived from NOAA's Coral Reef Conservation Program. Information and data available at: http://www.coris.noaa.gov/.

MANAGEMENT NEEDS

Current Management of Species and Habitats

The following section addresses the current management actions and future needs of key species and habitats of the NWHI. Future needs are being considered by all agencies with management authority over NWHI wildlife. Currently managed areas consist of a State Seabird Sanctuary, Federal wildlife refuge, and a Federal reserve. Hawaii's Comprehensive Wildlife Conservation Strategy recognizes the importance of the ongoing actions in these managed areas and considers these actions a priority.

In addition to currently managed areas, other conservation actions for NWHI are being considered. Revisions to catch limits, areas, and methods are being considered by DAR. The entire system of State Marine Managed Areas is also being reviewed to ensure consistency in designated use and purpose and to consider adding to or modifying current Marine Managed Areas. The Hawaiian Islands National Wildlife Refuge in the NWHI is developing an updated management plan for terrestrial and marine areas. The State is moving forward with plans to manage State waters in the NWHI as a Marine Refuge. The NWHI Coral Reef Ecosystem Reserve is being considered for conversion to a National Marine Sanctuary that could include co-management with Department of Land and Natural Resources (DLNR) in State waters. A bill in Congress proposes setting aside the entire NWHI area as a new form of Federal managed area called a National Marine Refuge. The discussion of future management needs is also highlighted within each current managed area.

***Kure Atoll State Seabird Sanctuary* (260 acres), DOFAW**

> ***Species:*** Ka‘upu (black footed albatross), mōlī (Laysan albatross), spinner dolphin.
> ***Habitats*:** Coastal system. Marine ecosystems including shallow coral reef, sandy beach, and rocky habitats.
> ***Current Management*:** Limited access, invasive introductions control and precautions, native vegetation replanting, bird, monk seal, dolphin and marine debris monitoring. Marine debris removal.
> ***Future Needs*:** Additional monitoring, year round presence. Develop management plan.

***Hawaiian Islands National Wildlife Refuge* (620,000 acres), USFWS**

> ***Species*:** Laysan finch, Laysan duck, Nihoa millerbird, Nihoa finch, 18 seabirds, Hawaiian monk seals, green sea turtles, endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins, and other marine mammals.
> ***Habitats:*** Coastal system, wetlands, hypersaline lake. Marine ecosystems.
> ***Current Management*:** Limited access, limited take, strict quarantine procedures to limit the immigration or emigration of non-native species or diseases, invasive species control and removal, endangered species monitoring, translocation, and range expansion; native species reintroduction, seabird monitoring and research (especially at Laysan and Tern Islands), coral reef monitoring and research. NMFS conducts research and monitoring on green sea turtles and monk seals and leads a multi-partner effort to remove marine debris from the beaches and reefs of the NWHI, collaboration with other marine researchers, and research and education.
> ***Future needs*:** Update management plan. Coordinate actions with the State and the Coral Reef Reserve or Sanctuary, and additional monitoring.

***NWHI Marine Refuge*, DAR <u>Proposed</u>**

Species: Hawaiian monk seals, green sea turtles, endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins, and other marine mammals.
Habitats: Marine ecosystems.
***Current Management*:** Limited access and take, no anchoring or any other activities that can damage coral, and no discharge of pollutants.
***Future needs*:** Develop and implement a management plan.

***NWHI Coral Reef Ecosystem Reserve,* NOAA**

Species: Hawaiian monk seals, green sea turtles, endemic coral reef organisms including some endemic only to NWHI, pelagic fishes, bottomfishes, sandy habitat organisms, spinner dolphins, and other marine mammals.
Habitats: Marine ecosystems.
***Current Management*:** Operation plan in place. Limited access and take, no anchoring or any other activities that can damage coral, and no discharge of pollutants.
***Future needs*:** Possible transition to a National Marine Sanctuary.

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CHAPTER 7: SPECIES OF GREATEST CONSERVATION NEED

In order to address required elements 1-5, Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS) presents information on the Species of Greatest Conservation Need through fact sheets on various taxonomic groups. Each fact sheet provides information related to the status of the taxa, general taxa information, distribution, abundance, location and condition of key habitats, threats, conservation actions, monitoring, and research priorities.

Given the large number of species, similarity of threats and needed actions, and lack of information on many species comprising Hawaii's Species of Greatest Conservation Need (SGCN), taxa and related fact sheets were divided into manageable groupings in the following categories: terrestrial mammal, forest birds, raptors, waterbirds, seabirds, migratory shorebirds and waterfowl, Northwestern Hawaiian Islands passerines, terrestrial invertebrates, freshwater fishes, freshwater invertebrates, anchialine pond fauna, marine mammals, marine reptiles, marine fishes, and marine invertebrates. Appendix A provides a comprehensive list of Hawaii's Wildlife (Fauna) Species of Greatest Conservation Need and identifies the fact sheet where information on that species may be found.

Appendix B provides a comprehensive list of Hawaii's (Flora) Species of Greatest Conservation Need. Though not a required element, Hawai‘i plans to develop fact sheets for the species of flora on the list over time, beginning with the "Genetic Safety Net" plants (i.e., plants with less than 50 individuals).

Photo: USFWS

Terrestrial Mammal

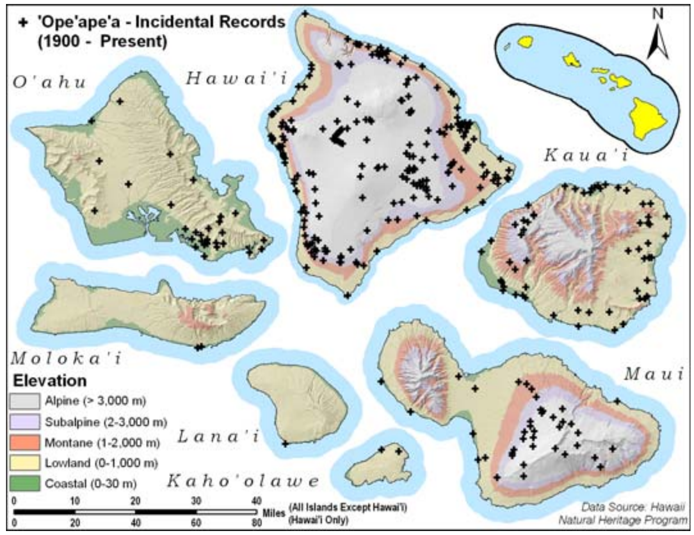
ʻŌpeʻapeʻa or Hawaiian Hoary Bat

Lasiurus cinereus semotus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous (at the species level and Endemic at the subspecies level)
NatureServe Heritage Rank G2/T2 – Species secure/Subspecies imperiled
Recovery Plan for the Hawaiian Hoary Bat – USFWS 1998

SPECIES INFORMATION: The ʻōpeʻapeʻa, or Hawaiian hoary bat (Family: Vespertilionidae), is Hawaii's only native terrestrial mammal, although fossil evidence indicates that at least one other bat species was native to the islands. Males and females have a wingspan of approximately one-third of a meter (one foot), and females are typically larger than males. Both sexes have a coat of brown and gray fur. Individual hairs are tipped or frosted with white; "hoary" means frosted. The Hawaiian name refers to a half taro leaf or canoe sail shape; these being somewhat similar to the shape of the bat. Little research has been done on the ʻōpeʻapeʻa, and little is known about its habitat requirements or population status. Fewer than 30 accounts of roosting are known statewide, but these indicate that ʻōpeʻapeʻa roost in native and non-native vegetation from one to nine meters (3 – 29 feet) above ground level; the species is rarely observed using lava tubes, cracks in rocks, or man-made structures for roosting. While roosting during the day, ʻōpeʻapeʻa are solitary, although mothers and pups roost together. They begin foraging either just before or after sunset depending on the time of year; altitude also may affect activity patterns. ʻŌpeʻapeʻa feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites; and similar to other insectivorous bats, prey is located using echolocation. Water courses and edges (e.g., coastlines and forest/pasture boundaries) appear to be important foraging areas; the species also is attracted to insects that congregate near lights. Breeding has only been documented on the islands of Hawaiʻi and Kauaʻi. Mating most likely occurs between September and December, and females give birth to twins during May or June. Mother bats likely stay with their pups until they are six to seven weeks old. Little is known regarding dispersal or movements, but inter-island dispersal is possible.

DISTRIBUTION: The hoary bat is the most widely distributed bat in North America. In Hawaiʻi, ʻōpeʻapeʻa has been reported from all the MHI except for Niʻihau, although specimen records only exist for Kauaʻi, Oʻahu, Maui, Molokaʻi, and the island of Hawaiʻi; currently the species may be extirpated from Oʻahu, and Molokaʻi. Evidence of breeding populations (e.g., pregnant or lactating individuals) is limited to Kauaʻi and the island of Hawaiʻi. ʻŌpeʻapeʻa occur in a wide range of habitats across a wide elevation gradient. On the island of Hawaiʻi, bats are found primarily from sea level to 2,288 meters (7,500 feet) elevation, although they have been observed near the island's summits (above 3,963 meters or 13,000 feet).



ABUNDANCE: Unknown. Survey methods to count or estimate populations of solitary roosting bats have not been developed. Although based on incomplete data, Kauaʻi and the island of Hawaiʻi may support the largest populations. Population estimates for all islands have ranged from hundreds to a few thousand, however, they were not based on systematic surveys.

LOCATION AND CONDITION OF KEY HABITAT: ʻŌpeʻapeʻa have been found roosting in ʻōhiʻa (*Metrosideros polymorpha*), pu hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), shower trees (*Cassie javanica*), pūkiawe (*Styphelia tameiameiae*), and fern clumps; they are suspected to roost in Eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands. Recent work on the island of Hawaiʻi found that bat activity varied with season and altitude, and the greatest level of activity occurred at low elevations (below 1,280 meters or 4,200 feet) from April to December. Because warm temperatures are strongly associated with reproductive success in this and other bat species, it has been suggested that key breeding habitat is likely to occur at sites where the average July minimum temperature is above 11°C (52°F). If true, key breeding habitat on the island of Hawaiʻi would occur below 1,280 meters (4,200 feet) elevation. Because bats use both native and non-native habitat for foraging and roosting, the importance of non-native timber stands, particularly those at low elevations, should be determined. Breeding sites are known for Mānuka Natural Area Reserve and scattered areas along the Hāmākua Coast.

THREATS: Bats are affected by habitat loss, pesticides, predation, and roost disturbance. A reduction in tree cover (e.g., roost sites) might be the primary reason for the species' decline in Hawaiʻi. Pesticides also may have reduced populations.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations and key breeding habitats, but also to establish additional populations thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward ʻōpeʻapeʻa should include:

- Conservation of known occupied habitat.
- Development and implementation of conservation plans that guide the management and use of forests to reduce negative effects to known bat populations.
- Continued support for the Hawaiian Hoary Bat Research Cooperative.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Given that little is known about ʻōpeʻapeʻa any research would contribute to the understanding of and ability to conserve this species. Research priorities for the ʻōpeʻapeʻa include:

- Development of a survey methodology that will allow the accurate estimation of populations.
- Identify key breeding and over-wintering sites.
- Quantify roost site characteristics and preferences.
- Continue efforts to track and monitor movements and behaviors.
- Determine the importance of temperature on reproductive success.
- Determine the extent to which bats use torpor.

References:

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Photo: Mark Collins

Forest Birds

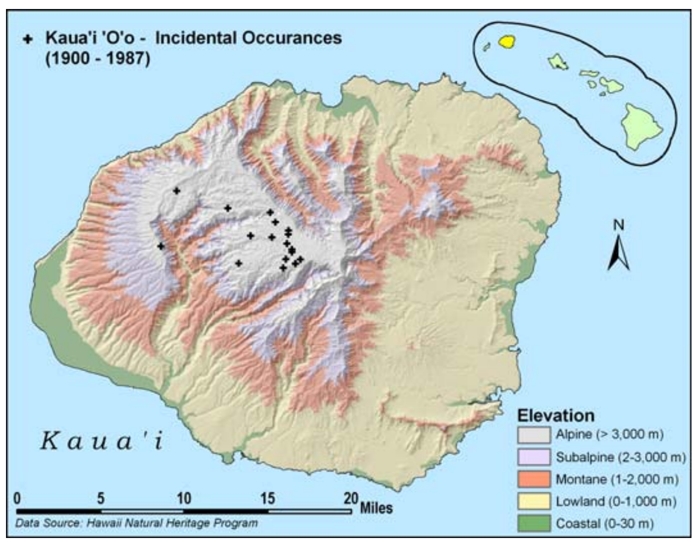
Kauaʻi ʻŌ ʻō

Moho braccatus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank GH—Possibly extinct
IUCN Red List Ranking—Extinct
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: Endemic to its namesake, the Kauaʻi ʻōʻō is the smallest of the five known species of Hawaiian honeyeaters (Family: Meliphagidae), and has the least gaudy plumage of the four Hawaiian species of *Moho*. ʻŌ ʻō eat a variety of arthropods, snails, ʻōlapa (*Cheirodendron* spp.) fruits, and nectar from the flowers of ʻōhiʻa (*Metrosideros polymorpha*), lobelia, as well as other species. Early naturalists reported the species extensively feeding on the flower bracts of ʻieʻie (*Freycinetia arborea*), a species abundant in lowland forests, but not in upper elevation forests. Little is known about the species' breeding biology. The only known nests were in cavities in large ʻōhiʻa snags.

DISTRIBUTION: Unknown. Possibly extinct. The species was last observed in stream valleys of the central Alakaʻi Wilderness Preserve. Historically, the Kauaʻi ʻōʻō occurred in forest habitat throughout the island.



ABUNDANCE: The Kauaʻi ʻōʻō was last observed in 1987, and may be extinct. Extensive surveys in 1989, 1994, 1996, and 2000 did not detect the species. The species was very common up to the end of 19th century.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. The last sightings of the Kauaʻi ʻōʻō were in dense ʻōhiʻa forests of the Alakaʻi swamp. Ironically, this habitat may have been low-quality or marginal ʻōʻō habitat. ʻIeʻie, an important food plant, common in the lower elevation forests previously occupied by ʻōʻō, is not found in the upper elevations forests where the species was last observed. Extensive damage to forests by hurricanes in 1982 and 1992 may have further reduced the suitability of high-elevation forests, especially given the species' apparent dependence on large snags for nest sites. The area where the species was last observed is managed by the State of Hawaiʻi as a Wilderness Preserve.

THREATS: Unknown. However, the Kauaʻi ʻōʻō was likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Kauaʻi ʻōʻō populations, the following likely were of particular concern:

- <u>Disease</u>. The precipitous decline of all Hawaiian *Moho* species suggests that disease played a role in the species' decline.
- <u>Hunting</u>. Although other ʻōʻō species were historically exploited by Native Hawaiians for their feathers, the role this activity played in the decline of the Kauaʻi ʻōʻō is equivocal, but likely minimal given the species' plumage.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds on Kauaʻi, including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct there are no research priorities specific to Kauaʻi ʻōʻō.

References:

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Sykes PW, Kepler AK, Kepler CB, Scott JM. 2000. Kauaʻi oʻo (*Moho braccatus*), Oʻahu ʻoʻo (*Moho apicalis*), Bishop's ʻoʻo (*Moho bishopi*), Hawaiʻi ʻoʻo (*Moho nobilis*), and kioea (*Chaetoptila angustipluma*). *In* The Birds of North America, No. 535 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

Forest Birds

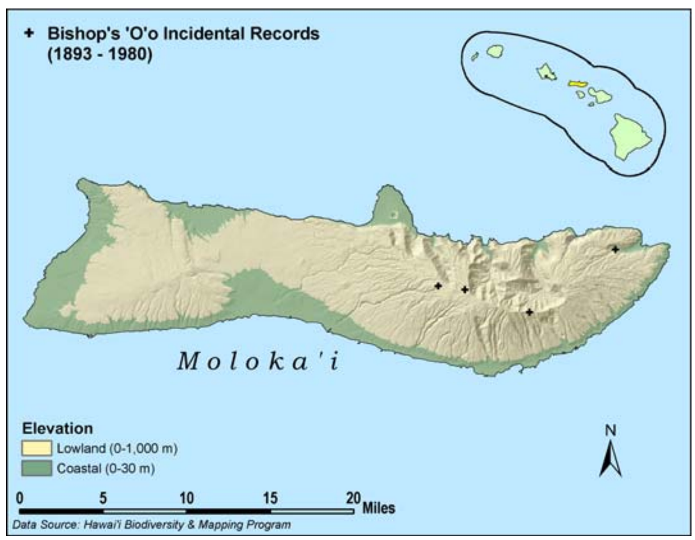
Bishop's ʻŌ ʻō

Moho bishopi

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank GH
—Known only from historic records
IUCN Red List Ranking—Extinct
Draft Revised Recovery Plan for Hawaiian Forest Birds
—USFWS 2003

SPECIES INFORMATION: Known only from Molokaʻi, Bishop's ʻōʻō is a large, noisy honeyeater (Family: Meliphagidae). This striking species is black with yellow ear patches, under tail coverts, and maxillary tufts; sexes are similar. The bird's vocalizations have been described as varied and "unlike any other native bird." Bishop's ʻōʻō appears to be primarily nectavorous, preferring lobelia (Campanulaceae) flowers. Little is known about this species' life history and nothing is known about its nesting biology.

DISTRIBUTION: Unknown. Probably extinct. Historic range of Bishop's ʻōʻō likely included all native forests of eastern Molokaʻi**.** Subfossils suggest this species may have occurred on Maui.



ABUNDANCE: Bishop's ʻōʻō was last observed in 1904 and is probably extinct. No information on historical abundance.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Bishop's ʻōʻō occupied the montane forests of eastern Molokaʻi. The areas where the species was last observed are managed by the State of Hawaiʻi as a Natural Area Reserve or by private conservation entities (e.g., The Nature Conservancy) as a Natural Area Partnership Preserve.

THREATS: Unknown. However, Bishop's ʻōʻō likely were susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Bishop's ʻōʻō populations, the following likely were of particular concern:

- Disease. This species rapid decline and the fact that no habitat above 1,250 meters (4,100 feet) occurs on Molokaʻi suggests disease may have played an important role in the species' decline.
- Hunting. Bishop's ʻōʻō were exploited for their feathers, which were used in Hawaiian featherwork articles such as capes and *kāhili* (feather standard). Exploitation may have increased with the introduction of firearms by Europeans.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds on eastern Molokaʻi, including the establishment and management of protected areas, regular surveys of forest bird populations, monitoring of habitat conditions, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Bishop's ʻōʻō.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Sykes PW, Kepler AK, Kepler CB, Scott JM. 2000. Kauaʻi oʻo (*Moho braccatus*), Oʻahu ʻoʻo (*Moho apicalis*), Bishop's ʻoʻo (*Moho bishopi*), Hawaiʻi ʻoʻo (*Moho nobilis*), and kioea (*Chaetoptila angustipluma*). *In* The Birds of North America, No. 535 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: DOFAW

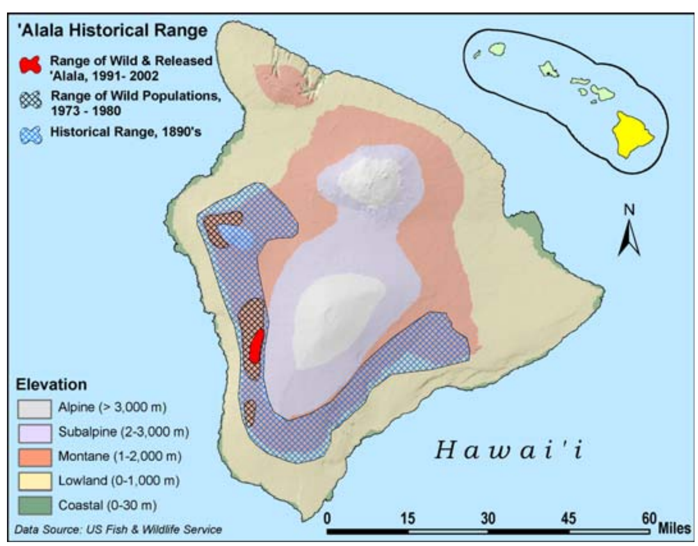
Forest Birds

ʻAlalā or Hawaiian Crow

Corvus hawaiiensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1-Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for the ʻAlalā —USFWS 2003

SPECIES INFORMATION: Historically at least five crow species (Family: Corvidae) occurred in Hawaiʻi, only the ʻalalā, or Hawaiian crow survives. Like other crows, ʻalalā are raucous, gregarious and vocal; young, captive-raised birds often engage in tug-of-war with sticks. Like many corvids, ʻalalā are long-lived and have a life span of 20 or more years. The species' diet primarily consists of native and introduced fruits, invertebrates, and eggs and nestlings of other forest birds, as well as nectar, flowers and carrion. Seasonal movements in response to weather and the availability of food plants (e.g., ʻieʻie [*Freycinetia arborea*]) have been noted. Although individuals form long-term pair bonds, extra-pair copulations have been observed. Nests are predominantly constructed in ʻōhiʻa (*Metrosideros polymorpha*) trees. Both sexes participate in nest construction, although only females incubate eggs and brood young. Clutch size ranges from two to five, although usually only one or two nestlings fledge. Fledglings typically cannot fly and often remain near the ground for long periods, likely increasing their susceptibility to disease (i.e., toxoplasmosis) and predation. Juveniles depend on their parents for at least eight months and remain with their family group until the following breeding season. Although large flocks characteristic of American crows (*C. brachyrhynchos*) have not been reported, historical reports suggest that birds associated with smaller, local flocks after the breeding season.



DISTRIBUTION: No individuals are known to exist in the wild. Historically, the ʻalalā occurred in high- and low-elevation forests of the western and southeastern regions of the island of Hawaiʻi.

ABUNDANCE: In 2005, the Keauhou and Maui Bird Conservation Centers housed the world’s entire ʻalalā population: 55 individuals.

LOCATION AND CONDITION OF KEY HABITAT: Historically, ʻalalā occupied dry and seasonally wet ʻōhiʻa and ʻōhiʻa/koa (*Acacia koa*) forests between 300 and 2,500 meters (1,000 – 8,200 feet) elevation. Because the last wild individuals were confined to a small subset of the species’ former range, specific knowledge of key habitat requirements are unknown. Currently, all potential habitat is degraded. The presence of non-native mammalian predators and birds, which can act as disease reservoirs, further reduces habitat quality. Core areas of the species’ former range are now managed by the State of Hawaiʻi and the USFWS.

THREATS: ʻAlalā are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻalalā populations, the following are of particular concern:

- <u>Predation</u>. The small Indian mongoose (*Herpestes auropunctatus*), rats (*Rattus* spp.) and feral cats (*Felis silvestris*) prey on ʻalalā. The ʻio (*Buteo solitarius*) and presumably pueo (*Asio flammeus sandwichensis*) also prey on juvenile and adults. ʻIo have been documented killing captive-raised birds released into the wild. Fledglings are unable to fly and this likely contributes to high rates of predation.
- <u>Shooting</u>. Many ʻalalā were killed around farms between 1890 and 1930. Despite legal protection in 1931, shooting of individuals occurred into the 1980s.
- <u>Disease</u>. Population declines were noted between 1890 and 1910, a period when other native bird populations declined, presumably because of mosquito-borne diseases. Seasonal movement may have increased exposure to diseases. In addition, ʻalalā are susceptible to toxoplasmosis, a condition caused by a protozoan (*Tosoplasma gondii*) carried by feral cats.
- <u>Habitat degradation</u>. Habitat conversion by human activity as well as by grazing ungulates has severely degraded former ʻalalā habitat. These changes may have limited food or nesting resources and may have increased the vulnerability of ʻalalā to predation by ʻio. Currently, little suitable habitat exists for the species.
- <u>Population size</u>. Small populations are plagued by a variety of potentially irreparable problems which fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios.
- <u>Captive-breeding</u>. There is some evidence that captive-reared birds lack important foraging and predator-avoidance behaviors.

CONSERVATION ACTIONS: The ʻalalā has been legally protected by the State of Hawaiʻi since 1931 and was listed as federally endangered in 1967. A captive propagation program was established in 1973; crows are now housed at the Keauhou Bird Conservation Center and the Maui Bird Conservation Center. These facilities are currently managed by the Zoological Society of San Diego. Although there has been some success in breeding ʻalalā at these facilities, the species generally does not breed well in captivity. The ʻAlalā Recovery Team was formed to facilitate the species recovery, and a related second group, the ʻAlalā Partnership, was formed to facilitate program implementation on private lands. Between 1993 and 1998, 27 captive-raised juvenile ʻalalā were released at McCandless Ranch. Of these, 21 died in the wild and six were recaptured and returned to the captive flock. Predator control was ongoing during the release program. Intensive field studies of the wild population and released juveniles were conducted between 1992 and 2002. In 1999, the Kona Forest Unit of Hakalau Forest National Wildlife Refuge was acquired, with the goal of restoring habitat in the core of the species’ historic range. To date, legal and operational constraints have impeded this effort. Restoration of future re-introduction sites is ongoing. In addition to the above efforts, ʻalalā likely will benefit from management activities designed to conserve other endangered forest birds on the island of Hawaiʻi including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the ʻalalā will include the following:

- Continuation of restoration of future re-introduction areas.
- Maintaining and increasing the captive flock without further loss of genetic diversity.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: The captive flock is monitored. If and when re-introduction occurs, wild populations will be intensively monitored.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ʻalalā include the following:

- Review all data from studies on captive and wild populations.
- Determine methods to increase the reproductive output of captive individuals.
- Conduct field studies to determine if understory restoration will reduce the ability of ʻio to prey on ʻalalā.
- Establish a set of habitat criteria that must be met prior to release of birds at a particular site.
- Develop methods to habituate captive-raised individuals to respond appropriately to mammalian and avian predators, and sources of toxoplasmosis.
- Determine potential re-introduction sites on other islands.

References:

Banko PC, Ball DL, Banko WE. 2002. Hawaiian crow (*Corvus hawaiiensis*). *In* The Birds of North America, No. 648 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Berger AJ. 1981. Hawaiian birdlife. Honolulu: University of Hawaiʻi Press. 260 pp.

U.S. Fish and Wildlife Service. 2003. Draft revised recovery plan for the ʻAlala (*Corvus hawaiiensis*). Portland, (OR): U.S. Fish and Wildlife Service. Xi+78 pp.

Photo: DOFAW

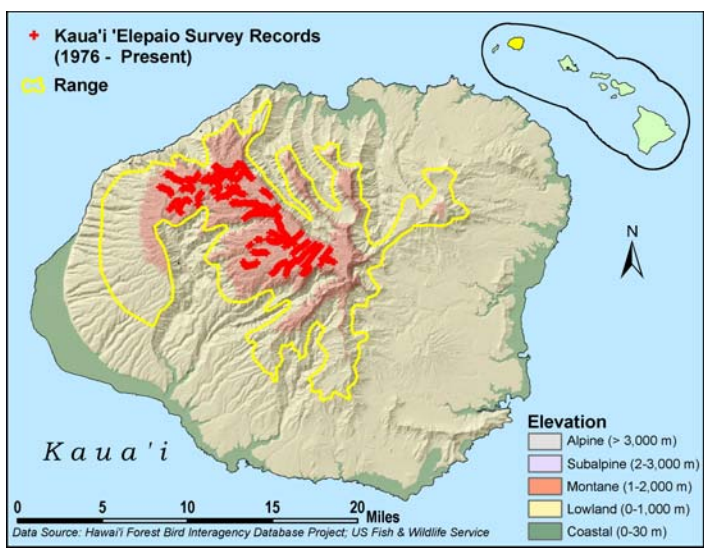
Forest Birds

Kauaʻi ʻElepaio

Chasiempis sandwichensis sclateri

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3/T2—Rare with restricted range/Subspecies imperiled globally
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The Kauaʻi ʻelepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of Kauaʻi at the subspecies level. ʻElepaio also occur on the islands of Hawaiʻi (*C. s. sandwichensis*) and Oʻahu (*C. s. ibidis*); the latter subspecies is Federally listed as endangered. Adult males and females have a dark grayish brown crown and back and white underparts with a rusty wash on the upper breast. The bird's name is derived from its primary song which is a shrill whistle given only by males. Little detailed life history information is available from Kauaʻi. On the islands of Hawaiʻi and Oʻahu, ʻelepaio use virtually all available substrates for foraging, including the ground, logs, rock crevices, snags, and all parts of tress. Equally diverse in the use of foraging maneuvers, ʻelepaio capture a wide range of arthropod prey by flycatching, gleaning while perched or hovering, and direct pursuit; foraging maneuvers vary depending on plant species from which prey is being captured and habitat type. For Kauaʻi, there is no information on plant species used, although ʻōhiʻa (*Metrodiseros polymorpha*) is likely. On the island of Hawaiʻi, pairs remain together throughout the year and long-term pair bonds are common. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven, cup nests are built in a variety of native and non-native trees. Clutch size is usually two and second nests are attempted, often while fledglings from first are still being fed. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months, which may allow young birds to hone their foraging skills.



DISTRIBUTION: Kauaʻi ʻelepaio are widely distributed above 600 meters (2,000 feet) elevation, but are most common above 1,100 meters (3,600 feet) elevation on the Alakaʻi Plateau. Original range likely included all forested regions of Kauaʻi.

ABUNDANCE: In 1984, the island-wide population was estimated at 40,000 individuals. The 2000 Kauaʻi Forest Bird Survey estimated the population in the Alakaʻi and Kōkeʻe region at nearly 25,000 individuals, and reported no change in the population since 1973. ʻElepaio densities peak in ʻōhiʻa forest between 1,300 and 1,500 meters (4,500 - 5,000 feet).

LOCATION AND CONDITION OF KEY HABITAT: Kauaʻi ʻelepaio are most common in dense wet ʻōhiʻa forests above 1,100 meters (3,600 feet) elevation; uncommon in the drier forests of Waimea Canyon, the Nā Pali coast, and the wet bogs of Waiʻaleʻale. ʻElepaio are found in some low elevation valleys with a mix of native and non-native tree species. Common non-native trees in this habitat include Java plum (*Syzygium cumini*), coffee (*Coffea arabica*), kukui (*Aleurites moluccana*), and *Albizia lebbeck.* The quality of these habitats varies considerably. The core of their range, the Alakaʻi Plateau and Kōkeʻe State Park, is managed by the State of Hawaiʻi as Forest Reserve, Wilderness Preserve, and State Park lands.

THREATS: Kauaʻi ʻelepaio are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Kauaʻi ʻelepaio populations, the following are of particular concern:

- <u>Disease</u>. Avian pox (*Poxvirus avium*) is known to reduce both nesting success and adult survival. On O'ahu, annual survival and reproductive success of birds with active pox lesions are lower compared to healthy birds; no information on the effect of avian malaria (*Plasmodium relictum*).
- <u>Predation</u>. On Oʻahu, predation by black rats (*Rattus rattus*) have been implicated in the loss of nests and death of adult females. Rat control in these populations resulted in large increases in nest success and in the survival of adult females. Other predators, including cats (*Felis silvestris*), Pueo (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*), occur throughout the forests of Kauaʻi.

CONSERVATION ACTIONS: Kauaʻi ʻelepaio likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the Kauaʻi ʻelepaio may include the following:

- Eradication or control of rats, feral cats, and barn owls in the Alakaʻi Wilderness Preserve.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other possible predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Kauaʻi ʻelepaio include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known subspecies.

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Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

VanderWerf EA. 1998. ʻElepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

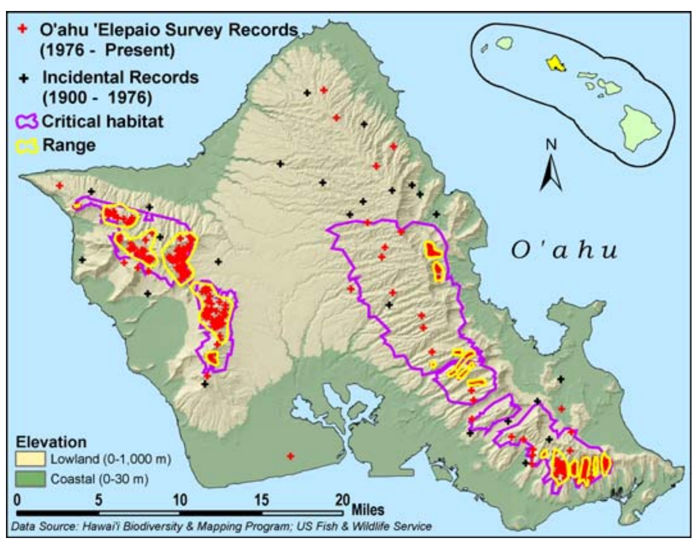
Photo: DOFAW

O'ahu 'Elepaio

Chasiempis sandwichensis ibidis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G3/T1—Rare with restricted range/Subspecies critically imperiled globally
IUCN Red List Ranking—Vulnerable
Draft Revised Recovery Plan for Hawaiian Forest Birds —USFWS 2003

SPECIES INFORMATION: The O'ahu 'elepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of O'ahu at the subspecies level. 'Elepaio also occur on Kaua'i (*C. s. sclateri*) and the island of Hawai'i (*C. s. sandwichensis*). Males and females are dark brown above and white below with variable light brown streaks on breast and conspicuous white wing bars, tail feather tips, and throat. Both sexes have variable amounts of blacking markings, but males tend to have more. The bird's name is derived from its primary song which is a shrill whistle given only by males. On the island of Hawai'i, 'elepaio use virtually all available substrates for foraging including the ground, logs, rock crevices, snags, and all parts of tress. Equally diverse in the use of foraging maneuvers, 'elepaio capture a wide range of arthropod prey by flycatching, gleaning while either perched or hovering, and direct pursuit; foraging maneuvers vary depending on plant species from which prey is being captured, and habitat. O'ahu 'elepaio use a variety of native and non-native trees for foraging. Pairs remain together throughout the year, and long-term pair bonds are common. Breeding season on O'ahu is January through July compared to March through August on the island of Hawai'i. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven cup nests are built in a variety of native and non-native trees. Clutch size is usually two and second and third nests are attempted after failures, but rarely is a second nest attempted if the first is successful. Fecundity is low even in areas were predators are controlled. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months which may allow young birds to hone their foraging skills.



DISTRIBUTION: Oʻahu ʻelepaio occur in the Koʻolau Range between 100 to 550 meters (325 – 1,800 feet) elevation, and in the Waiʻanae Range between 500 to 850 meters (1,625 – 2,775 feet) elevation. Dispersal between the ranges is unlikely. Each subpopulation consists of several populations; the amount of dispersal among these is unknown, but is likely low. Original distribution likely included all forested areas of Oʻahu. Currently estimated to occupy four percent of their original range.

ABUNDANCE: In 2001, the Oʻahu ʻelepaio population was estimated at less than 2,000 birds. It had previously been estimated at between 1,200 and 1,400 birds. Although Audubon Christmas bird counts from the 1960s through the 1980s provided strong evidence of a dramatic population decline, numbers are now so low that the rate of decline since the 1990s cannot be determined.

LOCATION AND CONDITION OF KEY HABITAT: Oʻahu ʻelepaio occur in a variety of forest types and across a range of elevations, primarily in valleys and particularly those with tall riparian vegetation, a continuous canopy, and dense understory. Common native plant species where ʻelepaio occur include papala kēpau (*Pisonia umbellifera*), lama (*Diospyros sandwicensis*), māmaki (*Pipturus albidus*), kaulu (*Sapindus oahuensis*) and ʻālaʻa (*Pouteria sandiwicensis*). Common introduced plants in ʻelepaio habitat include strawberry guava (*Psidium cattleianum*), common guava (*P. guajavai*), kukui (*Aleurites moluccana*), mango (*Mangifera indica*), and Christmas berry (*Schinus terebinthifolius*). Oʻahu ʻelepaio are not found in very wet forests, on windswept summits, or in very dry scrubland. Much of their current range is managed by the U. S. military or by the State of Hawaiʻi.

THREATS: Oʻahu ʻelepaio are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Oʻahu ʻelepaio populations, the following are of particular concern:

- Predation. Predation by black rats (*Rattus rattus*) have been implicated in the loss of nests and death of adult females. Rat control in Oʻahu populations resulted in large increases in nest success and in the survival of adult females.
- Low reproductive potential. The species' low annual productivity, even in quality habitat, makes it very susceptible to factors that reduce population size.
- Disease. Avian pox (*Poxvirus avium*) reduces both annual survival and reproductive success of birds with active pox lesions compared to healthy birds; no information on the effect of avian malaria (*Plasmodium relictum*).
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.
- Fire. Wildfires resulting from military activities threaten two populations.

CONSERVATION ACTIONS: Conservation efforts already undertaken to protect the Oʻahu ʻelepaio include the following: listing as an endangered species by both the USFWS and the State of Hawaiʻi, the initiation of long term population and demographic surveys which have identified the most serious threats to its survival, and ongoing rat control at the Honolulu Forest Reserve (DOFAW), at Schofield Barracks West Range and Mākua Military Reservation (U.S.

Army Environmental Division), in Honouliuli Preserve (The Nature Conservancy), and in Lualualei Valley (U.S. Navy and USDA). In addition, the O'ahu 'elepaio also benefits from management activities designed to conserve other endangered forest birds including the establishment of the O'ahu Forest National Wildlife Refuge in the Ko'olau Mountains, fencing and ungulate control, forest restoration, habitat monitoring and studies on disease and disease vectors. In addition to these efforts, future management specific to the O'ahu 'elepaio should include the following:

- Continuation and expansion of rat control.
- Protection of remaining forests on O'ahu, including fire prevention.
- Public outreach about the importance and benefits of rodent control.
- Continue demographic studies, especially in the largest populations.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the O'ahu 'elepaio include the following:

- Disease resistance and transmission. If resistant individuals are identified, translocation and/or captive propagation of these individuals may help recover populations.
- Determination of genetic population structure.
- Identify areas most suitable for re-introduction of populations or for creation of habitat dispersal links between existing populations.
- Continue efforts to develop techniques for captive propagation using surrogate species (e.g., Hawai'i 'elepaio (*Chasiempis sandwichensis sandwichensis*)).

References:

VanderWerf EA. 1998. 'Elepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

VanderWerf EA, Rohrer JL, Smith DG, Burt MD. 2001. Current distribution and abundance of the O'ahu 'elepaio. Wilson Bulletin 113:10-16.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Mark Collins

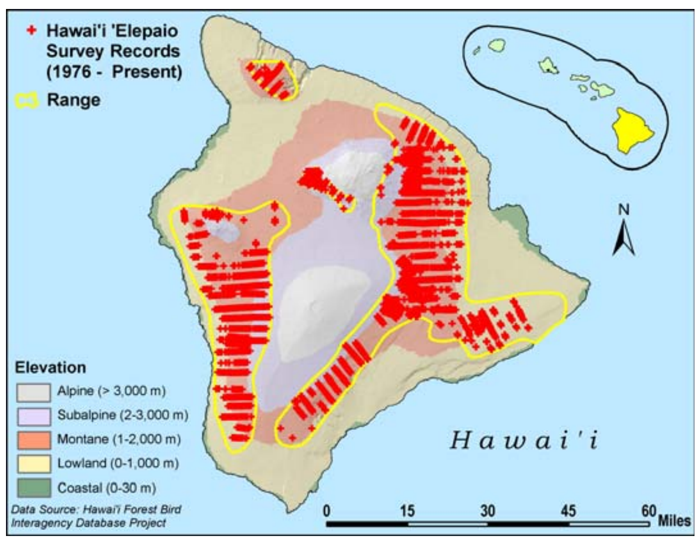
Forest Birds

Hawaiʻi ʻElepaio

Chasiempis sandwichensis sandwichensis

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3—Rare with restricted range
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The Hawaiʻi ʻelepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of Hawaiʻi at the subspecies level. ʻElepaio also occur on Kauaʻi (*C. s. sclateri*) and Oʻahu (*C. s. ibidis*); the latter subspecies is federally listed as endangered. Some authors recognize two additional subspecies on the island of Hawaiʻi (*C. s. ridgewayi* and *C. s. bryani*). Adult males and females are dark brown above and white below with variable amounts of brown streaking; males have black throats and females have white throats. The bird's name is derived from its primary song which is a shrill whistle given only by males. ʻElepaio use virtually all available substrates for foraging including the air, ground, logs, rock crevices, snags, and all parts of trees. Equally diverse in the use of foraging maneuvers, ʻelepaio capture a wide range of arthropod prey by flycatching, gleaning while perched or hovering, and direct pursuit; foraging maneuvers vary depending on plant species from which prey is being captured and habitat type. The Hawaiʻi ʻelepaio may prefer ʻōhiʻa (*Metrodiseros polymorpha*) and kāwaʻu (*Ilex anomola*) for foraging. Pairs remain together throughout the year and long-term pair bonds are common; one pair was together for 11 years. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven cup nests are built in ʻōhiʻa and in other trees in proportion to their availability. Clutch size is usually two and second nests are attempted, often while fledglings from first are still being fed. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months.



DISTRIBUTION: Hawaiʻi ʻelepaio occur in most forested areas above 600 meters (2,000 feet) elevation. Isolated populations occur in Kohala and on the western slope of Mauna Kea. Original distribution likely included all forested areas of the island.

ABUNDANCE: The Hawaiian Forest Bird Surveys (1976-79, 1983), estimated the statewide population of all subspecies at more than 270,000 individuals. The island of Hawaiʻi is home to three populations (150,000 individuals) of *C. s. ridgwayi*, plus one population each of *C. s. sandwichensis* (63,000) and *C. s. bryani* (2,500).

Kauaʻi population has been estimated at 40,000, while the Oʻahu population is estimated to be between 1,200 and 1,400. Highest density of birds occur between 1,300 and 1,900 meters (4,500-6,500 feet) elevation.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiʻi ʻelepaio populations occur in a variety of forest types and across a range of elevations, but are most common in wet or mesic forests at higher elevations. Highest densities occur in ʻōhiʻa or mixed ʻōhiʻa-koa (*Acacia koa*) forests above 1,100 meters (3,600 feet). Much of the current range of the Hawaiʻi ʻelepaio is managed for conservation by State and Federal agencies or private conservation partnerships.

THREATS: Hawaiʻi ʻelepaio are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Hawaiʻi ʻelepaio populations, the following are of particular concern:

- Predation. On Oʻahu, predation by black rats (*Rattus rattus*) has been implicated in the loss of nests and death of adult females. Rat control in these populations resulted in large increases in nest success and in the survival of adult females.
- Disease. Avian pox (*Poxvirus avium*) is known to reduce both nesting success and adult survival. On Oʻahu, annual survival and reproductive success of birds with active pox lesions are lower compared to healthy birds; no information on the effect of avian malaria (*Plasmodium relictum*).
- Habitat loss and degradation. Historic habitat loss and degradation, especially at low elevations, is considered a major cause of declines. In Hakalau Forest National Wildlife Refuge, population densities are lower in degraded, open forests than in intact, dense forests.

CONSERVATION ACTIONS: Hawaiʻi ʻelepaio likely have benefited from management activities designed to conserve other endangered forest birds species at Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, Puʻu Lāʻau, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawaiʻi ʻelepaio may include the following:

- Protection and restoration of high elevation native forests, including the elimination of feral ungulates and non-native invasive plant species.
- Public education and outreach about the importance and benefits of rodent control.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Hawaiʻi ʻelepaio include the following:

- Continue to screen individuals for disease resistance. If resistant individuals are identified, translocation and/or captive propagation of these individuals may help recover populations.

- Continue efforts to develop techniques for captive propagation to benefit Hawaiʻi ʻelepaio.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

VanderWerf EA. 1998. ʻElepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

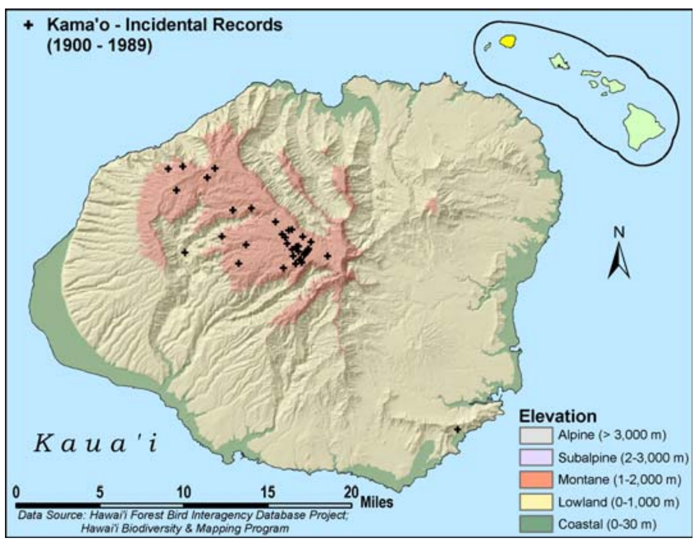
For photo see:
http://www.birdinghawaii.co.uk/AnnotatedListExtinct2.htm#KAMAO

Kāmaʻo
or Large Kauaʻi Thrush

Myadestes myadestinus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank GX
—Known only from historical occurrences
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for the Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The kāmaʻo, or large Kauaʻi thrush, is one of two Hawaiian solitaires (family: Turdidae) endemic to Kauaʻi. The kāmaʻo was often noted for flying upward, singing a few loud notes, and then suddenly dropping into the understory. Like all adult Hawaiian solitaires, the kāmaʻo has olive-brown and gray plumage, but it lacks the white-eye ring and pinkish legs of the smaller puaiohi or small Kauaʻi thrush (*M. palmeri*). The species' complex song is composed of a melodic series of liquid warbles, trills, and whistles, and is often heard before dawn and after dusk. The diet of the kāmaʻo is reported to consist of fruits and berries, particularly the bracts of ʻieʻie (*Freycinetia arborea*). The species' life history characteristics are mostly unknown, but are presumed similar to the ʻōmaʻo (*M. obscurus*). Breeding is thought to occur in the spring, although no nest has been described.



DISTRIBUTION: Since the mid-1960s the kāmaʻo has not been observed below 1,100 meters (3,500 feet) elevation. If the species persists, it is concentrated in the uppermost regions of the Alakaʻi Wilderness Preserve. Historically the kāmaʻo was found in moist forests near sea level on northern Kauaʻi as well as upland, interior mountain forests.

ABUNDANCE: Possibly extinct. The Hawaiian Forest Bird Survey (1981), estimated the population at 24 ± 30 (SE) individuals. The last kāmaʻo was observed in 1989, and it was not observed during the 2000 Kauaʻi Forest Bird Survey. Historically, the kāmaʻo was extremely common.

LOCATION AND CONDITION OF KEY HABITAT: Most recent kāmaʻo sightings have been in open canopy forests of ʻōhiʻa (*Metrosideros polymorpha*) and ʻōlapa (*Cheirodendron* spp.). Based on the diet and life history of the ʻōmaʻo, a diverse understory including epiphytes, tree ferns, and fruiting plants such as ʻieʻie, ʻōhā wai (*Clermontia* spp.), and ʻōhelo (*Vaccinium* spp.) would likely be high quality kāmaʻo habitat. However, because ʻieʻie, an important food plant, does not do well in high elevation forests, if this species persists it may be restricted to marginal habitat. The area where the species was last observed is managed by the State of Hawaiʻi as a Wilderness Preserve.

THREATS: Kāmaʻo are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For kāmaʻo populations, the following are of particular concern:

- <u>Disease</u>. Mosquito-borne disease is probably the most important factor in the decline of the kāmaʻo. Pox lesions (*Poxvirus avium*) were noted on this species in mid-19th century.
- <u>Habitat degradation</u>. The presence of native forest with abundant fruit-bearing plants below the species current range demonstrates that habitat degradation cannot entirely explain the species extirpation from lowland areas. However, several invasive plants and feral pigs (*Sus scrofa*) have degraded the understory of many native forests.
- <u>Competition</u>. Non-native birds, especially ecologically similar species (e.g., white-rumped shama [*Copsychus malabaricus*]), may have contributed to the species' decline.
- <u>Predation</u>. If kāmaʻo, like many solitaires, are cavity or low platform nesters their nests would be very susceptible to rats (*Rattus* spp.).
- <u>Non-native arthropods</u>. Recently introduced non-native insects, especially yellow jackets (*Vespula pensylvanica*) and Argentine ants (*Linepithema humile*), may compete with the kāmaʻo's native arthropod prey or disrupt the pollination of the species' food plants. Introduced herbivorous insects also could reduce the abundance of food plants.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management efforts designed to conserve other endangered forest birds on Kauaʻi, including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the recovery of the kāmaʻo may include the following:

- Aggressive ungulate control would likely improve the quality of kāmaʻo habitat and facilitate the recovery of degraded, but potential habitat. Control of non-native plants should be part of forest restoration efforts.
- Eradication of rats and feral cats (*Felis silvestris*) from the Alakaʻi Wilderness Preserve.
- Prevent introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other possible predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct there are no research priorities specific to kāmaʻo.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Wakelee KM, Fancy SG. 1999. ʻOmaʻo (*Myadestes obscurus*), kamaʻo (*Myadestes myadestinus*), olomaʻo (*Myadestes lanaiensis*), and ʻamaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Picture: Rothschild Collection

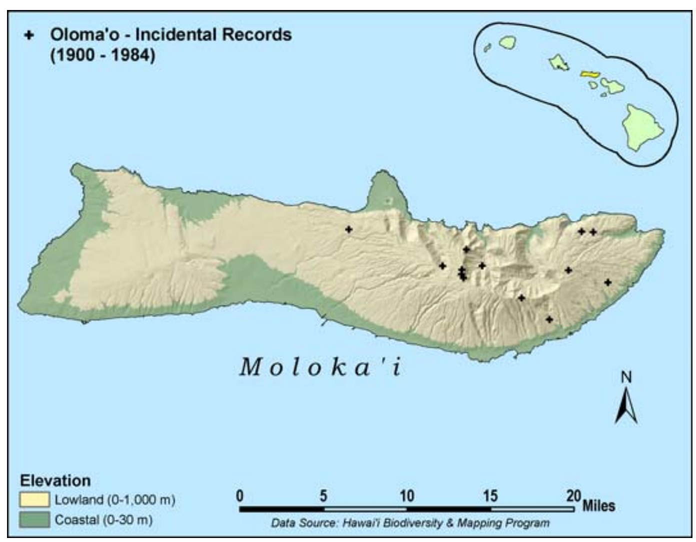
Olomaʻo or Molokaʻi Thrush

Myadestes lanaiensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank GH
—Known only from historical occurrences
IUCN Red List Ranking—Critically Endangered
Draft Revised Recovery Plans for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The olomaʻo, or Molokaʻi thrush, is one of five species of Hawaiian solitaires (family: Turdidae). All adult Hawaiian solitaires have olive-brown and gray plumage. Olomaʻo are prolific singers often singing into the night, and the species engages in song flights. Their song, like that of many thrushes, is melodious. Similar to other Hawaiian solitaires, the species often trembles their wings when perched. Olomaʻo are very philopatric, seldom leaving their small home range. The species feeds on a variety of small fruits and insects. Little is known about their breeding biology, but it is presumed to be similar to the ʻōmaʻo (*M. obscurus*).

DISTRIBUTION: Unknown. Possibly extinct. The historic range of the olomaʻo included the native forests of eastern Molokaʻi and Lānaʻi. Historically the species also may have occurred on Oʻahu and Maui, where subfossils of Hawaiian solitaires are abundant.



ABUNDANCE: Possibly extinct. Since 1907, olomaʻo have been observed on a dozen occasions, most recently in 1988. The Hawaiian Forest Bird Surveys (1979-1980) estimated the population at 19 ± 38 (SE) individuals. However, olomaʻo were not detected during surveys in the late 1980s and 1990s. There is little information on historical abundance.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Historically, the olomaʻo occupied closed, wet and mesic ʻōhiʻa (*Metrosideros polymorpha*) forests across a broad elevation range. The areas where the species was last observed are managed by the State of Hawaiʻi as a Natural Area Reserve or by private conservation entities (e.g., The Nature Conservancy).

THREATS: Unknown. However, olomaʻo likely were susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For olomaʻo populations, the following was likely of particular concern:

- Disease. This species' rapid decline and the fact that no habitat above 1,250 meters (4,100 feet) occurs on Molokaʻi or Lānaʻi suggests disease may have played an important role in the species decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds on eastern Molokaʻi, including the establishment and management of protected areas, regular surveys of forest bird populations, monitoring of habitat conditions, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is possibly extinct there are no research priorities specific to olomaʻo.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Wakelee KM, Fancy SG. 1999. ʻOmaʻo (*Myadestes obscurus*), kamaʻo (*Myadestes myadestinus*), olomaʻo (*Myadestes lanaiensis*), and ʻamaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: DOFAW

Forest Birds

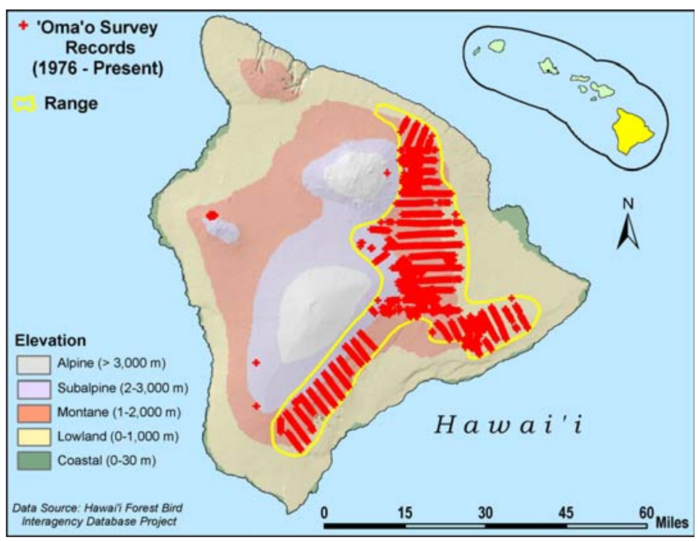
ʻŌmaʻo

Myadestes obscurus

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Ranking G3—
Rare with restricted range
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: One of five species of Hawaiian solitaires (family: Turdidae), the ʻōmaʻo is endemic to the island of Hawaiʻi. Although, ʻōmaʻo often perch silently for long periods, and are more often detected by their song, males perform a flight-song display known as "skylarking." Like all adult Hawaiian solitaires, ʻōmaʻo have drab olive-brown and gray plumage. The life history of this species is well-studied. Their diet consists primarily of fruits of native and introduced understory plant species, although they also take koa (*Acacia koa*) flowers from the canopy and prey on a variety of invertebrates, including earthworms, snails, spiders, and insects. Both sexes defend small nesting territories. Nests are built by females in a variety of locations (e.g., cavities, trunk forks); females also perform most incubation and brooding. Clutch size is one or two eggs, and double brooding occurs. Fledglings remain in their natal territories for four to six months after fledging. A male-biased sex-ratio exists, but its significance to populations is unknown.

DISTRIBUTION: ʻŌmaʻo primarily occur in two populations on the eastern and southern slopes of the island of Hawaiʻi at elevations greater than 1,000 meters (3,300 feet). A third, smaller population occurs in alpine scrub habitat between 2,000 and 3,000 meters (6,500 – 9,750 feet) elevation. Currently, ʻōmaʻo occupy an estimated 30 percent of their former range, which historically included habitats from 300 – 3,000 meters (1,000 – 9,750 feet) elevation.



ABUNDANCE: The Hawaiian Forest Bird Surveys (1976-79, 1983) estimated the population at 170,000 individuals. Based on more recent surveys, the populations appear stable, and may be increasing in habitats below 1,200 meters (3,450 feet).

LOCATION AND CONDITION OF KEY HABITAT: ʻŌmaʻo occur in mesic and wet montane ʻōhiʻa (*Metrosideros polymorpha*) or mixed ʻōhiʻa and koa forests in the Hāmākua, Kaʻū, and

Kīlauea districts. These forests support a variety of important food plants, including ʻōlapa (*Cheirodendron trigynum*), kōlea (*Myrsine lessertiana*), kāwaʻu (*Ilex anomala*), naio (*Myoporum sandwicense*), pilo (*Coprosma* spp.), pūkiawe (*Styphelia tameiameiae*), ʻōhelo (*Vaccinium* spp.), and ʻākala (*Rubus hawaiiensis*). In the small alpine scrub population on Mauna Loa, pūkiawe, ʻōhelo, kūkaenēnē (*Coprosma ernodeoides*), and ʻaʻaliʻi (*Dodonea viscosa*) are important food plants. Although most of the species' current range occurs on State and Federal lands, the condition of ʻōmaʻo habitat varies considerably.

THREATS: ʻŌmaʻo are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻōmaʻo populations, the following are of particular concern:

- <u>Disease</u>. The prevalence of disease in areas tested is low and five ʻōmaʻo exposed to malaria recovered quickly, suggesting a greater resistance to disease compared to other native forest birds. However, the disappearance of populations from lower elevations has been the pattern of decline noted in other Hawaiian birds susceptible to mosquito-borne diseases.
- <u>Predation.</u> ʻŌmaʻo nests are very accessible and therefore vulnerable to predation by rats (*Rattus* spp.). Predation by native raptors also is likely.
- <u>Habitat degradation</u>. ʻŌmaʻo occur at lower densities in degraded habitat. Pigs (*Sus scrofa*) and other ungulates likely destroy important food plants.

CONSERVATION ACTIONS: ʻŌmaʻo likely have benefited from management efforts designed to conserve other endangered forest birds and native habitat at Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to the protection of ʻōmaʻo populations may include the following:

- Protection and restoration of native forests above 1,500 meters (4,500 feet), including elimination of feral ungulates and non-native plants.
- Control or eradication of rats and feral cats (*Felis silvestris*) in areas occupied by ʻōmaʻo.
- Public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻōmaʻo include the following:

- Identification of disease resistant individuals.
- Development of improved techniques to control alien weed species.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Wakelee KM, Fancy SG. 1999. ‘Oma’o (*Myadestes obscurus*), kama’o (*Myadestes myadestinus*), oloma’o (*Myadestes lanaiensis*), and ‘amaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Jim Denny

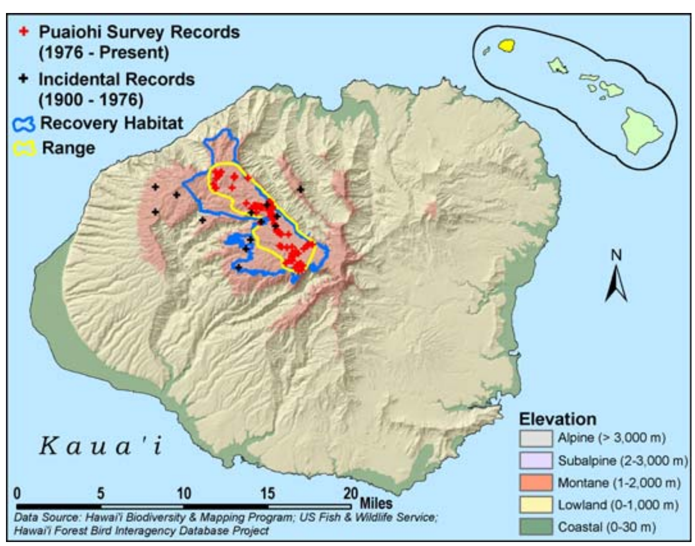
Puaiohi or Small Kaua‘i Thrush

Myadestes palmeri

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The puaiohi, or small Kaua‘i thrush, is the smaller of two solitaires (family: Turdidae) endemic to Kaua‘i, and was the last of the island's avifauna to be discovered by western ornithologists. In the late 1800s, the puaiohi was considered exceedingly rare, but this was likely due to its cryptic behavior and preference for remote, inaccessible ravines. Puaiohi are extremely sedentary and appear to have specific habitat requirements. Of the five Hawaiian solitaires, it is behaviorally, morphologically, and vocally the most divergent. Compared to the kāma‘o, or large Kaua‘i thrush (*M. myadestinus*), the puaiohi has a short tail, and a white eye-ring; in addition, it has a relatively simple song. The species life history is relatively well-known because of recent, intensive studies. The diet of the puaiohi includes fleshy fruits, insects, snails and other invertebrates. Fruit dominates the non-breeding season diet; insects are important during the breeding season. Nests are built by the female in cavities or on cliff ledges, and only females incubate eggs and brood young. Breeding peaks from April to June, and re-nesting occurs after failed and successful nest attempts. This, plus a high rate of nest success and a long breeding season, can result in high annual productivity. Hatch-year and second-year birds (i.e., helpers) are known to assist in nest defense and feeding of related nestlings and fledglings. Young are very sedentary for two to four days after fledging.

DISTRIBUTION: Puaiohi are restricted to a 20 square kilometer (7.6 square miles) area on the southern and central plateau of the Alaka‘i Wilderness Preserve. Currently, the species occurs above 1,050 meters (3,450 feet), which is similar to its upper limit historically.



ABUNDANCE: The most recent puaiohi surveys estimated the population at between 200 and 300 individuals. Densities peak at 16 breeding pairs per square kilometer

(0.62 square miles). This species was considered rare since the late 1800s.

LOCATION AND CONDITION OF KEY HABITAT: Puaiohi occur in areas characterized by deeply dissected, steep-walled ravines supporting wet montane forest dominated by ʻōhiʻa (*Metrosideros polymorpha*) and ʻōlapa (*Cheirodendron* spp.). Their former range included mesic areas dominated by ʻōhiʻa and koa (*Acacia koa*). These areas are now largely dominated by introduced plant species including fire tree (*Myrica faya*) and strawberry guava (*Psidium cattleianum*). Densities are very low even in apparently suitable habitat. The entire known range of this species is within the Alakaʻi Wilderness Preserve and is managed by the State of Hawaiʻi.

THREATS: Puaiohi are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For puaiohi populations, the following are of particular concern:

- Disease. Only five puaiohi have been tested for disease; none had lesions or scars and one carried malarial (*Plasmodium relictum*) antibodies. These data are equivocal, indicating low transmission rates, possible resistance, or very high mortality for this species.
- Predation. Two years of field data indicate that rats (*Rattus* spp.) were responsible for 14 to 22 percent of nest failures, as well as the mortality of three adult females. Fledglings typically spend their first days out of the nest within two meters (6.5 feet) of the ground, a behavior that makes them vulnerable to feral cats (*Felis silvestris*).
- Competition. Several non-native birds, including the introduced Japanese white-eyes (*Zosterops japonicus*), melodious laughing thrush (*Copsychus malabaricus*), and white-rumped shama (*Copsychus malabaricus*) occupy the same habitat and may compete with the puaiohi for food and nest resources.
- Habitat degradation. Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) have facilitated the invasion of non-native plants into puaiohi habitat. The establishment of these plants has altered the structure of these forests, especially that of the ground and shrub layer. Hurricanes in 1982 and 1992 further altered and degraded the forests of Kauaʻi, including those within the Alakaʻi Wilderness Preserve.
- Non-native arthropods. Recently introduced non-native insects, especially yellow jackets (*Vespula pensylvanica*) and Argentine ants (*Linepithema humile*), may compete with the puaiohi's native arthropod prey or disrupt the pollination of the species' food plants. Introduced herbivorous insects also could reduce the abundance of food plants.
- Natural disasters. The hurricanes of 1982 and 1992 likely caused the death of an unknown number of individuals.

CONSERVATION ACTIONS: In 1995, an intensive field ecology and behavior study was initiated. The results from this study are the basis for the current management actions directed at the species. Using captive propagation and re-introduction techniques developed using the ʻōmaʻo (*M. obscurus*), a captive breeding flock of puaiohi was established in 1996. To date, the program has been very successful. Thirty-four birds have been re-introduced, and these captive-raised birds have been documented successfully breeding. In addition, puaiohi likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the recovery of puaiohi will likely include the following:

- Systematic rat control using registered rodenticides in puaiohi nesting habitat.
- Continue re-introductions of captive-bred puaiohi with the goal of establishing additional populations.
- Aggressive ungulate control would likely improve the quality of puaiohi habitat and facilitate the recovery of degraded, but potential habitat. Control of non-native plants should be part of forest restoration efforts.
- Eradication of rats and feral cats from the Alaka'i Wilderness Preserve.
- Preventing the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other possible predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts. Additional monitoring for the puaiohi includes the following:

- Monitor survival and reproductive success of released birds to assess the efficacy of re-introduction efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods do control mosquito populations. Research priorities specific to the puaiohi include the following:

- The identification and captive-breeding of disease resistant individuals would potentially allow the establishment of disease-resistant populations at lower elevations.
- Continued field studies are needed to document survival and dispersal.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alaka'i swamp, Kaua'i. Conservation Biology 18:716-725.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Wakelee KM, Fancy SG. 1999. 'Oma'o (*Myadestes obscurus*), kama'o (*Myadestes myadestinus*), oloma'o (*Myadestes lanaiensis*), and 'amaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Bishop Museum

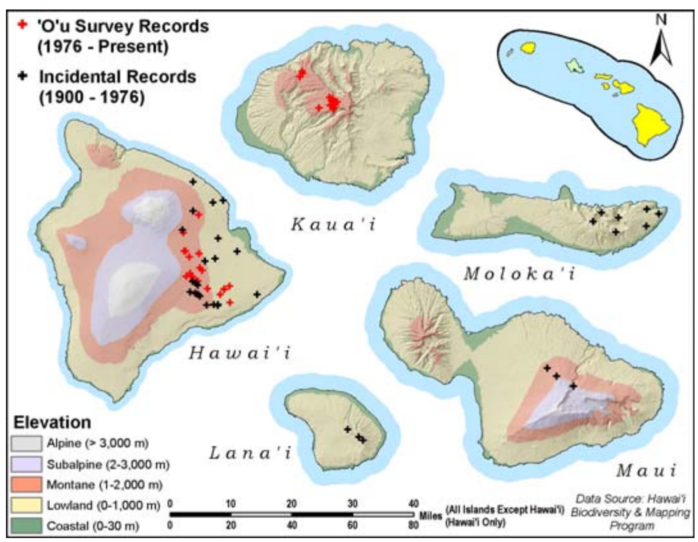
ʻŌʻū

Psittirostra psittacea

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds
—USFWS 2003

SPECIES INFORMATION: The ʻōʻū is a heavy-bodied Hawaiian honeycreeper (family: Fringillidae) with a distinctive thick, pink, parrot-like bill. Adults are overall olive-green with whitish undertail coverts; males have a bright yellow head. Early naturalist noted that ʻōʻū had a strong musky odor, which is retained in museum specimens. Like several of Hawaii's nectivorous birds, ʻōʻū are strong fliers and ranged widely in search of fruit. ʻIeʻie (*Freycinetia arborea*) inflorescences apparently are an important part of the species' diet, although ʻōʻū also feed on the fruits of *Clermontia* spp. as well as other native fruits. Geometrid caterpillars are an important food item during the breeding season. Little is known of the species life history and its nesting and breeding habits have not been described.

DISTRIBUTION: Possibly extinct. ʻŌʻū occupy forests between 900 and 1,500 meter (3,000 and 5,000 feet, respectively) elevations on the islands of Kauaʻi and Hawaiʻi. Historically widespread, ʻōʻū formerly occurred on all the Main Hawaiian Islands in low- to high-elevation forests. They are now presumed extirpated on every island except possibly on Kauaʻi and Hawaiʻi.



ABUNDANCE: Possibly extinct. The Hawaiian Forest Bird Surveys (1976-1981) estimated the population at 400 ± 300 (95% CI) individuals on the island of Hawaiʻi and nine or fewer individuals on Kauaʻi. ʻŌʻū have not been detected during more recent surveys, although unconfirmed sightings are occasionally reported.

LOCATION AND CONDITION OF KEY HABITAT: Although ʻōʻū are known from a wide range of forest types, all recent observations have occurred in mid-elevation mesic to wet ʻōhiʻa (*Metrosideros polymorpha*) forests with an understory of ʻieʻie (*Freycinetia arborea*), tree ferns

(*Cibotium* spp.), ʻōlapa (*Cheirodendron* spp.), kāwaʻu (*Ilex anomala*), kolea (*Myrsine* spp.), and pilo (*Coprosma* spp.). All recent sighting of ʻōʻū have occurred on lands managed by the State of Hawaiʻi.

THREATS: ʻŌʻū are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻōʻū populations, the following are of particular concern:

- Habitat degradation. Pigs (*Sus scrofa*) degrade the understory of wet forest destroying food plants.
- Disease. ʻŌʻū primarily occurred in low- to mid-elevation forests where the effects of mosquito-borne diseases was most severe. The species' foraging movements may have increased their exposure to disease.
- Predation. In addition to potentially depredating nests, rats (*Rattus* spp.) may also compete with ʻōʻū by reducing the availability of fruits.
- Natural disasters. In 1984, a large portion of the Upper Waiākea Forest Reserve was inundated by a lava flow from Mauna Loa. This flow occurred in an area where the most recent observations of the species were noted and destroyed high quality ʻōʻū habitat. In 1982 and 1992, two strong hurricanes struck Kauaʻi, devastating native forest habitat. The ʻōʻū, has not been observed on Kauaʻi since 1992.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management efforts designed to conserve other endangered forest birds on the island of Hawaii and Kauaʻi. On Hawaiʻi, these activities have included fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. On Kauaʻi these activities have included the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on the islands of Hawaiʻi and Kauaʻi. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species may be extinct, there are no research priorities specific to ʻōʻū.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Snetsinger TJ, Reynolds MH, Herrmann CM. 1998 ʻOʻu (*Psittirostra psittacea*) and Lanaʻi hookbill (*Dysmorodrepanis munroi*). *In* The Birds of North America, No. 335-336 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

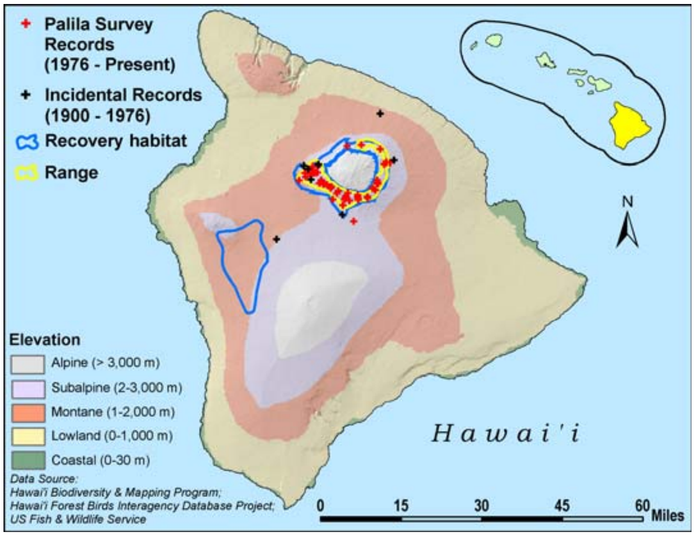
Photo: DOFAW

Palila

Loxioides bailleui

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds —USFWS 2003
Critical Habitat Designated 1977

SPECIES INFORMATION: The palila is a finch-billed Hawaiian honeycreeper (Family: Fringillidae) whose life history and survival is linked to māmane (*Sophora chrysophylla*), an endemic dry-forest tree in the legume family. Males and females are similar, having a yellow head and breast, greenish wings and tail, a gray back, and white underparts. Males have a black mask, and females have less yellow on the back of their heads and a gray mask. Approximately 90 percent of the palila's diet consists of immature māmane seeds; the remainder consists of māmane flowers, buds, leaves, and naio (*Myoporum sandwicense*) berries. Caterpillars and other insects comprise the diet of nestlings, but also are eaten by adults. Māmane seeds have been found to contain high levels of toxic alkaloids, and palila use particular trees for foraging, suggesting that levels of alkaloids may vary among trees. Individuals will move limited distances in response to the availability of māmane seeds. Palila form long-term pair bonds, and males perform low advertisement flights, sing, chase females, and engage in courtship feeding prior to breeding. Females build nests, usually in māmane trees, and males defend a small territory around the nest tree. Females mostly incubate eggs, brood nestlings and feed young with food delivered by male. First-year males sometimes help a pair by defending the nest and feeding the female and nestlings. Limited genetic testing found no evidence suggesting that helpers father the nestlings they were assisting, although more data are needed. Fledglings are dependent on their parents for three to four months, during this time they learn and practice foraging skills. The availability of green māmane seeds strongly influences the number of nesting attempts in a given year. In poor years, not all pairs will attempt to nest.



DISTRIBUTION: Palila are mostly restricted to the western slopes of Mauna Kea between 2,000 and 2,850 meters (6,500 – 9,250 feet) elevation; small scattered populations exist on the southern, northern, and eastern slopes. Historically, palila were common in all māmane forests. Currently, the species occupies approximately 10 percent of their historic range on the island of Hawaiʻi. Subfossil evidence indicates palila also occurred in māmane forest on Oʻahu and Kauaʻi.

ABUNDANCE: Annual population surveys between 1998 and 2005 yield a mean population estimate of 3,268 ± 190 (SE) individuals. In 2005, 2,909 birds were detected. Palila population estimates are variable among years, which may be an artifact of survey techniques or survey timing.

LOCATION AND CONDITION OF KEY HABITAT: Palila are restricted to māmane and māmane/naio forests, and densities are highest in areas at 2,300 meters (7,550 feet) elevation with large māmane trees and a high proportion of native shrubs. Up to 96 percent of the population and nearly all the successful breeding occurs in a 30 square kilometer (11.5 square mile) area on the western slope of Mauna Kea. In addition to having high quality habitat, this area is characterized by steep terrain. The latter is important because māmane occurring at different elevations flower and fruit at different times, ensuring that māmane seeds are always available. This is especially important during the breeding season. Most of the habitat in the species' range has been severely degraded by grazing ungulates, particularly mouflon sheep (*Ovis musimon*), and the spread of non-native plant species, especially fire-prone grasses. Most of the palila's current range occurs in the Mauna Kea Forest Reserve and is managed by the State of Hawaiʻi.

THREATS: Palila are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For palila populations, the following are of particular concern:

- Feral ungulates. Historically, large numbers of sheep (*Ovis* spp.) grazed on Mauna Kea, reducing the density and productivity of māmane trees. In addition to limiting the regeneration of other native plants, the sheep also caused soil erosion. More recently the introduction of mouflon sheep (*Ovis musimon*) has further degraded habitat.
- Invasive plants. Soil disturbance caused by sheep facilitated the spread of invasive plants. Fire-adapted grasses, such as fountain grass (*Pennisetum clandestinum*), are especially problematic in that they increase the risk of fire. Invasive plants also reduce the recruitment of native plants.
- Fire. A single large fire could severely limit food resources for the entire palila population.
- Predation. Predation by rats (*Rattus* spp.), feral cats (*Felis silvestris*), and the pueo (*Asio flammeus sandwichensis*) is an important factor limiting palila populations. In some areas, black rats (*R. rattus*) and feral cats may be responsible for up to 40 percent of nest failures, and feral cats have been documented preying on adults.
- Disease. Although palila are very susceptible to mosquito-borne diseases, mosquitoes do not occur at the elevation at which palila currently occur. However, disease almost certainly was important in the species decline and prevents palila from recolonizing low-elevation habitat.
- Non-native insects. Yellow jackets (*Vespula pensylvanica*) and Argentine ants (*Linepithema humile*) threaten the native caterpillars that nestlings depend on for food.

- Severe weather. The species' current range exposes them to severe weather that results in mortality in some years. Freezing temperatures, heavy rains, droughts, and high winds all can result in egg and nestling mortality.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: To date, a number of conservation efforts have been conducted to protect the māmane woodlands specifically for the protection and recovery of the palila. In the first half of the 20th century, 46,000 sheep as well as smaller numbers of feral cattle (*Bos tarus*), goats (*Capra hircus*), and pigs (*Sus scrofa*) were removed from māmane forests. This allowed the regeneration of the māmane trees on which the palila depend. Beginning in the late 1970s, control measures to reduce mouflon sheep numbers were initiated. Considerable research has been conducted on palila including estimating population size and determining their geographic range, documenting home range size, dispersal behavior, reproductive parameters, limiting factors, and habitat characteristics. Ongoing research mostly focuses on quantifying limiting factors, especially predation, food availability, and genetics as well as refining māmane restoration techniques. Beginning in 1993, translocations were conducted on an experimental basis to determine if new breeding populations could be established. In 2004, 32 birds were translocated and in 2005, 75 birds were moved. Although most birds return to their natal territory, approximately 25 percent remained at translocation sites. In 1996, a captive propagation program was initiated and palila have successfully bred in captivity. Between 2003 and 2004, 15 captive-raised birds were released into the wild. Initial attempts at outplanting māmane have been successful in areas where competing non-native vegetation is sparse. In addition to the above efforts, palila likely have benefited from management activities designed to conserve other endangered forest birds in Mauna Kea Forest Reserve and elsewhere on the island of Hawai'i. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the palila will likely include the following:

- Stabilize and increase at least one of the small populations using translocation or establish a new self-sustaining population while continuing to intensely manage the primary population. These efforts must include the restoration and regeneration of māmane forest as well as control of mammalian predators and parasitoid wasps that threaten food sources.
- Evaluate sites throughout the species' historic range for potential māmane restoration efforts. Appropriate areas should have a range of elevation or rainfall gradients to ensure that food resources are available throughout the year. These sites would eventually serve as re-introduction sites.
- Develop a comprehensive fire-management plan.
- Increase public education and involvement in palila recovery. Volunteer opportunities exist in habitat restoration efforts, monitoring weeds and predators, and education.
- Removal of feral sheep and mouflon from palila habitat.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the palila include the following:

- Refine survey methods.
- Further refine techniques to facilitate the establishment of new populations.
- Develop methods to control and eradicate the most harmful non-native plants and non-native insects that threaten native insect food sources.

References:

Banko PC, Johnson L, Lindsey GD, Fancy SG, Pratt TK, Jacobi JD, Banko WE. 2002. Palila (*Loxioides bailleui*). *In* The Birds of North America, No. 679 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.


Photo: Eric VanderWerf

Forest Birds

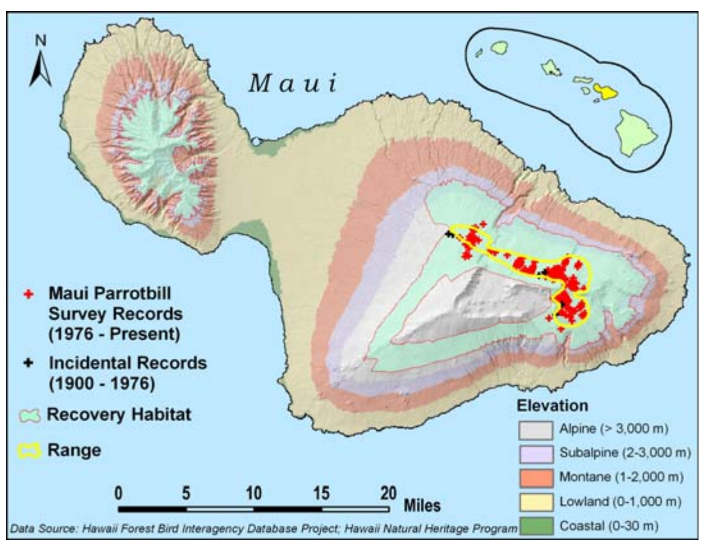
Maui Parrotbill

Pseudonestor xanthophrys

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Vulnerable
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The Maui parrotbill is stocky, bull-headed Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui, with a short tail and a relatively large, parrot-like bill. Adult males and females are mostly olive-green above with a yellow breast, belly and cheeks, and a bright yellow line above their eyes (i.e., supercilium). Males are typically brighter than females, although individuals are variable. Males are larger than females and have a larger bill. Maui parrotbills mainly feed on a variety of shrubs and small trees, especially ʻakala (*Rubus hawaiensis*), kanawao (*Broussaisia arguta*), and ʻōhiʻa (*Metrosideros polymorpha*) where it gleans prey from moss covered branches or uses its bill to chisel, crack, crush, dig, and tear bark and softer wood in search of beetle and Lepidoptera larvae and pupae. Also opens fruit in search of insects, but does not eat the fruit. Pairs defend relatively large, year-around home ranges. Females build nests, incubate eggs, and brood young. Clutch size is usually one and females feed nestlings with food delivered by males. Males will feed fledglings. Maui parrotbills will renest after a nest failure, but will not attempt another nest if the first is successful. Development of bill and acquisition of foraging techniques is prolonged and young remain with parents for five to eight months. Because of this long period of dependency, Maui parrotbills are often seen in small groups.

DISTRIBUTION: Maui parrotbills are restricted to a 50 square kilometer (19 square mile) area on the northwestern slopes of Haleakalā between 1,230 and 2,370 meters (4,000 – 7,700 feet) elevation. Subfossils indicate the species historically occurred in low elevation forests and on the island of Molokaʻi.



ABUNDANCE: The Hawaiian Forest Bird Survey (1980) estimated the population at 500 ± 230 (95% CI) individuals. More recent surveys have reported densities similar to those from the 1980 survey.

LOCATION AND CONDITION OF KEY HABITAT: The Maui parrotbill occurs in mid-to-upper-elevation montane wet forests dominated by ʻōhiʻa and in a few mesic areas dominated by ʻōhiʻa and koa (*Acacia koa*). These habitats support a dense, diverse native understory and subcanopy of ferns, sedges, epiphytes, shrubs, and small to medium trees. Most of the species' range is currently managed by the National Park Service, the State of Hawaiʻi, The Nature Conservancy, or through the East Maui Watershed Partnership.

THREATS: Maui parrotbills are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Maui parrotbill populations, the following are of particular concern:

- <u>Low reproductive potential</u>. Unlike many Hawaiian honeycreepers, Maui parrotbills have low annual fledgling production. This life history characteristic may be related to their very specialized foraging strategy. Regardless, the species is very susceptible to factors that reduce population size.
- <u>Disease</u>. Despite the availability of seemingly suitable habitat below 1,350 meters (4,500 feet), Maui parrotbill are not found in these areas, suggesting that disease may be restricting populations to higher elevations.
- <u>Predation</u>. Although predation on adult Maui parrotbills or their nests, has not been documented, predation by rats (*Rattus* spp.), cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit the species. Surveys have documented high densities of rats in the Hanawī area which supports a large portion of the Maui parrotbill population.
- <u>Habitat loss</u>. Historical accounts suggest that Maui parrotbills favored koa for foraging. Logging and ranching has resulted in the loss of large areas of mesic koa forest, and the current range of the Maui parrotbill is restricted to wet forests where koa density is relatively low. Therefore, like many endangered Hawaiian forest birds, Maui parrotbills may be restricted to suboptimal habitat.
- <u>Habitat degradation</u>. Maui parrotbills forage on a variety of shrubs and small trees and damage to understory vegetation by pigs (*Sus scrofa*) likely reduces its suitability and may contribute to reduced food availability and low reproduction. Habitat degradation also may increase the exposure of Maui parrotbill nests to inclement weather.
- <u>Population size</u>. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: To date, a number of conservation efforts have been undertaken to protect the Maui parrotbill. In 1997, a captive breeding program was initiated. As of 2003, ten Maui parrotbills have been produced from a captive population derived from three eggs and an injured adult male that were removed from the wild. In addition, the Maui parrotbill also benefits from management efforts designed to conserve other endangered forest birds on northeastern Haleakalā. These efforts include the establishment of the 3,000 hectares (7,500 acre) Hanawī Natural Area Reserve in 1986, the formation of the East Maui Watershed Partnership and the Maui Forest Bird Recovery Project, fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the recovery of the Maui parrotbill may include the following:

- Protection and restoration of habitat in high elevation disease-free areas.
- Fencing and ungulate control in low elevation habitat from the Hanawī Natural Area Reserve to Waikamoi. This would facilitate the recovery of the understory and subcanopy vegetation and eventually result in high-quality Maui parrotbill habitat.
- Establish a continuous corridor of suitable habitat around Haleakalā, by connecting established conservation lands on the southern and western parts of the mountain. Restoration of the koa forests to this area would be a key element to this effort, eventually providing Maui parrotbills with large tracts of their preferred habitat.
- Restore, fence, and eradicate pigs from the remnant mesic koa forests on the State Forest Reserve and Department of Hawaiian Home Lands in the Kahikinui region of southern Haleakalā. Restoration of this area would be a cost-effective starting point to providing the Maui parrotbill with high-quality habitat.
- Public outreach and education regarding the importance of rodent control.
- Continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Maui parrotbill include the following:

- Evaluate the effect of intensive rat control on the reproduction and survival of Maui parrotbills.
- Identification of disease resistant individuals. Determination of genetic markers or genotypes associated with resistance would allow targeted translocations of individuals possessing this genotype into populations currently lacking disease resistance and/or the establishment of new, disease resistant populations.
- Further refinements of captive breeding techniques and evaluation of experimental re-introduction sites. Evaluation should include surveys of mosquitoes and the determination of the disease prevalence in lower elevation sites.

References:

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Simon JC, Baker PE, Baker H. 1997. Maui parrotbill (*Pseudonestor xanthophrys*). *In* The Birds of North America, No. 311 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Chris Eckart

Forest Birds

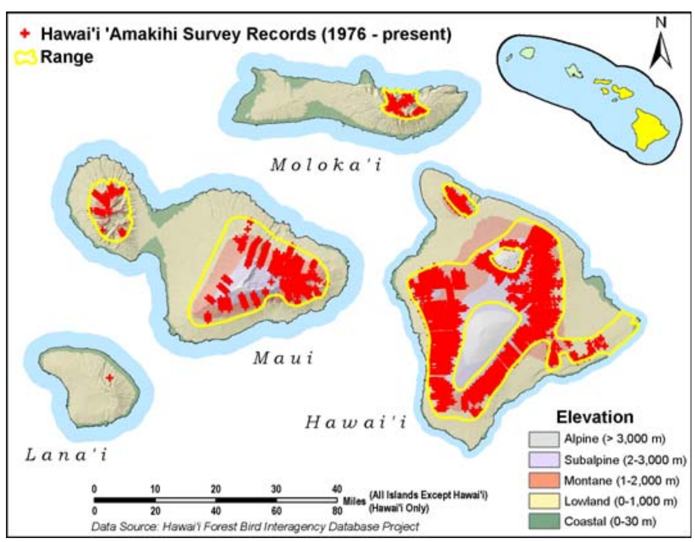
Hawai‘i ‘Amakihi

Hemignathus virens

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable

SPECIES INFORMATION: The Hawai‘i ‘amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae) that occurs on the islands of Hawai‘i, Maui, and Moloka‘i. Until 1995, the Hawai‘i ‘amakihi, and the O‘ahu (*H. flavus*) and Kaua‘i ‘amakihi (*H. kauaiensis*) were considered a single species: the common ‘amakihi (*H. virens*). Plumage of all species is similar; males are yellow-green to olive with black lores. Females are generally similar, but duller. All have decurved bills. Plumage of male Hawai‘i ‘amakihi is bright yellow-green above, and there is some inter-island variation, especially among females. The Hawai‘i ‘amakihi is brighter and smaller than the Kaua‘i ‘amakihi. Hawai‘i ‘amakihi are generalized foragers that most often glean arthropods from the leaves, blossoms, twigs, branches, and less frequently from tree trucks of a variety of trees, ferns, and shrubs. Feeds on nectar predominately from the flowers of ‘ōhi‘a (*Metrosideros polymorpha*), māmane (*Sophora chrysophylla*), and native lobelias (Campanulaceae), but also forages on flowers of a number of other native and non-native plants. Hawai‘i ‘amakihi also eats fruit from native and non-native plants, but predominately from pilo (*Coprosma* spp.). Forages alone, in pairs, in family groups, or in mixed flocks. Courtship behavior somewhat complex and includes courtship chases, advertising displays, and courtship feeding. Pairs will remain together for successive breeding seasons. Pair selects nest site; female builds an open-cup nest and lays two or three eggs. Only females incubate eggs and brood nestlings. Males deliver food to females who then feed nestlings. Fledglings are dependent on parents for up to three months. The Hawai‘i ‘amakihi usually raise two broods in a season.

DISTRIBUTION: Hawai‘i ‘amakihi occur between 300 and 2,900 meters (1,000 – 9,500 feet) on the islands of Hawai‘i, Maui and Moloka‘i; not common below 500 meters (1,625 feet). The species is widely distributed on the islands of Hawai‘i and Maui. Original range likely included all forested regions of the above islands as well as those on Lāna‘i, where it was least seen in 1976.



ABUNDANCE: The Hawaiian Forest Bird Survey (1976-1983) estimated the Hawai‘i ‘amakihi population at 870,000 ± 5,612 (95% CI) individuals on the island of Hawaiʻi, 44,000 ± 1,786 birds on east Maui, 3,000 ± 408 on west Maui, and 1,800 ± 357 individuals on Molokaʻi. Populations on the islands of Hawaiʻi and Maui are probably stable; the Molokaʻi population is probably declining.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiʻi ʻamakihi occupy a wide range of habitats on the islands of Hawaiʻi and Maui. These include native shrubland and dry, mesic, and wet forests in montane and subalpine communities. ʻAmakihi densities are highest on the island of Hawaiʻi in subalpine ʻōhiʻa scrub in Kaʻū, and in māmane/naio (*Sophora chrysophylla* and *Myoporum sandiwicense*) forests on Mauna Kea. ʻAmakihi also are common in koa (*Acacia koa*) reforestation areas at higher elevations. On Maui, ʻamakihi are common in subalpine dry communities dominated by ʻōhiʻa, māmane, pūkiawe (*Styphelia tamieameiae*) and ʻaʻaliʻi (*Dodonea viscosa*). They also occupy some non-native tree plantations on Maui, although these are near areas where native vegetation persists. Habitat on Molokaʻi is restricted to the ʻōhiʻa forests of the eastern half of the island. The condition of this habitat varies considerably. Much of the species' current range is under State or Federal jurisdiction.

THREATS: Although Hawaiʻi ʻamakihi populations appear stable they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease.

CONSERVATION ACTIONS: Hawaiʻi ʻamakihi likely have benefited from management activities designed to conserve other endangered forest birds in the Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawaiʻi ʻamakihi may include the following:

- Translocation of captive bred individuals to Lānaʻi and Kahoʻolawe.
- Public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Currently, USGS/BRD personnel are conducting the following research on Hawaiʻi ʻamakihi: genetic analyses to determine the species' phylogenetic status and examining the relationship between genetic diversity and disease resistance. Additional research priorities include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success, especially for Maui and Molokaʻi populations.
- Conduct studies to determine if competition with Japanese white-eyes (*Zosterops japonicus*) occurs, and if so, determine its effect on Hawaiʻi ʻamakihi populations.
- Translocation experiments using Hawaiʻi ʻamakihi would be valuable in re-establishing this and other Hawaiian honeycreeper populations.

References:

Lindsey GD, VanderWerf EA, Baker H, Baker PE. 1998. Hawaiʻi (*Hemignathus virens*), Kauaʻi (*Hemignathus kauaiensis*), Oʻahu (*Hemignathus chloris*) and greater ʻamakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: Eric VanderWerf

Forest Birds

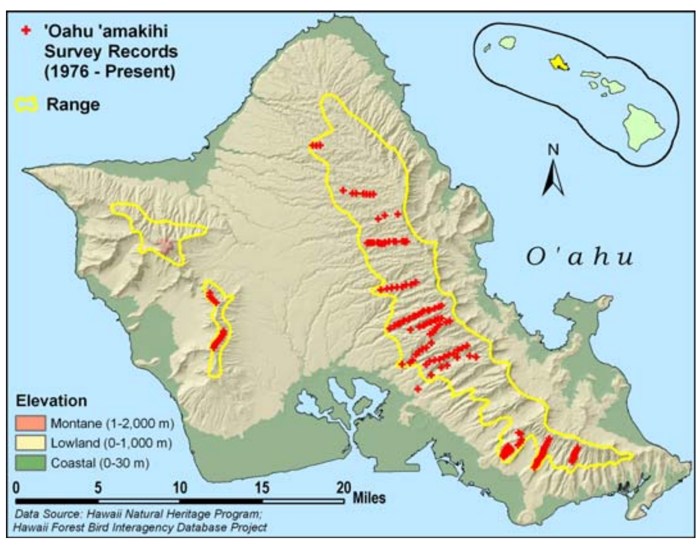
O'ahu 'Amakihi

Hemignathus flavus

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The O'ahu 'amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of O'ahu. Until 1995, the O'ahu 'amakihi, and the Hawai'i (*H. virens*) and Kaua'i amakihi (*H. kauaiensis*) were considered a single species: the common 'amakihi (*H. virens*). Plumage of all species is similar; males are yellow-green to olive with black lores. Females are similar, but duller. All have decurved bills. The plumage of some male O'ahu amakihi is variable in having yellow above eyes and more yellow breasts, and compared to the other species, female O'ahu 'amakihi have two dull wing bars. The O'ahu 'amakihi is brighter and smaller than the Kaua'i 'amakihi. O'ahu 'amakihi are generalized foragers that take arthropods from a variety of trees and substrates. The species often gleans arthropods from leaves and twigs, less frequently from larger branches and trucks. Feeds on nectar and fruit from a variety of native and non-native plants and has been observed eating sap from koa (*Acacia koa*) trees. Only three nests have been found; thus, the species' reproductive biology is poorly known, but is likely similar to Hawai'i 'amakihi.

DISTRIBUTION: O'ahu 'amakihi occur in two disjunct populations between 50 and 300 meters (180 – 1,000 feet) elevation, although the species is most numerous above 200 meters (650 feet). In recent years, range has increased to include some residential areas. Original range likely included all forested regions of O'ahu.



ABUNDANCE: A 1991 survey conducted by the State of Hawai'i Division of Forestry and Wildlife estimated the O'ahu 'amakihi population at between 20,000 and 60,000 individuals. Audubon Christmas bird counts from 1958-1985 documented a decrease in detections. Despite this, populations may be increasing in some areas.

LOCATION AND CONDITION OF KEY HABITAT: O'ahu 'amakihi occur in a variety of habitats from very wet forests in the Ko'olau Mountains to dry forests in the Wai'anae Mountains. They are more common in sheltered forests in valleys at middle elevations. Unlike, other Hawaiian passerines, the range of the O'ahu 'amakihi extends to low-elevation forest dominated by non-native plant species. Among introduced forests, 'amakihi are most abundant in areas dominated by guava (*Psidium guajava*) or kukui (*Aleurites moluccana*). Most of the species' range is managed by the U.S. Fish and Wildlife Service, U. S. Army, and the State of Hawai'i.

THREATS: Although O'ahu 'amakihi populations appear stable, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For O'ahu 'amakihi populations, the following are of particular concern:

- <u>Fire</u>. Non-native plants and military training activities often results in wildfires that threaten O'ahu 'amakihi habitat on military lands.

CONSERVATION ACTIONS: O'ahu 'amakihi likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the O'ahu Forest National Wildlife Refuge in the Ko'olau mountains, rat control directed at protecting nesting O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*), fencing and ungulate control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the O'ahu 'amakihi may include the following:

- Public outreach and education.
- Continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Initiate regular forest bird surveys on O'ahu and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Because the O'ahu 'amakihi appears to be surviving and possibly thriving in disturbed habitat and at elevations below the point were mosquitoes commonly occur they provide a number of potentially important research opportunities. Research priorities specific to the O'ahu 'amakihi include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success. Studies comparing life history characteristics between native and non-native habitats would be particularly useful.
- Identify and study disease resistant populations, focusing on the genetic basis of resistance.

References:

Lindsey GD, VanderWerf EA, Baker H, Baker PE. 1998. Hawai'i (*Hemignathus virens*), Kaua'i (*Hemignathus kauaiensis*), O'ahu (*Hemignathus chloris*) and greater 'amakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.


Photo: Jim Denny

Forest Birds

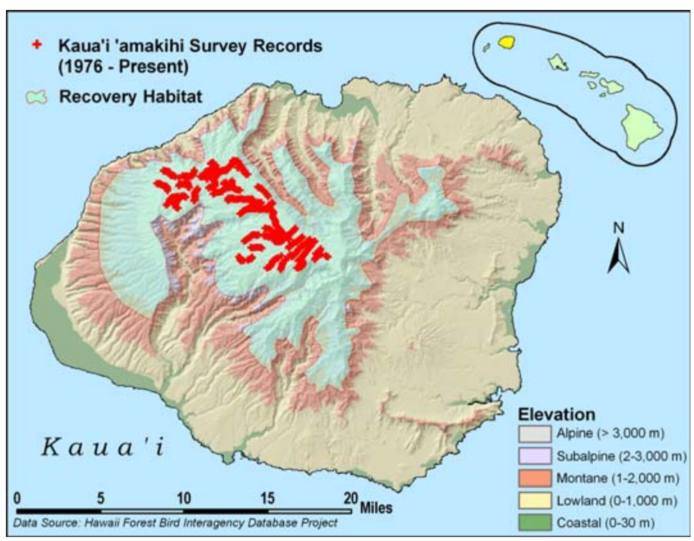
Kauaʻi ʻAmakihi

Hemignathus kauaiensis

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The Kauaʻi ʻamakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Kauaʻi. Until 1995, the Kauaʻi ʻamakihi, and the Hawaiʻi (*H. virens*) and Oʻahu ʻamakihi (*H.* falvus) were considered a single species: common amakihi (*H. virens*). The plumage of all species is similar; males are yellow-green to olive with black lores. Females are generally similar, but duller. All have decurved bills. The Kauaʻi ʻamakihi, is perhaps the dullest of the three species, is somewhat larger and has a longer, heavier and more decurved bill than the other species. The species often gleans arthropods from branches and trucks as well as leaves, often hanging upside down to examine the underside of branches. Also probes bark crevices for food items, pierces the bases of ʻōhiʻa (*Metrosideros polymorpha*) flowers for nectar, and feeds on the fruit of native and non-native plants. The species' reproductive biology is poorly known, however males display (i.e., rapidly move around the female and sing), chase, and feed females prior to breeding. Both sexes build the nest, typically in a non-blooming ʻōhiʻa tree, although the female does most of the construction while the male sings in adjacent trees. Females incubate a clutch of three eggs and brood nestlings at night and during inclement weather. Both parents feed nestlings. Fledglings are accomplished fliers. No information on post-fledgling behavior or parental dependency. Although weather has been implicated in nest failure, nest success is high.

DISTRIBUTION: Kauaʻi ʻamakihi occur above 600 meters (2,000 feet) elevation in the forests of Waimea Canyon, Nā Pali Plateau, the Alakaʻi Swamp and Makaleha Mountains. Original range likely included all forested regions of Kauaʻi.



ABUNDANCE: In the early 1970s the island-wide Kauaʻi ʻamakihi population was estimated at 10,743 ± 970 (SE) individuals. A survey in the late 1980s estimated the population at 15,000 to 20,000 individuals. The Kauaʻi Forest Bird Survey (2000) estimated the population in the Alakaʻi Swamp and Kōkeʻe State Park area at greater than 40,000 individuals, and reported a significant population increase between 1981 and 2000.

LOCATION AND CONDITION OF KEY HABITAT: Kauaʻi ʻamakihi occur in wet and mesic montane forests above 600 meters (2,000 feet) elevation dominated by ʻōhiʻa, koa (*Acacia koa*), ʻōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). At lower elevations, where the species historically occurred, native habitats are severely degraded. Although public hunting reduces the number of feral ungulates in the most accessible parts of the species' range, hunting is not an effective method to prevent habitat degradation. Occupied habitats above Waimea Canyon, in and west of the Alakaʻi swamp are managed by the State of Hawaiʻi.

THREATS: Although Kauaʻi ʻamakihi populations appear stable, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease.

CONSERVATION ACTIONS: Kauaʻi ʻamakihi likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the Kauaʻi ʻamakihi may include the following:

- Aggressive ungulate control would likely improve the quality of Kauaʻi ʻamakihi habitat and facilitate the recovery of degraded, but potential habitat.
- Control of non-native plants that degrade native habitat.
- Eradication of rats (*Rattus* spp.), feral cats (*Felis silvestris*), and barn owls (*Tyto alba*) from the Alakaʻi Wilderness Preserve.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other non-native predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Kauaʻi ʻamakihi include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.
- Determine the species' susceptibility to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*).
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species' diet.
- Determine the status of populations outside of the greater Alakaʻi swamp region.
- Conduct phylogenetic analyses to determine the relationship to other ʻamakihi species.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Lindsey GD, VanderWerf EA, Baker H, Baker PE. 1998. Hawaiʻi (*Hemignathus virens*), Kauaʻi (*Hemignathus kauaiensis*), Oʻahu (*Hemignathus chloris*) and greater ʻamakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: Jim Denny

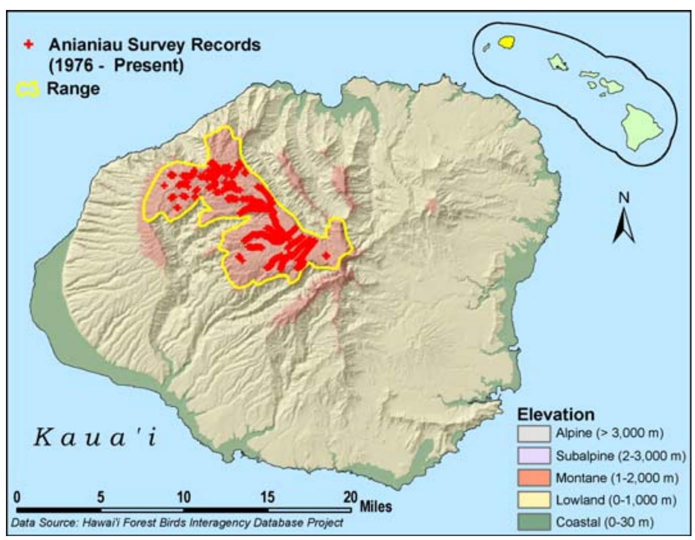
Forest Birds

ʻAnianiau or Lesser ʻAmakihi

Hemignathus parvus

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G3 – Vulnerable
IUCN Red List Ranking – Vulnerable

SPECIES INFORMATION: The ʻanianiau is the smallest Hawaiian honeycreeper (Family: Fringillidae). Endemic to Kauaʻi, the ʻanianiau also is one of the most common native birds of the island's high elevation forests. Adult males are brilliant yellow; females also are yellow, but duller. Constantly on the move, ʻanianiau feed on nectar from ʻōhiʻa (*Metrosideros polymorpha*), ʻōhelo (*Vaccinium* spp.), ʻalani (*Pelea* spp.), and other native and introduced plants. They also glean arthropods from the outer canopy and smaller twigs and branches of ʻōhiʻa and koa (*Acacia koa*) trees as well as from the foliage of shrubs, vines, and the fronds of tree ferns (*Cibotium* spp.). Nectar, spiders, and Lepidoptera larva comprise the bulk of the species' diet. ʻAnianiau are occasionally seen in small flocks, especially at favored nectar sources. Males sing a sweet, high-pitched trill, and predominantly defend breeding territories that may be as small as nine meters (29.3 feet) in diameter. Both sexes build the open-cup nest, females incubate eggs and brood young, and males provision females, generally away from the nest. No information on post-fledgling behavior or dependency.



DISTRIBUTION: ʻAnianiau occur above 600 meters (2,000 feet) elevation in native forests of the Kōkeʻe , Alakaʻi, and Waimea regions. They may occur as low as 100 meters (330 feet) elevation on the island's northwestern coast. Original range likely included all forested regions of Kauaʻi. Currently they occupy an estimated 15 percent of their former range.

ABUNDANCE: In the early 1970s the island-wide ʻanianiau population was estimated at 24,000 ± 3000 (SE) individuals. The Kauaʻi Forest Bird Survey (2000) estimated the population within the Alakaʻi and Kōkeʻe region at close to 35,000 individuals, and reported a significant population increase between 1981 and 2000. The population appears stable in its current range.

LOCATION AND CONDITION OF KEY HABITAT: ʻAnianiau occupy mesic and wet forests above 600 meters (2,000 feet) in elevation, although populations reach their highest densities above 1,100 meters (3,600 feet). These forests are dominated by ʻōhiʻa, koa, ʻōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). At lower elevations, where the species historically occurred, native habitats are severely degraded. Although public hunting reduces the number of feral ungulates in the most accessible parts of the species' range, hunting is not an effective method to prevent habitat degradation across its entire range. Occupied habitats above Waimea Canyon, in and west of the Alakaʻi swamp are managed by the State of Hawaiʻi.

THREATS: Although ʻanianiau populations appear stable they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻanianiau populations, the following are of particular concern:

- Disease. Only one of 94 ʻanianiau tested positive for malarial parasites (*Plasmodium relictum*) in areas where parasites were common in other species. This either indicates low transmission rates, possible resistance, or very high mortality for this species.
- Habitat degradation. The species is tolerant to habitat alteration, but it is most common in undisturbed native forest. Introduction of non-native plants is the most important threat as ʻanianiau density is negatively related to the presence of non-native shrubs.
- Competition. Competition with introduced Japanese white-eyes (*Zosterops japonicus*) may negatively affect ʻanianiau. Non-native insects, especially yellow-jackets (*Vespula pensylvanica*) and ants (*Linepithema humile*), may compete with or prey on the native arthropods on which ʻanianiau feed. The role of non-native insects in native forest ecosystems is unclear.
- Mammalian predators. Although predation on adult ʻanianiau or their nests has not been documented, rats (*Rattus* spp.) and cats (*Felis silvestris*) occur in the Alakaʻi Wilderness Preserve.

CONSERVATION ACTIONS: ʻAnianiau likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Since the ʻanianiau population appears stable, no future management specific to the species is anticipated. However, conservation efforts to maintain the stability of the species should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ʻanianiau include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

- Determine if diseased individuals exist, and if so, determine if resistance is passed to offspring. Disease-resistant individuals could be used as founders for new populations.
- Determine if competition with Japanese white-eyes occurs, and if so, determine its affect on ʻanianiau populations.
- Determine the effects of recently established non-native insects on native arthropods, especially on those arthropods that are part of the species' diet.
- Determine the status of populations outside of the greater Alakaʻi swamp region.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Lepson JK. 1997. ʻAnianiau (*Hemignathus parvus*). *In* The Birds of North America, No. 312 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Picture: Rothschild Collection

Forest Birds

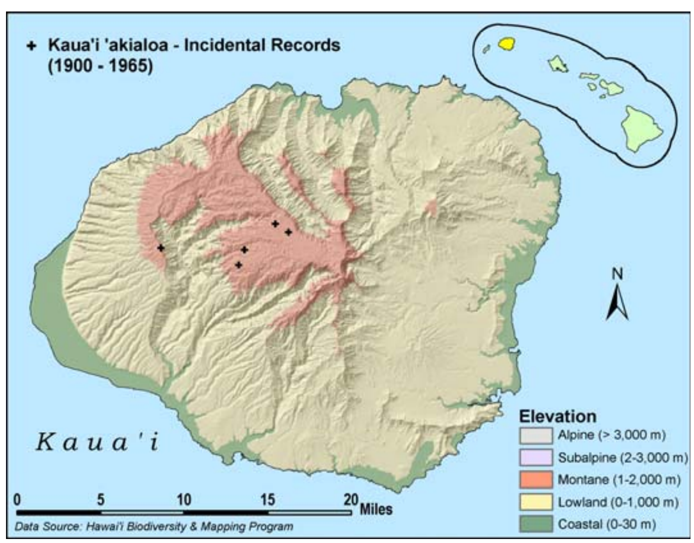
Kauaʻi ʻAkialoa

Hemignathus procerus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank GX—Presumed extinct
IUCN Red List Ranking—Extinct
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The Kauaʻi ʻakialoa is perhaps the most morphologically specialized of the Hawaiian honeycreepers (Family: Fringillidae) having a decurved bill that is up to half the length of their body. Both sexes are mostly olive-green; males being somewhat brighter, slightly larger, and have a longer bill. The life history of the Kauaʻi ʻakialoa is poorly known and mostly based on observations from the turn of the last century. The species principally foraged for arthropods on the trunks and branches of ʻōhiʻa (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees, and hapuʻu tree ferns (*Cibotium* spp.) by using its bill to probe bark cervices, decaying wood, epiphytes, and organic matter; observed to insert its entire bill into crevices. Foraging behavior has been described as being similar to that of a woodpecker or creeper. The ʻakialoa also took nectar from ʻōhiʻa and lobelia (Campanulaceae) flowers. Nothing is known about its breeding biology. ʻAkialoa also occurred on the islands of Hawaiʻi, Oʻahu, and Lānaʻi. Some authors consider each island population as a separate species, others lump all into a single, polytypic species. Regardless, none have been observed for at least 60 years.

DISTRIBUTION: Unknown. Probably extinct. The Kauaʻi ʻakialoa was last seen in the Alakaʻi swamp. Original range likely included all forested regions of Kauaʻi.



ABUNDANCE: Unknown. The Kauaʻi ʻakialoa was last observed in 1969, and is probably extinct. Extensive surveys in 1989, 1994, 1996, and 2000 did not detect the species. Historically, the species was reported to be fairly common.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. In the late 1800s, the Kauaʻi ʻakialoa occurred in most forests on Kaua'i from between 200 and 1,500 meters (650 – 4,875 feet) elevation. The species was last observed in the Alaka'i Wilderness Preserve.

THREATS: Causes of the decline of this species are unknown. However, 'akialoa likely were susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Kaua'i 'akialoa populations, the following likely was of particular concern:

- Disease. Avian pox (*Poxvirus avium*) lesions are noted in historic accounts and occur on museum specimens. Perkins (1903) noted Kaua'i 'akialoa was "grievously affected by…swelling on the legs and feet, as well as on the head at the base of the bill, and on the skin around the eyes."

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds on Kaua'i, including the establishment of the Alaka'i Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Kaua'i 'akialoa.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alaka'i swamp, Kaua'i. Conservation Biology 18:716-725.

Lepson JK, Johnston SM. 2000. Greater 'akialoa (*Hemignathus ellisianus*) and lesser 'akialoa (*Hemignathus obscurus*). *In* The Birds of North America, No. 512 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Perkins RC. 1903. Verebrata. Pp. 365-466 *In* Fauna Hawaiiensis. Volume 1, Part IV (Sharp D, editor). Cambridge, UK: University Press.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

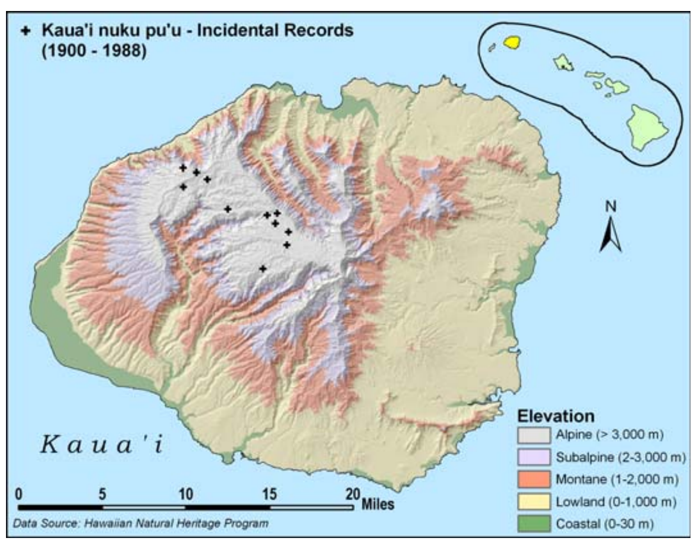
Kauaʻi Nuku Puʻu

Hemignathus lucidus hanapepe

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking— Critically endangered
Draft Revised Recovery Plan for Hawaiian
Forest Birds—USFWS 2003

SPECIES INFORMATION: The Kauaʻi nuku puʻu is a large, short-tailed Hawaiian honeycreeper (Family: Fringillidae) with a long, thin decurved bill; the lower mandible is half the length of the upper mandible. Nuku puʻu also are known from Oʻahu (*H. l. lucidus*) and Maui (*H. l. affinis*); the Oʻahu subspecies is certainly extinct. Currently, all nuku puʻu are considered one species, however, ongoing research suggests that populations occurring on the three islands are distinct species. Adult males are olive green with a yellow head, throat, and breast and have a small black mask; females are grayish green above and whitish below. Little is know about the species' life history. Often joins mixed species foraging flocks, especially those with ʻakikiki (*Oreomystis bairdi*). Apparently would creep along tree trunks, especially those of ōhiʻa (*Metrosideros polymorpha*) and koa (*Koa acacia*) trees, searching the bark and dead wood for arthropod prey; also may have taken nectar. Accounts vary regarding bill use. Either hammered surfaces, similar to its congener the ʻakiapōlāʻau (*H. munroi*), or used its upper mandible to fish out prey from crevices, catching them with its tongue and lower mandible. No information on the species' breeding biology, but likely is similar to the ʻakiapōlāʻau.

DISTRIBUTION: Unknown. Probably extinct. All recent Kauaʻi nuku puʻu sightings are from a small area of southwestern Kauaʻi between 610 and 1,220 meters (2,000–4,000 feet) elevation. The species' historic range also appeared very restricted.



ABUNDANCE: Unknown. Probably extinct. There are fewer than a dozen historical records of the Kauaʻi nuku puʻu. Extensive surveys in 1989, 1994, 1996, and 2000 did not detect the species.

LOCATION AND CONDITION OF KEY HABITAT: Kauaʻi nuku puʻu occur in mesic and wet montane forests. Habitat conditions of the species' historic range vary and all presumably support populations of *Culex* mosquitoes. Areas where Kaua'i nuku pu'u have most recently been observed are managed by the State of Hawai'i.

THREATS: Unknown. However, the Kaua'i nuku pu'u likely was susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Kaua'i nuku pu'u populations, the following likely was of particular concern:

- <u>Disease</u>. The precipitous decline of all nuku pu'u taxa suggests that mosquito-borne diseases played an important role in the species' demise.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds on Kaua'i, including the establishment of the Alaka'i Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Kaua'i nuku pu'u.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alaka'i swamp, Kaua'i. Conservation Biology 18:716-725.

Pratt TK, Fancy SG, Ralph CJ. 2001 'Akiapola'au (*Hemignathus munroi*) and nukupu'u (*Hemignathus lucidus*). *In* The Birds of North America, No. 600 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

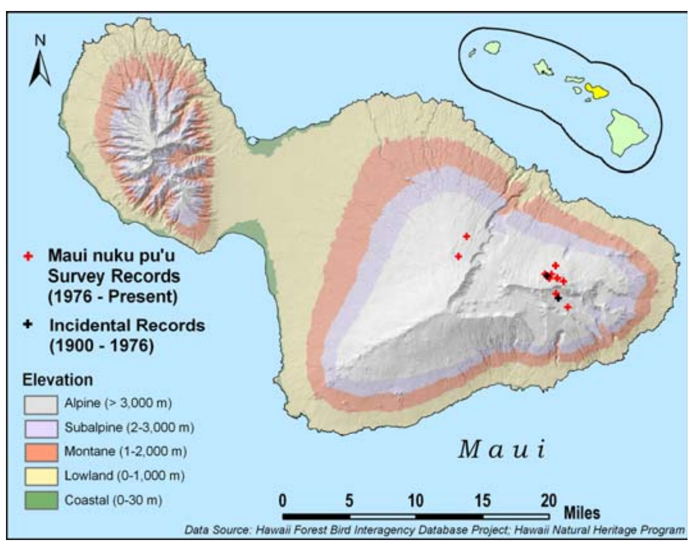
Maui Nuku Puʻu

Hemignathus lucidus affinis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The Maui nuku puʻu is a large, short-tailed Hawaiian honeycreeper (Family: Fringillidae) with a long, thin decurved bill; the lower mandible is half the length of the upper mandible. Nuku puʻu also are known from Oʻahu (*H. l. lucidus*) and Kauaʻi (*H. l. hanapepe*); the Oʻahu subspecies is certainly extinct. Currently, all nuku puʻu are considered one species, however, ongoing research suggests that populations occurring on the three islands are distinct species. Adult males are olive green with a yellow head, throat, and breast and have a small black mask; females are olive green above and variable yellow-gray below. Little is known about the species' life history. Often joins mixed species foraging flocks. Apparently would creep along large ʻōhiʻa (*Metrosideros polymorpha*) limbs searching epiphytes, moss, bark, and dead wood for arthropod prey; may also have taken nectar. Hammered bark with lower mandible, similar to its congener the ʻakiapōlāʻau (*H. munroi*), and used its upper mandible to fish out prey from excavations. No information on the species' breeding, but is likely similar ʻakiapōlāʻau.

DISTRIBUTION: Poorly known. Probably extinct. Most recent sightings between 1,100 and 2,100 meters (3,600–6,900 feet) elevation in the Kīpahulu Valley and the northeastern slope of Haleakalā. Historic range apparently very restricted, although subfossil evidence suggests the species may have occurred in dry forests.



ABUNDANCE: Unknown. Probably extinct. Based on a single sighting, the Hawaiian Forest Bird Survey (1980), estimated the population at 28 ± 56 (95% CI) individuals. More recent surveys have failed to detect the Maui nuku puʻu. Historically considered uncommon.

LOCATION AND CONDITION OF KEY HABITAT: Maui nuku puʻu occur in mixed ʻōhiʻa/koa (*Koa acacia*) forests and mixed shrub montane wet forests between 1,100 and 2,100 meters (3,600–6,900 feet). Historic and fossil evidence indicates that its range was much broader and remnant populations may have been surviving in marginal habitat. Habitat conditions of the species' former range vary. Areas where nuku puʻu were most recently sighted are managed as a Forest Reserve by the State of Hawaiʻi or by the National Park Service.

THREATS: Unknown. However, the Maui nuku puʻu was likely susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Maui nuku puʻu populations, the following was likely of particular concern:

- Disease. The precipitous decline of all nuku puʻu taxa suggests that disease played an important role in the species' decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management efforts designed to conserve other endangered forest birds on northeastern Haleakalā. These efforts include the establishment of the 3,000 hectares (7,500 acres) Hanawī Natural Area Reserve in 1986, the formation of the East Maui Watershed Partnership, fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol contained in the USFWS Draft Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Maui nuku puʻu.

References:

Pratt TK, Fancy SG, Ralph CJ. 2001 ʻAkiapolaʻau (*Hemignathus munroi*) and nukupuʻu (*Hemignathus lucidus*). *In* The Birds of North America, No. 600 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: UH EECB

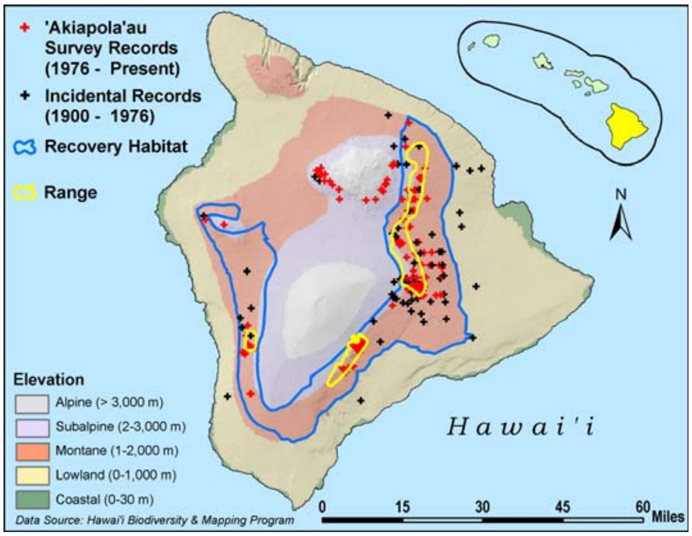
Forest Birds

ʻAkiapōlāʻau

Hemignathus munroi

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The ʻakiapōlāʻau is a stocky Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawaiʻi and most famous for their specialized bills, which have a long, decurved upper mandible and a short woodpecker-like lower mandible. Adult males have a bright yellow head and underparts, yellow-green back and wings, and a small, black mask. Adult females are olive above with grayish-yellow to yellow underparts. Males are larger than females and have longer bills. The species often joins mixed species foraging flocks; the constituent species vary depending on habitat. ʻAkiapōlāʻau are mainly insectivorous, with Lepidoptera larva, spiders, and beetle larva being the most important prey items; rarely takes nectar but takes sap from holes it excavates in ʻōhiʻa (*Metrosideros polymorpha*) trees. Most frequently, creeps along lichen covered and dead branches of koa (*Acacia koa*), kōlea (*Myrsine lessertiana*), māmane (*Sophora chrysophylla*), and naio (*Myoporum sandwicense*) trees tapping branches with their lower mandible to locate prey. Once a food item is located, lower mandible is used similar to that of a woodpecker bill to chisel open a hole. The upper mandible is then used to fish out the prey item. Upper mandible also used to probe natural cracks and crevices. Breeding has been documented year-round, although most activity occurs from February to July. The species' open cup nest is most often placed in ʻōhiʻa trees. Clutch size is usually one, rarely two, and females perform all incubation and brooding. Males provide females and nestlings with the majority of food. Only one fledgling is produced per year, and a long period of parental dependency, usually four to five months, is typical. Family groups consisting of hatch-year and second-year young have been observed. This species is characterized by low annual productivity.



DISTRIBUTION: ʻAkiapōlāʻau occur in four disjunct populations between 1,340 and 2,700 meters (4,355–8,775 feet) elevation on the island of Hawaiʻi, most occur between 1,500 and 2,000 meters (4,875–6,500 feet) elevation. Original range likely included all forested regions of the island.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the population at 1,500 ± 400 (95% CI). Surveys conducted between 1990 and 1995, estimated the population at between 1,109 and 1,217 individuals. Significant declines occurred in two of the four populations. The Kaʻū /Kapāpala population decreased from approximately 530 individuals to 44, and the Mauna Kea population dropped from approximately 50 birds to less than ten; in 2000 only three birds remained on Mauna Kea.

LOCATION AND CONDITION OF KEY HABITAT: ʻAkiapōlāʻau occur in mesic and wet montane forests dominated by koa and ʻōhiʻa. The small and declining population on Mauna Kea occurs in subalpine dry forest dominated by māmane and naio. A recent study documented ʻakiapōlāʻau occurring entirely in areas reforested with koa (i.e., second-growth, young forests). Habitat quality varies across the species' occupied range. All remaining populations predominately occur on lands that are managed by the State of Hawaiʻi and the U.S. Fish and Wildlife Service.

THREATS: ʻAkiapōlāʻau are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻakiapōlāʻau populations, the following are of particular concern:

- Low reproductive potential. Unlike many Hawaiian honeycreepers, ʻakiapōlāʻau have low annual fledgling production. This life history characteristic may be related to their very specialized foraging strategy. Regardless, the species is very susceptible to factors that reduce population size.
- Disease. Unlike several other honeycreepers found on the island of Hawaiʻi (e.g., Hawaiʻi amakihi [*H. virens*]), the ʻakiapōlāʻau is absent from most areas below 1,350 meters (4,500 feet). This suggests that the species is particularly susceptible to mosquito-borne avian disease.
- Predation. Although little evidence exists, predation by rats (*Rattus* spp.), cats (*Felis* silvestris), small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit ʻakiapōlāʻau populations. Recent surveys have determined that rat density in the Hakalau Forest National Wildlife Refuge, which supports a significant portion of the ʻakiapōlāʻau population, is high. In addition, the loud, persistent begging of juveniles may make them especially vulnerable to predators.
- Habitat degradation. The dispersal behavior of the ʻakiapōlāʻau is poorly known. Habitat loss and degradation from development, logging, and grazing has greatly fragmented the species' habitat.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: To date, conservation actions specific to ʻakiapōlāʻau have been restricted to annual population surveys of the Hakalau, ʻŌlaʻa/Kīlauea, Kona, and Mauna Kea populations. However, ʻakiapōlāʻau likely have benefited from management activities designed to conserve other endangered forest birds in the Kapāpala Forest Reserve, Hakalau Forest

National Wildlife Refuge, Puʻu Lāʻau, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the ʻakiapōlāʻau may include the following:

- Add Hāmākua, the upper Waiākea kīpuka, Kaʻū /Kapāpala and south Kona to annual surveys.
- Continue koa forest restoration and fencing in the Hakalau Forest National Wildlife Refuge.
- Continue restoration of māmane forests on Mauna Kea.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts. Additional monitoring for the akiapōlāʻau should include the following:

- Test survey methods for ʻakiapōlāʻau, and continue regular population surveys with improved methods.
- Monitor small mammal populations to assess effectiveness of control efforts, especially in dry forest sites.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ʻakiapōlāʻau include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success.
- Conduct studies to document habitat selection, preference, and foraging ecology, particularly in young forests.
- Conduct studies to document the response of ʻakiapōlāʻau populations to the control of mammalian predators.
- Development of captive propagation techniques.
- Determine the feasibility of ʻakiapōlāʻau re-introductions to suitable locations (e.g., Puʻu Waʻawaʻa, Hawaiʻi Volcanoes National Park).

References:

Pejchar, L. 2005. Home range size varies with habitat type in a Hawaiian honeycreeper: implications for native *Acacia koa* forestry. Ecological Applications 15:1053-1061.

Pratt TK, Fancy SG, Ralph CJ. 2001 ʻAkiapolaʻau (*Hemignathus munroi*) and nukupuʻu (*Hemignathus lucidus*). *In* The Birds of North America, No. 600 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Strommer L. University of Hawaiʻi graduate student. Unpublished data.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Jim Denny

Forest Birds

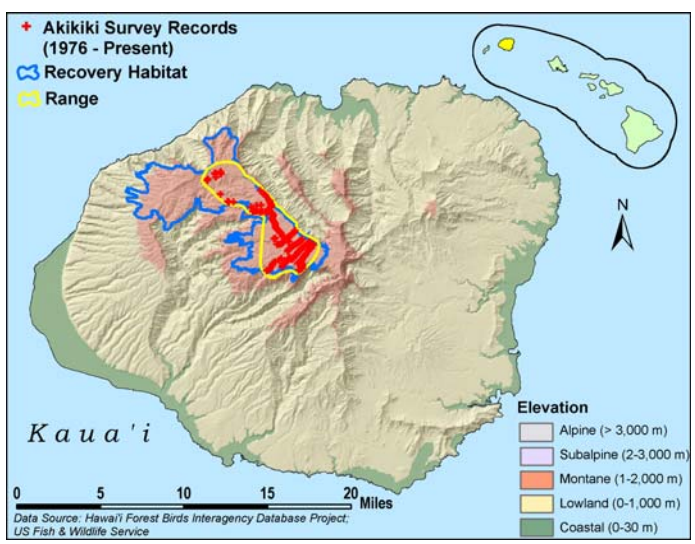
ʻAkikiki or Kauaʻi Creeper

Oreomystis bairdi

SPECIES STATUS:
Federal Candidate for Listing
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The ʻakikiki, or Kauaʻi creeper, is a small, drab Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Kauaʻi. Both males and females are predominantly dark gray to olive above, whitish below, and are indistinguishable in the field. ʻAkikiki have pinkish legs and feet, and their short, slightly decurved bill also is pink. They are usually found in pairs, family groups, or small flocks (8 – 12 individuals); during the non-breeding season ʻakikiki join mixed species foraging flocks. ʻAkikiki gleans and probes the bark and lichens and moss on trunks, branches, and twigs of live and dead ʻōhiʻa (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees for insects and spiders. The breeding biology of the species is poorly known, but their reproductive biology is likely similar to that of the closely related, and well-studied, Hawaiʻi creeper (*O. mana*). A long period of parental dependency makes double brooding unlikely. The ʻakikiki is one of the least known extant Hawaiʻi forest birds.

DISTRIBUTION: ʻAkikiki are restricted to a 36 square kilometer (13.8 square mile) area of the Alakaʻi Wilderness Preserve. In 1973, the species occupied an 88 square kilometer (33.7 square mile) area. Historically, ʻakikiki occupied both high- and low-elevation forests, although by the 1960s it was most common above 1,140 meters (3,750 feet) elevation. Subfossil remains suggest a prehistoric island-wide distribution.



ABUNDANCE: The Kauaʻi Forest Bird Survey (2000), estimated the population at 2,448 ± 1,200 (SE) individuals. Density estimates were 26 birds per square kilometer; 15 percent lower than in 1981.

LOCATION AND CONDITION OF KEY HABITAT: ʻAkikiki occupy mesic and wet forests between 600 and 1,600 meters (2,000 – 5,300 feet) elevation. Rainfall and topography varies tremendously across the species' known range, resulting in enormous habitat variation. Thus key habitat variables are difficult to quantify. The montane forests of Kauaʻi are dominated by ʻōhiʻa and have a subcanopy comprised of ʻōlapa or lapalapa (*Cheirodendron* spp.) and ʻōhiʻa hā (*Syzygium sandwicensis*). Common understory species include ʻōhelo (*Vaccinium calycinum*), kanawao (*Broussaisia arguta*), ʻōhā wai (*Clermontia* spp.), kāwaʻu (*Ilex anomala*), kōlea (*Myrsine lessertiana*), naʻenaʻe (*Dubautia spp.*), and pūkiawe (*Styphelia tamieameiae*). The entire known range of this species is within the Alakaʻi Wilderness Preserve.

THREATS: ʻAkikiki are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻakikiki populations, the following are of particular concern:

- Disease. Mosquitoes (*Culex* spp.) likely are ubiquitous on Kauaʻi, and avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*) are likely the most important factors limiting the species' distribution. To date, ten ʻakikiki have been tested for malaria. None had active infections or antibodies. These data are equivocal, indicating low transmission rates, possible resistance, or very high mortality.
- Habitat degradation. Pigs (*Sus scrofa*) and goats (*Capra hircus*) have contributed to the spread of non-native plants, but effects to ʻakikiki are unknown. Perhaps more importantly, severe hurricanes in 1982 and 1992 resulted in heavy damage to native forests, possibly resulting in short-term reductions in arthropod food resources.
- Natural disasters. Hurricanes of 1982 and 1992 likely caused the death of an unknown number of individuals.
- Competition. Although little evidence exists, it has been suggested that competition with introduced Japanese white-eyes (*Zosterops japonicus*) may negatively affect ʻakikiki. Non-native insects, especially yellow jackets (*Vespula* spp.) and ants (*Linepithema humile*), may compete with or prey on the native arthropods on which ʻakikiki feed. The role of non-native insects in native Hawaiian forests is unclear.
- Predation. Although predation on adults or their nests has not been documented, rats (*Rattus* spp.), cats (*Felis silvestris*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kaua'i.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: The ʻakikiki is a Federal candidate species for listing under the Endangered Species Act. Ongoing ecological studies are scheduled to produce a habitat suitability map that will be used to determine potential re-introduction sites. Captive propagation techniques are being developed for *Oreomystis* species at the Keauhou Bird Conservation Center that will benefit ʻakikiki. In addition, ʻakikiki likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the recovery of ʻakikiki may include the following:

- Aggressive ungulate control would likely improve the quality of ʻakikiki habitat and facilitate the recovery of degraded, but potential habitat. Control of non-native plants should be part of forest restoration efforts.
- Eradication of rats and feral cats from the Alakaʻi Wilderness Preserve.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other potential predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ʻakikiki include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.
- Determine the susceptibility of this species to avian malaria and avian pox.
- Determine if competition with Japanese white-eyes occurs, and if so, determine its affect on ʻakikiki populations.
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species' diet.

References:

Foster JT, Scott JM, Sykes PW. 2000. ʻAkikiki (*Oreomystis bairdi*). *In* The Birds of North America, No. 552 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.


Photo: Jack Jeffrey

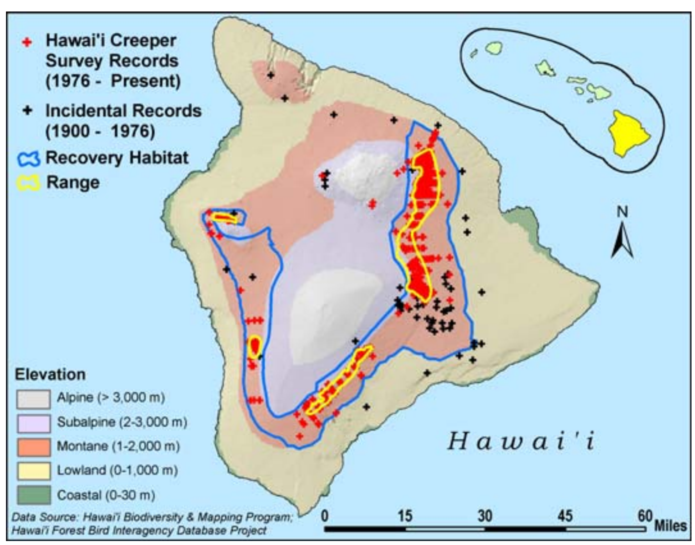
Hawaiʻi Creeper

Oreomystis mana

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Ranking G2—Imperiled
IUCN Red List Ranking—Endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The Hawaiʻi creeper is a small, inconspicuous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawaiʻi. Adult males and females are predominately olive-green above, dull buff below, and have a dark gray mask extending around the eyes; males are brighter. Their similarity to Hawaiʻi ʻamakihi (*Hemignathes virens*), Hawaiʻi ʻākepa (*Loxops coccineus coccineus*), and introduced Japanese white-eyes (*Zosterops japonicus*) complicates field identification. Unlike many Hawaiian forest birds, their life history is well known. Outside the breeding season, the species frequently joins mixed-species foraging flocks and forages over home ranges that average 11 hectares (17.3 acres). The Hawaiʻi creeper most frequently gleans insects, spiders, and other invertebrates from the branches, trunks, and foliage of live ʻōhiʻa (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees. During the breeding season the species' home range averages four to seven hectares (10 – 17 acres) and a 10 – 20 meter (33 – 66 feet) territory around the nest is defended. Most nests are open cup structures, but about 15 percent are placed in cavities or in bark crevices. Females build nests, incubate eggs, and brood nestlings. Males deliver food to the female on and off the nest. Both parents feed the young for approximately one month. Hawaiʻi creepers re-nest after nest failures and pairs have been documented raising two broods in a season. Nest success of Hawaiʻi creepers is very low, but adults have high annual survival.

DISTRIBUTION: Hawaiʻi creepers occur in four disjunct populations above 1,500 meters (5,000 feet) on the windward side of the island of Hawaiʻi. The Hawaiʻi creeper historically occurred across the island above 1,070 meters (3,500 feet) elevation.



ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the Hawaiʻi creeper population at 12,500 ± 2,000 (95% CI) individuals. The largest population consisted of 10,000 ± 1,200 birds.

LOCATION AND CONDITION OF KEY HABITAT: Hawai'i creeper occur most commonly in mesic and wet forests dominated by 'ōhi'a and koa, with a subcanopy of 'ōlapa (*Cheirodendron trigynum*), pūkiawe (*Styphelia tameiameiae*), 'ōhelo (*Vaccinium* spp.), 'akala (*Rubus hawaiiensis*), kōlea (*Myrsine* spp.), kāwa'u (*Ilex anomala*), and hapu'u tree ferns (*Cibotium* spp.). Habitat conditions vary across the species' range, with much of the habitat degraded by grazing ungulates, especially feral pigs (*Sus scrofa*). Most of the current range of the Hawai'i creeper is within the boundaries of State and Federally owned lands.

THREATS: Hawai'i creepers are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Hawai'i creeper populations, the following are of particular concern:

- Predation. Nest success of Hawai'i creepers is very low (11 to 50 percent) and rat (*Rattus* spp.) predation may be partially responsible. Hawai'i creepers place their nests near the main trunks of trees which may facilitate predation by rats.
- Disease. The Hawai'i creeper's absence from habitats below 1,350 meters (4,500 feet) elevation suggests that it may be particularly susceptible to mosquito-borne avian disease.
- Habitat loss and degradation. Logging and grazing ungulates has reduced, degraded, and fragmented suitable forest habitats. Habitat fragmentation may be a dispersal barrier preventing or restricting natural re-colonization of the species' former range.
- Competition. It has been suggested that competition with Japanese white-eyes (*Zosterops japonicus*) may negatively affect Hawai'i creepers.

CONSERVATION ACTIONS: Past or ongoing conservation efforts specific to the Hawai'i creeper include the following: studies documenting the species' productivity, recruitment, and survival were completed in 1999, and captive propagation techniques have been developed. In addition, Hawai'i creepers likely have benefited from management activities designed to conserve other endangered forest birds in the Hakalau Forest National Wildlife Refuge, the Kona unit of the Hakalau Forest National Wildlife Refuge, 'Ōla'a/Kīlauea Watershed Partnership, Kapāpala Forest Reserve, and Pu'u Wa'awa'a Wildlife Sanctuary. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawai'i creepers may include the following:

- Re-introduce the Hawai'i creeper to managed areas in their former range (e.g., Mauna Loa strip in Hawai'i Volcanoes National Park).
- Rodent control may enhance nestling and female survival. Aerial broadcast of rodenticides would be the most effective method to treat broad areas.
- Increase public education efforts to engender support for conservation of forest birds.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and

developing methods to control mosquito populations. Research priorities specific to the Hawai'i creeper include the following:

- Determine efficacy and health implications of broadcast rodenticide.

References:

Lepson JK, Woodworth BL. 2001. Hawai'i creeper (*Oreomystis mana*). *In* The Birds of North America, No. 680 (A. Poole and Fr. Gill, eds.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

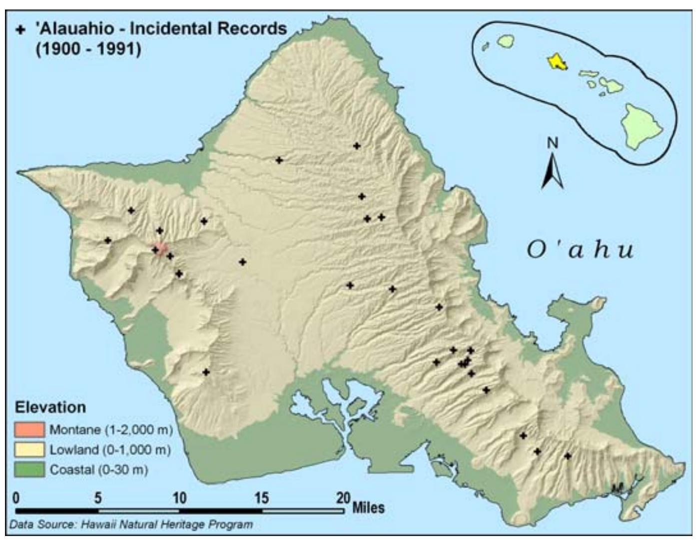
O'ahu 'Alauahio or O'ahu Creeper

Paroreomyza maculata

SPECIES STATUS:
Federally listed as Endangered
States listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The O'ahu 'alauahio, or O'ahu creeper, is a small, sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to O'ahu. Males are olive-green above with bright yellow underparts and forehead, females are grayish-green above and yellowish-white below. The plumage of this species is very similar to that of the O'ahu 'amakihi (*Hemignathus flavus*). The song of the O'ahu 'alauahio has never been described. The O'ahu 'alauahio is insectivorous and forages by methodically searching and probing the bark of large branches and tree trunks. Like other Hawaiian creepers, 'alauahio joins foraging flocks during non-breeding seasons. Little is known about the life history or breeding biology of the species, but it is likely similar to that of the Maui creeper (*P. montana*).

DISTRIBUTION: Unknown. Probably extinct. Historical range is poorly known as it was likely declining when first discovered, but it historically occurred in both the Ko'olau and Wai'anae ranges.



ABUNDANCE: Unknown. Probably extinct. The last well-documented sighting was of two birds in 1985. O'ahu was not included in the Hawai'i Rare Bird Search in the late 1990s, so it is possible that the O'ahu 'alauahio still exists in remote valleys.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. O'ahu 'alauahio occupied mid-elevation forests of 'ōhi'a (*Metrosideros polymorpha*) and koa (*Acacia koa*). Historically, the species is reported to prefer large koa trees, but they also were reported in areas without koa. All recent observations have occurred in mixed koa/'ōhi'a forest between 300 and 600 meters (1,000 – 2,000 feet). Forests where the Oʻahu ʻalauahio historically occurred are largely managed by the State of Hawaiʻi, the USFWS, or the U. S. Military.

THREATS: Unknown. However, the Oʻahu ʻalauahio likely were susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Oʻahu ʻalauahio populations, the following was likely of particular concern:

- Disease. This species' rapid decline, the fact that no habitat above 1,250 meters (4,100 feet) occurs on Oʻahu, and that historical accounts report seeing the species only above 350 meters (1,500 feet) elevation suggests disease may have played an important role in the species' decline.

CONSERVATION ACTIONS: Unfortunately, few forest birds remain on Oʻahu, and little if any, specific management is directed at forest birds other than the Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*). The Oʻahu Forest National Wildlife Refuge in the Koʻolau Range is near some of the most recent sightings, but whether the species still exists in the area is unknown. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Initiate regular forest bird surveys on Oʻahu and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Oʻahu ʻalauahio.

References:

Baker PE, Baker H. 2000. Kākāwahie (*Paroreomyza flammea*) and O'ahu alauahio (*Paroreomyza maculata*). *In* The Birds of North America, No. 503 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

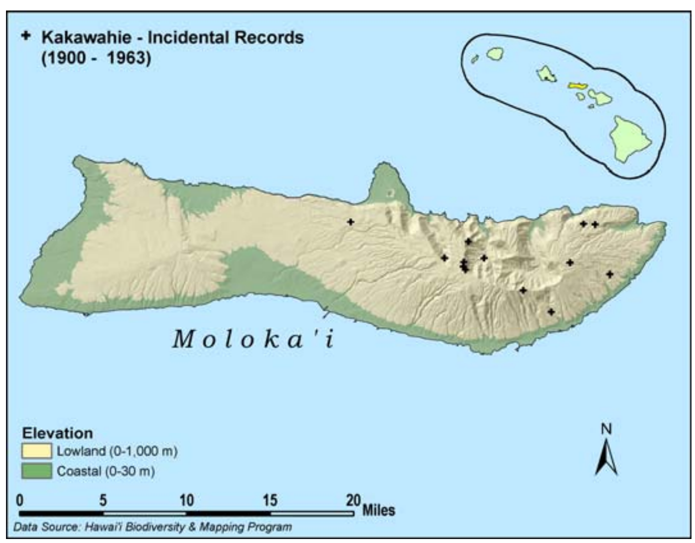
Kākāwahie or Molokaʻi Creeper

Paroreomyza flammea

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank GH—Possibly extinct
IUCN Red List Ranking—Extinct
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The kākāwahie, or Molokaʻi creeper, is a small, sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the forests of eastern Molokaʻi. Males are scarlet red; females are a dull rusty color. The species Hawaiian name translates as "woodchopping" and apparently describes the species chipping call. Kākāwahie forage in groups, gleaning invertebrates from leaves, bark, and epiphytes in wet ʻōhiʻa (*Metrosideros polymorpha*) forests. Little is known about the species' breeding biology, but it is assumed to be similar to that of the Maui creeper (*P. montana*). First described in 1889, the last bird was observed less than 100 years later.

DISTRIBUTION: Unknown. Probably extinct. The species was last observed on the west rim of Pelekunu Valley. Kākāwahie were common in native forests of eastern Molokaʻi at the end of the 19th century. Original range likely included all forested regions of Molokaʻi.



ABUNDANCE: Unknown. The last kākāwahie was observed in 1963 and the species is probably extinct.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Kākāwahie were known to occur in wet ʻōhiʻa (*Metrosideros polymorpha*) forests from low to high elevations, and other heavily wooded native areas of eastern Molokaʻi. The areas where the species was last observed are managed by the State as Natural Area Reserves or by The Nature Conservancy.

THREATS: Unknown. However, kākāwahie likely were susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For kākāwahie populations, the following likely was of particular concern:

- Disease. This species rapid decline and the fact that no habitat above 1,250 meters (4,100 feet) occurs on Molokaʻi suggests disease may have played an important role in the species' decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities designed to conserve other endangered forest birds of eastern Molokaʻi including the establishment of the protected areas, regular surveys of forest bird populations, monitoring of habitat conditions, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to kākāwahie.

References:

Baker PE, Baker H. 2000. Kākāwahie (*Paroreomyza flammea*) and Oʻahu alauahio (*Paroreomyza maculata*). *In* The Birds of North America, No. 503 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Jack Jeffrey

Forest Birds

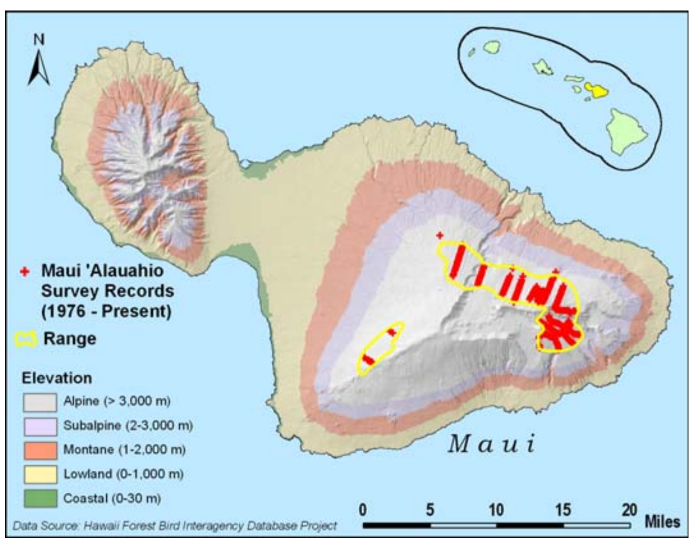
Maui ʻAlauahio or Maui Creeper

Paroreomyza montana

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G4—Apparently secure

SPECIES INFORMATION: The Maui ʻalauahio, or Maui creeper, is a small insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui. The species also occurred on Lānaʻi but was last seen in 1937 and is presumed extinct. Adult males are predominantly olive-green above and have a bright yellow face, throat, and belly; the amount and intensity of yellow varies among individuals. Adult females are similar, but generally not as bright; both have short, fine straight bills. Males and females do not obtain their adult plumage for several years. The Maui ʻalauahio gleans invertebrates from woody and leafy parts of a variety of plants. Males and females defend one to two hectare (2.5 – 5 acre) home ranges against conspecifics year round and will chase ʻapapane (*Himantione sanguinea*) and Japanese white-eyes (*Zosterops japnicus*) from the vicinity of their nests. ʻAlauahio are socially monogamous and pair for life, although extra-pair copulations have been confirmed through genetic analysis. Females choose the nest site and build open-cup nests. Clutch size is two, and birds will renest after initial failures, although double brooding has not been documented. Only females incubate eggs and brood nestlings. Maui ʻalauahio do not breed until their third year, and young birds (i.e., helpers) associate with breeding pairs. Helpers are usually offspring from the previous year and feed the female, nestlings, and fledglings. Fledglings are fed for two to three months, and young remain with their parents in family groups for 18 - 20 months.

DISTRIBUTION: Maui ʻalauahio occur in three disjunct populations above 900 meters (3,000 feet) elevation on the slopes of Haleakalā. ʻAlauahio were historically common in west Maui and on Lānaʻi; these populations are now extirpated. Fossil evidence suggests that ʻalauahio were common across the south side of the island and their range included lowland forests.



ABUNDANCE: The Hawaiian Forest Bird Survey (1980), estimated the ʻalauahio population at 35,000 ± 5000 (95% CI) individuals. Surveys conducted during 1995-1997 found similar numbers, but densities decreased below 1,600 meters (5,250 feet) elevation and the species' range appears to have contracted.

LOCATION AND CONDITION OF KEY HABITAT: Maui ʻalauahio occur primarily in wet and mesic montane forests dominated by ʻōhiʻa (*Metrosideros polymorpha*), although they also occur in subalpine māmane scrub (*Sophora chrysophylla*; e.g., Kahikinui), and in dry and mesic forests dominated by pine (*Pinus* spp.) and eucalyptus (*Eucalyptus* spp.; e.g., Polipoli State Park and Hosmer Grove); all populations occur above 900 meters (2,925 feet) elevation. Habitat conditions vary tremendously across the species' range. The northeastern part of the species' range is actively managed by the State of Hawaiʻi, (i.e., Forest Reserve and Natural Area Reserve), the National Park Service, and private landowners including the Nature Conservancy. All entities are current members of the East Maui Watershed Partnership. The remainder of the species' range occurs within the boundaries of State and Federally owned lands, but management efforts vary considerably.

THREATS: Although Maui ʻalauahio populations appear stable they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For Maui ʻalauahio populations, the following are of particular concern:

- Predation. Rats (*Rattus* spp.) have been observed depredating nests as well as incubating and brooding females. Female behavior of begging near nests may make them particularly susceptible to rats.
- Disease. Susceptibility to avian malaria (*Plasmodium relictum*) has been documented, and likely prevents the establishment of populations in lowland areas. In Kahikinui, few individuals show signs of avian pox (*Poxvirus avium*), although it is prevalent in ʻamakihi (*Hemignathus virens*) and ʻapapane (*Himatione sanguinea*). These data are equivocal, indicating low transmission rates, possible resistance, or very high mortality for this species.
- Habitat degradation. Current fencing around protected areas is not effective in excluding axis deer (*Axis axis*). Currently, deer populations on Maui are growing and threaten to further degrade forests occupied by the ʻalauahio.

CONSERVATION ACTIONS: Maui ʻalauahio, likely have benefited from management activities designed to conserve endangered forest bird species on northeastern Haleakalā including fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies on disease and disease vectors. In addition, ongoing fencing and ungulate control on Department of Hawaiian Home Lands at Kahikinui will likely benefit the small ʻalauahio population there, and in general, conservation efforts should also include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Maui ʻalauahio include the following:

- Develop a translocation protocol that will facilitate the re-introduction of this species into restored high-elevation forests.

References:

Baker H, Baker PE. 2000. Maui ʻalauahio (*Paroreomyza montana*). *In* The Birds of North America, No. 504 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: Jim Denny

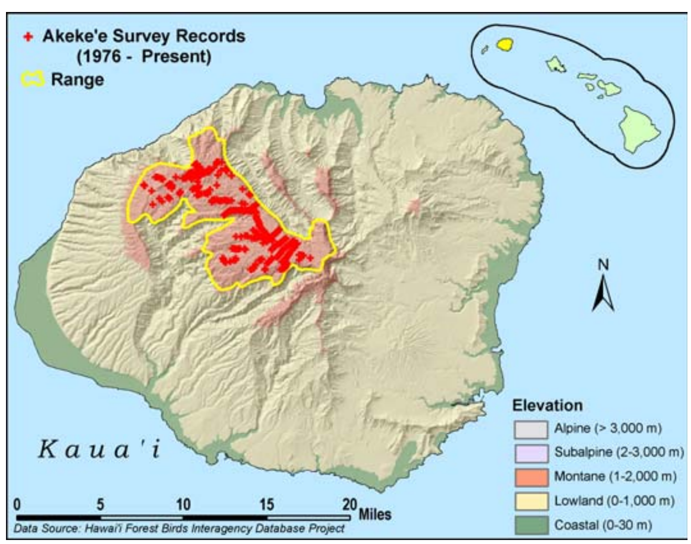
ʻAkekeʻe or Kauaʻi ʻĀkepa

Loxops caeruleirostris

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G2—Imperiled
IUCN Red List Ranking—Endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The ʻakekeʻe, or Kauaʻi ʻākepa, is a small, slightly sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to Kauaʻi. Adult males and females are greenish above and yellow below with a yellow crown and a black mask; females are slightly duller than males. Unlike the similar Kauaʻi amakihi (*Hemignathus kauaiensis*), the ʻakekeʻe's bill is conical. Although not visible in the field, the lower mandible of the ʻakekeʻe is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ʻākepa (*L. coccineus*). The ʻakekeʻe uses its bill to pry open ʻōhiʻa (*Metrosideros polymorpha*) leaves and flower buds in search of arthropods, primarily spiders, psyllids, and caterpillars. The species is an ʻōhiʻa specialist and rarely even perches on other trees or shrubs. The species' methodical probing of leaf buds is distinctive and can be used to identify the species. ʻAkekeʻe are most often observed in pairs or family groups. Only five ʻakekeʻe nests have been found and the species' breeding biology is virtually unknown, although it is likely similar to that of the ʻākepa. Based on observations from one nest, males and females participate in nest construction; in most other Hawaiian honeycreepers, only the female constructs the nest. All known nests have been located in the crowns of ʻōhiʻa trees. No information on clutch size, incubation, brooding, or parental care of young.

DISTRIBUTION: ʻAkekeʻe are widespread in native forests of the Alakaʻi swamp, upper Waimea, and Kōkeʻe regions mostly above 1,000 meters (3,280 feet) elevation. Although historically widespread, ʻakekeʻe apparently did not occur at lower elevations. Currently estimated to occupy 10-12 percent of their original range.



ABUNDANCE: In the early 1970s the island-wide ʻakekeʻe population was estimated at 5,066 ± 1,680 (SE) individuals. The Kauaʻi Forest Bird Survey (2000) estimated the population within the Alakaʻi and Kōkeʻe region at nearly 30,000 individuals, and reported a significant population increase between 1981 and 2000. The population appears stable in its current range. Densities are highest in the interior of the Alakaʻi Wilderness Preserve.

LOCATION AND CONDITION OF KEY HABITAT: ʻAkekeʻe occur above 600 meters (1,950 feet), although populations are densest above 1,100 meters (3,600 feet), in lowland mesic and wet forests dominated by ʻōhiʻa, koa (*Acacia koa*), ʻōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). Most of the species' current range occurs in Kōkeʻe State Park and the Alakaʻi Wilderness Preserve.

THREATS: ʻAkekeʻe are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻakekeʻe populations, the following are of particular concern:

- Habitat degradation. ʻAkekeʻe specializes on ʻōhiʻa, and the spread of non-native plants may reduce habitat suitability in the species' current range. To some degree, density patterns support this contention; however, the species still uses isolated ʻōhiʻa trees in otherwise open habitats in the Kōkeʻe region. This and the fact that its population appears stable after two devastating hurricanes suggest that the species may be tolerant of habitat degradation.
- Competition. Non-native insects, especially yellow-jackets (*Vespula pensylvanica*) and ants (*Linepithema humile*), may compete with or prey on the native arthropods on which ʻakekeʻe feed. The role of non-native insects in native Hawaiian forests is unclear.
- Predation. Although predation on adults or their nests has not been documented, rats (*Rattus* spp.), cats (*Felis silvestris*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kauaʻi.

CONSERVATION ACTIONS: ʻAkekeʻe likely have benefited from management activities designed to conserve other endangered forest birds including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the ʻakekeʻe may include the following:

- Aggressive ungulate control would likely improve the quality of ʻakekeʻe habitat and facilitate the recovery of degraded, but potential habitat. Control of non-native plants should be part of forest restoration efforts.
- Eradication of rats, feral cats, and barn owls from the Alakaʻi Wilderness Preserve.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other predators.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and

developing methods to control mosquito populations. Research priorities specific to the ʻakekeʻe include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.
- Determine the species' susceptibility to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*).
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species' diet.
- Determine the status of populations outside of the greater Alakaʻi swamp region.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Lepson JK, Pratt HD. 1997. ʻAkekeʻe (*Loxops caeruleirostris*). *In* The Birds of North America, No. 295 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Picture: Rothschild Collection

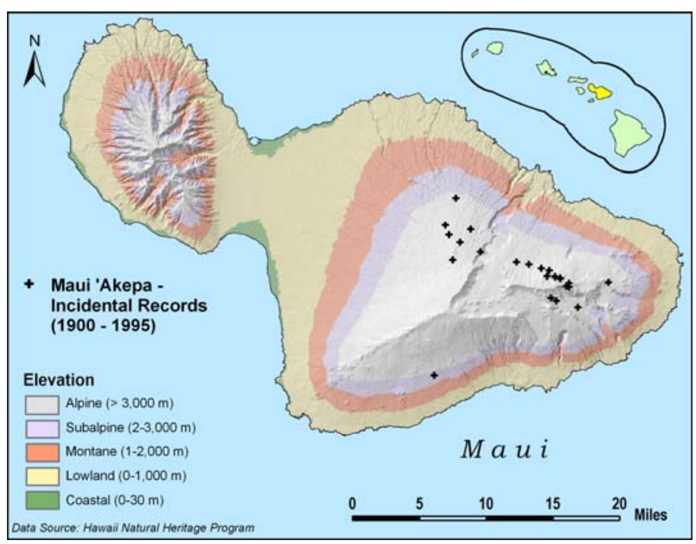
Forest Birds

Maui ʻĀkepa

Loxops coccineus ochraceus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1/TH—
Critically imperiled/Subspecies possibly extinct
IUCN Red List Ranking—Endangered
Draft Revised Recovery Plan for Hawaiian
Forest Birds—USFWS 2003

SPECIES INFORMATION: The Maui ʻākepa is a small, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Maui at the subspecies level. ʻĀkepa also are known from the island of Hawaiʻi (*L. c. coccineus*) and Oʻahu (*L. c. rufus*); the latter subspecies is certainly extinct. Currently, all ʻākepa are considered one species, although they are recognized as critically imperiled at the subspecies level. Adult males and females are less colorful compared to the Hawaiʻi ʻākepa, and there is no information on the plumage sequence of the Maui subspecies. The lower mandible of the ʻākepa is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ʻakekeʻe (*L. caeruleirostris*) and the Hawaiʻi ʻākepa. Although almost nothing is known about its life history, the Maui ʻākepa likely forages in a similar manner to the Hawaiʻi ʻākepa, and is most often observed in ʻōhiʻa (*Metrosideros polymorpha*) forests. Although based on a single observation, in stark contrast to the Hawaiʻi ʻākepa, the Maui subspecies apparently builds an open-cup nest in the terminal foliage of ʻōhiʻa trees.



DISTRIBUTION: Unknown. Probably extinct. Last sightings occurred on the northeastern slopes of Haleakalā between 1,700 and 2,000 meters (5,500 – 7,000 feet) elevation. Historical distribution is poorly known, but like many Hawaiian forest birds the original range likely included all forested regions of the island.

ABUNDANCE: The Hawaiian Forest Bird Survey (1980), estimated the population at 230 ± 290 (95% CI) individuals, but reliance on auditory detections may have biased this estimate. No ʻākepa were found during the Hawaiʻi Rare Bird Search (1995 - 1999). The last reliable sightings occurred in 1970.

LOCATION AND CONDITION OF KEY HABITAT: Virtually all sightings of the Maui ʻākepa in this century have occurred in wet montane ʻōhiʻa forests on the northeastern slopes of Haleakalā. These forests vary from intact to degraded. Areas where the Maui ʻākepa have most recently been observed are managed by the State of Hawaiʻi or by the National Park Service.

THREATS: Unknown. However, the Maui ʻākepa was likely susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Maui ʻākepa populations, the following was likely of particular concern:

- Disease. The precipitous decline of the Maui and Oʻahu subspecies and the restriction of the Hawaiʻi ʻākepa to high-elevation forests suggests that disease played an important role in the demise of Maui ʻākepa.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management efforts designed to conserve other endangered forest birds on northeastern Haleakalā. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol contained in the USFWS Draft Recovery Plan for Hawaiian Forest Birds would be implemented, and management in anticipation of that possibility should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to the Maui ʻākepa.

References:

Lepson JK, Freed LA. 1997. ʻAkepa (*Loxops coccineus*). *In* The Birds of North America, No. 294 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: DOFAW

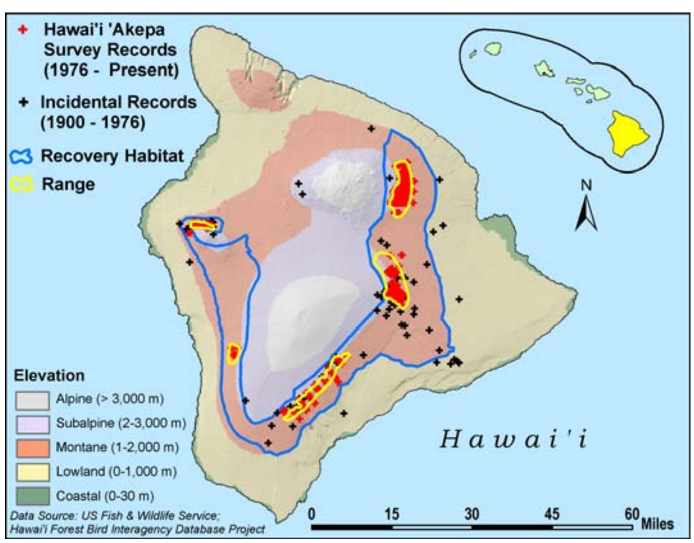
Forest Birds

Hawaiʻi ʻĀkepa

Loxops coccineus coccineus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage RankG1 – Critically imperiled
IUCN Red List Ranking – Endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds – USFWS 2003

SPECIES INFORMATION: The Hawaiʻi ʻākepa is a small, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawaiʻi at the subspecies level. ʻĀkepa also are known from Maui (*L. c. ochraceus*) and Oʻahu (*L. c. rufus*); both of which are likely extinct. Currently, all ʻākepa are considered one species, although they are recognized as critically imperiled at the subspecies level. After three years, males obtain their bright orange adult plumage; subadult plumage is dull brownish orange, although individual variation is high. Females are grayish green with a yellow breast band. The lower mandible of the ʻākepa is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ʻakekeʻe (*L. caeruleirostris*). The bend can be to the left or right, and depending on the direction of the bend, individuals also possess an accompanying leg asymmetry; the leg opposite the curve in the mandible is slightly longer than the other leg. Together, these adaptations likely improve the species foraging efficiency. Hawaiʻi ʻākepa often join mixed-species foraging flocks, particularly those with Hawaiʻi creepers (*Oreomystis mana*). The species feeds mainly on ʻōhiʻa (*Metrosideros polymorpha*) leaf clusters, but also on koa (*Acacia koa*) leaves and seed pods, where it uses its bill to pry open leaf and flower buds in search of small arthropods. ʻĀkepa are obligate cavity nesters, with most nests placed in natural cavities found in old-growth ʻōhiʻa and koa trees. Females build nests, incubate eggs, and brood nestlings, and males deliver food to the female on and off the nest. Both parents feed the young, which remain with their parents for two to three months after fledging.



DISTRIBUTION: Hawaiʻi ʻākepa occur in five disjunct populations all above 1,300 meters (4,300 feet) elevation on the windward side of the island of Hawaiʻi. Original range likely included all forested regions of the island.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the population at 14,000 ± 2500 (95% CI) individuals. The south Kona and Hualālai populations were estimated at

660 ± 250 birds and are apparently declining.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiʻi ʻākepa occur in ʻōhiʻa and ʻōhiʻa/koa forests above 1,300 meters (4,300 feet). Density appears to be related to the number of available cavities, and because cavities primarily occur in older, large trees, old-growth forests may be preferred. The highest density of ʻākepa occurs in the Pua ʻĀkala tract of Hakalau Forest National Wildlife Refuge, which has numerous large trees but a degraded understory. Many areas occupied by the species have been degraded by feral ungulates. Most of the current range of the Hawaiʻi ʻākepa is managed for conservation by State and Federal agencies or private conservation partnerships.

THREATS: Hawaiʻi ʻākepa are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻākepa populations, the following are of particular concern:

- Habitat degradation and loss. Logging and ranching has fragmented and reduced the amount of suitable habitat. Breeding density may be limited by nest-site availability and current levels of food availability may limit populations. In forest fragments, the large trees required for nesting may be more susceptible to windfall and desiccation. The slow growth rate of ʻōhiʻa complicates management for ʻākepa. In addition, habitat fragmentation may prevent or restrict natural re-colonization of former range.
- Disease. The Hawaiʻi ʻākepa is not found below 1,300 meters (4,300 feet) elevation. This suggests that it is particularly susceptible to mosquito-borne diseases.
- Predation. The cavity nests of ʻākepa may be vulnerable to rat (*Rattus* spp.) predation. However, nest-success is high at Pua ʻĀkala in the Hakalau Forest NWR, where rat densities are high.

CONSERVATION ACTIONS: Completed or ongoing conservation efforts specific to the Hawaiʻi ʻākepa include the following: demographic and reproductive studies have determined the importance of old-growth trees for nesting and that the species will use artificial cavities for nesting, and captive propagation techniques have been developed. In addition, Hawaiʻi ʻākepa likely have benefited from management activities designed to conserve other endangered forest birds in Hakalau Forest National Wildlife Refuge, the Kona unit of the Hakalau Forest National Wildlife Refuge, ʻŌlaʻa/Kīlauea Watershed Partnership, Kapāpala Forest Reserve, and Puʻu Waʻawaʻa Wilderness Sanctuary. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawaiʻi ʻākepa may include the following:

- Aerial broadcast of rodenticides would likely increase nestling and adult female survival for this and other species.
- Public education and out reach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Hawaiʻi ʻākepa include the following:

- Continue studies designed to refine the suitability of artificial cavities and evaluate their potential to facilitate the establishment of new populations.
- Determine the factors affecting the growth form of regenerating ʻōhiʻa and potential methods for protecting old-growth trees from wind and desiccation.
- Identification of disease resistant individuals. Determining if genetic markers or genotypes are associated with resistance would allow targeted translocations of individuals possessing this genotype into populations currently lacking disease resistance.

References:

Lepson JK, Freed LA. 1997. ʻAkepa (*Loxops coccineus*). *In* The Birds of North America, No. 294 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Eric VanderWerf

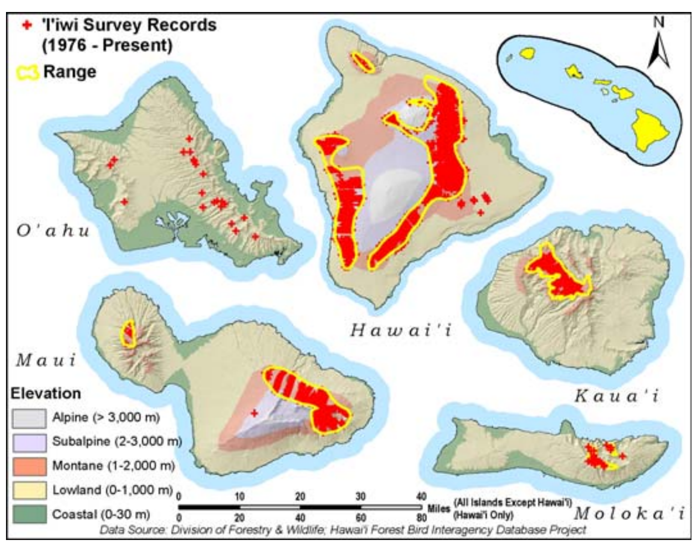
Forest Birds

ʻIʻiwi

Vestiaria coccinea

SPECIES STATUS:
State listed as Endangered on Oʻahu, Molokaʻi, Lānaʻi
State recognized as Endemic
NatureServe Heritage Rank G4/T1—Apparently secure/
Critically imperiled globally on Oʻahu and Molokaʻi
IUCN Red List Ranking—Near threatened

SPECIES INFORMATION: The ʻiʻiwi is one of the most beautiful of the extant Hawaiian honeycreepers (Family: Fringillidae). Both males and females are vermillion red, with a black tail and wings, and a long, decurved pink bill. Native Hawaiians created feather capes using hundreds of thousands of ʻiʻiwi feathers; such capes signified power and prestige. Like ʻapapane (*Himatione sanguinea*), ʻiʻiwi often fly long distances in search of flowering ʻōhiʻa (*Metrosideros polymorpha*) trees and are important ʻōhiʻa pollinators. Their diet consists primarily of nectar taken from a variety of native and non-native flowers and the presence of non-native flowers may have contributed to increases in some populations. Some suggest that ʻiʻiwi were especially suited to take nectar from curved lobelia (Campanulaceae) flowers, but further study is needed. In addition to nectar, ʻiʻiwi also eat small arthropods. Both sexes defend small nesting territories and may defend important nectar resources. Courtship chases and feeding may precede breeding. Nest sites are in terminal branches of ʻōhiʻa trees and both sexes build the open-cup nest. Only females incubate eggs (typically two) and brood young. Young are mostly provisioned by female; males feed females off the nest. Despite their widespread distribution, little is known about their life history.



DISTRIBUTION: ʻIʻiwi occur above 1,250 meters (4,100 feet) elevation on the islands of Hawaiʻi, Maui, and Kauaʻi; occurs at reduced densities below 1,000 meters (3,300 feet). Three small, isolated populations occur on Oʻahu, and a relict population occurs on Molokaʻi. Historically, ʻiʻiwi were common at low elevations on all the Main Hawaiian Islands.

ABUNDANCE: The following island population estimates are based on Hawaiian Forest Bird Surveys (1976-1981): 340,000 ± 12,000 (95% CI) individuals on island of Hawaiʻi (88% in Hāmākua), 19,000 ± 2,000 individuals on east Maui, 180 ± 150 on west Maui, 80 ± 65 individuals on Molokaʻi, and 5,400 ± 500 in the Alakaʻi Swamp on Kauaʻi. Recent surveys (1996) suggests Oʻahu supports less than 50 birds. In 1988, two birds were detected on Molokaʻi. On Kauaʻi, populations declined after the 1992 hurricane, but changed little between 1994 and 2000. The overall population may be declining, but the species' wide-ranging foraging complicates population estimates and the determination of long-term trends.

LOCATION AND CONDITION OF KEY HABITAT: ʻIʻiwi occupy mesic and wet forest dominated by ʻōhiʻa and koa (*Acacia koa*). Loss and degradation of habitat and high densities of cold-intolerant *Culex* mosquitoes, an important disease vector, in lowland areas restrict most birds to elevations above 1,250 meters (4,100 feet). Habitats with the highest ʻiʻiwi densities also support kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapuʻu tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat quality and management effort directed at habitat protection and restoration varies considerably.

THREATS: Although ʻiʻiwi populations appear stable on the islands of Hawaiʻi, Maui, and Kauaʻi, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻiʻiwi populations, the following is of particular concern:

- Disease. ʻIʻiwi are very susceptible to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*). Nine of ten individuals died within 37 days after receiving a single bite from mosquitoes infected with *Plasmodium*. Individuals infected with pox also are more likely to be infected with malaria. Because the highest points on Molokaʻi and Oʻahu are below 1,250 meters (4,100 feet), this susceptibility likely explains the severe population declines noted on these islands. Foraging movements may increase their exposure to disease.

CONSERVATION ACTIONS: ʻIʻiwi likely have benefited from management efforts designed to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Alakaʻi Wilderness Preserve and surrounding areas, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to the protection of ʻiʻiwi populations may include the following:

- Mosquito control in degraded habitats.
- Public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻiʻiwi include the following:

- Determine if disease resistant individuals exist and if so determine if resistance is passed to offspring. Disease-resistant individuals could be used to establish new populations.
- Determine the role of ʻiʻiwi in transmitting disease between low- and high-elevation habitats.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

References:

Fancy S G, Ralph CJ. 1998. ʻIʻiwi (*Vestiaria coccinea*). *In* The Birds of North America, No. 327 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

VanderWerf EA, Rohrer JL. 1996. Discovery of an ʻIʻiwi population in the Koʻolau Mountains of Oʻahu. ʻElepaio 56:25–28.

Photo: DOFAW

Forest Birds

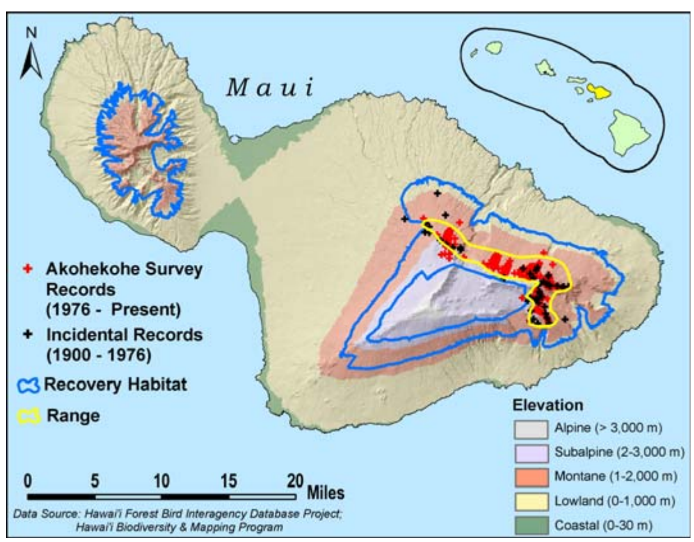
ʻĀkohekohe or Crested Honeycreeper

Palmeria dolei

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Vulnerable
Draft Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2003

SPECIES INFORMATION: The ʻākohekohe, or crested honeycreeper (Family: Fringillidae), is the largest extant honeycreeper on Maui Nui (Lānaʻi, Molokaʻi, Maui, and Kahoʻolawe). Although primarily black, the plumage of the ʻākohekohe is striking. Depending on their location, feathers are tipped with orange-yellow, gray, silver, or white. Orange feathers surround the eyes and extend over the nape, orange or yellow-white feathers cover the thighs, and the epaulettes are white with orange tips. Finally, the ʻākohekohe has a distinctive plume of white feathers that curl forward over the bill. The species does not sing, but produces a random series of buzzes, croaks, and whistles. ʻĀkohekohe are primarily nectarivorous, feeding mainly on ʻōhiʻa (*Metrosideros polymorpha*), but also from the flowers of other trees and shrubs. Like ʻapapane ((*Himatione sanguinea*) and iʼiwi (*Vestiaria coccinea*), ʻākohekohe are strong fliers and will move from low to high elevations in search of blooming ʻōhiʻa. Arthropods, mainly gleaned from ʻōhiʻa, are also part of the species' diet. ʻĀkohekohe may spend up to 70 percent of the day foraging. ʻĀkohekohe aggressively defend feeding and nesting territories year-around. Females build open-cup nests primarily in ʻōhiʻa, and females incubate the clutch of one or two eggs and broods nestlings; male feeds female on nest. Fledglings can forage independently ten to 14 days after leaving the nest. Pairs successfully fledge two to three broods per season.

DISTRIBUTION: ʻĀkohekohe are restricted to a 58 square kilometer (22 square mile) area on the northeastern slope of Haleakalā at 1,100 to 2,300 meters (3,600 – 7,550 feet) elevation. Subfossil evidence indicates the species also occurred in Maui's lowland dry forests. Currently they occupy five percent of their historic range. Also occurred in the forests of eastern Molokaʻi.



ABUNDANCE: The Hawaiian Forest Bird Survey (1980), estimated the population at 3,800 ± 700 (95% CI) individuals. Surveys in 1992 and 1995-97 indicated similar densities across the same range.

LOCATION AND CONDITION OF KEY HABITAT: ʻĀkohekohe occur in wet and mesic montane forests dominated by ʻōhiʻa and ʻōlapa (*Cheirodendron trigynum*); koa (*Acacia koa*) and kāwaʻu (*Ilex anomala*) occur at lower densities. Nearly all birds occur in forest between 1,500 and 2,100 meters (5,000 – 6,000 feet) elevation in rugged, steep terrain with a dense understory. The entire known range of the species occurs within State (e.g., Forest Reserve and Natural Area Reserve) or Federally (e.g., National Park) managed lands.

THREATS: ʻĀkohekohe are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻākohekohe populations, the following are of particular concern:

- Disease. Similar to ʻapapane and ʻiʻiwi, movements between low and high elevation foraging sites may increase their exposure to mosquito-borne diseases.
- Habitat degradation. Feral pig (*Sus scrofa*) damage to understory vegetation may reduce the availability of nectar producing plants important to ʻākohekohe, especially those flowering when ʻōhiʻa nectar is less available.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: Captive propagation of ʻākohekohe has been attempted, but to date has been unsuccessful. ʻĀkohekohe likely have benefited from management activities designed to conserve endangered forest bird species on the northeastern slope of Haleakalā including fencing, ungulate and small mammal control, forest restoration, monitoring of habitat conditions, and studies of disease and disease vectors. In addition to these efforts, future actions specific to the protection of ʻākohekohe populations may include the following:

- Establishment of a second ʻākohekohe population is important to reduce the chances that a catastrophe could result in the species' extinction. Potential re-introduction sites (e.g., west Maui and Molokaʻi) are limited because of the presence of mosquitoes.
- Continue attempts at establishing a captive population, especially if a second wild population cannot be establish.
- Additional fencing and feral pig control would likely improve understory conditions in occupied habitat and potentially facilitate expansion of ʻākohekohe populations.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and

developing methods to control mosquito populations. Research priorities specific to the ʻākohekohe include the following

- Determine if disease resistant individuals exist and if so determine if resistance is passed to offspring. Disease-resistant individuals could be used to establish new populations.
- Determine the role of ʻākohekohe in transmitting disease between high and low elevation habitats.

References:

Berlin KE, VanGelder EM. 1999. ʻAkohekohe (*Palmeria dolei*). *In* The Birds of North America, No. 400 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Eric Nishibayashi

Forest Birds

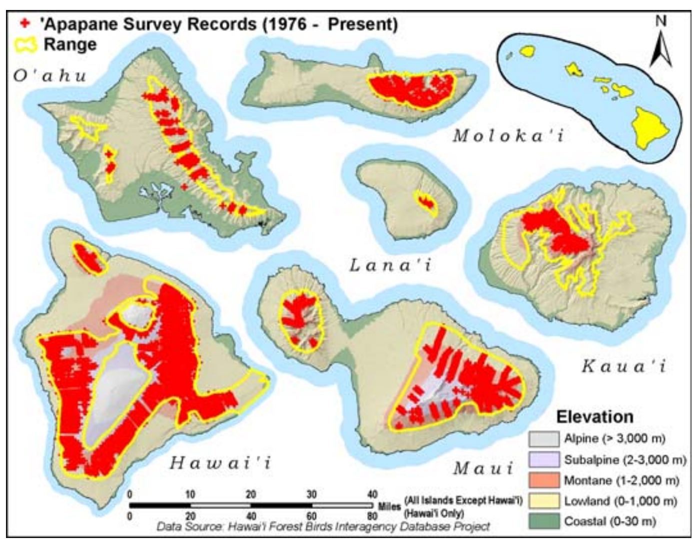
ʻApapane

Himatione sanguinea

SPECIES STATUS:
State recognized as Endemic
NatureServe Heritage Rank G4—Apparently secure

SPECIES INFORMATION: The ʻapapane is a small, crimson, primarily nectarivorous Hawaiian honeycreeper (Family: Fringillidae) and is an important ʻōhiʻa (*Metrosideros polymorpha*) pollinator. ʻApapane are the most abundant and widely distributed Hawaiian honeycreeper, and they are often seen flying above the canopy in search of patches of flowering ʻōhiʻa. The wide-ranging movements of ʻapapane may facilitate disease transmission among native forest birds. ʻApapane often forage in conspecific flocks, likely to overwhelm ʻiʻiwi (*Vestiaria coccinea*) and ʻākohekohe (*Palmeria dolei*), which often defend flower-rich trees. Outside the breeding season, ʻapapane also join mixed-species flocks. ʻApapane also eat insects, which they glean from outer foliage and twigs in the upper- and mid-canopy. Sexual chasing and courtship feeding often precede nest building, a task shared by both male and female. Pairs defend small territories around their nests. Females incubate three eggs and brood young; males feed females away from the nest. Both parents feed nestlings, and fledglings may remain with their parents for up to four months.

DISTRIBUTION: ʻApapane occur in native forests above 1,250 meters (4,100 feet) elevation on the islands of Hawaiʻi, Maui, and Kauaʻi. On Oʻahu, ʻapapane occur in the Koʻolau Range from 300 meters (975 feet) elevation to summit at 946 meters (3,075 feet), and are less common in the Waiʻanae Range above 600 meters (1,950 feet) elevation. Currently, rare or absent on Molokaʻi and Lānaʻi. Historically, ʻapapane were common at low elevations on all islands with appropriate habitat.



ABUNDANCE: The following island population estimates are based on Hawaiian Forest Bird Surveys (1976-1981): 1,080,000 ± 25,000 (95% CI) individuals on island of Hawaiʻi, 110,000 ± 9,000 individuals on Maui (86% on Haleakalā), 39,000 ± 5,000 individuals on Molokaʻi, 540 ± 213 individuals on Lānaʻi, and 30,000 ± 1,500 individuals on Kauaʻi. On Kauaʻi, populations declined after the 1992 hurricane but have significantly increased since. The 2000

Kauaʻi Forest Bird Survey estimated the population at 64,972 ± 2,014 (SE) individuals. Oʻahu was not included in the Hawaiian Forest Bird Survey. Rare or absent on Molokaʻi and Lānaʻi.

LOCATION AND CONDITION OF KEY HABITAT: ʻApapane occur in mesic and wet forests dominated by ʻōhiʻa and koa (*Acacia koa*), primarily at elevations greater than 1,250 meters (4,100 feet) elevation. The primary reason for this limitation is the high density of cold-intolerant *Culex* mosquitoes, an important disease vector, below this elevation. Occupied habitats also support kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapuʻu tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat quality and management effort directed at habitat protection and restoration varies considerably.

THREATS: Although ʻapapane populations appear stable on the islands of Hawaiʻi, Maui, and Kauaʻi, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻapapane populations the following is of particular concern:

- <u>Diseases</u>. Of Hawaii's native forest birds, ʻapapane have the highest prevalence of avian malaria (*Plasmodium relictum*). Individuals infected with avian pox (*Poxvirus avium*) also are more likely to be infected with malaria. Foraging movements may increase their exposure to disease. ʻApapane do breed in mid-elevation forests, suggesting that some individuals may be developing disease resistance.

CONSERVATION ACTIONS: ʻApapane likely have benefited from management activities designed to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, the ʻŌlaʻa/Kīlauea Watershed Partnership, and Alakaʻi Wilderness Preserve and surrounding areas. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to the protection of ʻapapane populations may include the following:

- Mosquito control in degraded habitats.
- Public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands. This information is useful in assessing the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻapapane include the following:

- Determine if disease resistant individuals exist and if so determine if resistance is passed to offspring. Disease-resistant individuals could be used as founders of new populations.
- Determine the role of ʻapapane in transmitting disease between high and low elevation habitats.

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

References:

Fancy SG, Ralph CJ. 1997. ʻApapane (*Himatione sanguinea*). *In* The Birds of North America, No. 296 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: DOFAW

Forest Birds

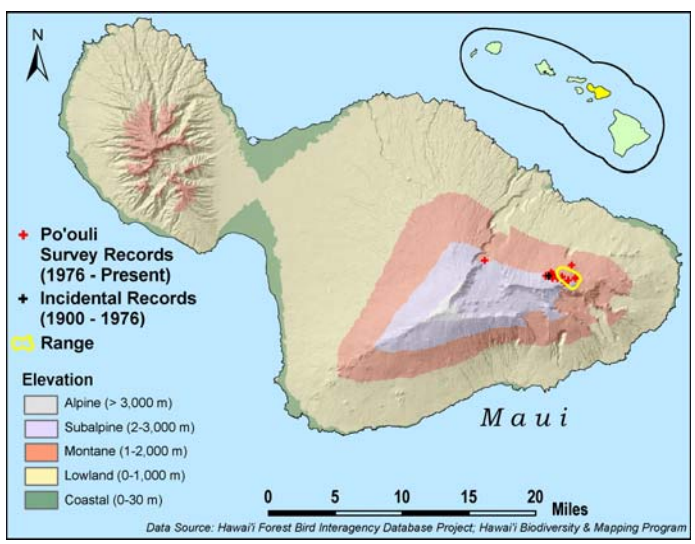
Poʻouli

Melamprosops phaeosoma

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking— Critically endangered
Draft Revised Recovery Plan for Hawaiian Forest Birds —USFWS 2003

SPECIES INFORMATION: The poʻouli is a stocky Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui that was not discovered until 1973. Poʻouli have short wings and tail, a finch-like bill, and distinctive plumage. Aptly named "black-faced" in Hawaiian, poʻouli have a large black face mask, white cheeks, throat and underparts and brown wings and back; no other Hawaiian forest bird is similarly colored. Although not well-studied, males and females are similar, although females have a grayish throat and breast. Little is known of the species' life history. Poʻouli often join mixed species foraging flocks. Forages primarily in the subcanopy and understory on tree branches of native shrubs and trees where they search moss, lichens, and bark for snails and arthropods. Breeding biology is based on observations from a single nesting pair and may be biased because of extremely low population density. For example, territorial behavior has not been observed. Nests are similar to those of other Hawaiian honeycreepers and are placed in ʻōhiʻa (*Metrosideros polymorpha*) trees. Only the female incubates eggs and broods nestlings; male feeds the female on and off the nest.

DISTRIBUTION: Poʻouli likely are restricted to a 1,300 hectare (3,200 acre) area between 1,440 and 2,100 meters (4,750 – 7,000 feet) elevation on the northeastern slope of Haleakalā on Maui. No historical data on range, although fossil evidence indicates that poʻouli once occurred over a wider geographic range.



ABUNDANCE: As of 2003 three known individuals. One captured and brought into captivity and later died. The remaining two birds have not been seen since January 2004. The species' poor detectability has hampered attempts to locate additional individuals or estimate population size. The Hawaiian Forest Bird Survey (1980), estimated the population at 140 ± 280 (95% CI) individuals.

LOCATION AND CONDITION OF KEY HABITAT: Poʻouli occur in mixed shrub montane wet forest dominated by ʻōhiʻa, with an understory dominated by a diversity of small trees and shrubs, many of which are used as foraging substrates (e.g., kanawao [*Broussaissea arguta*], kawaʻu [*Ilex anomala*]). Habitat conditions in areas occupied by poʻouli are variable, but improving. All known individuals occur in the Hanawī Natural Area Reserve which is managed by the State of Hawaiʻi.

THREATS: Unknown. However, the poʻouli is likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For poʻouli populations, the following are likely of particular concern:

- Habitat degradation. The species appears to prefer areas with low levels of soil and vegetation disturbance and therefore may be particularly sensitive to understory and ground cover damage by feral pigs (*Sus scrofa*).
- Predation. Rats (*Rattus* spp.) are abundant in poʻouli habitat and may depredate adults and nests.
- Competition. In addition to direct predation on adults and nests, rats also may compete with poʻouli for food resources, especially snails. In addition, the non-native garlic snail (*Oxychilus alliarius*) also is abundant and preys on native snails.

CONSERVATION ACTIONS: Since its discovery, major efforts have been directed at conserving the poʻouli. These include the establishment of the 3,000 hectares (7,500 acres) Hanawī Natural Area Reserve in 1986, which protects the species' entire known range. Fencing and pig removal has facilitated the recovery of the understory. In 1995, the Maui Forest Bird Recovery Project was created to research and protect native Hawaiian forest birds, including the poʻouli. Activities to date include: small mammal control, research on optimizing rodent control methods, surveys for native land snails, and banding and collecting blood samples to monitor demography and disease prevalence. In 2002, members of this team successfully translocated a female poʻouli to the home range of the male, however, she quickly returned to her own home range. In September of 2004, one poʻouli was successfully captured in an attempt to establish a captive population. Unfortunately, this individual died in captivity in November of the same year. The Hawaiʻi Department of Land and Natural Resources and the U. S. Geological Survey continue to search Hanawī and adjacent habitats for additional individuals. In addition, poʻouli populations likely have benefited from management efforts designed to conserve other endangered forest birds on northeastern Haleakalā including fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies on disease and disease vectors. In addition to these efforts, future management specific to the po'ouli may include the following:

- Continue pig and small mammal control efforts.
- Continue efforts to locate additional individuals.
- Continue efforts to locate and capture the two known individuals.
- Public outreach highlighting the importance of pig and rodent control to the remaining forest bird populations on Maui.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. In addition to the ongoing research on po'ouli outlined above, additional priorities specific to the species include the following:

- Studies to determine the distribution and abundance of the species' prey base to determine if food resource is a limiting factor.

References:

Pratt TK, Kepler CB, Casey TLC. 1997. Po'ouli (*Melamprosops phaesoma*). *In* The Birds of North America, No. 272 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2003. Draft revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

Photo: Jack Jeffery

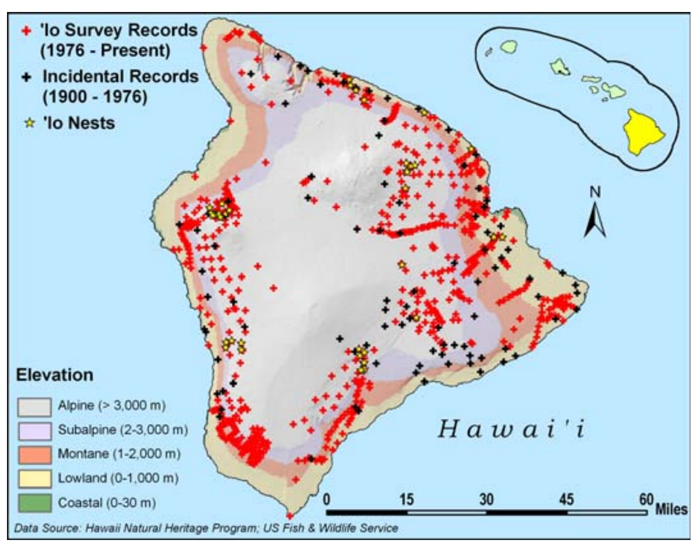
Raptors

ʻIo

Buteo solitarius

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G2—Imperiled
IUCN Red List Ranking—Near Threatened
Hawaiian Hawk Recovery Plan - USFWS 1984

SPECIES INFORMATION: The ʻio, or Hawaiian hawk, is the only broad-winged hawk (Family: Accipitridae) known to have colonized Hawaiʻi. ʻIo are considered ʻaumākua, or family gods by Native Hawaiians. Similar to many birds of prey, females are larger than males, and often weigh approximately 25 percent more than males. Also similar to many *Buteos*, two color morphs, light and dark, occur in ʻio populations. Prior to the arrival of Polynesians, ʻio may have exclusively preyed on birds, including now extinct flightless ibis (Family: Threskiornithidae) and rails (Family: Ralliade). Its diet now includes non-native insects, birds and rodents, as well as native insects and birds. ʻIo are socially monogamous and limited data indicates individuals form long-term pair-bonds and defend territories year-round. Nest construction is protracted, beginning up to two months before the first egg is laid, and continuing into the nestling period. Both sexes contribute to nest-building. Based on recent studies, clutch size is nearly always one, although historically clutches of two and three were reported. Both sexes incubate, although females perform most of the brooding of nestlings; males provide most of the food to chicks and female. Both adults feed fledglings, which are dependent on adults for up nine months.



DISTRIBUTION: ʻIo occur on the island of Hawaiʻi from sea level to 1,700 meters (5,600 feet) elevation. Historic range appears similar to current distribution. Fossil evidence indicates the species historically occurred on Kauaʻi, Molokaʻi, and Oʻahu.

ABUNDANCE: Based on an island-wide survey in 1993, the ʻio population was estimated at 1,600 birds. Based on a survey conducted in 1998, the population was estimated at 1,223 birds. Trends are difficult to determine because of varying census methodology, but the population appears stable.

LOCATION AND CONDITION OF KEY HABITAT: ʻIo occur in lowland non-native forests, urban areas, agricultural lands, pasturelands, and high elevation native forests with both intact and degraded understory. Although ʻio nests have been located in a number of non-native trees, including eucalyptus (*Eucalyptus* spp.), ironwood (*Casuarina equisetifolia*), mango (*Mangifera indica*), coconut palm (*Cocos nucifera*), and macadamia (*Macadamia integrifolia*), of 51 nests, 86 percent occurred in native trees, with 80 percent being in ʻōhiʻa (*Metrosideros polymorpha*). During the winter, ʻio have been reported in subalpine māmane-naio forest (*Sophora chrysophylla - Myoporum sandwicense*), suggesting some seasonal movements. Because of the species' use of a wide variety of habitats and a lack of historical population data, key habitat variables are difficult to determine.

THREATS: ʻIo are likely susceptible to the same factors that threaten other native Hawaiian birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ʻio populations, the following are of particular concern:

- Shooting, trapping and harassment. Harassment of nesting birds and shooting of adults may be the most significant threat to ʻio, although the level of harassment and shooting is difficult to assess.
- Contaminants or toxins. Although little recent evidence exists, the presence of organophosphates was noted in a bird recovered from a macadamia orchard. Although it is believed that secondary poisoning resulting from the consumption of rats poisoned with diphacinone poses little threat, however, further study is necessary.
- Disease. Early naturalists observed ʻio with pox-like lesions. Currently, disease does not appear to threaten the species and because their range includes low-elevation habitats, ʻio may be immune to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*).

CONSERVATION ACTIONS: ʻIo likely have benefited from management activities designed to conserve other endangered birds on the island of Hawaiʻi including fencing, ungulate and small mammal control, forest restoration, and habitat monitoring. In addition to these efforts, future actions specific to the protection of ʻio populations may include the following:

- Protection and management of foraging and nesting habitat, including native and non-native forests.
- Enforcement of laws prohibiting the harassment, shooting, or trapping of the species.

MONITORING: Regular island-wide population surveys are necessary to determine population trends for this species. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Currently, a study is underway to determine variation in reproductive success across a variety of habitats. Additional research priorities specific to ʻio include the following:

- Quantify the habitat characteristics of occupied versus unoccupied areas, and assess the effects of changes in vegetation coverage on the distribution of the ʻio.
- Quantify the mortality related to nest disturbance, poaching, and secondary poisoning.
- Evaluate the effects of pesticides on ʻio.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, and nesting phenology and success.

References:

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Photo: NRCS

Pueo or Hawaiian Short-eared Owl

Asio flammeus sandwichensis

SPECIES STATUS:
State listed as Endangered on Oʻahu
State recognized as Endemic at the subspecies level
NatureServe Heritage Rank G5/T2 –
Species secure/Subspecies imperiled

SPECIES INFORMATION: The pueo, or Hawaiian short-eared owl, is an endemic subspecies of the nearly pandemic short-eared owl (*Asio flammeus*; Family: Strigidae). The species is thought to have colonized the Hawaiian Islands sometime after the arrival of Polynesians. Unlike most owls, pueo are active during the day (i.e., diurnal), and are commonly seen hovering or soaring over open areas. Like short-eared owls in continental environments, those in Hawaiʻi primarily consume small mammals. Their relatively recent establishment on Hawaiʻi may have been tied to the rats (*Rattus exulans*) that Polynesians brought to the islands. Little is known about the breeding biology of pueo, but nests have been found throughout the year. Males perform aerial displays known as a sky dancing display to prospective females. Nests are constructed by females and are comprised of simple scrapes in the ground lined with grasses and feather down. Females also perform all incubating and brooding. Males feed females and defend nests. Chicks hatch asynchronously and are fed by female with food delivered by male. Young may fledge from nest on foot before they are able to fly and depend on their parents for approximately two months.

DISTRIBUTION: Found on all the Main Hawaiian Islands from sea level to 2,450 meters (8,000 feet).

ABUNDANCE: Unknown. Because of relatively few detections, the Hawaiian Forest Bird Survey did not estimate the population size of the pueo. Pueo were widespread at the end of the 19th century, but are thought to be declining.

LOCATION AND CONDITION OF KEY HABITAT: Pueo occupy a variety of habitats, including wet and dry forests, but are most common in open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation. Because of a lack of historical population data and the species' current, broad habitat use, key habitat variables are difficult to determine. Pueo occur in many areas that are managed by the Sate of Hawaiʻi or Federal agencies.

THREATS: Pueo are likely susceptible to the same factors that threaten other native Hawaiian birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. However, their persistence in lowland, non-native and rangeland habitats suggests that they may be less vulnerable to extinction than other native birds, especially because they may be resistant to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*). Despite this, for pueo populations, the following are of particular concern:

- "Sick owl syndrome". Mortality on Kauaʻi has been attributed to this syndrome, which may be related to pesticide poisoning or food shortages.
- Predation. Because pueo nest on the ground, their eggs and young are vulnerable to predation by rats (*Rattus* spp.), cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Habitat loss. May be particularly important to Oʻahu pueo populations.
- Contaminants or toxins. Because pueo are top predators, fat-soluble contaminants may accumulate in prey species; may be related to "sick owl syndrome" (see above).
- Human interaction. Hunting behavior and habitat use predispose pueo to vehicular collisions, which have been documented on Lānaʻi and the island of Hawaiʻi.

CONSERVATION ACTIONS: Pueo likely have benefited from management activities designed to conserve other endangered birds. They also may benefit from game bird management; high densities of pueo occur on lands where game birds also are common. In addition to these efforts, future management specific to the pueo may include the following:

- Determine population trends, especially on islands where "sick owl syndrome" has been documented.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Regular island-wide population surveys are necessary to determine population trends for this species. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities specific to pueo include the following:

- Analysis of population trends and changes in habitat occupancy, especially on Oʻahu.
- Determine the cause of "sick owl syndrome" and its potential effect on populations.
- Quantify the number of vehicular collisions and determine the level of threat to populations.

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Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.


Photo: Richard Palmer

ʻAukuʻu or Black-crowned Night Heron

Nycticorax nycticorax hoactli

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The ʻaukuʻu or black-crowned night heron (Family: Ardeidae) is a stocky cosmopolitan species that breeds on every continent except for Australia and Antarctica. Four subspecies are recognized and *N. n. hoactli* occurs in Hawaiʻi, as well as across North America and most of South America. Adult males and females have a black crown and upper back, with a white throat, cheeks, and a narrow band above the bill that extends over the eyes, gray wings, and whitish underparts; males are larger than females. Juveniles are overall brown with light spots. The species' stout bill is black; legs and feet are yellow, and the eyes are red. ʻAukuʻu (black-crowned night heron) are gregarious and unlike continental birds, those in Hawaiʻi are diurnal. The species uses a variety of shallow wetlands for foraging and employs various techniques to capture a diversity of prey including insects, fish, frogs, mice, and the young of other native waterbirds. Information on breeding in Hawaiʻi is limited, but the species is a colonial nester, and in North America breeding occurs from December to August. Eggs are laid in a bulky stick nest usually placed low in vegetation.

DISTRIBUTION: ʻAukuʻu (black-crowned night heron) is widely distributed throughout the MHI.

ABUNDANCE: Island-wide population numbers, based on semi-annual waterbird counts conducted by DOFAW, indicate that the population is variable, but appears stable. Between 1983 and 2003 the average number of ʻaukuʻu (black-crowned night heron) counted has been just over 400 individuals. This number is certainly an under-estimate as all stream habitats are not surveyed.

LOCATION AND CONDITION OF KEY HABITAT: ʻAukuʻu (black-crowned night heron) occur in a wide-range of aquatic habitats including mountain streams, lowland ponds and estuaries (wetlands and open water), aquaculture farms, and suburban/urban waterways (e.g., golf course ponds, concrete channels).

THREATS: Similar to the rest of Hawaiian native waterbirds, ʻaukuʻu (black-crowned night heron) are threatened by:

- Habitat loss. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift in wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.

- Introduced predators. Dogs (*Canis domisticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), and barn owls (*Tyto alba*) all potentially prey on adult or young ʻaukuʻu (black crowned night heron).
- Non-native invasive plants. Several species of invasive plants, including pickleweed (*Batis maritima*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases. The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).
- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to Hawaiian waterbirds.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawaiʻi and the USFWS have protected 23 percent of the State's remaining coastal plain wetlands. In 1997, Ducks Unlimited developed a comprehensive, cooperative plan to protect and restore wetlands used by native waterbirds. Currently there are no conservation actions specifically directed at ʻaukuʻu (black-crowned night heron); however, the species certainly benefits from actions taken for the protection of Hawaii's endangered waterbirds including wetland protection and predator control efforts. In addition to common statewide and island conservation actions, specific actions directed at ʻaukuʻu (black-crowned night heron) should include:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue waterbird surveys and habitat monitoring on all islands. This information is needed to identify significant population declines.

RESEARCH PRIORITIES:

- Conduct studies to determine the effects on endangered waterbird populations by ʻaukuʻu (black-crowned night heron) predation on the young of these species.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

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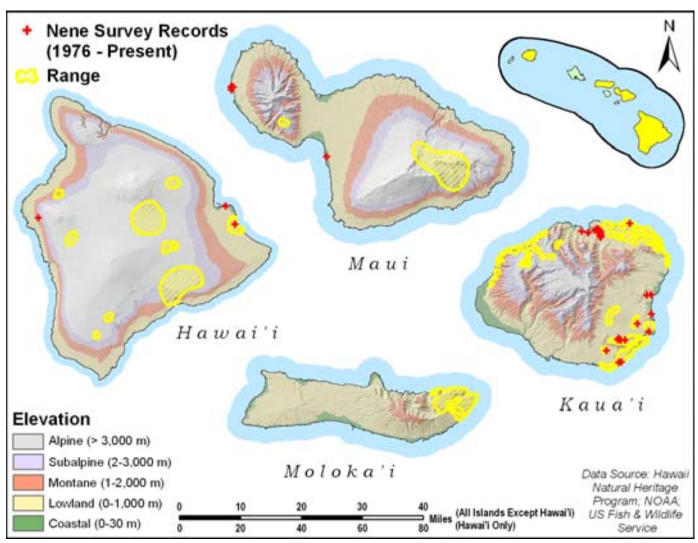
Photo: Jack Jeffery

Nēnē
or Hawaiian Goose
Branta sandvicensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1 - Critically imperiled
IUCN Red List Ranking - Vulnerable
Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*) – USFWS 2004

SPECIES INFORMATION: Historically, at least five species of geese (family: Anatidae) occurred in Hawai'i; today, only the nēnē, or Hawaiian goose, survives. Adult males and females are mostly dark brown or sepia with a black face and crown, cream-colored cheeks, and a buff neck with black streaks. Females are smaller than males. Compared to other geese, nēnē are more terrestrial and have longer legs and less webbing between their toes; these differences likely facilitate nēnē walking on lava flows. Nēnē graze and browse on the leaves, seeds, flowers, and fruits of at least 50 native and non-native grasses, sedges, composites, and shrubs. Composition of diet varies with location and habitat, and the species may require a diverse suite of food plants. Currently, several species of non-native grass are important in high-elevation habitats. Nēnē disperse seeds and therefore play an important ecological role, especially in influencing the species composition of early successional plant communities. Historically, flocks moved between high-elevation feeding habitats to lowland nesting areas. Pairs mate for life and engage in relatively simple courtship displays in which the male attacks or threatens potential competitors, runs back to his mate, and calls loudly. Nēnē have an extended breeding season and eggs can be found in all months except May, June, and July, although the majority of birds nest between October and March, and most clutches are laid between October and December. Nēnē nests consist of a shallow scrape, moderately lined with plant materials and down. Pairs typically return to previous years' nests sites, typically in dense vegetation; when available, kīpuka may be preferred. Females lay between two and five eggs which hatch after 30 days. Young are precocial and are not fed by their parents; however, young remain with their parents for up to one year.



DISTRIBUTION: Nēnē occur between sea level and 2,400 meters (7,800 feet) elevation on the island of Hawai'i, Maui, Kaua'i, and Moloka'i. Historically the species was found on all MHI and likely were widespread.

ABUNDANCE: Current population is estimated at between 1,300 and 1,500 individuals with 378 birds on the island of Hawaiʻi (148 at Hawaiʻi Volcanoes National Park and 230 scattered throughout the rest of the island, including Hakalau Forest National Wildlife Refuge, Kahuku, Keauhou, Kīpuka ʻĀinahou, Keaʻau, and Puʻu Waʻawaʻa), 295 to 325 birds on Maui (200-230 at Haleakalā National Park, 95 on west Maui), 720 birds on Kauaʻi (including Hanalei National Wildlife Refuge, Kīlauea National Wildlife Refuge, Crater Hill, Kīpū Kai and the Nā Pali Coast), and 74 birds on Molokaʻi. All populations have been or are currently being supplemented by captive-bred birds. In 1951, the wild nēnē population was estimated at 30 individuals. Information on historical abundance is limited by a lack of information on the historical distribution and composition of native plant communities.

LOCATION AND CONDITION OF KEY HABITAT: Nēnē historically occurred in lowland dry forest, shrubland, grassland, and montane dry forest and shrubland. Habitat preferences of contemporary populations are likely biased as preferences may be influenced by the location of release sites of captive-bred birds. Birds currently use a wide variety of habitats including coastal dune vegetation and non-native grasslands (e.g., golf courses, pastures, rural areas), sparsely vegetated low and high elevation lava flows, mid-elevation native and non-native shrubland, early successional cinderfall, cinder deserts, native alpine grasslands and shrublands, and open native and non-native alpine shrubland-woodland community interfaces. On the island of Hawaiʻi, nēnē can be found from sea level to 2,400 meters (7,900 feet) elevation, on Maui from sea level to 2,348 meters (7,700 feet) elevation, on Kauaʻi from sea level to 183 meters (600 feet) elevation, and on Molokaʻi from sea level to 274 meter (900 feet) elevation. Breeding areas encompass a variety of habitats including beach strand, shrubland, grassland, and lava rock, and occur at a range of elevations. On the island of Hawaiʻi and Maui, most nests are built under native vegetation such as pūkiawe (*Styphelia tameiameiae*), ʻaʻaliʻi (*Dondonaea viscose*), and ʻōhiʻa (*Metrosideros polymorpha*). On Kauaʻi however, most nesting areas are dominated by non-native species and nēnē often nest under Christmas berry (*Schinus terebinthifolius*), shrub verbena (*Lantana camara*), and ironwood (*Casuarina* spp.). The condition of habitats occupied by nēnē varies considerably. Many of the areas used by the species are managed by the State of Hawaiʻi and the USFWS.

THREATS: Historical threats included habitat loss and degradation, hunting, and predation by rats (*Rattus* spp.), cats (*Felis silvestris*), dogs (*Canis domisticus*), and the small Indian mongoose (*Herpestes auropunctatus*). Current threats include predation by the above suite of non-native mammals, exposure in high-elevation habitats, nutritional deficiency due to habitat degradation which may result in low productivity, a lack of lowland habitat, human-caused disturbance and mortality (e.g., road mortality, disturbance by hikers), behavioral problems related to captive propagation, and inbreeding depression.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. Past and current actions include captive propagation and release of captive-bred individuals into the wild, predator control, habitat enhancement, research and monitoring, private conservation efforts, formation of the Nēnē Recovery Action Group, and public education. In addition to common statewide and island conservation actions, specific management directed toward nēnē should include:

- Identify and protect all habitats used by nēnē including foraging habitat, breeding grounds, and summer flocking areas.
- Increase predator control effort and effectiveness and habitat enhancement and restoration efforts, especially in native grasslands and shrublands.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) on Kauaʻi and the establishment of other potential predators on all islands.
- Develop standardized monitoring protocols.
- Minimize the potential for human-nēnē interactions or conflicts through increased public education.
- Develop a statewide, long-range management plan for all populations.

MONITORING:

- Continue surveys of populations and their distribution in known and likely habitats.
- Monitor the efficacy of predator control techniques.

RESEARCH PRIORITIES:

- Conduct studies on diet and nutrition, particularly as it relates to the nutritional value of non-native versus native vegetation, focusing on the needs of goslings and breeding females.
- Determine the role of disease in limiting populations. If disease is determined to be problematic in some populations, determine the prevalence of disease-resistant individuals.
- Refine predator control methods.
- Conduct studies to examine other potential limiting factors and to determine the carrying capacity of different habitats.

References:

Banko PC, Black JM, Banko WE. 1999. Hawaiian goose (*Branta sandvicensis*). *In* The Birds of North America, No. 434 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2004. Draft revised recovery plan for the Nene or Hawaiian Goose (*Branta sandvicensis*). Portland, (OR): U.S. Fish and Wildlife Service. 148 + xi pp.

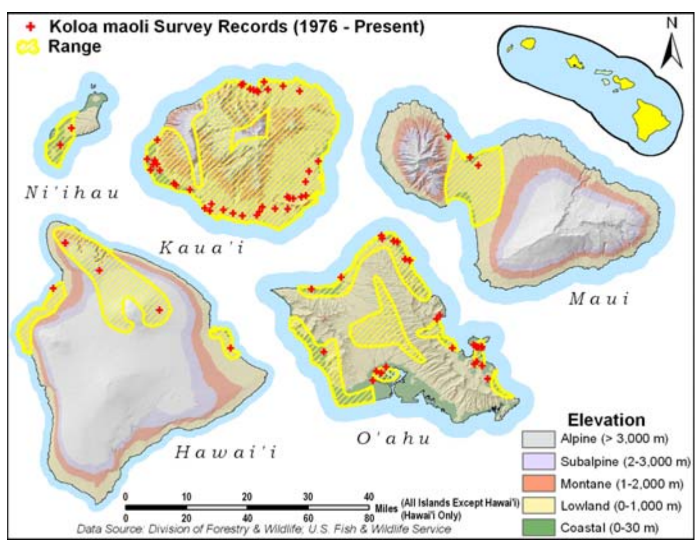

Photo: Richard Palmer

Koloa Maoli or Hawaiian Duck

Anas wyvilliana

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1 - Critically imperiled
IUCN Red List Ranking - Endangered
Recovery Plan for Hawaiian Waterbirds – USFWS 1999

SPECIES INFORMATION: The koloa maoli, or Hawaiian duck, is one of two extant native duck species (Family: Anatidae) found in Hawaiʻi and is closely related to the well-known, but non-native mallard (*A. platyrhynchos*). Adult males and females are mottled brown overall. Males have darker heads and necks, olive bills and bright orange feet. The bills of females are more orange, their feet are dull orange, and they are smaller than males. Koloa maoli (Hawaiian ducks) forage in a wide variety of freshwater habitats, including artificial wetlands. Movements between feeding and breeding habitats and between Kauaʻi and Niʻihau occur. The species typically forages in shallow water (less than 13 centimeters or five inches deep). Like mallards, koloa maoli (Hawaiian ducks) are opportunistic and their diet includes snails, dragonfly larvae, earthworms, grass seeds, green algae, and seeds/leaf parts of wetland plants. Koloa maoli (Hawaiian duck) are usually found alone or in pairs and are wary, especially when nesting or molting, although during the winter they may gather in larger numbers to exploit abundant food resources. The species' nesting biology is poorly known. Although some pairs nest in lowland habitats, on Kauaʻi, koloa maoli (Hawaiian duck) nest in the upper Alakaʻi swamp. Nesting occurs year round, but most activity occurs between January and May. Nests are usually on the ground near water, but few nests are found in areas frequented by humans or areas supporting populations of mammalian predators. Generally eight to ten eggs are laid, and the precocial chicks hatch after an unknown incubation period, but likely less than 30 days.



DISTRIBUTION: Koloa maoli (Hawaiian duck) are generally found in wetland habitats from sea level to 3,000 meters (9,900 feet) elevation on all the MHI except for Kahoʻolawe; populations on all islands except for Kauaʻi originated from re-introduced birds. On Kauaʻi, populations are found in Hanalei National Wildlife Refuge and montane streams. On Oʻahu, populations are found in Kawainui, Hāmākua, and Heʻeia marshes, James Campbell National Wildlife Refuge, and in wetland habitats in or near Punahoʻolapa, Haleʻiwa, Pearl Harbor, and Lualualei Valley. On Maui, koloa maoli (Hawaiian duck) are found in Kahului, Kanahā and Keālia ponds. On the island of Hawaiʻi populations occur in the Kohala Mountains, in Pololū, Waimanu and Waipiʻo valleys, and Mauna Kea. Historically, koloa maoli (Hawaiian duck) occurred on all the MHI except for Lānaʻi and Kahoʻolawe.

ABUNDANCE: The population is estimated at 2,500 individuals, with 80 percent of individuals occurring on Kauaʻi. Because of the remoteness and inaccessibility of some habitats, this estimate is likely an underestimate. Historically, koloa maoli (Hawaiian duck) were fairly common in natural and agricultural wetland habitats. By 1949, only about 530 individuals remained, with 30 on Oʻahu and the remainder on Kauaʻi.

LOCATION AND CONDITION OF KEY HABITAT: Koloa maoli (Hawaiian duck) occur in a wide variety of natural and artificial wetland habitats including freshwater marshes, flooded grasslands, coastal ponds, streams, montane pools, forest swamplands, taro, lotus, shrimp, and fish ponds, irrigation ditches, reservoirs, and mouths of larger streams. Some important habitats are located in National Wildlife Refuges or on State lands (see distribution) and receive management attention. However, other important habitats are not protected. These mostly include wetlands facing development or those used for agriculture or aquaculture. Examples include: playa lakes on Niʻihau, Opaekaʻa marsh, Lumahaʻi wetlands on Kauaʻi, Amorient prawn farms, Lāʻie wetlands, Uko, Punahoʻolapa, and Waiheʻe marshes, Waialua lotus fields, and Waipiʻo Peninsula ponds on Oʻahu, Paialoa and ʻŌʻōʻia playa fishponds on Molokaʻi, and Opaeʻula, and Waiākea-Loko Waka ponds on the island of Hawaiʻi.

THREATS: Currently the most important threat to koloa maoli (Hawaiian duck) populations is hybridization with non-native mallards. This is especially problematic on Oʻahu where most individuals are hybrids. In addition, feral pigs (*Sus scrofa*) and goats (*Capra hircus*) significantly reduce the suitability of nesting habitat for koloa maoli (Hawaiian duck) along montane streams. Historically, hunting pressure likely reduced populations. Similar to the rest of Hawaiian native waterbirds, koloa maoli (Hawaiian duck) also are threatened by:

- <u>Habitat loss</u>. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift from wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.
- <u>Introduced predators</u>. Koloa maoli (Hawaiian duck) eggs and ducklings are especially vulnerable to predation by dogs (*Canis domisticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), ʻaukuʻu or black-crowned night herons (*Nycticorax nycticorx hoactli*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), and non-native fish.
- <u>Altered hydrology</u>. Modifications to wetland habitats for flood control or to provide municipal water sources are generally incompatible with koloa maoli (Hawaiian duck) populations.
- <u>Non-native invasive plants</u>. Several species of invasive plants, including pickleweed (*Batis maritime*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- <u>Avian diseases</u>. The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).

- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to Hawaiian waterbirds.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawaiʻi and the USFWS have protected 23 percent of the State's remaining coastal plain wetlands. In 1997, Ducks Unlimited developed a comprehensive, cooperative plan to protect and restore wetlands used by native waterbirds. Efforts directed at this species included prohibiting hunting, importation restrictions on mallards, population monitoring, basic life history research, and captive propagation and re-introduction. Between 1958 and 1982, 326 birds were released on Oʻahu. In 1989, 12 birds were released on Maui. Between 1976 and 1982, 200 birds were released on the island of Hawaiʻi. In addition to common statewide and island conservation actions, specific actions directed at koloa maoli (Hawaiian duck) should include:

- Continue restoration of important habitats.
- Eliminate mallards and evaluate elimination of mallard/koloa maoli hybrids.
- Conduct education and awareness programs, particularly to address issues of predation by dogs and feral cats.

MONITORING: Continue statewide surveys of populations in known and likely habitats. This information is needed to assess the efficacy of habitat management efforts. Additional monitoring related to koloa maoli (Hawaiian duck) populations should include the following:

- Monitor the presence of hybrids in populations.
- Monitor population responses to invasive species and modifications to watersheds.

RESEARCH PRIORITIES:

- Conduct studies to determine the best methods to control and eliminate hybridization between mallards and koloa maoli (Hawaiian duck).
- Conduct research on potential limiting factors and the importance of montane stream habitats.
- Conduct long-term demographic studies to determine basic reproductive biology, population trends, survival rates, and limiting factors as well as feeding habits. Design studies to facilitate comparisons between populations using managed wetlands and those located in unmanaged wetlands.
- Conduct studies directed at determining the role of disease in limiting populations, particularly on Kauaʻi.

References:

Engilis A Jr., Uyehara KJ, Giffin, JG. 2002. Hawaiian duck (*Anas wyvilliana*). *In* The Birds of North America, No. 694 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

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Photo: W.C. Gagne

Waterbirds

Laysan Duck

Anas laysanensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1 - Critically imperiled
IUCN Red List Ranking - Critically endangered
Draft Revised Recovery Plan for the Laysan Duck (*Anas laysanensis*) - USFSW 2004

SPECIES INFORMATION: The Laysan duck is a small dabbling duck (Family: Anatidae) endemic to Hawai'i, and until recently was restricted to Laysan Island (370 hectares/911 acres) in the NWHI. Even after a recent successful translocation effort to Midway Atoll, the species still has one of the smallest geographic ranges of any duck. Adults are dark brown overall with a prominent white eye-ring and varying amounts of white feathers on the head and neck; the sexes are similar. Unlike many other duck species, Laysan ducks have low fecundity, are nocturnal, very terrestrial, and highly sedentary; the species also is relatively long-lived. During the day, ducks take cover under vegetation such as bunchgrass or shrub. Individuals forage mainly at night around and in a large hypersaline lake, feeding primarily on larvae, pupae, and adult Dipteran brine flies (*Neoscatella sexnotata*), the larvae and pupae of a noctuid moth (*Agrotis dislocatae*), and brine shrimp (*Arternia* spp.); seeds, leaves, algae, and other invertebrates also are taken. Most common method of foraging is running through swarms of adult brine flies while moving head back and forth snapping up flies. Moth larvae and pupae are taken by "filter feeding" in sand under low vegetation. The species also dabbles along the lake shore. Long-term pair bonds are not formed and males do not participate in brood-rearing. Nesting occurs between February and November, although most eggs are laid between April and August. Nests are well concealed and typically are placed at the base of dense vegetation, especially bunch grass (*Eragrostis variabilis*). Nests are shallow scrapes lined with dead grass and some down. Typically three to five eggs are laid, and they hatch after 28 days. Ducklings are precocial and are not fed by the female. Due to the fact that the species evolved with avian predators, when surprised, individuals tend to walk away rather than fly, and freeze rather than flush.

DISTRIBUTION: Until 2003, the Laysan duck was restricted to Laysan Island in the NWHI. In 2004, 20 ducks were successfully translocated to Midway Atoll, also in the NWHI. As late as 1844, Laysan ducks were still extant on Lisianski. Fossil and subfossil evidence indicates that Laysan ducks were widespread in the NWHI and MHI prior to the arrival of Polynesians and occurred on the islands of Hawai'i, Moloka'i, O'ahu, Maui, and Kaua'i.

ABUNDANCE: On Laysan, the Laysan duck population is somewhat variable, but generally does not exceed 500 individuals; surveys conducted in 2005 estimated the population at 459 individuals. In 1911, the population fell to between six and 12 individuals. By the early 1990s the population had grown to 450 individuals; however, by early 1994, the population fell to 100. As of July 2005, there were 32 individuals on Midway Atoll National Wildlife Refuge.

LOCATION AND CONDITION OF KEY HABITAT: Two habitats are critical to the survival of Laysan Duck: vegetated uplands and wetlands. Uplands supporting vegetation such as beach naupaka (*Scaevola taccada*) and bunch grass provide ducks with shelter and nesting habitat. The hypersaline lake provides ducks with foraging habitat. The importance of upland vegetation was demonstrated by the severe decline of ducks at the turn of the last century when rabbits (*Oryctolagus curriculus*) denuded Laysan and by the species' subsequent recovery after the rabbit population was eradicated and the vegetation recovered. Similarly, the number of ducks varies considerably depending on lake water levels; in 1987, there was a total breeding failure due to a drought and a lack of brine flies. The entire range of the Laysan duck occurs in the Hawaiian Islands National Wildlife Refuge and Midway Atoll National Wildlife Refuge.

THREATS: Historic threats included the introduction of rabbits which subsequently denuded the island's vegetation (see above), sport hunting, and guano mining. Habitat degradation related to the filling of the lake by sand is a current concern given the importance of the lake to the duck. Other current threats are mostly related to the species' limited population size and small geographic range. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. The species' limited geographic range exacerbates the risk of extinction due to stochastic events such as hurricanes or droughts.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. Rabbits were eradicated from Laysan in the 1920s. In 1967, the USFWS translocated 12 ducks to Pearl and Hermes Reef. This translocation attempt was not successful and the ducks were not subsequently seen. The USFWS has successfully controlled the non-native grass, *Cenchrus echinatus*, and has begun replanting native vegetation and installing snow fences to stabilize sand dunes near the lake. In the fall of 2004, the USFWS and USGS translocated 20 hatch-year Laysan ducks to reclaimed habitats (artificially created seeps) on Midway Atoll. To date, 19 of the 20 ducks have survived and as of July 2005, five females produced 13 ducklings. Another translocation is planned for the fall of 2005. In addition to common statewide and island conservation actions, specific management directed toward Laysan ducks should include:

- Restoration of habitat with native plants as well as continued maintenance of existing habitat (e.g., weed control, stabilization of dunes and vegetation to prevent sand from filling the lake).
- Restoration of invertebrate species to increase food availability.
- Prevention of the establishment of additional non-native plants and animals.
- Continue efforts to establish additional populations.

MONITORING:

- Continue surveys of the population, and attempt to establish a year-round monitoring program that will allow for better population estimates.
- Monitor for invasive species.

RESEARCH PRIORITIES:

- Conduct long-term demographic studies to determine basic reproductive biology, population trends, and survival rates.
- Conduct additional studies to better understand the species foraging needs.
- Improve population monitoring methods.

References:

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

Moulton DW, Marshall AP. 1996. Laysan duck (*Anas laysanensis*). *In* The Birds of North America, No. 242 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Reynolds MH. 2002. Habitat use and home range of the Laysan Teal on Laysan Island, Hawai'i. Waterbirds 27:183-192.

U.S. Fish and Wildlife Service. 2004. Draft revised recovery plan for the Laysan Duck (*Anas laysanensis*). U.S. Fish and Wildlife Service, Portland, OR. Vii+94 pp.

Photo: NRCS

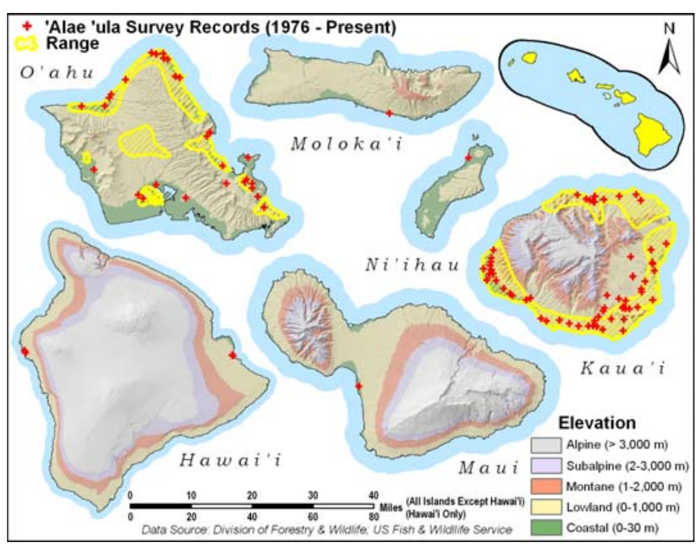
Waterbirds

ʻAlae ʻUla or Hawaiian Moorhen

Gallinula chloropus sandvicensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous
NatureServe Heritage Rank G5 - Secure
Recovery Plan for Hawaiian Waterbirds – USFWS 1999

SPECIES INFORMATION: The ʻalae ʻula or Hawaiian moorhen is a small, striking waterbird (Family: Rallidae), and is one of 12 recognized subspecies; *G. c. sandvicensis,* endemic to Hawaiʻi. ʻAlae ʻula (Hawaiian moorhen) is very similar to its North American relative in appearance; adult males and females are black above and dark slate blue below, with a white stripe on their flanks, and a prominent red shield over their red and yellow bill. Feet are lobed rather than webbed, and males are larger than females. In Hawaiian mythology, a moorhen brought fire to humans, which explains the red on its forehead, a symbol of the scorching from the fire. The species' life history and breeding biology are poorly known. The species uses a variety of freshwater habitats and can be somewhat secretive, although it is often seen swimming across open water. ʻAlae ʻula (Hawaiian moorhen) are opportunistic feeders and their diet likely varies with habitat, but includes algae, grass seeds, plant material, insects, and snails. Nesting habitat is restricted to areas with standing freshwater less than 61 centimeters (24 inches) deep with dense emergent vegetation. Nesting occurs year round, but most activity occurs between March and August. Nesting phenology is apparently tied to water levels and the presence of appropriately dense vegetation. Platform nests are constructed in dense vegetation over water. The particular species of emergent plant used for nest construction is not as important as stem density and vegetation height. Five to six eggs are laid and hatch after 22 days. Although chicks are precocial and can swim shortly after hatching, they are dependent on their parents for several weeks.



DISTRIBUTION:
ʻAlae ʻula (Hawaiian moorhen) generally occur in wetland habitats below 125 meters (410 feet) elevation on the islands of Kauaʻi and Oʻahu, although there have been reports from Keʻanae Peninsula on Maui and from the island of Hawaiʻi. On Kauaʻi, the largest populations occur in the Hanalei and Wailua river valleys. ʻAlae ʻula

(Hawaiian moorhen) also occur in the irrigation canals on the Mānā Plains of western Kauaʻi and in taro fields. On Oʻahu, the species is widely distributed with most birds found between Haleʻiwa and Waimanalo; small numbers occur at Pearl Harbor and the leeward coast at Lualualei Valley. Historically, ʻalae ʻula (Hawaiian moorhen) occurred on all the MHI except for Lānaʻi and Kahoʻolawe.

ABUNDANCE: ʻAlae ʻula (Hawaiian moorhen) are quite secretive and current survey methods are inadequate to accurately estimate population size. Island-wide population, based on semi-annual waterbird counts conducted by DOFAW, suggests that the population is increasing, but count numbers are variable. Between 1993 and 2003, the average annual number of ʻalae ʻula (Hawaiian moorhen) counted has been just under 300 individuals. The species was common at the turn of the last century, but by the 1940s its status was considered precarious.

LOCATION AND CONDITION OF KEY HABITAT: ʻAlae ʻula (Hawaiian moorhen) occur in freshwater marshes, wetland agricultural areas (e.g., taro patches), reedy margins of water courses (e.g., streams, irrigation ditches), reservoirs, and wet pastures, and infrequently, brackish water habitats. Important breeding areas are found on the Hanalei National Wildlife Refuge on Kauaʻi, and the Kahuku and ʻUkoʻa wetlands and Waialua lotus fields on Oʻahu. Key habitat features for ʻalae ʻula (Hawaiian moorhen) include dense stands of robust emergent vegetation near open water, floating or barely emergent mats of vegetation, and water depths less than one meter (3.3 feet). Some important habitats are located in National Wildlife Refuges or on State lands (see distribution) and receive management attention. However, other important habitats are not protected. These mostly include wetlands facing development or those used for agriculture or aquaculture. Examples include: Opaekaʻa marsh, Lumahaʻi wetlands on Kauaʻi, and Amorient prawn farms, Lāʻie wetlands, Uko, Punahoʻolapa, and Waiheʻe marshes, Waialua lotus fields, and Waipiʻo Peninsula ponds on Oʻahu.

THREATS: Similar to the rest of Hawaiian native waterbirds, ʻalae ʻula (Hawaiian moorhen) are threatened by:

- Habitat loss. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift in wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.
- Introduced predators. Dogs (*Canis domisticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), and bullfrogs (*Rana catesbeiana*) all potentially prey on adult or young ʻalae ʻula (Hawaiian moorhen).
- Altered hydrology. Modifications to wetland habitats for flood control or to provide municipal water sources are generally incompatible with ʻalae ʻula (Hawaiian moorhen) populations.
- Non-native invasive plants. Several species of invasive plants, including pickleweed (*Batis maritima*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases. The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).
- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to Hawaiian waterbirds.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawaiʻi and the USFWS have protected 23 percent of the State's remaining coastal plain wetlands. In 1997, Ducks Unlimited developed a comprehensive, cooperative plan to protect and restore wetlands used by native waterbirds. Efforts directed at this species included prohibiting hunting, population monitoring, basic life history research, and re-introduction efforts. In 1983, the USFWS translocated six ʻalae ʻula (Hawaiian moorhen) to Molokaʻi. In addition to common statewide and island conservation actions, specific actions directed at ʻalae ʻula (Hawaiian moorhen) should include:

- Restoration of wetland habitat as well as continued management of existing habitat.
- Re-introduce ʻalae ʻula (Hawaiian moorhen) to Maui Nui and Hawaiʻi.

MONITORING: Continue statewide surveys of populations in known and likely habitats. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES:

- Refine census methods.
- Conduct long-term demographic studies to determine basic reproductive biology, population trends, and survival rates as well as feeding habits. Design studies to facilitate comparisons between populations near urban areas and those located in more rural locations.

References:

Bannor BK, Kiviat E. 2002. Common moorhen (*Gallinula chloropus*). *In* The Birds of North America, No. 685 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1999. Draft revised recovery plan for Hawaiian waterbirds, Second Revision. Portland, (OR): U.S. Fish and Wildlife Service. 107 pp.

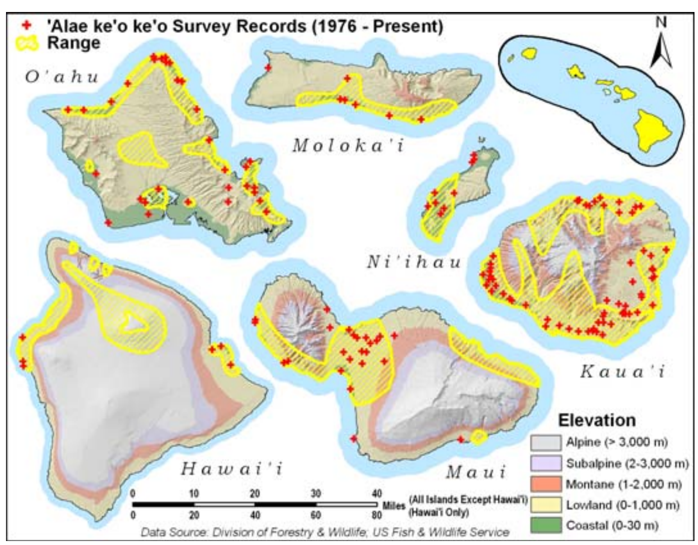
Photo: DOFAW

ʻAlae keʻokeʻo or Hawaiian Coot

Fulica alai

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as endemic
NatureServe Heritage Rank G2 - Imperiled
IUCN Red List Ranking - Vulnerable
Recovery Plan for Hawaiian Waterbirds - USFWS 1999

SPECIES INFORMATION: The ʻalae keʻokeʻo or Hawaiian coot is a small waterbird (Family: Rallidae) endemic to Hawaiʻi. Adult males and females have a black head, a slate gray body with white undertail feathers, and a prominent white frontal shield and bill; feet are lobed rather than webbed and are greenish-gray. The Native Hawaiian considered ʻalae keʻokeʻo (Hawaiian coot) to be a deity, but also considered it good to eat. Life history and breeding biology are poorly known. The species is somewhat gregarious and uses freshwater and brackish wetlands, including agricultural (e.g., taro fields) wetlands and aquaculture ponds. ʻAlae keʻokeʻo (Hawaiian coot) are generalists and feed on land, from the surface of the water, or will dive; also will graze on grass adjacent to wetlands. Food items include seeds and leaves, snails, crustaceans, insects, tadpoles, and small fish. The species will travel long distances, including between islands, when local food sources are depleted. Nesting habitat includes freshwater and brackish ponds, irrigation ditches, and taro fields. Floating nests are constructed of aquatic vegetation and found in open water or anchored to emergent vegetation. Open water nests are usually composed of mats of water hyssop (*Bacopa monniere*) and Hilo grass (*Paspalum conjugatum*). Nests in emergent vegetation are typically platforms constructed from buoyant stems of species such as bulrush (*Scirpus* spp.). Nesting occurs year round, but most activity occurs between March and September. Nest initiation is tied to rainfall as appropriate water levels are critical to nest success. Clutch size range from three to ten eggs, and precocial young hatch after a 25 day incubation period.



DISTRIBUTION: ʻAlae keʻokeʻo (Hawaiian coot) occur in coastal plain wetlands usually below 400 meters (1,320 feet) elevation on all the MHI except for Kahoʻolawe; however, breeding is restricted to relatively few sites. About 80 percent of the population occurs on Kauaʻi (Hanalei, Huleʻia, Opaekaʻa), Oʻahu (coastal wetlands and reservoirs such as Lake Wilson and Nuʻuanu Reservoir, Kahuku Point and along the windward shore), and Maui (Kanahā and Keālia Ponds, Nuʻu Pond). The remaining 20 percent of the population occurs in coastal ponds and playa wetlands, such as Paialoa Pond on Molokaʻi, the Lānaʻi City wastewater treatment, ʻAimakapā and ʻŌpaeʻula ponds on the Kona Coast, and Waiākea and Loko Waka ponds on the island of Hawaiʻi.

ABUNDANCE: Island-wide population, based on semi-annual waterbird counts conducted by DOFAW, suggests that the population is stable and is estimated at between 2,000 and 4,000 individuals.

LOCATION AND CONDITION OF KEY HABITAT: ʻAlae keʻokeʻo (Hawaiian coot) generally occur in lowland wetland habitats with suitable emergent plant growth interspersed with open water, especially freshwater wetlands and taro fields, but also freshwater reservoirs, canefield reservoirs, sewage treatment ponds, brackish wetlands, and rarely saltwater habitats. However, on Kauaʻi, some birds occur in plunge pools above 1,495 meters (4,900 feet) elevation and on the island of Hawaiʻi, stock ponds up to 2,000 meters (6,600 feet) elevation. The species typically forages in water less than 30 centimeters (12 inches) deep, but will dive in water up to 120 centimeters (48 inches) deep. Compared to ʻalae ʻula (Hawaiian moorhen), ʻalae keʻokeʻo (Hawaiian coot) prefer to forage in more open water. Logs, rafts of vegetation, narrow dikes, mud bars, and artificial island are important for resting. Ephemeral wetlands support large numbers during nonbreeding season and may provide a key habitat. Some important habitats are located in National Wildlife Refuges and State sanctuaries (see distribution) and receive management attention. However, other important habitats are not protected. These mostly include wetlands facing development or those used for agriculture or aquaculture. Examples include: playa lakes on Niʻihau, Opaekaʻa marsh, Lumahaʻi wetlands on Kauaʻi, Amorient prawn farms, Lāʻie wetlands, Uko, Punahoʻolapa, and Waiheʻe marshes, Waialua lotus fields, and Waipiʻo Peninsula ponds on Oʻahu, Paialoa and ʻŌʻōʻia playa fishponds on Molokaʻi, and Opaeʻula, and Waiākea-Loko Waka ponds on the island of Hawaiʻi.

THREATS: Similar to the rest of Hawaiian native waterbirds, ʻalae keʻokeʻo (Hawaiian coot) are threatened by:

- Habitat loss. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift from wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.
- Introduced predators. Dogs (*Canis domisticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), and bullfrogs (*Rana catesbeiana*) all potentially prey on adult or young ʻalae keʻokeʻo (Hawaiian coot).
- Altered hydrology. Modifications to wetland habitats for flood control or to make them suitable as municipal water sources are generally incompatible with ʻalae keʻokeʻo (Hawaiian coot) populations.
- Non-native invasive plants. Several species of invasive plants, including pickleweed (*Batis maritima*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases. The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).

- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to Hawaiian waterbirds.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawaiʻi and the USFWS have protected 23 percent of the State's remaining coastal plain wetlands. In 1997, Ducks Unlimited developed a comprehensive, cooperative plan to protect and restore wetlands used by native waterbirds. Efforts directed at this species included population monitoring and basic life history research. In addition to common statewide and island conservation actions, specific actions directed at ʻalae keʻokeʻo (Hawaiian coot) should include:

- Restoration of wetland habitat as well as continued management of existing habitat.

MONITORING: Continue statewide surveys of populations in known and likely habitats. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES:

- Conduct long-term demographic studies to determine basic reproductive biology, population trends, survival rates, and limiting factors as well as feeding habits. Design studies to facilitate comparisons between populations using managed wetlands and those located in unmanaged wetlands.

References:

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

Pratt DH, Brisbin IL. 2002. Hawaiian coot (*Fulica alai*). *In* The Birds of North America, No. 697 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1999. Draft revised recovery plan for Hawaiian waterbirds, Second Revision. Portland, (OR): U.S. Fish and Wildlife Service. 107 pp.

Photo: NRCS

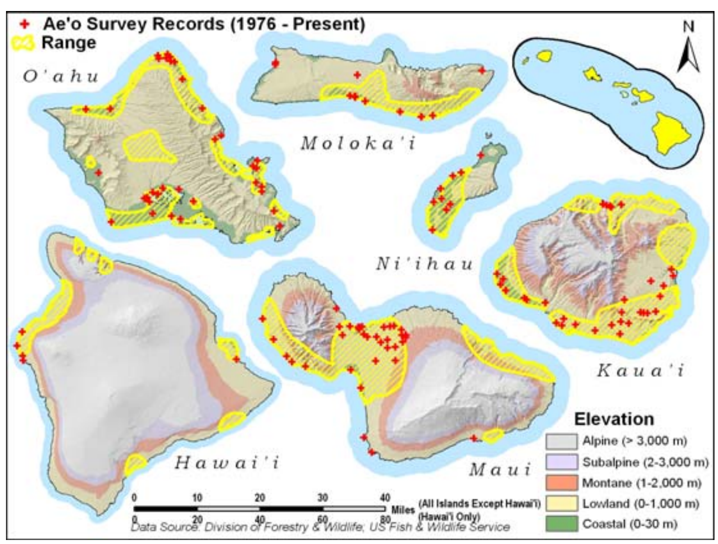
Aeʻo or Hawaiian Stilt

Himantopus mexicanus knudseni

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous
NatureServe Heritage Rank G5 - Secure
Recovery Plan for Hawaiian Waterbirds - USFWS 1999

SPECIES INFORMATION: The aeʻo or Hawaiian stilt is a slender, graceful waterbird (Family: Recurvirostridae) that is considered distinct from the North American subspecies, *H. m. mexicanus*. Adult males and females are mostly black above and white below with a long, thin black bill and long, delicate pink legs. Foraging habitat consists of ephemeral fresh, brackish, or salt water habitats. Water depth and vegetation density are important determinants of the suitability of foraging habitat. Aeʻo (Hawaiian stilt) prefers sites with a water depth of less than 24 centimeters (nine inches), limited and low growing vegetation, or exposed tidal flats. The species is opportunistic and preys on a variety of animals that inhabit shallow water or mudflats, including polychaete worms, small crabs, insects, and small fish. Aeʻo (Hawaiian stilt) frequently move among wetland habitats in search of food. Breeding habitat differs from foraging habitat and individuals move between the two habitats daily. Nesting occurs on freshly exposed mudflats with some low growing vegetation, also will nest on islands in fresh and brackish ponds or artificial floating nest structures. Aeʻo (Hawaiian stilt) aggressively defend their nests, calling and diving at intruders and performing broken-wing displays to attract potential predators away from their nests. Nesting occurs between March and August and peaks in May and June. Generally three to four eggs are laid and the precocial (i.e., capable of leaving nest shortly after hatching) chicks hatch approximately 24 days latter. Both parents incubate eggs and brood young, and fledglings remain with their parents for several months. Inter-island movements by aeʻo (Hawaiian stilt) are suspected.

DISTRIBUTION: Aeʻo (Hawaiian stilt) are generally found in wetland habitats below 200 meters (660 feet) elevation on all the MHI except for Kahoʻolawe. On Oʻahu, most of the population can be found on the north and windward coast at Kahuku Point on the James Campbell National Wildlife Refuge, Kahuku Point oyster ponds, Amorient aquaculture ponds, and Roland and Nuʻupia ponds in Kāneʻohe. Smaller numbers use wetland habitats associated with Pearl Harbor and along the leeward coast. On Kauaʻi, stilts are found in large river



valleys including Hanalei, Wailua, and Lumahaʻi, on the Mānā Plains, and at reservoirs and sugarcane effluent ponds in Līhue and Waimea. Aeʻo (Hawaiian stilt) populations move annually between Kauaʻi and Niʻihau in response to water level changes in Niʻihau's ephemeral lakes. On Maui, most populations use the coastal wetlands of Kanahā and Keālia, smaller numbers use reservoirs and aquaculture habitats. On Molokaʻi, the southern coastal wetlands and playa lakes are important habitats. On Lānaʻi, a small population of aeʻo (Hawaiian stilt) are permanent residents at the Lānaʻi City wastewater treatment ponds. Finally, on the island of Hawaiʻi, the largest number of aeʻo (Hawaiian stilt) are found on the Kona coast, especially in anchialine ponds, from Kawaihae Harbor south to Kailua. Other habitats include Makalawena and Aimakapā ponds, Cyanotech Ponds, the Kona wastewater treatment ponds, wetlands along the Hāmākua Coast, and the Kohala River valleys of Waipiʻo, Waimanu, and Pololū. Historically, aeʻo (Hawaiian stilt) certainly occurred on Niʻihau, Kauaʻi, Oʻahu, Maui, and Molokaʻi; there are no documented records of the species on the island of Hawaiʻi prior to 1961.

ABUNDANCE: Island-wide population, based on semi-annual waterbird counts conducted by DOFAW, suggests that the population is stable or slightly increasing, but count numbers are variable. Between 1993 and 2003, excluding 2001, the average annual number of aeʻo (Hawaiian stilt) counted has been approximately 1,300 individuals; in 2001 an average of 2,680 individuals was recorded. Historic population estimates are variable.

LOCATION AND CONDITION OF KEY HABITAT: Aeʻo (Hawaiian stilt) use a variety of wetland habitats, but have specific habitat requirements. Preferred foraging habitats are early successional marshlands with shallow water, and perennial, low growing vegetation or exposed tidal flats (see species information); other wetland habitats that share similar characteristics also are used. Examples include freshwater habitats: ephemeral lakes, reservoirs, settling basins, natural or manmade ponds, and sugar settling basins; brackish water habitats: coastal ponds, silted fish ponds, and estuaries; and saltwater habitats: inshore reefs, silted beach areas, and tidal flats. Ephemeral lakes on Molokaʻi, Maui, and Niʻihau provide important habitats for aeʻo (Hawaiian stilt) as do prawn farms and anchialine pools. Preferred nesting habitats are sites adjacent to or low-relief islands in bodies of fresh, brackish, or salt water. Examples include reservoirs, settling basins, natural or manmade ponds, marshes, taro patches, silted fish ponds, salt evaporation pans, and other wetlands. Loafing areas are usually open mudflats or open flooded pasture lands where visibility is good and predator populations are low. Some important habitats are located in National Wildlife Refuges or on State lands (see distribution) and receive management attention. However, other important habitats are not protected. These mostly include wetlands facing development or those used for agriculture or aquaculture. Examples include: playa lakes on Niʻihau, Opaekaʻa marsh, Lumahaʻi wetlands on Kauaʻi, Amorient prawn farms, Lāʻie wetlands, Uko, Punahoʻolapa, and Waiheʻe marshes, Waialua lotus fields, and Waipiʻo Peninsula ponds on Oʻahu, Paialoa and ʻŌʻōʻia playa fishponds on Molokaʻi, and Opaeʻula, and Waiākea-Loko Waka ponds on the island of Hawaiʻi.

THREATS: Historically, the species was a popular game bird, and hunting contributed to population declines until its prohibition in 1939. Similar to the rest of the Hawaiian native waterbirds, aeʻo (Hawaiian stilt) are threatened by:

- <u>Habitat loss</u>. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift in wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.

- Introduced predators. Ae‘o (Hawaiian stilt) are especially vulnerable to predation by dogs (*Canis domisticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), and bullfrogs (*Rana catesbeiana*) as well as by pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*), and ‘auku‘u or black-crowned night herons (*Nycticorax nycticorx hoactli*); all potentially prey on adult or young ae‘o (Hawaiian stilt).
- Altered hydrology. Modifications to wetland habitats for flood control or to provide municipal water sources are generally incompatible with ae‘o (Hawaiian stilt) populations.
- Non-native invasive plants. Several species of invasive plants, including pickleweed (*Batis maritime*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases. The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).
- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to Hawaiian waterbirds.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawai‘i and the USFWS have protected 23 percent of the State's remaining coastal plain wetlands. In 1997, Ducks Unlimited developed a comprehensive, cooperative plan to protect and restore wetlands used by native waterbirds. Efforts directed at this species included prohibiting hunting, population monitoring, and basic life history research. In addition to common statewide and island conservation actions, specific actions directed at ae‘o (Hawaiian stilt) should include:

- Restoration of wetland habitat as well as continued management of existing habitat.
- Development of more effective predator control methods.

MONITORING: Continue statewide surveys of populations in known and likely habitats. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES:

- Conduct long-term demographic studies to determine basic reproductive biology, population trends, survival rates, and limiting factors as well as feeding habits. Design studies to facilitate comparisons between populations near urban areas and those located in more rural locations.

References:

Robinson JA, Reed JM, Skorupa JP, Oring LW. 1999. Black-necked stilt (*Himantopus mexicanus*). *In* The Birds of North America, No. 449 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1999. Draft revised recovery plan for Hawaiian waterbirds, Second Revision. Portland, (OR): U.S. Fish and Wildlife Service. 107 pp.


Photo: David Leonard, USFWS

Mōlī or Laysan Albatross
Phoebastria immutabilis

SPECIES STATUS:
State recognized as Indigenous
Bird of Conservation Concern at the Regional Level
NatureServe Heritage Rank G3 - Vulnerable
North American Waterbird Conservation Plan - High concern
IUCN Red List Ranking - Vulnerable
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The mōlī or Laysan albatross is a large, abundant seabird (Family: Diomedeidae) whose breeding range is centered in Hawaiʻi. Adult males and females are mostly white except for black wings and tail; upperwings entirely dark, underwings mostly white with variable amounts of black especially along leading and trailing edges. Bill pink with gray, hooked tip; legs and feet light pink. Like all albatross, mōlī (Laysan albatross) are accomplished fliers using dynamic soaring to cover great distances. Mainly feeds at night and often far from breeding colony (e.g., 1,770 kilometers [1,100 miles]). Mōlī (Laysan albatross) often feed with conspecifics, but rarely with other species, and similar to other albatross, seizes prey from the surface while sitting on the water. Scavenges from carrion and follows fishing boats, but not as frequently as kaʻupu or black-footed albatross (*P. nigripes*). In Hawaiʻi, diet consists primarily of squid, as well as deep-water crustaceans, fish and flyingfish eggs. Like most seabirds, mōlī (Laysan albatross) breed in colonies, have long-term pair bonds and high site fidelity, lay only one egg per season, and both parents participate in all aspects of raising young. Pairs engage in long, noisy, ritualized courtship dances. Typically select nest site closer to vegetation than kaʻupu (black-footed albatross), and nest varies from a scrape to a ring-like structure comprised of sand, vegetation, and debris. In Hawaiʻi eggs are laid between November and December and chicks fledge in July, no post-fledgling care provided by parents. Young birds do not return to land until their third year after fledging. These birds do not breed, but dance, build nests, and prospect for mates. Birds first breed between eight and nine years of age, and the oldest known individual was 51 years old.

DISTRIBUTION: Mōlī (Laysan albatross) breed throughout the NWHI and on the MHI of Kauaʻi and Oʻahu and Lehua Island off of Niʻihau. Outside of Hawaiʻi, mōlī (Laysan albatross) breed on islands off of Japan and Mexico. Outside the breeding season, mōlī (Laysan albatross) disperse widely throughout the North Pacific.

ABUNDANCE: In Hawaiian Archipelago, population is estimated at greater than 590,000 pairs with largest colonies occurring on Midway Atoll (441,000 pairs) and Laysan (145,000 pairs).

Total population of all MHI colonies is less than 100 pairs. Worldwide population is estimated at 630,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Mōlī (Laysan albatross) may prefer to breed on low coral and sand islands, but also breed on high volcanic islands. On the former sites they breed on flat open areas; on the latter, including such islands as Nihoa and Lehua, nest on steep rocky areas. A majority of the world's mōlī (Laysan albatross) breed within the Hawaiian Islands National Wildlife Refuge and on Midway Atoll National Wildlife Refuge. Two of the largest breeding colonies on the MHI occur in the Kīlauea Point National Wildlife Refuge on Kauaʻi and the Kaʻena Point Natural Area Reserve on Oʻahu. Predators are controlled at both these sites. Attempts to breed are discouraged (e.g., eggs are removed) at several military bases in the MHI in an effort to reduce collisions with aircraft. **Marine**: Pelagic.

THREATS:

- Humans. Historically, wanton killing for feathers (i.e., millinery trade) greatly reduced populations. Populations extirpated from Johnston, Wake, and Marcus islands by Japanese feather hunters at the turn of the last century are only recently being re-colonized. Untold numbers were killed as a result of military activities in the Pacific during World War II. Between 1954 and 1964, 54,000 albatross were killed on Midway to reduce the risk of collisions with aircraft. In 1909, 300,000 birds were killed on Laysan Island. Prior to banning drift net fisheries in 1993, thousands were killed annually. In the 1990s, longline fisheries killed thousands annually.
- Introduced predators. Like all seabirds, adults and nests are susceptible to mammal predation by pigs (*Sus scrofa*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Introduced invasive species. Non-native plants, specifically golden crown-beard (*Vervesina encelioides*), degrades nesting habitat and may limit nesting density, reduce productivity, and provide habitat for mosquitoes (*Culex* spp.) that carry avian pox. Introduced big-headed ants (*Pheidole megacephala*) at Kure may facilitate the destruction of native vegetation by a non-native scale insect.
- Contaminants. At Midway, lead contaminated soil is ingested by chicks and affects survival rates.
- Marine pollution. Similar to other albatross, ingestion of plastic debris and oil likely a threat.
- Collisions. At Midway, albatross collide with buildings, lights, antenna wires, and other man-made structures. In 1964 alone, 3,000 albatross were killed by colliding with communication antennas on Midway.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to mōlī (Laysan albatross) populations should include the following:

- Continue predator and ungulate control efforts at MHI colonies.

- Continue efforts to control non-native vegetation at Midway, Pearl and Hermes, and Kure Atoll.
- Remove lead contaminated soils from Midway.
- Eradicate mosquitoes from Midway.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue annual censuses of breeding colonies and design and implement a population monitoring program that will allow the estimation of age-specific survival rates.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to mōlī (Laysan albatross) include the following:

- Analyze and report on demographic data based on 50 years of USFWS banding data.
- Design a sampling program to estimate breeding populations at Midway.
- Support efforts to estimate annual mortality from U.S. and foreign fisheries and use demographic models to determine the effect of this mortality on population.
- Continue research and development of techniques and gear that will minimize mortality and continue to explore alternatives to mitigate mortality (i.e., take) of mōlī (Laysan albatross) by fishing industry.

References:

Hawai'i Natural Heritage Program [Hawai'i Biodiversity and Mapping Program]. 2004. Natural diversity database. University of Hawai'i, Center for Conservation Research and Training. Honolulu, HI.

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Whittow GC. 1993. Laysan albatross (*Diomedea immutabilis*). *In* The Birds of North America, No. 66 (Poole A, Gill F, editors.). Philadelphia: The Academy of Natural Sciences; Washington DC: The American Ornithologists' Union.

Photo: David Leonard, USFWS

Ka'upu or Black-footed Albatross

Phoebastria nigripes

SPECIES STATUS:

State listed as Threatened
State recognized as Indigenous
Bird of Conservation Concern at the National Level
NatureServe Heritage Rank G5 - Apparently secure
North American Waterbird Conservation Plan - High concern
IUCN Red List Ranking - Endangered
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ka'upu or black-footed albatross is the smallest albatross (Family: Diomedeidae) found in Hawai'i. Adult males and females are entirely black except for a narrow whitish area at the base of the bill and another under the eyes; ten percent of the individuals also have a white rump and undertail coverts. Like all albatross, ka'upu (black-footed albatross) are accomplished fliers using dynamic soaring to cover great distances. Ka'upu (black-footed albatross) feed from the surface by seizing prey while sitting on the water, and will "tip-up" very similar to ducks. Like many seabirds, uses a well-developed olfactory sense to locate food. Ka'upu (black-footed albatross) form long-term pair bonds and exhibit a high degree of nest site philopatry. Breeding occurs in large colonies and nests are placed on open, sandy beaches or dunes. Pairs engage in noisy, ritualized courtship dances. Pairs remain together until the death or disappearance of a partner, but do not breed every year. Ka'upu (black-footed albatross) nest in scooped out hollows on the upper parts of sandy beaches. In Hawai'i, eggs are laid in November and chicks fledge in June and July, and like many seabirds, only one egg is laid per year. Both male and female incubate egg, and brood and feed young. Young birds do not return to land until their third year after fledging. These birds do not breed, but dance, build nests, and prospect for mates. Age at first breeding is at least 5 years old, and the oldest-known black-footed albatross is at least 43 years old.

DISTRIBUTION: With the exception of a few breeding colonies off Japan, the breeding distribution of the black-footed albatross is restricted to the NWHI where breeding occurs on all islands. Historically, bred on Johnston, Marcus, Wake, Volcano Island, Marshall Island, and the Northern Marianas; no evidence of historically breeding on MHI. Non-breeding range is the northern Pacific Ocean.

ABUNDANCE: In Hawai'i, population estimated at approximately 55,000 breeding pairs; 95 percent of the world's population. Majority of individuals breed on Laysan (19,500 pairs) and Midway (20,400 pairs).

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Kaʻupu (black-footed albatross) breed on low coral and sand islands, and use open sandy beaches or dunes for nest sites, occasionally nesting occurs among vegetation. **Marine**: Pelagic.

THREATS:

- Humans. Historically, feather hunters decimated populations. Occupation of Pacific islands by military during World War II also took a heavy toll on this species. For example, during the 1950s and 1960s tens of thousands were killed at Midway to reduce collisions with aircraft.
- Fishing Industry. Longline fisheries now are responsible for the death of most kaʻupu (black-footed albatross); between 1990 and 1994, it is estimated that greater than 23,000 individuals were killed on longline hooks set by the north Pacific swordfish fishery. An estimated 1,800 were killed annually between 1994 and 1998 by the Hawaiʻi longline fishery.
- Marine pollution. Similar to other albatross, ingestion of plastic debris and oil likely threaten kaʻupu (black-footed albatross).
- Contaminants. Organochlorine levels high enough to result in eggshell thinning and embryonic defects have been detected in kaʻupu (black-footed albatross).
- Global climate change. Kaʻupu (black-footed albatross) nest close to the shoreline, thus sea level increases may pose a critical threat.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. Past actions have included efforts to mitigate the impact of longline fisheries and predator control. In addition to these efforts, future management specific to Hawaiian populations of kaʻupu (black-footed albatross) should include the following:

- Complete a status assessment.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue annual censuses of breeding colonies and design and implement a population monitoring program that will allow the estimation of age-specific survival rates.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to the kaʻupu (black-foot albatross) include the following:

- Analyze and report on demographic data based on 50 years of USFWS banding data.
- Support efforts to estimate annual mortality from U.S. and foreign fisheries and use demographic models to determine the effect of this mortality on population.
- Continue research and development of techniques and gear that will minimize mortality and continue to explore alternative to mitigate mortality (i.e., take) of kaʻupu (black-foot albatross) by fishing industry. Estimate mortality from all U.S. and foreign fisheries and determine effect of this mortality to population.

References:

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Whittow GC. 1993. Black-footed albatross (*Diomeda nigripes*). *In* The Birds of North America, No. 65 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Forest and Kim Starr, USFWS

Short-tailed Albatross

Phoebastria albatrus

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
NatureServe Heritage Rank G1 - Critically imperiled
North American Waterbird Conservation Plan – High concern
IUCN Red List Ranking - Vulnerable

SPECIES INFORMATION: The short-tailed albatross is the largest seabird (Family: Diomedeidae) found in Hawaiʻi, although currently it is very rare and only found on Midway Atoll. Adult males and females are mostly white, with varying amounts of black, mostly on the upper side of the wings, and a golden wash on the head. Huge pink bill has a bluish tip and legs and feet are pale pink. Like other albatross, uses air currents to glide and soar for long periods of time. Compared to other albatross forages closer to land, and similar to other albatross, feeds by seizing prey from the surface while sitting on the water. Scavenges from carrion and follows fishing boats. In Japan, diet consists primarily of shrimp, squid, and fish, including bonita, flyingfish, and sardines. As far back as the 1930s, individuals have occurred among nesting mōlī or Laysan (*P. immutabilis*) and kaʻupu or black-footed (*P. nigripes*) albatross at Midway Atoll. In the 1990s a pair of short-tailed albatross produced two infertile eggs. See fact sheets for mōlī (Laysan albatross) or kaʻupu (black-footed albatross) for details of breeding biology. Like other albatross, short-tailed albatross likely have a life span of at least 50 years.

DISTRIBUTION: Small numbers of individuals regularly visit the NWHI, particularly Midway Atoll. Outside of Hawaiʻi, the short-tailed albatross breeds on two small islands off of Japan. Outside the breeding season, short-tailed albatross disperse widely across the temperate and subarctic North Pacific.

ABUNDANCE: See distribution for Hawaiʻi numbers. Worldwide population is estimated at 1,700 individuals.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Short-tailed albatross breed on oceanic islands and atolls. Nests are similar to other albatross species. **Marine**: Pelagic.

THREATS:

- Humans. Historically the most common albatross in the North Pacific, numbered in the million. By the 1930s the short-tailed albatross was thought to be extinct as a result of wanton killing for their feathers (i.e., millinery trade).
- Commercial fishing. In Hawaiian waters, the principle threat to short-tailed albatross is the longline fishery.

- Marine pollution. Similar to other albatross, ingestion of plastic debris and oil likely a threat.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, management specific to short-tailed albatross should include the following:

- Continue attempts (e.g., decoys and playing of vocalizations) to establish a breeding population on Midway Atoll.
- Determine the number of short-tailed albatross that are killed as a result of fishing industry.
- Develop a recovery plan.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to short-tailed albatross includes the following:

- Support efforts to estimate annual mortality from U.S. and foreign fisheries and use demographic models to determine the effect of this mortality on population.
- Continue research and development of techniques and gear that will minimize mortality and continue to explore alternatives to mitigate mortality (i.e., take) of short-tailed albatross by fishing industry.

References:

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: C. Hodges, NPS

ʻUaʻu or Hawaiian Petrel

Pterodroma sandwichensis

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Indigenous
NatureServe Heritage Rank G2/T2 – Species globally imperiled/Subspecies locally imperiled
North American Waterbird Conservation Plan - Moderate concern
IUCN Red List Ranking - Vulnerable
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻuaʻu or Hawaiian petrel is a large, nocturnal gadfly petrel (Family: Procellariidae) endemic to Hawaiʻi. Adult males and females are uniformly dark grayish black above forming a partial collar which contrasts with white throat, forehead, and cheeks; entirely white below except for black tail and leading and trailing edges of underwings. Bill black, and legs and feet mostly pink. Even during the breeding season, ʻuaʻu (Hawaiian petrel) often feeds thousands of kilometers from colonies, usually foraging with mix-species feeding flocks, typically over schools of predatory fishes. ʻUaʻu (Hawaiian petrel) feeds by seizing prey while sitting on the water or by dipping prey while flapping just above the ocean surface, often pattering water with feet. In Hawaiʻi, ʻuaʻu (Hawaiian petrel) feed primarily on squid, but also on fish, especially goatfish and lantern fish, and crustaceans. ʻUaʻu (Hawaiian petrel) nest in colonies, form long-term pair bonds, and return to the same nest site year after year. Colonies are typically located in high elevation, xeric habitats or wet, dense forests. Nests in burrows, crevices, or cracks in lava tubes; nest chamber can be from one to nine meters (3 - 30 feet) deep. Most eggs are laid in May and June and most birds fledge by December. Both parents incubate single egg, and brood and feed chick. Birds likely first breed at five to six years of age.

DISTRIBUTION: ʻUaʻu (Hawaiian petrel) breed on MHI of Maui, Hawaiʻi, and Kauaʻi and possibly on Molokaʻi, Lānaʻi, the sea stacks off of Kahoʻolawe and Lehua off of Niʻihau. Subfossil evidence indicates that prior to the arrival of Polynesians, ʻuaʻu (Hawaiian petrel) was common throughout the MHI. Outside the breeding season, ʻuaʻu (Hawaiian petrel) are most common near nesting colonies but may range as far as 1,300 kilometers (800 miles) from land.

ABUNDANCE: Total number of individuals is estimated at 20,000 with a breeding population between 4,500 and 5,000 pairs, although inaccessible nesting locations make accurate counts difficult. As many as 1,000 pairs breed in Haleakalā National Park on Maui. Although undocumented and difficult to assess, most birds may breed on the island of Kauaʻi.

LOCATION AND CONDITION OF KEY HABITAT: **Terrestrial**: ʻUaʻu (Hawaiian petrels) breed in a variety of remote, inland habitats. On the islands of Hawaiʻi and Maui, colonies are located above 2,500 meters (8,200 feet) elevation in xeric habitats with very sparse vegetation, but with suitable substrates for burrowing or with existing crevices in lava. On Kauaʻi, habitat includes lower elevation wet forests dominated by ʻōhiʻa (*Metrosideros polymorpha*) with a dense understory of uluhe fern (*Dicranopteris linearis*). **Marine**: Pelagic.

THREATS:

- Historic human hunting. Nestlings were considered a delicacy by Polynesians, and were harvested from nest burrows. Adults were netted as they returned to colonies, and smoky fires were sometimes lit along flight corridors to disorient and ground birds.
- Introduced predators. Like all seabirds, adults and nests are susceptible to mammal predation. Polynesians brought dogs (*Canis domisticus*), pigs (*Sus scrofa*), and rats (*Rattus exulans*), Europeans added additional rat species, feral cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Feral ungulates. Feral goats (*Capra hircus*), mouflon sheep (*Ovis musimon*), and potentially axis deer (*Axis axis*) trample burrows.
- Artificial lighting. Street and resort lights, especially in coastal regions, disorient fledglings causing them to eventually fall to the ground exhausted or increasing their chance of colliding with artificial structures (i.e., fallout). Once on the ground, fledglings are unable to fly and are killed by cars, cats, and dogs or die because of starvation or dehydration.
- Colony locations. Remoteness of colonies, as well as the habitat they occur in (e.g., steep terrain or dense forest) complicates predator and ungulate eradication or control.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. Past actions directed at ʻaʻo or Newell's shearwater (*Puffinus auricularis*) have benefited ʻuaʻu (Hawaiian petrel) populations and these include: the rescue and rehabilitation of downed fledglings by the conservation project Save Our Shearwaters, and efforts to shade resort lighting and streetlights. In addition to these efforts, future management specific to ʻuaʻu (Hawaiian petrel) populations should include the following:

- Continue predator and ungulate control efforts at colonies on the islands of Hawaiʻi and Maui.
- Locate additional colonies on the islands of Hawaiʻi and Maui.
- Locate colonies on Kauaʻi and initiate predator and ungulate control.
- Survey Molokaʻi, Lānaʻi, and Kahoʻolawe to determine if breeding colonies exist.
- Initiate predator control at accessible, potential colony sites such as Lehua.
- Continue to identify fallout areas and work to minimize effects of powerlines and artificial lights.
- Continue to support efforts of Save Our Shearwater Program, particularly its outreach initiatives concerning raising public awareness of light fallout and rescue and rehabilitation program, and determine the need and feasibility of establishing a similar program on other islands.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻuaʻu (Hawaiian petrel) include the following:

- Development and implementation of standardized survey protocols to determine current population size and status.
- Expand radar studies to monitor population trends, locate colonies, investigate behavior, determine geographic variability in threats, and quantify efficacy of conservation measures.
- Initiate studies designed to increase understanding of how lights affect petrels with the goal being to minimize effects.
- Conduct long-term demographic studies to determine basic reproductive biology, population trends, and survival rates. Design studies to facilitate comparisons between colonies near urban areas and those located in remote locations.
- Develop powerline and windfarm mitigation measures.
- High elevation colonies provide the opportunity to study the physiological adaptations which allow eggs and nestlings to develop and survive at high-elevations.

References:

Hawai'i Natural Heritage Program [Hawai'i Biodiversity and Mapping Program]. 2004. Natural diversity database. University of Hawai'i, Center for Conservation Research and Training. Honolulu, HI.

IUCN Red List of Threatened Species. Available at: http://www.redlist.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

Simons TR, Hodges CN. 1998. Dark-rumped petrel (*Pterodroma phaeopygia*). *In* The Birds of North America, No. 345 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: Rachel Seabury, USFWS

Bonin Petrel

Pterodroma hypoleuca

SPECIES STATUS:
State recognized as Indigenous
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The Bonin petrel is a small, nocturnal gadfly petrel (Family: Procellariidae) which breeds further north than any of its Pacific relatives. Like many pelagic seabirds, Bonin petrels mostly have dark upper parts and light underparts and the sexes are similar in appearance. Flight is fast, and compared to other petrels, the species is very maneuverable. Bonin petrels generally forage far offshore, and feed by seizing prey while sitting on the water or while hovering. Usually forages alone, but may join mixed species flocks. Unlike most of its congeners, Bonin petrels feed mostly on fish, primarily lantern fishes (Myctophidae) and hatchetfishes (Sternoptychidae), although squid (Ommastrephidae) also are important. Bonin petrels are winter breeders, and interestingly, the only other gadfly petrel that breeds in Hawaiʻi (i.e., ʻuaʻu or Hawaiian petrel [*P. phaeopygia*]) nests in the summer. Like most seabirds, Bonin petrels breed in their natal colonies, form long-term pair bonds, have high site fidelity, lay only one egg per season, and both parents participate in all aspects of raising young. Bonin petrels nest in burrows which they excavate in sandy soils. In Hawaiʻi, eggs are laid in mid January and chicks fledge by June. Competes with larger ʻuaʻu kani (or wedge-tailed shearwater [*Puffinus pacificus*]) for burrows, and late fledging petrel chicks are sometimes killed by returning shearwaters. No information on age of first breeding. The oldest known Bonin petrel is 19 years old.

DISTRIBUTION: Bonin petrels breed on the NWHI from French Frigate Shoals to Kure. Historically bred on MHI. Outside of Hawaiʻi, breeding populations are restricted to Bonin and Volcano islands off of Japan. Outside the breeding season a few individuals remain in the waters surrounding the Hawaiian Islands, but most disperse widely mainly between Hawaiʻi and Japan.

ABUNDANCE: In the Hawaiian Archipelago, population estimated at between 270,000 and 395,000 breeding pairs, with the largest populations occurring on Lisianski (150,000 - 250,000 pairs), Laysan (50,000 - 75,000 pairs), and Midway Atoll (70,000 pairs). Prior the introduction of rats (*Rattus* spp.) in the 1930s, an estimated 250,000 pairs nested on Midway. Worldwide population is unknown.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Bonin petrels breed on predator free islands. Sandy soils are necessary for nest burrow excavation. Currently all breeding colonies in Hawaiʻi occur in the Hawaiian Islands National Wildlife Refuge or the Midway Atoll National Wildlife Refuge. **Marine**: Pelagic.

THREATS:

- Non-native mammals. Historically, mammalian introductions to islands supporting nesting colonies resulted in declines or extirpations. On Lisianski and Laysan, rabbits (*Oryctolagus cuniculus*) denuded the island resulting in erosion which destabilized burrows. On Midway and Kure, rats (*Rattus* spp.) resulted in declines of breeding populations. Over a 40 year period, the Midway population declined from 250,000 to 5,000 pairs. Rabbits and rats have been eradicated from all NWHI.
- Collisions. Disorientation due to artificial lighting increases vulnerability to collisions with man-made structures.
- Invasive species. Non-native plants, specifically golden crown-beard (*Vervesina encelioides*) and sandbur (*Cenchrus agrimonioides*), degrades nesting habitat by providing poor soil stabilization. Introduced big-headed ants (*Pheidole megacephala*) at Kure may cause nestling mortality, but also facilitate the destruction of native vegetation by a non-native scale insect.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protection, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of Bonin petrels should include the following:

- Eradicate golden crown-beard on Pearl and Hermes Reef and Midway, and prevent its establishment on other islands.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats, and develop and implement a monitoring program to track recovering populations at Midway and Kure post rat eradication.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to the Bonin petrel include the following:

- Conduct long-term demographic studies to determine population trends, survival rates, and reproductive success.
- Determine the effect of non-native ants and scale insects on Bonin petrel populations and develop methods to eradicate or control ants and scale.

References:

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Photo: DOFAW

‘Ou or Bulwer’s Petrel

Bulweria bulwerii

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G4 - Apparently secure
North American Waterbird Conservation Plan - Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ‘ou or Bulwer’s petrel is a highly pelagic, nocturnal gadfly petrel (Family: Procellariidae) with a pantropical distribution. Individuals have long pointed wings, a long pointed tail, a black bill and pale short legs. Adult males and females are overall sooty brown, with a pale bar across the proximal half of upper wings. Flight is buoyant and erratic; individuals fly low over the water using short wing beats followed by glides. ‘Ou (Bulwer’s petrel) forage alone. Foraging behavior is poorly known as is diet. Likely takes prey at surface by dipping on the wing or seizing while sitting on the water. Diet includes fish and squid, but also crustaceans and sea-striders. ‘Ou (Bulwer’s petrel) form long-term pair bonds and breed in large colonies. Limited data suggests they return to their natal colonies to breed and pairs return to the same nest site year after year. Nest is placed in a variety of hollows or crevices. Nests have a strong musky odor and may be nothing more than the cavity floor or may be lined with feathers, vegetation, or rubble. In Hawai‘i, eggs are laid from mid May to mid June and most nestlings fledge by early October. Both parents incubate the egg, and brood and feed the chick. Age at first breeding is six years, and the oldest known individual was 24 years old.

DISTRIBUTION: ‘Ou (Bulwer’s petrel) breed throughout the NWHI and on offshore islets of the MHI, including Hulu, Kaeoi, Kāohikaipu, Kapapa, Ka‘ula, Lehua, Mānana, Moke‘ehia, Mōkōlea Rock, Moku Lua, Moku Manu, Mokuho‘oniki, Molokini, and Popoi‘a. Outside of Hawai‘i, ‘ou (Bulwer’s petrel) breed on a limited number of islands in the North Atlantic, North and South Pacific, and Indian Ocean. Non-breeding season range is poorly known, but have been observed dispersing to the southeast after breeding.

ABUNDANCE: In Hawai‘i, population estimated at between 75,000 and 103,000 breeding pairs on the NWHI and between 500 and 1,000 pairs on MHI. Largest colony on Nihoa (75,000 to 100,000 pairs); which supports the world’s largest known breeding colony. Smaller colonies are found on Laysan (1,000 - 2,000 pairs), French Frigate Shoals (200 - 500 pairs), and Necker (250 - 500 pairs). Prior to the introduction of rats (*Rattus* spp.) to Midway, ‘ou (Bulwer’s petrel) were abundant. The worldwide population is unknown.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: ‘Ou (Bulwer’s petrel) breed on rocky islets and atolls, nesting in rock crevices, rock or coral rubble, under vegetation, and man-made nest structures. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests susceptible to predation by rats and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats. Recent eradication of rats from Midway and Kure should allow re-establishment of breeding colonies.
- Invasive species. Introduced big-headed ants (*Pheidole megacephala*) have been observed killing piping chicks.
- Catastrophic events. Given that a large portion of the world's population breeds on Nihoa, a single catastrophic event (e.g., hurricane) could decimate the species.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of 'ou (Bulwer's petrel) should include the following:

- Eradication and control of introduced predators at current and potential breeding colonies.
- Facilitate the re-colonization of islands in MHI to reduce the species' vulnerability to catastrophes.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to 'ou (Bulwer's petrel) include the following:

- Baseline research on this species is needed as most aspects of its biology are poorly known.

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Photo: Forest and Kim Starr, USFWS

ʻUaʻu kani or Wedge-tailed Shearwater

Puffinus pacificus

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G4/G5 - Apparently secure/Secure
North American Waterbird Conservation Plan - Low concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻuaʻu kani or wedge-tailed shearwater is a large, abundant seabird (Family: Procellaridae) that produces a variety of wails and moans that surely inspired the Hawaiian name of this bird which means "calling or moaning petrel." Individuals have long thin wings, a wedge-shaped tail, and a hooked bill. ʻUaʻu kani (wedge-tailed shearwater) are polymorphic, having two color phases, dark or light, and sexes are similar. Light-phase adults are grayish brown above with white underparts except for dark trailing edges of wings and tail. Dark-phase adults are uniformly sooty brown. Flight is similar to that of albatross but flaps wings with greater frequency. Often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. ʻUaʻu kani (wedge-tailed shearwater) use a variety of foraging techniques, most frequently plunges head into water while on the wing, also seizes prey will sitting on the water; often follows fishing vessels. In Hawaiʻi, diet primarily consists of larval goatfish, flyingfish, squirrelfish, and flying squid. Like most seabirds ʻuaʻu kani (wedge-tailed shearwater) breed in their natal colonies, form long-term pair bonds (although breeding failure in this species may result in divorce), have high site fidelity, lay only one egg per season, and both parents participate in all aspects of raising young. ʻUaʻu kani (wedge-tailed shearwater) excavate burrows or nest in rock cervices. In Hawaiʻi, breeding is very synchronous, and most eggs are laid in June with most young fledging in November. Birds first breed at four years of age, and the oldest known individual was 29 years old.

DISTRIBUTION: ʻUaʻu kani (wedge-tailed shearwater) breed throughout the NHWI and on offshore islets of most of the MHI. Outside of Hawaiʻi, ʻuaʻu kani (wedge-tailed shearwater) breeds on islands throughout the tropical and subtropical Indian and Pacific oceans. Outside the breeding season, ʻuaʻu kani (wedge-tailed shearwater) migrate to the eastern Pacific.

ABUNDANCE: In Hawaiʻi, population estimated at 270,000 breeding pairs with the largest colonies occurring on Laysan (125,000 - 175,000 pairs), Nihoa (30,000 - 40,000 pairs), and Lisianski (10,000 - 30,000 pairs). The population in the MHI is estimated at between 40,000 and 60,000 breeding pairs with the largest colonies occurring on the offshore islands of Mānana (10,000 - 20,000 pairs), Moku Loa (10,000 - 20,000 pairs), Lehua (23,000 pairs), and Kaʻula (1,500 - 2,500 pairs). Smaller populations occur on Moku Manu, Mokuʻauia, Kāpapa, Molokini, Mōkapu Peninsula, Kaʻena Point Natural Area Reserve on Oʻahu, and Kīlauea Point National Wildlife Refuge on Kauaʻi. Worldwide population is estimated at over one million breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: **Terrestrial:** **ʻ**Uaʻu kani (wedge-tailed shearwater) breed on low, flat islands and sand spits with little or no vegetation, but also excavate burrows on the slopes of extinct volcanoes and in old volcanic craters. Burrows require firm soil or plant roots to stabilize loose soil, generally nesting habitat is devoid of tall woody plants. In locations where nest sites are scarce or the ground is too hard to excavate burrows individuals will nest in rock crevices or above ground. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to mammal predation by pigs (*Sus scrofa*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Human disturbance. Laysan (*Telespiza cantans*) and Nihoa (*T. ultima*) finches will depredate eggs left unattended because of human disturbance. Trampling by humans will collapse burrows.
- Artificial lighting. Street and resort lights, especially in coastal regions, disorient fledglings causing them to eventually fall to the ground exhausted or increasing their chance of collision with artificial structures (i.e. fallout). Once on the ground, fledglings are unable to fly and are killed by cars, cats, and dogs or die because of starvation or dehydration.
- Overfishing. Because ʻuaʻu kani (wedge-tailed shearwater) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.
- Contaminants. Mercury, lead, and organochlorines have been detected in Hawaiian birds.
- Disease. Pox-like lesions have been observed on birds breeding on Maui and Molokaʻi.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to ʻuaʻu kani (wedge-tailed shearwater) populations should include the following:

- Continue eradication and control of introduced predators at current and potential nesting sites on MHI.
- Eradicate rabbits from Lehua Island.
- Limit human access to colonies.
- Continue to support efforts of Save Our Shearwater Program, particularly its outreach initiatives concerning raising public awareness of light fallout and rescue and rehabilitation program, and establish similar programs on other islands where appropriate.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻuaʻu kani (wedge-tailed shearwater) include the following:

- Monitor contaminant levels, their effects, and investigate potential sources.
- Investigate the cause and effect of pox-like lesions in populations on Maui and Molokini.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on ʻuaʻu kani (wedge-tailed shearwater) populations.

References:

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Photo: Forest and Kim Starr, USFWS

Christmas Shearwater

Puffinus nativitatis

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G3/G4 - Vulnerable/Apparently secure
North American Water Bird Conservation Plan - High concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The Christmas shearwater is a medium-sized, dark-brown shearwater (Family: Procellaridae), with a short, wedge-shaped tail and a shiny, black bill. Adult males and females are entirely dark brown, although underparts are lighter than upperparts. Flight is characterized by fast, stiff wing beats, followed by long glides. Often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. Christmas shearwaters feed from the surface by seizing prey while sitting on the water or by shallow pursuit plunges; also feeds by dipping or picking prey from the water while on the wing. Diet almost equally split between fish and squid (Ommastrephidae). Like most seabirds, Christmas shearwaters breed in their natal colonies, although colonies are often small, have high site fidelity, lay only one egg per season, and both parents participate in all aspects of raising young. In this species, divorce appears to occur at a higher frequency than in other seabirds. Christmas shearwaters nest in rock crevices or under dense vegetation. In Hawaiʻi, eggs are laid beginning in February, and nestlings fledge in October or November. No post-fledging care is provided. Based on a small sample, age of first breeding is four years, and the oldest known individual was 17 years old.

DISTRIBUTION: Christmas shearwaters breed throughout NWHI, except for Necker Island and Gardner Pinnacles, and in MHI on offshore islets (e.g., Kaʻula, Lehua, Moku Manu). Outside of Hawaiʻi, Christmas shearwaters nest on islands throughout the central and eastern Pacific. Non-breeding distribution includes the eastern Pacific Ocean.

ABUNDANCE: In Hawaiʻi, breeding colonies estimated at less than 3,000 pairs, with largest populations occurring on Laysan (1,500 - 2,000 pairs), Lisianski (400 - 600 pairs), Nihoa (200 - 250 pairs), and Midway Atoll (200 pairs). Worldwide population unknown but likely less than 10,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: The Christmas shearwater typically breeds on remote sandy islands in rock crevices or under dense vegetation, such as naupaka (*Scaevola sericea*), bunchgrass (*Eragrostis variabilis*), tree heliotrope (*Tournefortia argentea*), *Lepturus repens*, and beach morning glory (*Ipomea* spp.). Also has been known to nest in wooden debris, under buildings, or in abandoned burrows. Christmas shearwater eggs and young must be shaded to protect them from lethal temperatures. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Invasive species. On Lisianski and Laysan, rabbits (*Oryctolagus cuniculus*) denuded the island reducing suitable nesting locations. Golden crown-beard (*Vervesina encelioides*) also degrades nesting habitat. Introduced big-headed ants (*Pheidole megacephala*) at Kure may cause nestling mortality, but also facilitate the destruction of native vegetation by a non-native scale insect.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of Christmas shearwaters should include the following:

- Eradication and control of introduced predators at current and potential nesting sites.
- Eradication and control of invasive species.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to the Christmas shearwater include the following:

- Conduct long-term demographic studies to determine population trends, survival rates, and reproductive success of this poorly known species.
- Updated population estimates.
- Locate foraging areas and determine non-breeding range and model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on Christmas shearwater populations.

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Photo: Brenda Zaun, USFWS

ʻAʻo or Newell's Shearwater

Puffinus auricularis newelli

SPECIES STATUS:
Federally listed as Threatened
State listed as Threatened
State recognized as Indigenous
NaturServe Heritage Rank G2/T2 – Imperiled species/Imperiled subspecies
North American Waterbird Conservation Plan - Highly imperiled
IUCN Red List Ranking - Endangered
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻaʻo or Newell's shearwater (Family: Procellaridae) is highly pelagic year-round, and is endemic to the Hawaiian Islands at the subspecific level. Adult males and females are dark, sooty brown above, with white throat and underparts, and have a dark bill with a hooked tip. Flight is direct, fast and usually low over water, powered by rapid wing beats interspersed with glides; wing loading is higher than in more aerial shearwaters due to the species' foraging method (see below). Often forages in large, mixed species flocks associated with schools of large, predatory fishes which drive prey species to the surface. ʻAʻo (Newell's shearwater) feed mainly by pursuit-plunging; individuals dive into water and swim using their partly folded wings for propulsion. Diet is not well known, but likely consists of fish and squid. ʻAʻo (Newell's shearwater) are colonial and nest on steep mountain slopes, with variable amounts of vegetation, where they lay a single egg in burrows, which are often placed at the base of a tree. Breeding is highly synchronous, and eggs are laid in early June, and most young fledge by November. Both parents incubate egg, and brood and feed nestling. Parents forage hundreds of kilometers offshore and return to colony at night to feed chick. No post-fledging care is provided. Age at first breeding is likely between six and seven years.

DISTRIBUTION: ʻAʻo (Newell's shearwater) breed on Kauaʻi, the island of Hawaiʻi, Molokaʻi, and Lehua, also may breed on Oʻahu, Maui, and Lānaʻi, but not confirmed. Subspecies does not breed outside of Hawaiʻi. Non-breeding season distribution includes the eastern tropical Pacific.

ABUNDANCE: Population numbers are difficult to estimate because of the remoteness and terrain of nesting colonies. In the early 1990s, population estimate based on at sea densities was 84,000 individuals (included adults and non-breeding birds). Estimates based on demographic data suggest a population of 14,600 breeding pairs, 75 percent of which nest on Kauaʻi; estimates based on radar detections suggest this number is valid. Since these estimates were made, demographic modeling and the recovery of injured or dead fledglings indicates that the population on Kauaʻi is in decline. Hurricane Iniki, which struck Kauaʻi in the fall of 1992 when chicks were near fledgling, likely resulted in the mortality of young. Between 1993 and 2001, radar detections of ʻaʻo (Newell's shearwater) have declined by 62 percent. Apparently abundant prior to the arrival of Polynesians, hunting and predation by introduced predators resulted in declines and the species was thought extinct by 1908. Species was rediscovered at sea in 1947 and breeding individuals were located on Kauaʻi in 1967.

LOCATION AND CONDITION OF KEY HABITAT: On Kauaʻi, most breeding colonies occur between 160 and 1,200 meters (525 - 3,936 feet) elevation on steep, densely vegetated mountains, however, birds also nest on the dry, sparsely vegetated cliffs of the Nā Pali coast and on Lehua. On the island of Hawaiʻi, ʻaʻo (Newell's shearwater) nest on forested cinder cones. Colonies are usually located in areas of open native forest dominated by ʻōhiʻa (*Metrosideros polymorpha*) with a dense understory of ʻuluhe fern (*Dicranopteris linearis*).

THREATS:

- Historic human hunting. Subsistence hunting by Polynesians likely reduced populations, and the species was likely captured using methods described for ʻuaʻu or Hawaiian petrel (e.g., nets and smoke from fires).
- Introduced predators. Like all seabirds, adults and nests are susceptible to mammal predation. Polynesians brought dogs (*Canis domisticus*), pigs (*Sus scrofa*), and rats (*Rattus exulans*). Europeans added barn owls (*Tyto alba*), additional rat species, feral cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*). Despite the remoteness of colonies, predation by feral cats has been documented. The largest breeding colonies occur on Kauaʻi, the only Main Hawaiian Island where the small Indian mongoose is not established.
- Habitat loss and degradation. Kauaʻi has lost approximately 75 percent of its forest in the last 150 years, and much of the remaining forest is being degraded by non-native plant species and feral ungulates. On the island of Hawaiʻi, cinder mining has resulted in habitat loss in several colonies.
- Artificial lighting. Street and resort lights, especially in coastal regions, disorient fledglings causing them to eventually fall to the ground exhausted or increase their chance of colliding with an artificial structure (i.e., fallout). Once on the ground, fledglings are unable to fly and thousands are killed annually by cars, cats, and dogs or die because of starvation or dehydration. On Kauaʻi approximately 1,500 fledglings are recovered annually from fallouts; an unknown number are never found. ʻAʻo (Newell's shearwater) use traditional flight corridors, and power lines that cross these corridors kill both adults and fledglings.
- Overfishing. Because ʻaʻo (Newell's shearwater) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations. The effect on the breeding populations is unknown, but may result in adults expending more energy to provision chicks.
- Disease. ʻAʻo (Newell's shearwater) fledglings have been found with pox lesions, suggesting that disease also may be affecting breeding populations.
- Colony locations. Remoteness of colonies, as well as the habitat they occur in (e.g., steep terrain or dense forest) complicates predator and ungulate eradication or control.
- Catastrophes. Given that a large proportion of the population breeds on Kauaʻi, catastrophic events, like hurricanes, threaten this species.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. Past actions have included the rescue and rehabilitation of downed fledglings by the conservation project Save Our Shearwaters (SOS). Since 1978, SOS has recovered and released almost 30,000 shearwaters. Efforts to shade resort lighting appear to have been successful and beginning in the early 1980s Kauaʻi Electric Company began installing hoods on streetlights in areas of heavy fallout; recently all lights on the island have been hooded. In addition to these efforts, future management specific to ʻaʻo (Newell's shearwater) should include the following:

- Continue predator and ungulate control efforts at key colonies on Kauaʻi and the island of Hawaiʻi, and initiate predator control at other colony sites as well as at potential colony sites.
- Continue to support efforts of Save Our Shearwater Program, particularly its outreach initiatives concerning raising public awareness of light fallout and rescue and rehabilitation program, and determine the need and feasibility of establishing a similar program on other islands.
- Eradicate and/or control invasive plants from current colony sites and from potential sites.
- Prioritize restoration projects using location data (e.g., based on location of existing or potential colonies in relationship to flyways) and estimated benefits to productivity and survival.
- Continue to identify fallout areas and work to minimize effects of powerlines and artificial lights.
- Develop partnerships with private landowners to assist conservation measures.

MONITORING: Continue surveys of population and distribution in known and likely habitats. Assess the efficacy of predator control efforts.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻaʻo (Newell's shearwater) include the following:

- Develop and implement standardized survey protocols to determine current population size and status.
- Expand radar studies to monitor population trends, locate colonies, investigate behavior, determine geographic variability in threats, and quantify the efficacy of conservation measures.
- Initiate studies to determine how lights affect shearwaters with the goal being to minimize effects.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on ʻaʻo (Newell's shearwater) populations.
- Conduct long-term demographic studies to determine basic reproductive biology, population trends, survival rates, and reproductive success. Design studies to facilitate comparisons between colonies near urban areas and those located in remote locations.

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Photo: Steve McConnell

ʻAkēʻakē or Band-rumped Storm-Petrel

Oceanodroma castro

SPECIES STATUS:
Federal candidate for listing
State listed as Endangered
State recognized as Indigenous
NatureServe Heritage Rank G4 - Apparently secure
North American Waterbird Conservation Plan - High concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻakēʻakē or band-rumped storm-petrel is a medium sized, highly pelagic storm-petrel (Family: Hydrobatidae), and is the smallest and rarest seabird that breeds in Hawaiʻi. Adult males and females are primarily blackish-brown and have a sharply defined narrow white band across rump area. Flight is characterized by shallow wing beats and long glides just over the surface of the ocean. Forages alone or with conspecifics, ʻakēʻakē (band-rumped storm-petrel) feed while sitting on the water or by dipping prey while flapping just above the ocean surface, often pattering water with feet. No diet information from Hawaiʻi, but elsewhere primarily consists of small fish, squid, and some crustaceans. The species' breeding biology in Hawaiʻi is poorly known, but ʻakēʻakē (band-rumped storm-petrels) nest in burrows or natural cavities in a variety of high-elevation, inland habitats. Like most seabirds a single egg is laid per season. In Hawaiʻi, eggs are laid between May and June, and nestlings fledge in October. ʻAkēʻakē (band-rumped storm-petrel) likely do not breed until they are three to seven years old, and likely live for 15 to 20 years.

DISTRIBUTION: ʻAkēʻakē (band-rumped storm-petrel) breed on Kauaʻi at elevations around 600 meters (1,950 feet), on Maui and the island of Hawaiʻi at elevations greater than 1,200 meters (3,900 feet), and on Lehua. Historically, the species was abundant and widespread throughout MHI. In the Pacific outside of Hawaiʻi, ʻakēʻakē (band-rumped storm-petrel) breed in Japan and on the Galapagos, and in the Atlantic on several islands including the Azores, Cape Verdes, and Ascension Island. The non-breeding season range includes the Pacific and Atlantic oceans.

ABUNDANCE: In Hawaiʻi, breeding population unknown, but likely very small. Breeding population on Kauaʻi estimated at between 171 and 221 breeding pairs. Worldwide population is unknown, but likely less than 25,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: ʻAkēʻakē (band-rumped storm-petrel) breed in a variety of remote, high-elevation, inland habitats. On Kauaʻi, colonies are in steep valleys vegetated with shrubs and grasses. On Maui and the island of Hawaiʻi colonies occur on high, barren lava flows. Nest in burrows or crevices in rock or lava, also has been documented using artificial nest boxes. Colonies on Maui occur in Haleakalā National Park and those on the island of Hawai'i occur in Hawai'i Volcanoes National Park.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by pigs (*Sus scrofa*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Introduced ungulates. Pigs, goats (*Capra hircus*), and mouflon sheep (*Ovis musimon*) degraded nesting habitat.
- Artificial lighting. Street and resort lights, especially in coastal regions, likely disorient fledglings causing them to eventually fall to the ground exhausted or increase their chance of colliding with artificial structures (i.e., fallout). Once on the ground, fledglings are unable to fly and are killed by cars, cats, and dogs (*Canis domisticus*) or die because of starvation or dehydration.
- Colony locations. Remoteness of colonies, as well as the habitat they occur in (e.g., steep terrain or dense forest) complicates predator and ungulate eradication or control.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. Past actions directed at 'a'o or Newell's shearwater (*Puffinus auricularis*) have benefited 'akē'akē (band-rumped storm-petrel) populations and these include: the rescue and rehabilitation of downed fledglings by the conservation project Save Our Shearwaters, and efforts to shade resort lighting and streetlights. In addition to these efforts, future management specific to Hawaiian populations of 'akē'akē (band-rumped storm-petrel) should include the following:

- Determine population size and status.
- Locate additional colony sites.
- Locate potential sites for the establishment of new breeding colonies.
- Continue efforts to eradicate and control predators and ungulates, particularly on Lehua where birds have been recently observed.
- Continue to support efforts of Save Our Shearwater Program, particularly its outreach initiatives concerning raising public awareness of light fallout and rescue and rehabilitation program, and establish similar programs on other islands where appropriate.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to 'akē'akē (band-rumped storm-petrel) includes the following:

- Conduct basic life history studies to assess the management needs and conservation status of this poorly known species.
- Identify factors currently limiting populations.
- Determine the amount of mortality related to power lines and coastal lighting.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

Slotterback JW. 2002. Band-rumped Storm-petrel (*Oceandroma castro*). *In* The Birds of North America, No. 673 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.


Photo: Ian Jones, USFWS

Tristram's Storm-Petrel

Oceanodroma tristrami

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G3 - Vulnerable
North American Waterbird Conservation Plan – High concern
IUCN Red List Ranking - Near threatened
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: Tristram's storm-petrel is a large storm-petrel (Family: Hydrobatidae) with long, pointed wings, and a notched tail. Adult males and females are entirely brownish-gray. Flight is typical of storm-petrels, gliding low over water searching for food. Forages alone or with conspecifics, and typically forages at night. Tristram's storm-petrel feeds by dipping prey from the ocean's surface on the wing, often pattering the water with feet. In Hawai'i, diet includes fish, squid, coelenterates, crustaceans, and insects. Tristram's storm-petrels are winter breeders, and are nocturnal at nesting colonies. Nests are placed in recesses in rocks, under piles of mined guano, or burrows that they excavate under vegetation. Eggs are laid between December through February and nestlings fledge by June. Little information on parental care of egg or young. Like most storm petrels, age at first breeding is likely three to five years and individuals likely live between 15 and 20 years.

DISTRIBUTION: Tristram's storm-petrels breed on Nihoa and on all NWHI except for Midway and Kure atolls, although they historically bred on both as well as on MHI. Outside of Hawai'i, breeding colonies only occur on three small Japanese islands. Outside the breeding season, Tristram's storm-petrels range across the subtropical central and western Pacific Ocean.

ABUNDANCE: In Hawai'i, breeding colonies estimated at less than 10,000 pairs, with the largest populations occurring on Nihoa (2,000 - 3,000 pairs), Laysan (500 - 2,000 pairs), and Pearl and Hermes Reef (1,000 - 2,000 pairs). Worldwide population unknown.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Islands in Hawai'i and Japan, which include both low-lying coralline sand islands and high volcanic islands. For nesting, prefers recesses in rock scree, under mined guano piles, or burrows excavated under vegetation. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats. Extirpation from Midway and Kure atolls likely the result of the introduction of rats; since the eradication of rats from Midway in 1996, individuals have been mist-netted but nesting has not been documented.

- Invasive species. The continued expansion of golden crowned-beard (*Verbesina encelioides*) on Pearl and Hermes Reef and Kure likely will reduce nesting habitat. The effects of big-headed ants (*Pheidole megacephala*), and mice (*Mus musculus*) on Tristram's storm-petrels are unknown.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of Tristram's storm-petrel should include the following:

- Eradicate golden crown-beard on Pearl and Hermes Reef, Midway, and Kure.
- Eradicate mice from Midway and facilitate recolonization using attraction programs.
- Determine population size, status, and trends in Hawai'i.
- Continue protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats, particularly for re-colonization of Midway Atoll.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to Tristram's storm-petrel include the following:

- Design a reliable monitoring program.
- Determine the effects of ants on reproductive success.
- Research basic life history traits, demography, and factors limiting populations.

References:

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

Slotterback JW. 2002. Band-rumped Storm-petrel (*Oceandroma castro*). *In* The Birds of North America, No. 673 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

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Photo: Eric VanderWerf

Koaʻe kea or White-tailed Tropicbird

Phaethon lepturus

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G5 - Secure
North American Waterbird Conservation Plan – High concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The koaʻe kea or white-tailed tropicbird is a showy, white seabird (Family: Phaethontidae), related to boobies and frigatebirds. Six koaʻe kea (white-tailed tropicbird) subspecies are recognized; only one (*P. l. dorothea*) breeds in Hawaiʻi. Adult male and females are mostly white, although sometimes with pale pinkish wash, except for a narrow black eye patch, black streak on upper wings, and black on the leading edge of the outer primaries; both sexes have long, narrow, white central tail feathers. Large yellow-green bill; legs and feet are very small. Flight is characterized by rapid wing beats, interspersed with brief periods of gliding. Koaʻe kea (white-tailed tropicbird) usually forage alone, but occasional with conspecifics, most often far from land; often will follow ships. Koaʻe kea (white-tailed tropicbird) captures prey by plunge diving from 15 to 20 meters (50 – 65 feet) above the water. Diet is poorly known, but includes flyingfish and is likely similar to koaʻe ula or red-tailed tropicbird (*P. rubricauda*). Koaʻe kea (white-tailed tropicbird) breed in colonies and pairs remain together for years. At the beginning of the breeding season, pairs engage in complex aerial displays. Nests are placed in hard to reach locations on cliffs as well as in caves and tree hollows; nests have little if any material. In Hawaiʻi, breeding occurs March through October and a single egg is laid per season. Both parents incubate the egg, and brood and fed the chick. No post-fledging care is provided. Based on few data, age at first breeding is likely after fourth year; no data on longevity.

DISTRIBUTION: Koaʻe kea (white-tailed tropicbird) breed on Midway Atoll and in the MHI at the following locations: Waimea Canyon, Kīlauea Point National Wildlife Refuge, and the Nā Pali Coast on Kauaʻi; Pelekunu Valley, Waikolu, and windward sea cliffs on Molokaʻi; Kaholo Pali, Maunalei Gulch, Hauola Gulch on Lānaʻi ; Kīlauea Crater and windward coast on the island of Hawaiʻi, and the offshore islet Mokoliʻi. A few pairs nest on southeastern Oʻahu. Outside of Hawaiʻi, koaʻe kea (white-tailed tropicbird) breed on oceanic islands throughout the Atlantic, Indian, and Pacific oceans as well as the Caribbean. Outside the breeding season, adults are solitary and pelagic, and their range is poorly known.

ABUNDANCE: In Hawaiʻi, population estimated at 1,800 breeding pairs with most occurring in the MHI. The worldwide population is estimated at less than 200,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Koa'e kea (white-tailed tropicbird) breeds mainly on oceanic islands. Frequently nests in inaccessible crevices or ledges on cliff walls, outside of Hawai'i the species is known to nest in a variety of sites including caves, tree hollows, and in closed-canopy rain forests. **Marine:** Pelagic and nearshore.

THREATS:
- Introduced predators. Like all seabirds, adults and nests susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*).

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of koa'e kea (white-tailed tropicbird) should include the following:
- Eradication and control of introduced predators at current and potential breeding colonies.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to koa'e kea (white-tailed tropicbird) include the following:
- Conduct long-term demographic studies to determine population trends, philopatry to nest colonies and nest sites, survival rates, and reproductive success.
- Develop survey protocol to assess population status and monitor trends.

References:
Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

Lee DS, Walsh-McGehee M. 1998. White-tailed tropicbird (*Phaeton lepturus*). *In* The Birds of North America, No. 353 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

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Photo: DOFAW

Koaʻe ʻula or Red-tailed Tropicbird

Phaethon rubricauda

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G4/G5 – Apparently secure/Secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The koaʻe ʻula or red-tailed tropicbird is a showy, white seabird (Family: Phaethontidae) related to boobies and frigatebirds. Four koaʻe ʻula (red-tailed tropicbird) subspecies are recognized, and one (*P. r. roseotincta*) breeds in Hawaiʻi. Adult males and females are mostly white, although sometimes with pale pinkish wash, except for partial black eye ring and short eye line, black flanks, and black shafts of outer primaries; both sexes have long, narrow, tail feathers with red shafts. Large reddish orange bill with black tip; legs and feet are very small. Flight is characterized by strong flapping interspersed with gliding; koaʻe ʻula (red-tailed tropicbird) are capable of flying long distances. Koaʻe ʻula (red-tailed tropicbird) usually forage alone, but occasional with other species, most often far from land; often will follow ships. Koaʻe ʻula (red-tailed tropicbird) captures prey by plunge diving. In Hawaiʻi, diet is mainly comprised of flyingfish, but also takes squid, mackerel scads, dolphinfish, truncated sunfish, and ballonfish. Koaʻe ʻula (red-tailed tropicbird) breed in colonies and pairs remain together for years. At the beginning of the breeding season, pairs engage in complex aerial displays. Nests are placed on the ground, and generally are a simple scrape lined with some vegetation. In Hawaiʻi, breeding can occur throughout the year, but most nests are active between February and June. A single egg is laid per season, and both parents incubate the egg, and brood and feed the chick. No post-fledgling care is provided. Age at first breeding is between two and four years, and the oldest known individual was 23 years old.

DISTRIBUTION: Koaʻe ʻula (red-tailed tropicbird) breed throughout the NWHI and at a limited number of sites on MHI, mostly on offshore islets, but possibly on Niʻihau, Kaʻula, Lānaʻi, and Kahoʻolawe. Outside of Hawaiʻi, koaʻe ʻula (red-tailed tropicbird) breed on oceanic islands in the Indian and Pacific oceans. Outside the breeding season, adults are solitary and pelagic, and their range is poorly known.

ABUNDANCE: In Hawaiʻi, population estimated at between 9,000 and 12,000 breeding pairs, with the largest populations occurring on Midway Atoll and Laysan. The worldwide population is estimated at 17,000 to 21,000 breeding pairs, with the majority residing in the Pacific Ocean.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Koaʻe ʻula (red-tailed tropicbird) breed mainly on oceanic islands and coral atolls with shrubs, including beach magnolia (*Scaevola sericea*) and beach heliotrope (*Tournefortia argentea*). Koaʻe ʻula (red-tailed tropicbird) nest on the ground, generally in inconspicuous places such as under vegetation or in cliff crevices. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of koaʻe ʻula (red-tailed tropicbird) should include the following:

- Eradication and control of introduced predators at current and potential breeding colonies.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to koaʻe ʻula (red-tailed tropicbird) include the following:

- Conduct long-term demographic studies to determine population trends, survival rates, and reproductive success.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

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Schreiber EA, Schreiber RW. 1993. Red-tailed tropicbird (*Phaeton rubricauda*). *In* The Birds of North America, No. 43 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: Holly Freifeld, USFWS

ʻĀ or Masked Booby

Sula dactylatra

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G5 - Secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻā or masked booby is the largest booby (Family: Sulidae), and like its Hawaiian congeners, has a pantropical distribution. Four ʻā (masked bobby) subspecies are recognized, and one (*S. d. personata*) is resident in Hawaiʻi. Individuals have long, pointed wings and a short, wedge-shaped tail. Adult males and females are overall white, except for a brownish black tail, black trailing wing edges and black facial skin around the bill. Large bill varies in color from yellow to orange and is brighter in males; females are larger than males. Flight is characterized by strong flapping interspersed with gliding, rhythmically ascending with flapping and descending while gliding. ʻĀ (masked booby) forage alone or in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. Forages as far as 150 kilometers (90 miles) from shore, and ʻā (masked booby) captures prey by plunge-diving from up to 30 meters (100 feet) over the water, often diving to a depth of three to four meters (10 – 13 feet). In Hawaiʻi, diet is comprised almost entirely of fish, primarily flyingfish and jacks. ʻĀ (masked booby) breed in dense colonies and most return to their natal colony to breed, and at Kure at least 45 percent of pairs remained together through a second breeding season. Nest on open ground often near a cliff edge or on low sandy beaches; eggs are laid in a shallow scrape. Unlike most seabirds, ʻā (masked boobies) typically lay two eggs per breeding season. The eggs hatch asynchronously, and the first chick to hatch usually pushes the other sibling out of the nest. In Hawaiʻi, breeding season is synchronous, and eggs are laid between January and July and young fledge five months after eggs are laid. Both parents incubate eggs, and brood and feed chicks. Adults continue to feed young up to six months after fledging. Birds first breed at three to four years of age and the oldest known individual was 20 years old.

DISTRIBUTION: ʻĀ (masked booby) breeds mainly in NWHI, but also breeds in MHI on Kaʻula, Lehua, and Moku Manu. Outside of Hawaiʻi, ʻā (masked booby) breed on islands in the tropical waters of the Pacific and Atlantic oceans and the Red Sea. Outside the breeding season birds are most common near their breeding colonies, but individuals may wander thousands of kilometers from colonies.

ABUNDANCE: In Hawaiʻi, population estimated at 2,500 breeding pairs with most occurring on NHWI; approximately 450 pairs breed in the MHI. The worldwide population is estimated at several hundred thousand birds.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: ʻĀ (masked boobies) breed on small islands or islets, both on low-lying coralline sand islands and high volcanic islands, nesting in the open on sandy beaches or on cliff ledges. **Marine***:* Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Non-native plants. Invasive plants, mainly golden crown-beard (*Verbesina encelioides*), has resulted in loss of nesting habitat.
- Human disturbance. Pairs often susceptible to human disturbance.
- Overfishing. Because ʻā (masked booby) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of ʻā (masked booby) should include the following:

- Eradication and control of introduced predators at current and potential breeding colonies.
- Eradication of golden crown-beard, especially from Midway Atoll, Kure, and Pearl and Hermes.
- Limit human disturbance to colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻā (masked booby) include the following:

- Long-term banding and demographic studies are needed to determine dispersal patterns and demographic parameters.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on to ʻā (masked booby) populations.

References:

Anderson DJ. 1993. Masked booby (*Sula dactylatra*). *In* The Birds of North America, No. 73 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

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Photo: USFWS

ʻĀ or Brown Booby

Sula leucogaster

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G5 – Secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻā or brown booby is a large, striking seabird (Family: Sulidae) with a pantropical distribution. Four ʻā (brown booby) subspecies are recognized, and one (*S. l. plotus*) is resident in Hawaiʻi. Individuals have long pointed wings and a relatively short, wedge-shaped tail. Adult males and females are overall dark brown, with white belly and underwings with a sharp demarcation across lower breast between the white of belly and brown of neck. Large bill and legs and feet are yellow in females and grayish-green in males; females are larger than males. Flight is characterized by strong flapping interspersed with gliding. Will forage alone, but most often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. ʻĀ (brown booby) generally forages in nearshore waters and captures prey by plunge-diving from one to 15 meters (3 – 50 feet) above the water, often remaining underwater for 25 to 40 seconds. In Hawaiʻi, diet is comprised of flying fish, squid, mackerel scad, juvenile goatfish, and anchovy. Nest in small colonies of tens to hundreds of pairs and most return to natal colony to breed. ʻĀ (brown booby) is the only ground nesting booby that builds a nest, and its construction is an important part of courtship. Nests are constructed from whatever is available including branches, seabird bones, and human debris. Unlike most seabirds, ʻā (brown booby) typically lays two eggs per breeding season. The eggs hatch asynchronously, and the first chick to hatch usually pushes the other sibling out of the nest. In Hawaiʻi, peak egg laying occurs between March and May and chicks fledge by September. Both parents incubate eggs and brood and feed chicks. Adults continue to feed young up to 37 weeks after fledging. Birds first breed at four to five years of age and the oldest known individual was 26 years old.

DISTRIBUTION: ʻĀ (brown booby) breed throughout the NWHI and in MHI on offshore islets (e.g., Moku Manu, Lehua), and possibly on the island of Oʻahu on the cliffs of Ulupaʻu Head at the Kāneʻohe Bay Marine Corps Base. Outside of Hawaiʻi, ʻā (brown booby) breed on islands in the tropical waters of the Pacific, Indian, and Atlantic oceans, the Caribbean and Red seas, and seas north of Australia. Little is known about movements and distribution outside the breeding season.

ABUNDANCE: In Hawaiʻi, population estimated at 1,400 breeding pairs with the largest population occurring on Lehua. Worldwide population estimate for *S. l. plotus* is 50,000 to 70,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: **Terrestrial:** ʻĀ (brown booby) breed on small islands or islets, both on low-lying coralline sand islands and high volcanic islands, nesting on open ground or on cliff ledges. **Marine:** Nearshore waters.

THREATS:
- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Human disturbance. Newly formed pairs are often very susceptible to human disturbance.
- Overfishing. Because ʻā (brown booby) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of ʻā (brown booby) should include the following:
- Eradication and control of introduced predators at current and potential breeding colonies.
- Limit human disturbance in colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻā (brown booby) include the following:
- Long-term banding and demographic studies are needed to determine dispersal patterns and demographic parameters.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on ʻā (brown booby) populations.

References:
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Photo: Jack Jeffery

ʻĀ or Red-Footed Booby

Sula sula

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G5 – Secure
North American Waterbird Conservation Plan – Not at risk
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻā or red-footed booby is the smallest booby (Family: Sulidae), and like its Hawaiian congeners has a pantropical distribution. Three ʻā (red-footed booby) subspecies are recognized, and one (*S. s. rubripes*) is resident in Hawaiʻi. Individuals have long pointed wings and a relatively long, wedge-shaped tail. Several color phases exist, ranging from all brown to all white; almost all Hawaiian birds are white. Adult male and females are overall white, except for brownish black primary and secondary wing feathers; females are larger than males. Feet and legs orange to red, bill bluish except for base of lower mandible which is pinkish, and facial skin around bill ranges from pink to red and blue. Flight is characterized by strong flapping interspersed with gliding; may glide for long distances. ʻĀ (red-footed booby) forage alone or in mixed species feeding flocks, generally feeding further from land than congeners. ʻĀ (red-footed booby) capture prey by plunge-diving generally from four to eight meters (13 – 26 feet) over the water. In Hawaiʻi, diet is mainly comprised of flyingfish and squid, but also includes mackerel scads, saury, and anchovies. ʻĀ (red-footed booby) breed in colonies ranging from ten to ten thousand pairs and pairs generally retain mates throughout several breeding seasons. Unlike other boobies, ʻā (red-footed booby) roost and build nests in shrubs or trees. In Hawaiʻi, breeding season is synchronous, but can occur throughout the year. Egg laying peaks in February through April and most young have fledged by September. Both parents incubate egg, and brood and feed chick. Adults continue to feed young up to four months after fledging. Birds first breed at three to four years of age and the oldest known individual was 22 years old.

DISTRIBUTION: ʻĀ (red-footed booby) breed throughout the NWHI and at a limited number of sites on MHI including Kīlauea Point National Wildlife Refuge on Kauaʻi, the cliffs of Ulupaʻu Head at the Kāneʻohe Bay Marine Corps Base on Oʻahu, and on offshore islets including Moku Manu and Lehua. Outside of Hawaiʻi, ʻā (red-footed booby) breed on islands in the tropical waters of the Pacific, Indian, and Atlantic oceans, Caribbean Sea, and seas north of Australia. Little is known about the movements of the ʻā (red-footed booby) outside nesting season, but birds in Hawaiʻi appear to disperse eastward and move between islands.

ABUNDANCE: In Hawaiʻi, population estimated at between 7,000 and 10,500 breeding pairs. The worldwide population is estimated at less than 300,000 breeding pairs, with the majority residing in the eastern Pacific.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: ʻĀ (red-footed booby) breed on small islands or islets, both on low-lying coralline sand islands and high volcanic islands. Nest in bushes or trees, including beach magnolia (*Scaevola sericea*) and beach heliotrope (*Tournefortia argentea*). Will occasionally nest on deserted man-made structures, on bare ground, or on low piles of vegetation. Builds nest of twigs, grass, and other vegetation. **Marine:** Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Invasive species. Introduced big-headed ants (*Pheidole megacephala*) at Kure may facilitate the destruction of native vegetation by a non-native scale insect, thus reducing nesting habitat.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of ʻā (red-footed booby) should include the following:

- Eradication and control of introduced predators and rabbits (*Oryctolagus cuniculus*) at current and potential breeding colonies (e.g., on Lehua).
- Eradication of invasive species that may alter ʻā (red-footed boobies) nesting habitat (e.g., scale insects).
- Limit human disturbance in colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to ʻā (red-footed booby) include the following:

- Long-term banding and demographic studies are needed to determine dispersal patterns and demographic parameters.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

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Photo: David Smith

ʻIwa or Great Frigatebird

Fregata minor

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G4 – Apparently secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan – USFWS 2005

SPECIES INFORMATION: The ʻiwa or great frigatebird is a large, graceful seabird (Family: Fregatidae) related to boobies and tropicbirds, with a pantropical distribution. Five ʻiwa (great frigatebird) subspecies are recognized, and one (*F. m. palmerstoni*) breeds in Hawaiʻi. Individuals have slim bodies, a long deeply forked tail, a long hooked bill, and almost useless legs and feet. Adult males are almost entirely black, with varying amounts of a dark green sheen on head and neck; during courtship males inflate large, red gular pouch. Adult females are larger than males, and are black with a white breast patch and a gray throat; both sexes may have a buff bar on the upper surface of wings. Flight is characterized by long periods of soaring. An adept aerial flier, the species obtains some of its food by harassing other seabirds until they regurgitate their prey. Although ʻiwa (great frigatebird) captures most of its own prey, this behavior inspired both its Hawaiian and English names: ʻiwa means "thief" and "frigate" refers to the fast ships used by pirates. Often feeds far from land alone or in pairs, but will join mixed species feeding flocks, especially ʻewaʻewa or sooty terns (*Sterna fuscatata*) and ʻuaʻu kani or wedge-tailed shearwaters (*Puffinus pacificus*), feeding over schools of predatory fishes. ʻIwa (great frigatebird) take prey on the wing, seizing it by dipping bill into water or from the air. In Hawaiʻi, diet primarily consists of flyingfish and squid. Nests in colonies, often with other species, ranging from ten to thousands of pairs, and constructs platform nests in low bushes. Unlike many seabirds, pairs usually switch partners every breeding season, likely because females often only nest every two to four years. Both parents incubate single egg, and brood and feed chick. Post-fledging feeding is provided by female for up to 18 months. Birds first breed at eight to ten years of age, and the oldest known individual was 37 years old.

DISTRIBUTION: ʻIwa (great frigatebird) breed throughout the NWHI. Large numbers roost on offshore islets of the MHI, but breeding has not been documented. Outside of Hawaiʻi, ʻiwa (great frigatebird) nest on islands mainly in the tropical Atlantic, Indian, and Pacific oceans. Outside the breeding season, adults remain relatively close to breeding colonies, but young and nonbreeders disperse throughout tropical oceans.

ABUNDANCE: In Hawaiʻi, population is estimated at 10,000 breeding pairs with the largest breeding colonies occurring on Nihoa (3,500 – 4,500 pairs) and Laysan (2,000 - 2,500 pairs). Smaller colonies in NWHI include French Frigate Shoals (350 –3 75 pairs), Necker (700 - 900 pairs), Lisianski (750 – 850 pairs), Pearl and Hermes Atoll (300 – 400 pairs), and Kure Atoll (200 -

250 pairs). Worldwide population is estimated at 500,000 – 1,000,000 individuals. Numbers at roost locations in MHI include Moku Manu (0 - 1 pairs), Kaʻula (250 – 350 pairs), and Lehua (5 - 10 pairs).

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: ʻIwa (great frigatebird) breed and roost on small remote islands, typically within regions with tradewinds. Builds nests in the tops of various species of bushes and trees, including beach naupaka (*Scaevola sericea*), beach heliotrope (*Tournefortia argentea*), pisonia trees (*Pisonia grandis*), and mangrove trees (*Brugiera* spp., *Rhizophora* spp.) **Marine:** Pelagic.

THREATS:
- Introduced predators. Like all seabirds, adults and nests susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Habitat degradation. Introduced herbivores, insects, and plants can degrade native vegetation used for nesting. Rabbits (*Oryctolagus cuniculus*) denuded vegetation on Laysan, Lisianski, and Lehua islands greatly reducing nesting habitat; with the eradication of rabbits, Laysan and Lisianski have since recovered and support large colonies.
- Overfishing. Because ʻiwa (great frigatebird) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of ʻiwa (great frigatebird) should include the following:
- Eradication and control of introduced predators at current and potential breeding colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻiwa (great frigatebird) should include the following:
- Surveys of colonies to determine current population status.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on ʻiwa (great frigatebird) populations.

References:
Metz VG, Schreiber EA. 2002. Great frigatebird (*Fregata minor*) *In* The Birds of North America, No. 681 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

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Photo: Forest and Kim Starr, USFWS

Pākalakala or Gray-backed Tern

Sterna lunata

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G3/G4 – Vulnerable/Apparently secure
North American Waterbird Conservation Plan - Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The pākalakala or gray-backed tern (Family: Laridae) is endemic to the central Pacific and breeds on small and remote islands and atolls, however, its historical and current distribution are poorly known. Adults are mostly slate gray above and white below with a black crown and nape. Forehead has a narrow white patch that is continuous with white eye-brow that extends above and past eye and is completely bordered with black. Flight is direct and graceful and body appears to move up and down with each wing beat. Outside the breeding season, may remain in flight continuously. Often forages with ʻewaʻewa or sooty terns (*S. fuscata*) and ʻuaʻu kani or wedge-tailed shearwaters (*Puffinus pacificus*). Pākalakala (gray-backed terns) feed mainly by plunge diving or by dipping the surface while hovering. Diet primarily consists of fish, especially five-horned cowfish, juvenile flyingfish, goatfish, herring, and dolphinfish, but also eats squid, crustaceans, mollusks, and marine and terrestrial insects. Pākalakala (gray-backed terns) nest in shallow depressions in sand or gravel, and like most seabirds lay a single egg per season. In Hawaiʻi, nesting season varies from year to year, but most eggs are laid in February and March and most nestlings fledge by late July. Both males and females incubate egg, and brood and feed the chick. Oldest known bird was 25 years old.

DISTRIBUTION: Pākalakala (gray-backed terns) breed throughout NWHI, and a few pairs have been recorded breeding on Moku Manu off of the island of Oʻahu. Outside of Hawaiʻi, pākalakala (gray-backed terns) nest on the Marianas, Howland and Baker, Johnston, Wake, Jarvis, Line Islands, American Samoa, the Marquesas, and Tuamotu. Non-breeding distribution includes the central Pacific Ocean.

ABUNDANCE: In Hawaiʻi, population estimated at 44,000 breeding pairs, with largest populations occurring on Lisianski (20,000 pairs), Nihoa (12,000 pairs), and Laysan (10,000 pairs). Worldwide population unknown but likely on the order of 70,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: **Terrestrial:** Pākalakala (gray-backed terns) breed on remote islands and atolls. Nests are constructed in a variety of habitats (e.g., rocky ledges, open, sandy beaches) but usually at the base of shrubs or refuse. On Midway and Kure, individuals nest on runways. Nests are typically shallow depressions in sand or gravel and in surf zones, making them vulnerable to storm tides. **Marine**: Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Human disturbance. Pākalakala (gray-backed terns) are sensitive to nest disturbance, and flush from nests when humans approach. Exposed eggs and chicks are vulnerable to predation by ʻiwa or great figatebirds (*Fregata minor*), ʻakekeke or ruddy turnstones (*Arenaria interpres*), kioea or bristle-thighed curlews (*Numenius tahitiensis*), and Laysan (*Telespiza cantans*) and Nihoa (*T. ultima*) finches.
- Manmade structures. On Kure, collisions with man-made structures have resulted in mortality.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of pākalakala (gray-backed terns) should include the following:

- Eradicate cats, mice (*Mus musculus*), and rats from islets off MHI.
- Protect colonies from human disturbance.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals. Research priorities specific to the pākalakala (gray-backed tern) include the following:

- Long-term demographic studies are needed to determine population trends, survival rates, and reproductive success.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

Mostello CS, Palaia NA, Clapp RB. 2000. Gray-backed tern (*Sterna lunata*). *In* The Birds of North America, No. 525 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

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Photo: Forest and Kim Starr, USFWS

ʻEwaʻewa or Sooty Tern

Sterna fuscata

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G5 - Secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The ʻewaʻewa or sooty tern is an abundant and gregarious tern (Family: Laridae) with a pantropical distribution, and is able to remain on the wing for years. Eight ʻewaʻewa (sooty tern) subspecies are recognized, and one (*S. f. oahuensis)* breeds in Hawaiʻi. Individuals have long, slender wings and a deeply forked tail. Adult males and females are blackish above, except for white forehead and white on the edges of the outer most tail feathers, and entirely white below. The sharp bill, legs, and feet are black. Flight is characterized by powerful flapping, gliding and soaring, capable of long distance migration and breeding adults remain aloft between breeding seasons. Generally forages in large mixed species feeding flocks, typically feeding over schools of predatory fishes, especially yellowfin tuna (*Neothunnus macropterus*) and skipjack tuna (*Katsuwonus pelamis*). ʻEwaʻewa (sooty tern) feed primarily by seizing prey from the water or air while on the wing, infrequently by shallow dives; species' plumage has poor waterproofing and easily becomes waterlogged. In Hawaiʻi, ʻewaʻewa (sooty tern) diet consists of squid, goatfish, flyingfish, and mackerel scad. Nests in large, dense colonies consisting of thousands to a million pairs of terns. Individuals return to natal colony to breed, some long-term pair bonds have been documented, and breeders prefer to return to previous nest locations. Nests are shallow scrapes often lined with bits of shell or vegetation. Timing of breeding varies among years and locations, even within Hawaiʻi, but generally eggs are laid beginning of February and most birds fledge by July. Both parents incubate single egg and brood and feed chick. Parents continue feeding young for two weeks after fledging and young remain aloft until they return to breed. Birds first breed between four and ten years of age and the oldest known individual was 32 years old.

DISTRIBUTION: ʻEwaʻewa (sooty tern) breed throughout the NWHI and on Moku Manu off of the island of Oʻahu. Outside of Hawaiʻi, ʻewaʻewa (sooty tern) breed on most islands throughout the world's tropical oceans. Outside the breeding season, ʻewaʻewa (sooty tern) are highly pelagic.

ABUNDANCE: In Hawaiʻi, population estimated at greater than one million breeding pairs with the largest populations occurring on Laysan (500,000 pairs) and Lisianski (500,000 pairs). Worldwide population is estimated at between 60 and 80 million breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: ʻEwaʻewa (sooty tern) breed on oceanic islands and atolls. Nest is usually on sandy substrates with sparse vegetation. **Marine**: Pelagic.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Native predators. ʻIwa or great frigatebirds (*Fregata minor*), cattle egrets (*Bubulcus ibis*), ʻakekeke or ruddy turnstones, (*Arenaria interpres*) ʻaukuʻu or black-crowned night herons (*Nycticorax nycticorax*), Laysan (*Telespiza cantans*) and Nihoa (*T. ultima*) finches will depredate eggs and chicks.
- Overfishing. Because ʻewaʻewa (sooty terns) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.
- Oil pollution. ʻEwaʻewa (sooty terns) populations are vulnerable to oil spills.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of ʻewa ʻewa (sooty terns) should include the following:

- Eradication and control of introduced predators at current and potential nesting sites.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to ʻewaʻewa (sooty terns) include the following:

- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on ʻewaʻewa (sooty terns) populations.

References:

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U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: Forest and Kim Starr, USFWS

Noio Kōhā or Brown Noddy

Anous stolidus

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G5 - Secure
North American Waterbird Conservation Plan – Not currently at risk
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The noio kōhā or brown noddy is a medium-sized, abundant tern (Family: Laridae) with a pantropical distribution, and is very similar to noio (black noddy) in appearance and behavior. Five subspecies of noio kōhā (brown noddy) are recognized, and one (*A. s. pileatus*) is resident in Hawaiʻi. Individuals have slender wings and a wedge-shaped tail. Adult males and females are dark brown with a white cap and have a black bill, legs, and feet; males are larger than females. Flight is swift with rapid wing beats and usually direct and low over the ocean, this species almost never soars high. Often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. Noio kōhā (brown noddy) generally forage in nearshore waters and mainly feed by dipping the surface from the wing or by making shallow dives. In Hawaiʻi, diet is comprised mostly of fish, but squid are also taken. Breed in large, dense colonies and nest on the ground, on cliffs or in trees. In Hawaiʻi, breeding is synchronous with peaks occurring in the spring and summer. Pairs stay together throughout the year, but there is little information on the length of pair bonds. Both parents incubate the single egg, and brood and feed chick. Birds first breed at three to seven years of age, and the oldest known individual was 25 years old.

DISTRIBUTION: Noio kōhā (brown noddy) breed throughout the Hawaiian Archipelago, including all islands of NWHI and the offshore islets of MHI. Outside of Hawaiʻi, noio kōhā (brown noddy) breed on island in the tropical Atlantic and Pacific oceans. Noio kōhā (brown noddy) typically remain near (within 100 kilometers [62 miles]) their breeding colonies year-round.

ABUNDANCE: In Hawaiʻi, population estimated at 112,000 breeding pairs with the largest populations occurring on Nihoa (35,000 pairs) and Kaʻula (35,000 pairs). Worldwide population is estimated 500,000 to 1,000,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: **Terrestrial:** Noio kōhā (brown noddy) breed on small islands or islets, both on low-lying coralline sand islands and high volcanic islands and use a wide variety of nesting locations, including the ground, trees, shrubs, cliffs and human-made structures. In Hawaiʻi, nests are predominantly located on open ground or under vegetation, or on human-made structures. **Marine:** Nearshore waters.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.
- Native predators. ʻIwa or great figatebirds (*Fregata minor*), ʻaukuʻu or black-crowned night herons (*Nycticorax nycticorax*), and Laysan (*Telespiza cantans*) and Nihoa (*T. ultima*) finches will depredate eggs and chicks, especially when adults are flushed from nests by human disturbance.
- Overfishing. Because noio kōhā (brown noddy) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of noio kōhā (brown noddy) should include the following:

- Eradication and control of introduced predators at current and potential breeding colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to noio kōhā (brown noddy) include the following:

- Conduct long-term banding and demographic studies to determine dispersal dynamics and demographic parameters.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on noio kōhā (brown noddy) populations.

References:

Chardine JW, Morris RD. 1996. Brown noddy (*Anous stolidus*). *In* The Birds of North America, No. 220 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: USFWS

Noio or Black Noddy

Anous minutus

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G5 - Secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The noio or black noddy is a medium-sized, abundant, and gregarious tern (Family: Laridae) with a pantropical distribution. Seven noio (black noddy) subspecies are generally recognized, and two are resident in Hawai'i: *A. s. melanogenys* (MHI) and *A. s. marcusi* (NWHI). Individuals have slender wings, a wedge-shaped tail, and black bill which is slightly decurved. Adult males and females are sooty black with a white cap and have reddish brown legs and feet; bill droops slightly. Flight is swift with rapid wing beats and usually direct and low over the ocean; this species almost never soars high. Often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. Noio (black noddy) generally forage in nearshore waters and feeds mainly by dipping the surface from the wing or by making shallow dives. Opportunistic, in Hawai'i, noio (black noddy) primarily takes juvenile goatfish, lizardfish, herring, flyingfish, and gobies. Nests in large, dense colonies that include non-breeding juvenile birds. Established pairs return to the same nest site year after year. Breeding is highly variable and egg laying occurs year-round. Both parents incubate single egg, and brood and feed chick. Birds first breed at two to three years of age, and the oldest known individual was 25 years old.

DISTRIBUTION: Noio (black noddy) breed throughout the Hawaiian Archipelago, including all islands of NWHI and the coastal cliffs and offshore islets of MHI. Outside of Hawai'i, noio (black noddy) breed on islands throughout the world's tropical oceans. Noio (black noddy) typically remain near (within 80 kilometers [50 miles]) their breeding colonies year-round.

ABUNDANCE: In Hawai'i, population estimated at 12,000 breeding pairs with the largest populations occurring on Midway Atoll (6,000 pairs) and Nihoa (5,000 pairs). Worldwide population is estimated at 1,000,000 to 1,500,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Noio (black noddy) breed on oceanic and offshore islands, both on low-lying coralline sand islands and high volcanic islands. In Hawai'i, noio (black noddy) place their nests on ledges and in crevices of coastal cliffs, in sea caves, and in ironwood (*Casuarina* spp.) trees. **Marine**: Nearshore waters.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats, however the MHI support large populations of non-native mammalian predators.

- Native predators. ʻIwa or great frigatebirds (*Fregata minor*), Laysan Finches (*Telespiza cantans*), and shorebirds will depredate eggs and chicks.
- Habitat degradation. Non-native vegetation such as golden crown-beard (*Verbesina encelioides*) can alter potential nesting habitat and the removal of non-native ironwood trees from Midway could result in a reduction in nest sites.
- Human disturbance. Kayak and zodiac tours of sea caves used for nest sites can result in adults flushing from nests, resulting in predation by native birds.
- Nearshore pollution. Because noio (black noddy) forage close to shore, oil spills and dumping of waste may be more important to this species than those that forage far offshore. Oiled individuals are regularly seen in the NHWI.
- Overfishing. Because noio (black noddy) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of noio (black noddy) should include the following:

- Eradicate golden crown-beard and other exotic species on all islands used for breeding, especially those that can change the structure of the existing vegetation (e.g., scale insects).
- Eradication and control of introduced predators at current and potential breeding colonies.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to noio (black noddy) include the following:

- Conduct long-term banding and demographic studies to determine dispersal dynamics and demographic parameters.
- Determine the source of oil affecting birds in the NWHI.
- Determine the significance of recreational activities (e.g., kayaking), and if appropriate determine protocols to reduce disturbance.
- Model interactions and importance of predatory fish, seabirds, and their prey to determine the long-term effects of overfishing on noio (black noddy) populations.

References:

Gauger VH. 1999. Black noddy (*Anous minutus*). *In* The Birds of North America, No. 412 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.


Photo: Fefer, USFWS

Blue-gray Noddy

Procelsterna cerulean

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Rank G4 - Apparently secure
North American Waterbird Conservation Plan - High concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The blue-gray noddy or Necker Island tern is the world's smallest tern (Family: Laridae) and is widely distributed across the Pacific. Five subspecies are recognized, and one (*P. c. saxatilis*), is resident in Hawaiʻi. Adult males and females are entirely bluish gray and have a partial white eye-ring, a short, slender bill, and a shallow forked tail. Flight is characterized by constant and rapid wing beats. The blue-gray noddy feeds nearshore, often with other species, by hover-dipping and surface-dipping. The species captures the smallest prey of any Hawaiian seabird, mainly larval lizardfishes, flounders, goatfishes, and flyingfish, as well as squid, crustaceans, and insects. Blue-gray noddies use a variety of substrates for nesting. In Hawaiʻi, they nest in aggregations among cavities or crevices in lava flows. In Hawaiʻi, nesting appear to occur throughout the year, and eggs have been found March through September. Little is known about the breeding behavior or biology of the blue-gray noddy. The oldest known bird was 11 years old, but blue-gray noddies likely live longer.

DISTRIBUTION: Blue-gray noddies breed mainly on Necker and Nihoa, but small colonies also are present on La Perouse Pinnacle, French Frigate Shoals, and Gardner Pinnacles. Historically the species bred on Kaʻula Island off of Niʻihau. Outside of Hawaiʻi, blue-gray noddies nest on islands throughout the Pacific Ocean. Blue-gray noddies typically remain near their breeding colonies year-round, and are rarely found far from land.

ABUNDANCE: In Hawaiʻi, population estimated at 3,600 breeding pairs with 3,500 pairs on Necker and Nihoa combined. Worldwide population estimated at 100,000 breeding pairs, but inaccessible nesting locations make accurate counts difficult.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Blue-gray noddies breed on remote islands and atolls. They nest on a variety of substrates, but in NHWI mostly use crevices or cavities in ancient lava flows. Currently all breeding colonies in Hawaiʻi occur in the Hawaiian Islands National Wildlife Refuge or the Midway Atoll National Wildlife Refuge. **Marine**: Nearshore waters.

THREATS:

- <u>Introduced predators</u>. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats.

- Native predators. On Nihoa and Laysan, native finches (*Telespiza* spp.) are responsible for considerable egg mortality.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of blue-gray noddy should include the following:

- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to the blue gray-noddy include the following:

- Development and implementation of standardized survey protocols to determine current population size and status.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.


Photo: David Leonard, USFWS

Manu-o-Kū or White (Fairy) Tern
Gygis alba

SPECIES STATUS:
State listed as Threatened
State recognized as Indigenous
NatureServe Heritage Rank G4 - Apparently secure
North American Waterbird Conservation Plan – Moderate concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The manu-o-Kū or white tern is a small, entirely white tern (Family: Laridae) with a pantropical distribution. Individuals have dark eyes and a thick, sharply pointed black bill with an electric blue base. Adult males and females are identical and there are no seasonal changes in plumage. Flight is buoyant and characterized by erratic changes in direction and speed. Manu-o-Kū (white tern) feed by dipping the surface or surface diving. Often joins mixed species feeding flocks and usually preys on fish driven to the surface by large, predatory fish. In Hawaiʻi, the diet of white terns consists mostly of juvenile goatfish and flying fish. Breeding adults remain close to nest sites and forage in inshore areas such as shoals and banks with occasional forays into offshore waters. Not as colonial or social as most other terns, preferring to nest in loosely associated groups or singly. Manu-o-Kū (white tern) remain paired for several seasons and often return to the same nest site year after year. No nest is constructed; a single egg is laid wherever a suitable depression is found. Most nests are on tree branches, buildings, or other man-made structures, rock ledges, or on the ground. In Hawaiʻi, manu-o-Kū or (white tern) breeds year-round, but most eggs are laid between February and June. Pairs will replace an egg after initial nest failure, and some successfully raise two or three broods per year. Both parents incubate egg and brood and feed the chick. Fledglings are dependent on adults for up to two months. Birds first breed at five years of age, and the oldest known individual was 42 years old.

DISTRIBUTION: Manu-o-Kū (white tern) breed throughout the NWHI and on the island of Oʻahu. Outside of Hawaiʻi, manu-o-Kū (white tern) breeds on islands throughout subtropical and tropical oceans, although breeding in the southern Atlantic Ocean is limited. Non-breeding distribution is unknown. Manu-o-Kū (white tern) typically remain near their breeding colonies year-round, seldom venturing far from shore.

ABUNDANCE: In the Hawaiian Archipelago, population estimated at 15,000 breeding pairs, with largest populations occurring on Midway (7,500 pairs), Nihoa (5,000 pairs), and Laysan (1,000 pairs). On Oʻahu, the number of pairs has increased from one to greater than 250 between 1961 and 2005. Worldwide population unknown but likely exceeds 100,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Manu-o-Kū (white tern) breed on oceanic islands, both on low-lying coralline sand islands and high volcanic islands. Nests are not built, eggs are laid on whatever suitable depression is found. Nest sites include volcanic pinnacles, cliffs, rocky slopes, large bushes or trees, and man-made structures. **Marine**: Nearshore waters.

THREATS:

- Introduced predators. Like all seabirds, adults and nests are susceptible to predation by rats (*Rattus* spp.), and feral cats (*Felis silvestris*). All sites in NWHI are free of rats and cats. However, given the remote nature of nesting sites (e.g., cliffs), manu-o-Kū (white terns) are less vulnerable to predation than many other seabirds. Historically, rats likely preyed on eggs, young and adults on Midway.
- Introduced insects. On Midway, big-headed ants (*Pheidole megacephala*) have been observed attacking pipped eggs and incubating adults. On Kure, introduced scale insects are killing native vegetation, but the effects on manu-o-Kū (white tern) are unknown.
- Overfishing. Because manu-o-Kū (white tern) rely on predatory fish to drive prey to the surface, overfishing may eventually affect Hawaiian populations.

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In Hawai'i, currently there are no ongoing management actions specific to manu-o-Kū (white tern).

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to the manu-o-Kū (white tern) include the following:

- Determine the effect of introduced invertebrates on nesting habitat and their potential for limiting populations.

References:

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

Niethammer KR, Patrick-Castilaw LB. 1998. White tern (*Gygis alba*). *In* The Birds of North America, No. 371 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.


Photo: Eric VanderWerf

Migratory Birds

American Wigeon

Anas americana

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The American wigeon, or "Baldpate," is a widespread North American dabbling duck (Family: Anatidae), which winters in small numbers in the Hawaiian Islands. Wigeons are common across most of North America, with a breeding population estimated in excess of three million. While wigeons are dun-colored across most of the body, breeding males sport a bright white stripe across the crown of the head, bright green patches on either side of the head, and contrasting white and dark plumage on the rump. During the breeding season, males' contrasting colors are used in courtship displays to attract females and discourage competing males. However, in winter, male plumage is much more similar to that of females, retaining the brown body coloration but changing to dark gray on the head and neck. Wigeons are the most vegetarian of dabbling ducks, eating the stems and leafy parts of aquatic plants, leafy parts of grasses, and leaves and seeds of some marsh and crop plants. Breeding females, however, feed largely on insects (including dragonflies and damselflies), mollusks, and crustaceans.

DISTRIBUTION: In North America, wigeons' winter range extends across the central and southern United States, south through Mexico, and along the U.S. east coast as far north as Cape Cod. In Hawaiʻi, they have been sighted throughout the Main Hawaiian Islands (MHI) but have not been recorded in the Northwestern Hawaiian Islands.

ABUNDANCE: U.S. Fish and Wildlife Service surveys from 1955 through 1997 yield an average breeding population estimate of approximately 2.62 million birds for North America. The 1997 estimate was 3,117,600 ± 161,600 (SE), about 19 percent higher than the long-term average. In Hawaiʻi, State Waterbird counts of American wigeons from 1986 to 2003 have averaged 19.5 ± 8.4 (SE) birds throughout the MHI.

LOCATION AND CONDITION OF KEY HABITAT: Wigeons winter in a wide range of habitats including freshwater marshes, rivers, lakes, impoundments, estuaries, bays, and agricultural lands that provide an abundance of emergent and submergent vegetation. In Hawaiʻi, wigeons winter at Kanahā Pond State Wildlife Sanctuary and Kealia Pond National Wildlife Refuge on Maui, and near Waipiʻo on Oʻahu. Use of agricultural lands suggests flooded taro fields could attract wigeons. Some suitable habitat of these types is already protected, primarily wetlands within the bounds of wildlife refuges and sanctuaries.

THREATS: Primary threats include the following:

- Loss of wetland habitat to development.
- Degradation of habitat due to pollution, hydrology alteration, or invasions by alien species.
- West Nile virus or other avian diseases.

CONSERVATION ACTIONS: To protect the ability of wintering American wigeons to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Little study of visiting wigeons has been undertaken, probably in part because of their annual presence and numbers are uncertain. Research priorities should include the following:

- Better understanding of habitat needs and preferences, including foraging and population limiting factors.
- Increased understanding of movements of individuals that overfly the Hawaiian Islands.

References:

Mowbray T. 1999. American wigeon (*Anas americana*). *In* The Birds of North America, No. 401 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo available from website:
http://www.birds.cornell.edu/programs/AllAboutBirds/BirdGuide/Northern_Shoveler.html

Koloa Mōhā or Northern Shoveler

Anas clypeata

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The koloa mōhā, or northern shoveler, is a common North American dabbling duck (Family: Anatidae) that winters in the Main Hawaiian Islands (MHI), typically arriving in September and October and departing for Alaska by March or April. By virtue of their unusually large flat bills, koloa mōhā are adapted to a diet primarily of aquatic invertebrates such as water fleas (*Daphnia* spp.) and crustaceans (copepods and ostracods), which they obtain by filtration. In addition to nektonic prey, however, koloa mōhā are also known to eat seeds and gastropods. Like many ducks, koloa mōhā are sexually dichromatic in plumage, with breeding males sporting a dark green head, white throat, and brown belly, in contrast to the females' more uniform mottled brown plumage. Koloa mōhā are less gregarious than other dabbling ducks, are among the most territorial during breeding, and maintain pair bonds longer than other similar species. They are known to hybridize with at least three other North American duck species (blue-winged and cinnamon teals, and muscovy ducks) and with several other species in Eurasia.

DISTRIBUTION: Common throughout the southern and western United States and Mexico during the winter, shifting to the northernmost central U.S., west central Canada, and Alaska during the breeding season. Koloa mōhā are also common through Eurasia. In Hawaiʻi, koloa mōhā have been sighted routinely on all of the MHI, but have not be recorded in the NWHI.

ABUNDANCE: U.S. Fish and Wildlife Service surveys from 1955 through 1995 yield an average breeding population estimate of approximately 1.87 million birds in North America, with a rising trend through the mid-1990s. Estimates for 1994 and 1995 were high at approximately three million. The most abundant dabbling duck wintering in the MHI (mallards are year-round residents), koloa mōhā numbers in State waterbird surveys from 1986 to 2003 averaged 296 ± 30.4 (SE) birds. There is some evidence of a downward trend of about ten birds per year over that period.

LOCATION AND CONDITION OF KEY HABITAT: During winter, koloa mōhā utilize a variety of wetland habitats, including freshwater and saline marshes, and agricultural ponds. They prefer shallow open lakes containing dense growth of aquatic vegetation, and tend not to forage on dry land. In Mexico, they are known to inhabit coastal lagoons, estuaries, and some mangrove swamps. Some of these areas are already protected, but much habitat has been lost to development.

THREATS: Primary threats include the following:

- Loss of wetland habitat to development, pollution, or habitat-modifying invasive plants.
- Avian disease.

CONSERVATION ACTIONS: To protect the ability of wintering American koloa mōhā to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Little study of visiting koloa mōhā has been undertaken, probably in part because of their annual presence and numbers are uncertain. Research priorities should include the following:

- Better understanding of habitat needs and preferences, including foraging and population limiting factors.
- Increased understanding of movements of individuals that overfly the Hawaiian Islands.

References:

Dubowy PL. 1996. Northern shoveler (*Anas clypeata*). *In* The Birds of North America, No. 217 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Jim Denny

Migratory Birds

Koloa māpu or Northern Pintail

Anas acuta

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The Koloa māpu, or northern pintail, is a dabbling duck (Family: Anatidae), common throughout the northern hemisphere, that winters in the main Hawaiian Islands, typically arriving in August, and departing for Siberia, Alaska, or Canada in late March or April. Koloa māpu feed primarily on the seeds and leafy parts of aquatic grasses, as well as aquatic invertebrates such as snails and beetles, with live prey being especially important in the early spring. As with most dabbling ducks, koloa māpu are sexually dichromatic in plumage, but less dramatically so than mallards. Breeding males are dark brown on the head and upper neck, white across the lower throat, and gray about most of the body, while female plumage is mottled light and dark brown. Nonbreeding male plumage is similar to that of females. Being gregarious, koloa māpu form pair bonds but remain promiscuous during breeding. They are known to hybridize with six other North American duck species (mallard, black duck, green-winged teal, American wigeon, Chiloe wigeon, and redhead) and with at least three other species in Eurasia.

DISTRIBUTION: Common throughout the southern and western United States and Mexico during the winter, shifting to the northernmost central U.S., west central Canada, and Alaska during the breeding season. Koloa māpu are also common through Eurasia. In Hawaiʻi, koloa māpu have been sighted routinely on all of the MHI, but have not been recorded in the NWHI.

ABUNDANCE: Among the most populous of North American ducks, koloa māpu surveys (USFWS) for the region from 1955 through 1995 yield an average breeding population estimate of over three million birds, with populations declining from over six million in the early 1970s to less than three million into the early 1990s. A fairly common visitor to the Main Hawaiian Islands (MHI), koloa māpu are usually present each year in the low hundreds. State Waterbird surveys from 1986 to 2003 provide an average of 190 ± 29 (SE) birds per year wintering in the MHI.

LOCATION AND CONDITION OF KEY HABITAT: During winter, koloa māpu utilize a variety of shallow inland freshwater and intertidal habitats, typically shallow wetlands with little emergent cover (although at night they prefer emergent stands of food plants). They will also use flooded agricultural habitats (especially rice, corn, wheat, soybeans, and pastures), reservoirs, tidal wetlands, bays, and estuarine habitats. In Mexico, koloa māpu favor areas where excess irrigation water flows into salt flats or tidal basins; also mangrove mud flats, irrigation reservoirs, and ephemeral ponds. Some of these types of areas are already protected; others have been lost to development.

THREATS: Primary threats include the following:

- Loss of wetland habitat to development, pollution, or habitat-modifying invasive plants.
- Avian disease.

CONSERVATION ACTIONS: To protect the ability of wintering koloa māpu to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Only one published study of visiting koloa māpu has been undertaken, probably in part because of their annual presence and numbers are uncertain. Research priorities should include the following:

- Better understanding of habitat needs and preferences, including foraging and population limiting factors.
- Population reactions to habitat modifications, changes in food availability, and competition with other migrants.
- Life-history and population dynamics in wintering areas.
- Better understanding of geographic relationship between nesting areas and wintering areas.
- Make-up of local populations relative to survival and condition during winter.

References:

Austin JE, Miller MR. 1995. Northern pintail (*Anas acuta*). *In* The Birds of North America, No. 163 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Udvardy MD, Engilis, Jr., A. 2001. Migration of northern pintail across the Pacific with reference to the Hawaiian Islands. Studies in Avian Biology No. 22: 124-132.


Photo: Eric VanderWerf

Migratory Birds

Lesser Scaup

Aythya affinis

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The lesser scaup is a medium-sized black and white diving duck (Family: Anatidae), one of the most abundant and widespread ducks in North America. Lesser scaups winter in the Main Hawaiian Islands (MHI), typically arriving in October and departing for Alaska or Canada as early as February. Lesser scaups feed primarily on aquatic invertebrates such as insects, crustaceans, and mollusks; seeds and vegetative parts of aquatic plants are also important. As with many ducks, lesser scaups are sexually dichromatic in plumage, with breeding males showing a dramatic contrast between their white body and black head, neck, throat, and rump. Female plumage is a more monochromatic dark brown. Nonbreeding male plumage shows less contrast, with the body becoming more brown at the margins. Being gregarious, lesser scaups form pair bonds but remain promiscuous during breeding. They are known to hybridize with four other North American duck species (greater scaup, ring-necked duck, redhead, and canvasback) in the wild, and with four others (tufted duck, European pochard, American wigeon, and wood duck) in captivity.

DISTRIBUTION: Common throughout the southern and western United States and Mexico during the winter, shifting to the northernmost central U.S., west central Canada, and Alaska during the breeding season. Lesser scaups are also common through Eurasia. In Hawaiʻi, lesser scaups have been sighted routinely on all of the MHI, but have not been recorded in the NWHI.

ABUNDANCE: Lesser scaup surveys (by USFWS) from 1955 through 1995 yield an average breeding population estimate of 5,512,445 ± 147,090 (SE) in North America (the most abundant diving duck in the region), with winter population estimates declining by about half since the 1960s. A fairly common visitor to the Main Hawaiian Islands, Hawaiʻi State waterbird surveys of lesser scaups from 1986 to 2003 have averaged 55.7 ± 20.4 (SE) birds.

LOCATION AND CONDITION OF KEY HABITAT: Winter diet of lesser scaups varies geographically, but specific dietary habits of Hawaiian migrants have not been documented in the published literature. On the continental U.S., lesser scaups are found along lake coastlines, reservoirs, and fresh to brackish coastal bays and estuaries. During severe weather, they may move to more saline waters, and they are more common in such saline habitats than other diving ducks. In Texas, they are found on hypersaline estuaries, usually close to inland freshwater ponds where individuals go to drink. Unlike other, more herbivorous diving ducks, distribution of lesser scaups during migration and winter is not closely related to distribution of aquatic plant foods.

THREATS: Primary threats include the following:

- Loss of wetland habitat to development, pollution, or habitat-modifying invasive plants.
- Avian disease.

CONSERVATION ACTIONS: To protect the ability of wintering lesser scaups to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Little study of visiting lesser scaups has been undertaken, probably in part because of their annual presence and numbers are uncertain. Research priorities should include the following:

- Better understanding of habitat needs and preferences, including foraging and population limiting factors.
- Increased understanding of movements of individuals that overfly the Hawaiian Islands.
- Better understanding of adaptation to modified wintering habitats and how they affect migration routes.

References:

Austin JE, Custer CM, Afton AD. 1998. Lesser scaup (*Aythya affinis*). *In* The Birds of North America, No. 338 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: DOFAW

Migratory Birds

Kōlea
or Pacific Golden-Plover

Pluvialis fulva

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan - High concern

SPECIES INFORMATION: The kōlea or Pacific golden-plover is a moderately small yellow-and-buff mottled shorebird (Family: Charadriidae) which winters in the Main Hawaiian Islands (MHI) and breeds in Siberia and westernmost Alaska. Most adults arrive in Hawaiʻi in August, while juveniles arrive in October; spring departures begin in late April. Kōlea feed primarily on terrestrial insects such as cockroaches, moths, caterpillars, and earwigs, all of which they locate by sight. During the breeding season, they are also known to eat berries, leaves, and seeds. Kōlea show high site fidelity to wintering grounds and will chase intruders from their territories while foraging. Hawaiʻi is thought to support a large proportion of the world's wintering kōlea population.

DISTRIBUTION: Kōlea winter across the tropical Pacific, in upland and coastal areas from Hawaiʻi to Japan. In Hawaiʻi, kōlea are more common in NWHI year-round, but between August and May are also commonly seen on all of the MHI.

ABUNDANCE: Reliable estimates of the global kōlea population have not been made. One estimate of the east Asian population was 90,000, while the population of the MHI has been estimated at 74,000 individuals. In the late 1960s, the Oʻahu population was estimated at about 15,000. From 1986 to 2004, the average number of kōlea in Hawaiʻi State waterbird surveys has been about 950 ± 170 (SE) individuals across MHI. Estimated wintering densities range from 0.22 to 44.7 birds per hectare in wild habitats such as forest trails and coastal mudflats. Densities in developed habitats in Hawaiʻi have been estimated as 1.4 birds per hectare on golf courses and 5.2 birds per hectare on lawns.

LOCATION AND CONDITION OF KEY HABITAT: The winter range of kōlea is extremely varied, including crop fields, pastures, coastal salt marshes, mudflats, beaches, mangroves, grassy areas at airports, cemeteries, athletic fields, parks, residential lawns, golf courses, roadsides, and clearings in heavily wooded areas. In Hawaiʻi, birds also use open stands of ironwood (*Casuarina* spp.) and small urban lawns and gardens in areas such as downtown Honolulu. Military bases and airports often provide important wintering grounds. Where suitable habitats (pastures, etc.) occur on mountain slopes, kōlea range to at least 2,500 meters (8,125 feet) elevation. Extensive land-clearing in Hawaiʻi, dating back to the Polynesian colonization, has probably improved wintering conditions by creating open habitat with plentiful insects.

THREATS: Hunting was a significant threat until 1941 when it was prohibited, and populations are thought to have rebounded since then. Effects of pesticide exposure on wintering grounds and along migratory routes are unknown, but on golf courses in Hawaiʻi, kōlea come into contact with herbicides and pesticides that may be harmful. Aircraft strikes at Līhuʻe (Kauaʻi) and Kahului (Maui) airports occur occasionally in the fall, apparently as naive juvenile birds attempt to establish foraging territories on airport grounds.

CONSERVATION ACTIONS: To protect the ability of wintering kōlea to survive while in Hawaiʻi and to return in good condition to breeding grounds in Alaska, current statewide and island-specific conservation actions should include:

- Protection of current habitat.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Kōlea studies remain fragmentary, probably because the species is neither endemic nor endangered. Research priorities should include the following:

- Increased study of all aspects of ecology and behavior of kōlea in Hawaiʻi, and comparative research on unstudied populations elsewhere.
- Evaluation of conditions on winter range habitats as related to expanding human activities (e.g., agriculture, reclamation, urbanization, pollution).
- Increased effort to make accurate population estimates, along with systematic monitoring wherever possible to facilitate the recognition of trends and potential problems.

References:

Johnson OW, Connors PG. 1996. Pacific golden-plover (*Pluvialis fulva*). *In* The Birds of North America, No. 201-202 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Eric VanderWerf

Migratory Birds

ʻŪlili or Wandering Tattler

Heteroscelus incanus

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan—Moderate concern

SPECIES INFORMATION: The ʻūlili, or wandering tattler, remains one of North America's least known birds. ʻŪlili winter in the Hawaiian Islands, arriving in stages (adults from July to August, juveniles September to November) and showing strong winter range fidelity. Diet varies with season, and in winter mainly consists of invertebrates such as marine worms, aquatic insects, mollusks, crustaceans, and small fish. On nonbreeding grounds, forages in intertidal habitats (such as coral reefs), less frequently in soft mud or sand, picking food from moist substrates or surface of shallow water. ʻŪlili also forage along mountain streams, in wetlands, fish ponds, and human-modified areas.

DISTRIBUTION: ʻŪlili breed mostly in mountainous areas of Alaska, and also in eastern Siberia, but densities are sparse so that precise identification of breeding areas is lacking. Winter range includes most of Oceania from Hawaiʻi through more southerly archipelagos. Most abundant in southern and central Pacific. Less common or infrequent in more distant areas of the Pacific. In Hawaiʻi, ʻūlili are more prevalent on shorelines of the NWHI than in the MHI.

ABUNDANCE: Global population has been estimated at between 10,000 and 25,000 birds, of which 90 percent breed in North America. ʻŪlili are not particularly common in Hawaiʻi: State waterbird surveys from 1986 through 2004 yield an average summer count for the MHI of 81 ± 8.7 (SE) and a winter MHI count of 74 ± 6.5 (SE). NWHI populations are probably larger: estimates at Laysan Island in 1984 and 1985 were 450 and 170, respectively. Monitoring in Hawaiʻi has not been regular or thorough enough to detect trends, but where monitoring data are more detailed, trend analysis is inconclusive.

LOCATION AND CONDITION OF KEY HABITAT: Wintering habitats throughout the Pacific and mainland Asia are more varied than breeding habitat. ʻŪlili are common in coastal areas on coral reefs and the basalt platforms of most atolls and islands. They will also make use of soft substrates, especially river mouth areas and littoral margins of lagoons. In the NWHI, they can be found on pickleweed (*Sesuvium portulacastrum*) flats, and elsewhere in Hawaiʻi they will forage in grassy areas around airports and golf courses.

THREATS: Primary threats include the following:

- Loss of wetland habitat to development, pollution, or habitat-modifying invasive plants.

- Avian disease.

CONSERVATION ACTIONS: To protect the ability of wintering ʻūlili to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: ʻŪlili have been only minimally studied. Research priorities should include the following:

- Basic research on demography in wintering habitat.
- More information about population sizes and trends, and population regulation.
- Better understanding of habitat needs and preferences, including foraging needs, population limiting factors, and adaptation to modified wintering habitats and how they affect migration routes.
- Increased understanding of movements of individuals that overfly the Hawaiian Islands.

References:

Gill RE, McCaffery BJ, Tomkovich PS. 2002. Wandering tattler (*Heteroscelus incanus*). In The Birds of North America, No. 642 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Eric VanderWerf

Kioea or Bristle-thighed Curlew

Numenius tahitiensis

SPECIES STATUS:
State recognized as Indigenous
IUCN Red List Ranking-Vulnerable

SPECIES INFORMATION: Kioea, or Bristle-thighed curlews, are large-bodied shorebirds (Family: Scolopacidae) that twice annually make a nonstop migration of at least 4,000 kilometers (2,480 miles) between Hawaiʻi and Alaska. They typically arrive in Hawaiʻi in late July and August and depart in early May for breeding grounds in western Alaska. Kioea (Bristle-thighed curlews) are the only migratory shorebirds that winter exclusively on oceanic islands, that become flightless during molt, and that use tools in foraging. Documented tool use behavior consists of picking up rocks with their bills and hurling them at albatross eggs to crack them open. Males and females are identical in plumage, but females are slightly larger and have slightly straighter and less tapered bills. Kioea are highly opportunistic feeders during winter, consuming a variety of prey such as intertidal and terrestrial invertebrates, seabird eggs and hatchlings, carrion, lizards, rodents, and fruit. Males are highly territorial during breeding season, defending large territories of up to 275 hectares (680 acres) with dramatic aerial displays, chases, and complex vocalizations.

DISTRIBUTION: The species breeds in two relatively small areas of Alaska near the Kotzebue Peninsula. Winter range comprises most oceanic islands across the Pacific, from the Marshall Islands in the west to Pitcain Island at the southeasterly extreme. In Hawaiʻi, highest numbers are in the Northwestern Hawaiian Islands (NWHI), with small numbers wintering the Main Hawaiian Islands (MHI), particularly the islands of Oʻahu and Hawaiʻi.

ABUNDANCE: Estimates based on surveys conducted between 1988 and 1992 of the species' breeding range in Alaska estimated the population at 3,200 breeding pairs. Based on a study conducted between 1988 and 1990, about 800 birds were thought to winter in NWHI: 300–350 on Laysan, 300–400 on Lisianski Island, and 100 at Midway. Hawaiʻi State waterbird surveys since 1996 yield an average of 6.3 ± 1.5 (SE) birds in the MHI in summer, and 9.7 ± 3.9 (SE) in the winter.

LOCATION AND CONDITION OF KEY HABITAT: No detailed study has been published describing winter habitat use. However, wintering kioea have been observed to use a variety of habitats, including tidal mudflats, marshy areas, edges of mangrove swamps and lagoons, reefs, saltpans, channels among islets, beaches, airport runways, and open areas well away from shoreline. In the MHI, they occur in open grassy areas, vegetated dunes, and wetlands, while in the NWHI, they are found on beaches and shoreline coral ledges some of the time but more often in grass- and forb-dominated interior portions. Censuses on Laysan Island in fall 1988 obtained 68 percent of sightings inland in beach morning glory (*Ipomoea pes-caprae*), native bunchgrass (*Eragrostis variabilis*), or a mix of both; only one percent of sightings were on beaches.

THREATS: Factors limiting Kioea populations are not well-documented. Habitat alteration in winter range, especially human development of shoreline areas, is considered to be severe. Other threats may include degradation of habitat due to pollution or invasions by alien species. Populations may also be adversely affected by avian disease. Ingestion of ubiquitous plastic debris in northern parts of winter ranges is likely, but not confirmed. Curlews on Midway forage in lead-contaminated soils, but tissue concentrations of lead have not been studied in curlews.

CONSERVATION ACTIONS: To protect the ability of wintering kioea to survive while in Hawaiʻi and to return in good condition to breeding grounds in Alaska, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional wetland habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Comprehensive studies of kioea were not undertaken before the late 1980s. Priorities for further research should include the following:

- Identification of high concentrations of wintering birds.
- Identification of migratory stopover sites (if any) south of the Hawaiian Islands.
- Monitoring of population trends.
- Protection and management of key islands and atolls throughout winter ranges.

References:

Marks JS, Tibbitts L, Gill RE, Jr., McCaffery B. 2002. Bristle-thighed curlew (*Numenius tahitiensis*). *In* The Birds of North America, No. 705 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.


Photo: Jim Denny

Migratory Birds

ʻAkekeke or Ruddy Turnstone

Arenaria interpres

SPECIES STATUS:
State recognized as Indigenous
U.S. Shorebird Conservation Plan—High Concern

SPECIES INFORMATION: The ʻakekeke, or ruddy turnstone, is a small, calico-colored shorebird (Family: Scolopacidae) that is one of the most northerly breeding shorebirds. Each year ʻakekeke migrate from tropical coastlines to the Arctic Circle, where they breed in coastal areas and island interiors. ʻAkekeke have short bills, bright reddish-orange legs. They spend their days probing among rocks and pebbles along the shoreline in search of insects, especially flies, spiders, beetles, and grubs. Outside of the breeding season, however, their diet becomes much more diversified, extending to crustaceans, mollusks, worms, small fish, and even carrion, rubbish, and bird eggs.

DISTRIBUTION: During breeding season, ʻakekeke range from the eastern coast of Greenland to the north-eastern coast of Siberia, with most of the North American population concentrated on the northern coast of Alaska and the Arctic islands north of Canada. In winter, ʻakekeke range across a wide swath of tropical coastal regions from southeastern Asia to southwestern Africa and southern Europe. In Hawaiʻi, ʻakekeke are more prevalent on shorelines of the NWHI than in the MHI.

ABUNDANCE: Global population has been estimated at approximately 445,000 individuals, of which about 60percent (267,000) breed in North America. Trend analysis from 1972 to 1983 suggested that the U.S. Atlantic Coast population was in decline, but high variability of counts both within and between years increased uncertainty about the statistical validity of this trend. Average winter population in the MHI from 1986 to 2004, based on State waterbird surveys, was 512 ± 101 (SE), while during breeding season counts averaged 458 ± 62 (SE). Abundance in the NWHI has not been estimated but is probably larger than the MHI population.

LOCATION AND CONDITION OF KEY HABITAT: In winter, ʻakekeke are almost exclusively coastal, foraging mostly along stony or rocky shorelines with abundant seaweed. However, especially in Hawaiʻi and other Pacific Islands, ʻakekeke are also common on sandy shorelines and in mudflats and river deltas. Preferred habitats include ocean beaches along sheltered coastlines or bordering estuaries and other wetlands.

THREATS: Across most of their winter range, primary threats to ʻakekeke are human industrial and recreational activity leading to habitat loss and degradation by means of chemical contamination and disturbance. Avian diseases are also a threat.

CONSERVATION ACTIONS: To protect the ability of wintering ʻakekeke to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of coastal habitat.
- Protection and restoration of additional coastal habitat, especially where it can be reclaimed from abandoned urban or agricultural uses.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Little study of visiting ʻakekeke has been undertaken, probably in part because their annual presence and numbers are uncertain. Research priorities should include the following:

- Identification of stopover sites, their biological attributes, and long-term usage patterns.
- Better understanding of ecological requirements for successful over-wintering, along with growth and development of wintering birds, for all age groups.
- Better understanding of time and energy budgets in relation to molt and preparation for spring migration.
- Measurement of growth and postfledging-survival rates for first arrivals at wintering location.
- More information on known and suspected threats, including degradation of coastal ecosystems, direct interactions with humans, habitat disturbance and destruction, and toxic and chemical contamination.

References:

Nettleship DN. 2000. Ruddy turnstone (*Arenaria interpres*). *In* The Birds of North America, No. 537 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo available from website:
http://animaldiversity.ummz.umich.edu/site/accounts/pictures/Calidris_alba.html

Hunakai or Sanderling

Calidris alba

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The hunakai, or sanderling, is a sandpiper (Family: Scolopacidae) which is well-known for its habit of foraging at the edge of the surf zone and running up and down the beach to avoid waves while probing the sand for invertebrates. Hunakai are small, plump sandpipers, usually about 19 centimeters (7.5 inches) in length, with bills that are short, straight, and black. Their legs and feet are also black, but the rest of their body is white about the head, pale-gray on the back and ventrally white. Hunakai winter in the Hawaiian Islands, arriving by October and departing for breeding areas in the Arctic Circle by June, with juvenile birds tending to migrate later than adults. Hunakai diet changes markedly with the season, consisting almost exclusively of insects during the breeding season, and consisting of hippid crabs, isopods (*Excirolana* spp.), insects, talitrid amphipods, polychaete worms, and small bivalve mollusks in winter. Hunakai of both sexes are strongly territorial in and above the intertidal zone, but otherwise forage in non-territorial flocks.

DISTRIBUTION: Hunakai may be the most widespread maritime shorebird wintering in North America, with a winter range extending from British Columbia to southern Chile and from Maine to Argentina. Pacific winter range extends from Hawaiʻi and the Mariana and Marshall Islands through more southerly archipelagos (Phoenix, Union, and Galapagos Islands).

ABUNDANCE: Global population size is unknown, but the North American population is estimated to be 300,000 individuals. Estimated population for Hawaiʻi, based on State waterbird surveys from 1986 through 2003 yield an average summer count for the MHI of 138 ± 36 (SE), and a winter MHI count of 272 ± 32.6 (SE). NWHI populations may be larger, but data are lacking. In other areas, such as Mexico, shoreline densities of hunakai have been estimated at six birds per kilometer (about nine birds per mile) on sandy beaches, and about one-third of that on rocky coastlines. Trend data are sparse and not conclusive, but suggest a slight decline in numbers through the Americas since the late 1950s.

LOCATION AND CONDITION OF KEY HABITAT: Preferred foraging habitat during winter is sandy beach, mainly intertidal zone at high tide. Tidal sandflats and mudflats are also used, along with shores of lakes and rivers. Hunakai occasionally make use of rocky shores, sloughs, and river mouths, and have been rarely detected at sewage-treatment plants and municipal dumps. Hunakai tend to exhibit strong fidelity to wintering sites.

THREATS: The most severe threats to this species are considered to be environmental (e.g., effects of global warming and oil spills). Global warming is expected to have the greatest impact on breeding populations, although reduced food supplies for wintering birds could also result in adverse impacts. The greatest threats to wintering birds in Hawaiʻi include loss and degradation of habitat and avian disease.

CONSERVATION ACTIONS: To protect the ability of wintering hunakai to survive while in Hawaiʻi and to return in good condition to breeding grounds in North America, statewide and island-specific conservation actions should include:

- Protection of current habitat.
- Protection and restoration of additional habitat.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Hunakai have been only minimally studied. Research priorities should include the following:

- Better understanding of habitat requirements and behavioral plasticity, to improve assessments of probable responses to coastal (beach) development, habitat degradation, pollution, and other human disturbances.
- Increased understanding of movements of individuals that overfly the Hawaiian Islands, support needed studies of the extent to which distinct breeding populations exist and whether migration routes and wintering areas are population-specific.

References:

Macwhirter B, Austin-Smith P, Kroodsma D. 2002. Sanderling (*Calidris alba*). *In* The Birds of North America, No. 653 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Sheila Conant, USFWS

Nihoa Millerbird

Acrocephalus familiaris

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
Northwestern Hawaiian Islands Passerines Recovery Plan —USFWS 1984

SPECIES INFORMATION: The Nihoa millerbird is an obligate insectivore endemic to Nihoa Island in the Northwestern Hawaiian Islands. The Nihoa millerbird and its congener, the Laysan millerbird, are the only known Old World warblers (subfamily Sylviinae) known to have colonized the Hawaiian Archipelago. The Laysan subspecies, discovered first, was named "millerbird" because of its fondness for feeding on large miller moths (Family Noctuidae). Although the Laysan subspecies was driven to extinction by 1923 after European rabbits (*Oryctolagus cuniculus*) were introduced to Laysan in 1903, the Nihoa millerbird has persisted. Nihoa millerbirds are small (about 13 centimeters, or about five inches, in length), drably colored, and highly active due to their insectivorous habits. Male and female Nihoa millerbirds have similar plumage, but differ in size, with males being slightly larger than females. Nihoa millerbirds feed exclusively on insects and larvae, especially moths and caterpillars (Lepidoptera), gleaned from shrubs and bunchgrass tussocks. Like most insectivores, Nihoa millerbirds are territorial, and display a high degree of year-to-year territory fidelity. During breeding season, both sexes construct nests and incubate eggs.

DISTRIBUTION: Nihoa millerbirds are restricted to the approximately 63 hectares (156 acres) area of Nihoa Island. Of those 63 hectares, approximately 40 hectares (100 acres) are considered suitable habitat for millerbird territories. With a mean territory size estimated at 0.2 - 0.4 hectares (0.5-1 acres), Nihoa Island can support, on average, between 100 and 200 millerbird territories.

ABUNDANCE: The U.S. Fish and Wildlife Service has conducted transect surveys at Nihoa Island during most years since 1967. Based on these surveys, the average population size over that time period has been estimated as 386 ± 218 (SD) birds. The high degree of uncertainty (wide confidence intervals) associated with the estimates indicate that millerbirds maintain a clumpy, irregular spatial distribution. The 1996 population size estimate was 155, within the typical range of variation observed since the 1960s. Density estimates have averaged ten birds per hectare (25 per acre).

LOCATION AND CONDITION OF KEY HABITAT: Nihoa millerbirds reside year-round on the steep-sided, rocky, and shrub-covered island of Nihoa. Maximum elevation is 277 meters (839 feet), with steep cliffs on three of the island's four sides. Nihoa's vegetation community comprises about 25 species of plants; the four most abundant are (in descending order of abundance): the shrub *Chenopodium oahuense*, the shrub *Solanum nelsonii*, the shrub *Sida fallax*, and the bunchgrass *Eragrostic variabilis*. Millerbirds are found throughout the island's 32 to 40 hectares (80 to 100 acres) of optimal habitat, and in suboptimal habitat as well. Millerbirds have not been observed to congregate at, or drink from, Nihoa's five to seven small freshwater seeps. The entire range of this species occurs within the Hawaiian Islands National Wildlife Refuge.

THREATS: Limiting factors for Nihoa millerbirds are primarily weather (i.e., drought and storms), variations in food supply (typically due to weather), and availability of appropriate nest sites. Nihoa finches have been observed breaking and eating millerbird eggs, but the incremental mortality attributable to this behavior has not been estimated. Additional threats include:

- <u>Invasive alien plants</u>. Habitat quality could be degraded by weed invasions. The millerbird diet of mature and larval insects depends on the abundance of native plant populations, which could be adversely affected by competition with invasive alien plants such as *Miconia calvescens* or *Clidemia hirta*.
- <u>Invasive alien arthropods</u>. Preferred food insects could be suppressed by competition with, or predation by, introduced arthropods, which might not be attractive or palatable to millerbirds.
- <u>Arthropod irruptions</u>. Nihoa is currently experiencing an irruption of a native grasshopper, reducing island plant cover to unusually low levels. Although this sort of fluctuation could be natural, irruptions of non-prey species could lead to declines in population levels of preferred prey species. When irruptions occur among prey species, even though millerbirds are obligate insectivores, a transient excess of prey could cause a boom in the millerbird population which would subsequently prove unsustainable.
- <u>Population size</u>. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.
- <u>Introduced mammals</u>. The risk of rat (*Rattus* spp.) introduction via transport (i.e., ships, planes) is of concern as rats are known to have decimated passerine populations in the NWHI in the past as a result of shipwrecks.

CONSERVATION ACTIONS: Nihoa millerbird persistence requires that the integrity of the island's small, remote ecosystems be maintained. This requires excluding and removing any introduced non-native plants, insects, passerine birds, avian disease, and mammalian and reptilian land animals. Quarantine measures and visitation restrictions in place for researchers appear to be controlling the rate of new introductions, but species that do become established may be extremely difficult to eradicate. Thus, rigorous statewide reduction or elimination of non-native invertebrates and plants introductions through stricter quarantine and reduction of ship groundings are necessary. In addition to these efforts, future management specific to the recovery of Nihoa millerbirds may include the following:

- Aggressive weed control and native plant restoration to stabilize habitat quality.
- Monitoring and, when warranted, aggressive control of unstable arthropod populations.
- Prevent the introduction of rats and other possible predators.

MONITORING: Continue current program of transect counts and habitat monitoring. This information is needed to assess population trends and the efficacy of habitat management.

RESEARCH PRIORITIES: More research is needed on best quarantine techniques, best methods for early detection of alien species, and best eradication methods. Current knowledge suggests that Nihoa millerbird reproduction may be driven by variable external environmental factors, such as rainfall, but knowledge of breeding behavior and demographics is limited. The millerbird population is small, and the extirpation of the Laysan subspecies suggests an urgent need to establish another population. If Nihoa millerbirds were translocated to another site such as Laysan Island, the small size of the Nihoa population would require that the removal of millerbirds from Nihoa not jeopardize the source population. Thus translocation should be attempted only during high-population years. Research priorities specific to Nihoa millerbirds include the following:

- Additional demographic studies to further refine estimates of population structure, dispersal, survivorship, nesting phenology and success, and other life history and behavioral characteristics.
- Further study of translocation techniques and habitat restoration on target islands. Keeping insectivorous passerines alive for translocation is extremely difficult, but known techniques could be refined using non-endangered closely related species. Native plant and arthropod communities on Laysan would need to be substantially improved before attempting Nihoa millerbird translocation.

References:

Morin M, Conant S. 2002. Laysan millerbird (*Acrocephalus familiaris familiaris*) and Nihoa millerbird (*Acrocephalus familiaris kingi*). *In* The Birds of North America, No. 302 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: the American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1984. Recovery plan for the Northwestern Hawaiian Islands passerines. Portland, (OR): U.S. Fish and Wildlife Service. 66 pp.


Photo: Kate Willis, USFWS

Laysan Finch

Telespiza cantans

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
NWHI Passerines Recovery Plan—USFWS 1984

SPECIES INFORMATION: The Laysan finch is an omnivorous, ground-nesting Hawaiian honeycreeper (Family: Fringillidae) endemic to Laysan Island in the Northwestern Hawaiian Islands. Laysan finches have black legs, large feet, and relatively large bills suitable for eating seeds. They are vocally inventive and have a varied song repertoire. Male and female finches have different plumage, with adult males being a brighter yellow over a larger proportion of their head and body than females. Males are also about six percent larger by weight than females. Laysan finches are known to feed on seeds, fruits, leaves, flowers, stems, seedlings, roots, carrion, invertebrates, and eggs. Typically found in pairs during the breeding season, Laysan finches are non-territorial and forage in small groups (four to twelve individuals) during the non-breeding season. The breeding biology of the species has been well-documented, in addition to studies of geographic variation in genetics, morphology, and nest substrate choice. During breeding season, males defend their mates and nest sites, while females construct nests and incubate eggs. Females rely upon males for nuptial feedings during the incubation period. In good years, Laysan finches are quite fecund, and double and even triple clutches have been documented. Given the remoteness of their habitat, Laysan finches are among the most-studied endangered birds.

DISTRIBUTION: Laysan finches are restricted to the approximately 200 hectare (450 acre) vegetated area of Laysan Island. Since 1967, translocated finches have occupied the 12 hectare (25 acre) and two hectare (four acre) vegetated areas of Southeast Island and Grass Island (respectively) at Pearl and Hermes Reef. Between 1973 and 1998, populations also existed at North Island and Seal-Kittery Island at Pearl and Hermes Reef; those populations were extinct by 1998.

ABUNDANCE: The U.S. Fish and Wildlife Service has conducted transect surveys at Laysan Island during all but four years since 1966. Based on these surveys, the average population size has been estimated as 11,217 ± 3,784 (SD). The 1998 population size estimates for the Laysan, Southeast, and Grass populations are 9,911, 350, and 30, respectively, which are within the typical range of variation observed since the 1960s. Density estimates have averaged 56 birds per hectare (25 birds per acre) at Laysan. Densities have been lower, on average, at Southeast and Grass Islands, by 42 percent and 78 percent, respectively.

LOCATION AND CONDITION OF KEY HABITAT: Laysan finches reside year-round on the flat, low-elevation islands of Laysan and Pearl and Hermes Reef. Climate is similar to that of nearby Midway Atoll. Finches inhabit all vegetated areas of the islands, foraging among several vegetation associations of grasses, herbs, and prostrate vines. On Laysan, however, the finches nest primarily in tussocks of the bunchgrass *Eragrostis variabilis*, whose seeds are also a major food source. *Eragrostis* is markedly less abundant at Pearl and Hermes, particularly at Southeast Island, and finches there frequently nest in marine debris (plastic crates, etc.) that have washed up onto the island. Several freshwater seeps drain into Laysan Island's hypersaline lake; Pearl and Hermes islands have no sources of fresh water, so finches get water from rainfall and from dew accumulations on plants. Plant communities at both Laysan and Pearl and Hermes Reef have been altered by human activity, most notably by both intentional and accidental introductions of alien plants. The entire range of this species occurs within the Hawaiian Islands National Wildlife Refuge.

THREATS: Laysan finches have not generally been as strongly impacted by the factors that threaten other native Hawaiian birds, such as habitat loss, predation by introduced mammals, and disease. Habitat loss, for example, has been prevented by the island's status as a refuge, and disease establishment has been impeded by the lack of standing fresh water necessary for mosquito breeding. However, the finches' remoteness carries with it a different, but related, set of threats:

- <u>Invasive alien plants</u>. Habitat quality has been degraded by weed invasions. Finches have integrated some invasive plants into their diet, but changes to the quality of nesting habitat have been more problematic: *Setaria verticillata* appears to have displaced *Eragrostis variabilis* at Southeast Island (Pearl and Hermes Reef), leading to lower nest density and lower reproductive success among nests in *Setaria*. Conversely, the more recent invasion at Southeast by *Verbesina encelioides* appears to have caused the population to quadruple within two years, only to subsequently crash.
- <u>Population size</u>. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.
- <u>Introduced mammals</u>. The risk of rat (*Rattus* spp.) introduction via transport (i.e., ships, planes) is of concern as rats are known to have decimated passerine populations in the NWHI in the past as a result of shipwrecks.
- <u>Sea level rise</u>. Both the Intergovernmental Panel on Climate Change and the U.S. Environmental Protection Agency project sea level to increase 34-42 centimeters (13-16 inches) by 2100. The mean elevation at Southeast Island is just over one meter (3 feet), so that during spring tides, most of the island would be inundated. Grass Island would lose less area, but is already too small to provide significant reduction of extinction risk for the species. Therefore, if sea level does rise as projected, both of the Pearl and Hermes Reef populations would be seriously jeopardized.

CONSERVATION ACTIONS: Laysan finch persistence requires that the integrity of the island's small, remote ecosystems be maintained. This requires excluding and removing any introduced non-native insects, plants, passerine birds, avian disease, and mammalian and reptilian land animals. Quarantine measures in place for researchers appear to be reducing the rate of new introductions, but many species already established (e.g., *Verbesina encelioides*) are extremely difficult to eradicate. Thus, rigorous statewide reduction or elimination of non-native invertebrate and plant introduction through stricter quarantine and reduced ship groundings are needed. In addition to these efforts, future management specific to the recovery of Laysan finches may include the following:

- Aggressive weed control and native plant restoration to stabilize habitat quality.
- Prevent the introduction of rats and other possible predators.
- Stabilize islands to minimize erosional and submersion-based losses of land area.

MONITORING: Continue current program of transect counts and habitat monitoring. This information is needed to assess population trends and the efficacy of habitat management.

RESEARCH PRIORITIES: More research is needed on best quarantine techniques, best methods for early detection of alien species, and best eradication methods. Research priorities specific to Laysan finches include the following:

- Additional demographic studies to further refine estimates of population structure, dispersal, survivorship, nesting phenology and success, and other life history and behavioral characteristics.
- Assess which management options (e.g., additional translocations, or supplementation of small populations with birds from Laysan, or both) would be most beneficial in terms of extinction risk reduction.

References:

Morin M., Conant S. 2002. Laysan finch (*Telespiza cantans*) and Nihoa finch (*Telespiza ultima*). *In* The Birds of North America, No. 639 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1984. Recovery plan for the Northwestern Hawaiian Islands passerines. Portland, (OR): U.S. Fish and Wildlife Service. 66 pp.


Photo: Craig Rowland, USFWS

Nihoa Finch

Telespiza ultima

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1—Critically imperiled
IUCN Red List Ranking—Critically endangered
NWHI Passerines Recovery Plan—USFWS 1984

SPECIES INFORMATION: The Nihoa finch is an omnivorous, ground-nesting Hawaiian honeycreeper (Family: Fringillidae) endemic to Nihoa Island in the Northwestern Hawaiian Islands. Nihoa finches have black legs, large feet, and sturdy bills suitable for seed-eating, but in all body dimensions they are smaller than the congeneric Laysan finches. Male and female Nihoa finches have different plumage, with adult males being a brighter yellow over a larger proportion of their head and body than females. Nihoa finches are known to feed on seeds, fruits, leaves, flowers, stems, seedlings, roots, carrion, invertebrates, and eggs. Although their social behavior has not been thoroughly studied, Nihoa finches are thought to be similar to Laysan finches in being non-territorial outside of the breeding season. During breeding season, males defend nest sites in rock crevices, while females construct nests and incubate eggs. Females rely upon males for nuptial feedings during the incubation period.

DISTRIBUTION: Nihoa finches are restricted to the approximately 63 hectare (156 acre) area of Nihoa Island. An introduced population at Tern Island, French Frigate Shoals, was extinct by the early 1980s.

ABUNDANCE: The U.S. Fish and Wildlife Service has conducted transect surveys at Nihoa Island during most years since 1966. Based on these surveys, the average population size is estimated to have been 3,196 ± 925 (SD). The 1996 population size estimate was 2,362, which is within the typical range of variation observed since the 1960s. Density estimates have averaged 51 birds per hectare (21 birds per acre).

LOCATION AND CONDITION OF KEY HABITAT: Nihoa finches reside year-round on the steep-sided, rocky, and shrub-covered island of Nihoa. Finches prefer open but vegetated habitat and are reported to forage in all areas of the island. Finches frequently congregate around Nihoa's five to seven small freshwater seeps, or at ephemeral puddles of fresh water. About 25 species of plants comprise Nihoa's vegetation community; the four most abundant are (in descending order of abundance): the shrub *Chenopodium oahuense*, the shrub *Solanum nelsonii*, the shrub *Sida fallax*, and the bunchgrass *Eragrostic variabilis*. Finch presence is positively correlated with *Sida fallax* height and percent cover, and also with mean and maximum *Solanum nelsoni* height. The entire range of this species occurs in the Hawaiian Islands National Wildlife Refuge.

THREATS: Limiting factors for Nihoa Finches are primarily weather (i.e., drought and storms), variations in food supply (typically due to weather), and availability of appropriate nest sites. During population highs, the proclivity of Nihoa finches to break conspecific eggs might increase, but this has not been studied. Additional threats include:

- Invasive alien plants. Habitat quality could be degraded by weed invasions. While the finches, being omnivorous, would likely integrate some invasive plants into their diet, native plant populations could be adversely affected by competition with invasive alien plants such as *Miconia calvescens* or *Clidemia hirta*. To the extent that such alien plants would be lower-quality food resources, the finch population would be affected.
- Arthropod irruptions. Nihoa is currently experiencing an irruption of a native grasshopper, which is reducing island plant cover to unusually low levels. Although this sort of fluctuation is natural, it can lead to declines in population levels of other species.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.
- Introduced mammals. The risk of rat (*Rattus* spp.) introduction via transport (i.e., ships, planes) is of concern as rats are known to have decimated passerine populations in the NWHI in the past as a result of shipwrecks.

CONSERVATION ACTIONS: Nihoa finch persistence requires that the integrity of the island's small, remote ecosystems be maintained. This requires excluding and removing any introduced non-native insects, plants, passerine birds, avian disease, and mammalian and reptilian land animals. Quarantine measures and visitation restrictions in place for researchers appear to be controlling the rate of new introductions, but species that do become established may be extremely difficult to eradicate. Thus, rigorous statewide reduction or elimination of non-native invertebrate and plant introductions through stricter quarantine and reduction of ship groundings are necessary. In addition to these efforts, future management specific to the recovery of Nihoa finches may include the following:

- Aggressive weed control and native plant restoration to stabilize habitat quality.
- Prevent the introduction of rats and other possible predators.

MONITORING: Continue current program of transect counts and habitat monitoring. This information is needed to assess population trends and the efficacy of habitat management.

RESEARCH PRIORITIES: More research is needed on best quarantine techniques, best methods for early detection of alien species, and best eradication methods. Research priorities specific to Nihoa finches include the following:

- Additional demographic studies to further refine estimates of population structure, dispersal, survivorship, nesting phenology and success, and other life history and behavioral characteristics.
- Assess which management options (e.g., translocation) would be most beneficial in terms of extinction risk reduction.

References:

Morin M., Conant S. 2002. Laysan finch (*Telespiza cantans*) and Nihoa finch (*Telespiza ultima*). *In* The Birds of North America, No. 639 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 1984. Recovery plan for the Northwestern Hawaiian Islands passerines. Portland, (OR): U.S. Fish and Wildlife Service. 66 pp.


Photo: W. P. Mull; *Achatinella* spp.

Terrestrial Invertebrates

Oʻahu Tree Snails

Achatinella spp.

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1 - Critically imperiled
IUCN Red List Ranking - Critically endangered
Recovery Plan for the Oʻahu Tree Snails of the Genus *Achatinella* – USFWS 1992

SPECIES INFORMATION: The entire genus *Achatinella* consisting of 41 species of small, colorful tree snails (Family: Achatinellidae), is endemic to Oʻahu; 22 species are believed to be extinct and 18 are near extinction. Although varied in color patterns and shapes, all are approximately two centimeters (.75 inch) in length, and most have smooth, glossy oblong or ovate shells that are decorated with various colors. Based on their occurrence in Native Hawaiian stories and their use in leis, Oʻahu tree snails must have been very abundant when Polynesians arrived in Hawaiʻi. Oʻahu tree snails are nocturnal and graze on fungus that grows on the leaves of native plants. Although native snails are sometimes found on non-native plants it is not known if the fungus on these introduced species is sufficient to support healthy populations. Adult snails are hermaphroditic and can live for many years, although growth rates and fecundity are very low. For example, *A. mustelina* does not become sexually mature for three to five years, may live for over ten years, and only produces four to seven offspring per year. Young are born alive.

DISTRIBUTION: Currently, Oʻahu tree snails are restricted to remnant native forest on the highest ridges of the Koʻolau and Waiʻanae ranges on the island of Oʻahu. Historically, the genus was widely distributed from near sea level along the windward coast to the central plains and throughout the Koʻolau and Waiʻanae mountains.

ABUNDANCE: Unknown. A lack of systematic, island-wide surveys impedes any effort to estimate the population sizes of most of the remaining species. However, a loss of 75 to 95 percent of native habitats supports a conclusion that the remaining populations are restricted and small. Two species, *A. mustelina* and *A. sowerbyana*, are believed to be the most abundant of the extant species. Population estimates for *A. mustelina* are just under 1,000 individuals.

LOCATION AND CONDITION OF KEY HABITAT: All *Achatinella* are arboreal, living in trees and bushes where they feed on fungi on the leaves and trunks. Oʻahu tree snails occur in a variety of habitats including dry, mesic, and wet forests and shrublands. Condition of occupied habitat varies considerably. Currently, lands managed by the State of Hawaiʻi, the U.S. Military, and The Nature Conservancy support populations of Oʻahu tree snails.

THREATS: Historically, the loss of native forest habitat and the introduction of rats (*Rattus exulans*) likely affected snail populations; the impact of collecting for leis and other ornaments on snail populations is unknown but likely contributed to some declines. In the recent past, the introduction of additional rat species, over-collection, and the introduction of the carnivorous snail *Euglandina rosea* have resulted in declines in the genus. Ironically, *E. rosea* was introduced to control the giant African snail (*Achatina fulica*) a non-native, agricultural pest. Current threats include the continued degradation of habitat by non-native, invasive vegetation, especially strawberry guava (*Psidium cattleianum*), Christmas berry (*Schinus terebinthifolius*), silk oak (*Grevillea banksii*), shrub verbena (*Lantana camara*), and Koster's curse (*Clidemia hirta*). Pigs (*Sus scrofa*) also degrade habitat and predation by rats and introduced snails continues to be a problem. Low reproductive rates and limited dispersal abilities increase the vulnerability of this genus.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. A captive breeding program at the University of Hawaiʻi at Mānoa supports at least two species, *A. apexfulva* and *A. fuscobasis*, that are extinct in the wild. This facility has been successful in breeding snails. The U.S. Army is actively managing populations of *A. mustelina* under a Biological Opinion regarding continued military training issued by the USFWS. In addition to common statewide and island conservation actions, specific management directed toward Oʻahu tree snails should include:

- Protection of all existing habitat and restoration and management of potentially suitable but degraded habitat, including rat and *E. rosea* control.
- Continuation of captive propagation and the initiation of a program to re-introduce snails to restored habitats.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue surveys of populations and their distribution in known and potential habitats.
- Continue surveys of predator populations and non-native vegetation.

RESEARCH PRIORITIES:

- Conduct life history studies to quantify growth, population size, age distribution, and habitat needs.
- Develop and refine survey protocols to facilitate the collection of useful population data.

References:

U.S. Fish and Wildlife Service. 1992. Recovery plan for the O'ahu Tree Snails of the genus *Achatinella*. Portland, (OR): U.S. Fish and Wildlife Service. 64 pp. + 64 pp. of Appendices + 5 figures.


Photo: Gordon Smith, USFWS

Terrestrial Invertebrates

Kauaʻi Cave Arthropods

Adelocosa anops
(Kauaʻi Cave Wolf Spider),
Spelaeorchestia koloana
(Kauaʻi Cave Amphipod)

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
NatureServe Heritage Rank G1 - Critically imperiled
Draft Recovery Plan for the Kauaʻi Cave Arthropods: the Kauaʻi Cave Wolf Spider *Adelocosa anops*) and the Kauaʻi Cave Amphipod (*Spelaeorchestia koloana*) – USFWS 2004
Final Rule: Designation of Critical Habitat for the Kauaʻi Cave Wolf Spider and Kauaʻi Cave Amphipod Critical Habitat – USFWS 2003

SPECIES INFORMATION: Both the Kauaʻi cave wolf spider and the Kauaʻi cave amphipod were discovered in 1971, and both are known from less than a dozen caves on the island of Kauaʻi. Although a few wolf spider species (Family: Lycosidae) have reduced eyes, the Kauaʻi cave wolf spider has completely lost all vestiges of eyes; this trait justifies the species placement in the monotypic genus *Adelocosa*. Adult spiders are between 12 and 19 millimeters (0.5 to 0.75 inches) in length and are overall reddish brown in color. The species' life history is poorly known. Like all spiders, the Kauaʻi cave wolf spider is a predator and actively stalks its prey using its sense of touch or chemoreceptors. The species likely feeds on the Kauaʻi cave amphipod and non-native arthropods. Unlike other wolf spiders, the fecundity of the Kauaʻi cave wolf spider is low.

Compared to other amphipods (Family: Talitridae), the Kauaʻi cave amphipod has unusual morphological attributes which justifies its placement in the monotypic genus *Spelaeorchestia*. Like the Kauaʻi cave wolf spider, the Kauaʻi cave amphipod is blind, although it does possess eyes. Adults are seven to ten millimeters (0.25 to 0.4 inches) in length and have a translucent appearance. The species is a detritivore and has been observed feeding on rotting roots, plant material washed into the caves, and frass (i.e., arthropod fecal material). Little is definitively known about the species' life history.

DISTRIBUTION: Found only on Kauaʻi. Both are restricted to caves found in a 10.5 square kilometer (four square mile) lava flow. The Kauaʻi cave wolf spider has been documented in six caves, but only regularly observed in one. The Kauaʻi cave amphipod has been documented in nine caves, but only regularly observed in two. The amphipod also occurs in a limestone cave formed on top of the lava flow.

ABUNDANCE: Unknown. Currently no survey methods exist to accurately estimate the population of either species. However, counts have never documented more than 30 spiders or 80 amphipods.

LOCATION AND CONDITION OF KEY HABITAT: Caves in a single exposed lave flow in the Koloa Basin with very rocky to extremely rocky soils, and free from erosional sediments. Both species are restricted to dark, moist areas of larger caverns and smaller subterranean spaces. The latter may be the primary habitat for both the spider and amphipod. Both species appear to require very high humidity.

THREATS:

- All the land supporting these species is privately owned. Activities associated with development and agriculture (e.g., removal of native vegetation, filling and grading) degrade the delicate environments supporting the Kauaʻi cave wolf spider and Kauaʻi cave amphipod. Removal of vegetation results in a reduction of organic material that the amphipod feeds on and affects the humidity levels in the caves. Filling and grading increases the rate at which sediments fill the caves.
- Non-native competitors and predators.
- Droughts could alter the high-humidity environment that is required by the species and that also limits the establishment of non-native cave fauna.
- Human disturbance or visitation to the caves, the use of pesticides, and the use of biocontrol agents are serious threats to both species.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. Both species were listed as endangered in 2000. In 2003, the USFWS designated 106 hectares (272 acres) as critical habitat for both species. In addition to common statewide and island conservation actions, specific management directed toward Kauaʻi cave arthropods should include:

- Protect habitat from further loss or degradation, including above-cave habitats.
- Habitat enhancement or restoration including outplanting with native species to stabilize cave environments and increase food resources for cave fauna.
- Prevent the establishment of additional non-native invertebrate species and control existing non-native species that potentially limit cave arthropod populations.
- Conduct public outreach to increase public understanding of and support for both species.

MONITORING:

- Continue monitoring the status of known populations to better understand the abundance and distribution of both species.

RESEARCH PRIORITIES:

- Develop methods to survey populations that are accurate and minimize damage to fragile cave environments.
- Conduct surveys or initiate studies to determine local population sizes and movements of individuals.
- Identify additional populations of both species.
- Conduct studies to determine the most appropriate plants to restore above-cave habitats.

- Conduct studies to determine the factors that regulate cave humidity levels and how variation in humidity affects both species.
- Assess the feasibility of translocating individuals to suitable, but unoccupied caves.

References:

U.S. Fish and Wildlife Service. 2003. Final Rule: designation of Critical Habitat for the Kauaʻi cave wolf spider and Kauaʻi cave amphipod. Available at: http://www.fws.gov/pacific/pacificislands/CHRules/kauaicavefinal.pdf.

U.S. Fish and Wildlife Service. 2004. Draft recovery plan for the Kaua'i cave arthropods: the Kaua'i cave wolf spider (*Adelocosa anops*) and the Kaua'i cave amphipod *(Spelaeorchestia koloana*). Portland, (OR): U.S. Fish and Wildlife Service. 55 pp.


Photo: Jamie Brunch, KIRC

Terrestrial Invertebrates

Blackburn's Sphinx Moth

Manduca blackburni

SPECIES STATUS:
Federally listed as Endangered
State listed as Endangered
State recognized as Endemic
NatureServe Heritage Rank G1 - Critically imperiled
Draft Recovery Plan for the Blackburn's Sphinx Moth (*Manduca blackburni*) - USFWS 2003
Designation of Critical Habitat for the Blackburn's Sphinx Moth: Final Rule – USFWS 2003

SPECIES INFORMATION: Blackburn's sphinx moth is one of Hawaii's largest native insects (Family: Sphingidae) with a wing span of up to 12 centimeters (5 inches). Adults are overall gray with black bands across the top of their wings and five orange spots on each side of their abdomen. Caterpillars are large and populations contain two color morphs, bright green or gray. Both morphs have scattered white speckles across their back and a horizontal white stripe on the side of each segment. Caterpillars feed on plants in the nightshade family (Solanaceae), especially native trees in the genus *Nothocestrum,* but also on non-native solanacious plants such as commercial tobacco (*Nicotiana tabacum*), tree tobacco (*N. glauca)*, eggplant (*Pseudomonas solanacearum*), tomato (*Lycopersicon esculentum*), and Jimson weed (*Datura stramonium*). Adults have been observed feeding on the nectar of koaliawa (*Ipomea indica)*. Other likely adult nectar sources include other species of *Ipomea*, maiapilo (*Capparis sandwichiana)*, and ʻilieʻe (*Plumbago zeylancia*); it is believed that the moth pollinates these species, but further study is necessary. Development from egg to adult may be as short at 56 days, but larva may aestivate (i.e., period of dormancy during hot or dry conditions) in the ground for as long as a year. Moths are found year-round, but may be most active between January and April and again between September and November.

DISTRIBUTION: Believed to be extinct in the late 1970s, the species was rediscovered in 1984 on East Maui. Additional populations recently have been found on Kahoʻolawe and the island of Hawaiʻi. Historically, the species likely occurred on Kauaʻi, Oʻahu, and Molokaʻi as well. Blackburn's sphinx moth can be found across a broad elevational gradient from sea level to 1,540 meters (5,000 feet).

ABUNDANCE: Unknown. The species short life span, rarity, and mobility makes estimating population sizes difficult. Despite this, it is believed that populations have declined over the past 100 years. Currently, the largest populations reside on Maui and Hawaiʻi. Historical accounts suggest the species was widespread and abundant on most of the MHI.

LOCATION AND CONDITION OF KEY HABITAT: Historical records indicate that Blackburn's sphinx moth mostly occurred in coastal, lowland, and dry forests in areas receiving less than 127 centimeters (50 inches) of rain per year. Human modification of Hawaiian landscapes has greatly reduced these communities; for example, more than 90 percent of

Hawaii's dry forests have been destroyed. Depending on the location and elevation, the composition of the plant species in moth habitat varies considerably. However, some common native plants found in areas where the species occurs include lama (*Diospyros sandwiceneses*), ʻohe (*Reynoldsia sandwicensis*), hao (*Raovolfia sandwicensis*), ʻālaʻa (*Pouteria sandwicensis*), āulu (*Pisonia sandwicensis* and its varieties), ʻaʻaliʻi (*Dodonaea viscose*), naio (*Myoporum sandwicense*), and wiliwili (*Erythrina sandwicensis*). The populations on Maui and Hawaiʻi are primarily associated with ʻaiea (*Nothocestrum* spp.) trees. Perhaps the largest stand of ʻaiea trees in the State are located on Maui in the Kanaio Natural Area Reserve. Other large stands are found on Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, and the island of Hawaiʻi. On Molokaʻi, potential moth habitat consists of mixed-species in mesic and dry forests with both native and non-native plants (see below). On Kahoʻolawe, caterpillars currently feed on the non-native tree tobacco, as do populations on Maui and the island of Hawaiʻi. Although the species will feed on non-native plants, primary constituent elements of critical habitat as designated by the USFWS (see below; critical habitat) include the endemic larval host plant species *N. latifolium* and *N. breviflorum*, and native nectar sources for adults including koaliawa, other species of *Ipomoea*, maiapilo, and ʻilieʻe. These species are superior to non-natives in that they are more persistent, especially during drought conditions.

THREATS: Historically, habitat loss and degradation due to ranching, introduced plants and animals, human development, and wildfire reduced the quantity and quality of native habitats. In 2003, 40,420 hectares (99,433 acres) of critical habitat was designated by the USFWS on the islands of Hawaiʻi, Maui, Molokaʻi, and Kahoʻolawe. Current threats include non-native ants, especially the big-headed ant (*Linepithema humile*) and several species of parasitic flies and wasps. Although little documentation exists of direct predatation or parasitism, in areas where big-headed ants occur, native insects have been eliminated. Several of the wasp species have been documented parasitizing species closely related to Blackburn's sphinx moth. All species of *Nothocestrum* are declining. Because of development, competition from non-native species, browsing by cattle, and wildfire, the larval host plant, *N. breviflorum* on the island of Hawaiʻi, and the potential host plant, *N. peltatum* on Kauaʻi, are federally listed as endangered. The species' striking appearance makes adult moths vulnerable to over-collection. Finally, small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. For example, given that the species inhabits dry habitats, natural variation in rainfall can result in reduced food availability and negatively affect moth populations.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. Past actions directed at this species include the designation of critical habitat at seven sites on the islands of Hawaiʻi, Kahoʻolawe, Maui, and Molokaʻi. The Kanahā Pond Sanctuary dune restoration project on Maui is planting native host plants in response to observations of caterpillars on plants in the restoration area. In addition to common statewide and island conservation actions, specific management directed toward Blackburn's sphinx moth should include:

- Restoration of habitat (e.g. dry and mesic shrub land and forests) and increased protection of currently occupied habitats, especially those supporting host plants (e.g., *Nothocestrum* spp.).
- Support cultivation and restoration of *Nothocestrum* species.
- Restore *Nothocestrum* on the island of Kahoʻolawe to support moth populations.

- Re-establish moth populations throughout their historic range.
- Prevent introduction of non-native invertebrates that may pose a risk to existing moth populations.

MONITORING:

- Continue surveys of populations in known and potential habitats.
- Continue monitoring of *Nothocestrum* species.
- Monitor non-native plant and animal populations in known as well as potential moth habitat.

RESEARCH PRIORITIES: Currently the USFWS is funding research examining the life history, captive rearing, and conservation biology of Blackburn's sphinx moth. Additional research priorities include the following:

- Continue studies to improve understanding of the species' habitat needs.
- Continue studies to improve knowledge of the species' population status and life history.

References:

U.S. Fish and Wildlife Service. 2003. Designation of Critical Habitat for the Blackburn's Sphinx Moth: final rule. 68 FR 34710. Honolulu, (HI).

U.S. Fish and Wildlife Service. 2003. Draft recovery plan for the Blackburn's Sphinx Moth (*Manduca blackburni*). Portland, (OR): U.S. Fish and Wildlife Service. Ix+113 pp.

Photo not available

Bristlethighs

Order Archaeognatha

ORDER INCLUDES:
1 Native Family
1 Native Genus
5 Native Species
5 Endemic Species

GENERAL INFORMATION: Bristletails are primitive insects. They feed on algae, lichen, plant material, and possibly on dead arthropods. Fertilization is external and may involve courtship. Compared to other invertebrate orders found in Hawaiʻi, Archaeognatha is represented by very few native species. The order is poorly known in Hawaiʻi.

DISTRIBUTION: Bristletails are known from all MHI except Kahoʻolawe and Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Bristletails occupy a variety of habitats including leaf litter on forest floors, rotting logs and stumps, dead tree fern fronds, bunch grass, caves, and lava tubes.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward bristletails should include:
- Conduct surveys to determine the distribution and abundance of known bristletails and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:
Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawaiʻi Press.

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Photo: Bishop Museum; *Achatinella sowerbyana*

Photo: Kapua Kawelo; *Partulina spp*.

Land Snails

Orders Stylommatophora, Archaeogastropoda

ORDERS INCLUDE:
Oahu Tree Snails, Federally/State Listed as Endangered
13 Native Families
51 Native Genera
767+ Native Species
767+ Endemic Species

GENERAL INFORMATION: The Hawaiian native land snail fauna is probably the most diverse in the world per unit of area, with many species endemic to a single island. Over 98 percent of known land snail species are endemic to the Hawaiian Islands. All but two families, Hydrocenidae and Helicinidae, are in the order Stylommatophora. The families Amastridae and Achatinellidae are the most specious with 325 and 209 species, respectively. The family Endodontidae may contain as many as 200 undescribed species; to date only 33 are described. There are 60 described species in the family Helicarionidae, 56 in Pupillidae, 42 in Succineidae, 14 in Helicinidae, ten in Zonitidae, ten in Ellobiidae (native but mostly not endemic), two in Hydrocenidae, and one in Punctidae. The systematics of the amastrids, achatinellids, helicarionids, pupillids, helicinids, and zonitids was revised in the first half of the 20th century, but these taxonomies should be updated. The other families have never been comprehensively revised. The ecology of some species in Achatinellidae, especially those in the genera *Achatinella* and *Partulina* are well-known, and studies on some species in the family Succineidae are underway. The basic ecology of most other species is lacking.

DISTRIBUTION: Land snails are known from all MHI and NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents accurate population estimates for all but a few species in the genus *Achatinellidae*. However, because of declines in the availability of suitable habitat, combined with the widespread presence of introduced predators, particularly non-native carnivorous snails (e.g., *Euglandina rosa*), it is believed that most (90%) native snail species are extinct and the remaining species are in steep decline. Of the extant groups, the most abundant, although still threatened or endangered, are members of the genus *Tornatellides* (Achatinellidae), and a few members of the family Succineidae, such as *Succinea caduca*. All other extant species are critically endangered.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiian tree snails occur in all native forests, including dry, mesic, and wet.

THREATS:
- Loss and degradation of habitat.
- Non-native invasive predators (particularly *E. rosea* and rodents).

- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward land snails should include:

- Surveys to determine the geographic ranges of all extant species.
- Systematic surveys of all extant populations to determine abundance.
- Systematic surveys to locate unknown populations.
- Conservation of remaining native forests from further loss and/or degradation.
- Control predators.

MONITORING:

- Monitor known populations to assess population trends.

RESEARCH PRIORITIES:

- Conduct life history studies to quantify growth, population size, age distribution, and habitat needs.
- Develop and refine survey protocols to facilitate the collection of useful population data.

References:

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Photo not available

Mites (and Ticks)

Order Acari

ORDER INCLUDES:
58 Native Families
102 Native Genera
164 Native Species
153 Endemic Species

GENERAL INFORMATION: Mites are the most diverse and abundant arachnid, and except for ticks, mites are barely visible to the naked eye. The order is ubiquitous and is one of the oldest terrestrial animal taxa. Feeding habits of mites vary greatly; some species prey on or are parasites of animals, while others feed on plants, fungus, decaying organic matter, excrement, or carrion. Many mites are considered to be pests, while some are considered useful for biocontrol of other pests. All ticks are external parasites of vertebrates, feeding on blood. Ticks transmit the widest variety of pathogens of any blood-sucking arthropod, including bacteria, rickettsiae, protozoa, and viruses. The order Acari is poorly known in Hawaiʻi.

DISTRIBUTION: Mites and ticks are known from all the MHI as well as some of the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Mites and ticks inhabit a wide range of terrestrial and aquatic habitats. Key habitats are unknown.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward mites should include:
- Conduct surveys to determine the distribution and abundance of known mites and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

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Photo: Bill Mull; *Theridion grallator* or Happy-face spider

Terrestrial Invertebrates

Spiders

Order Araneae

ORDER INCLUDES:
Kauaʻi Cave Wolf Spider, Federally Endangered
16 Native Families
36+ Native Genera
132+ Native Species
128+ Endemic Species

GENERAL INFORMATION: Spiders have four pairs of legs and no antennae, and they are predaceous. Worldwide there are over 75,000 species. Hawaiʻi has at least 132 native species which are believed to have originated from 34 founder species. Most Hawaiian spiders are believed to have dispersed to Hawaiʻi by ballooning, a method of travel where a spider is carried by the wind on a strand of web. Eighty percent of the known Hawaiian native spider species belong to ten genera in seven families: *Cyclosa* (Araneidae), *Orsonwelles* (Linyphiidae), *Pagiopalus* and *Pedinopistha* (Philodromidae), *Havaika* (Salticidae), T*etragnatha* (Tetragnathidae), *Argyrodes* and *Theridion* (Theridiidae), and *Mecaphesa* and *Misumenops* (Thomisidae). However, many more species remain to be described, particularly in the genera *Tetragnatha* and *Argyrodes*, and perhaps also in *Cyclosa*, *Havaika*, and *Theridion*. Common and widespread native species include *Tetragnatha quasimodo*, *Misumenops anguliventris*, *M. facundus*, and *Pagiopalus* spp. The happy-face spider (pictured above) also is a well-known species that comes in a variety of color morphs. This variation may have evolved to reduce predation by preventing birds from establishing a reliable search image. Like many invertebrates found in Hawaiʻi, some taxa of spiders have undergone extensive adaptive radiations. For example, the 50 or so species in the genus *Tetragnatha* (long-jawed spiders), occur on all of the MHI and are found in most habitats. The constituent species encompasses a huge spectrum of colors, shapes, sizes, ecological affinities, and behaviors. They reach their highest diversity in montane wet and mesic forests, dry forests, high and low shrublands and scrub. There are likely many species yet to be discovered in this genus. Due to the fact that most species are nocturnal, Hawaiian native spiders remain poorly known.

DISTRIBUTION: Spiders are known from all of the MHI.

ABUNDANCE: As a group unknown. A lack of systematic surveys hampers population estimates. However, the loss of native habitats likely means that species within the order are declining. Of the known species, *Adelocosa anops* (limited to a single cave on Kauaʻi) and *Doryonychus raptor* (largely restricted to low elevation habitats on Kauaʻi) appear to be the most threatened.

LOCATION AND CONDITION OF KEY HABITAT: Spiders occur in all habitats in Hawaiʻi including caves, lava flows, forests, and shrublands. Key habitat requirements are poorly known.

THREATS:

- Predation by invasive, non-native species, especially social insects such as ants and wasps, and perhaps also other spiders.
- Loss or degradation of habitat. *Adelocosa anops* (Lycosidae) is known from a single cave on Kaua'i that is threatened by development.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward spiders should include:

- Forest restoration. Spider populations have responded positively to reforestation efforts at Auwahi on East Maui.
- Control of invasive non-native invertebrates.
- Conduct surveys to determine the distribution and abundance of known spiders and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Monitor known populations to assess trends in abundance.

RESEARCH PRIORITIES:

- Conduct systematic and taxonomic assessments of poorly known taxa, including radiations from the following families and genera: Lycosidae, Theridiidae (*Argyrodes* and *Theridion*), Araneidae (*Cyclosa*), Linyphiidae, Philodromidae, Oonopidae, Salticidae (*Havaika*), Thomisidae, Tetragnathidae (*Tetragnatha*).
- Conduct studies to document the biology, habitat requirements, and life history of native species.

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Photo not available

False scorpions

Order Pseudoscorpionida

ORDER INCLUDES:
7 Native Families
8 Native Genera
15 Native Species
15 Endemic Species

GENERAL INFORMATION: False scorpions are small predatory insects that prey on other arthropods. Unlike scorpions, false scorpions do not have a stinging tail. Fertilization is either external or internal. Most females construct a brood nest. The order is poorly known in Hawaiʻi.

DISTRIBUTION: **F**alse scorpions are known from Kauaʻi, Maui, Oʻahu, the island of Hawaiʻi and on Midway Atoll and Laysan Island in the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: False scorpions prefer habitats that provide cracks, nooks, or crevices in which they can retreat. In Hawaiʻi, caves are an important habitat; however, the importance of other habitats is unknown.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward false scorpions should include:
- Conduct surveys to determine the distribution and abundance of known false scorpions and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

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Photo not available

Bristlethighs

Order Archaeognatha

ORDER INCLUDES:
1 Native Family
1 Native Genus
5 Native Species
5 Endemic Species

GENERAL INFORMATION: Bristletails are primitive insects. They feed on algae, lichen, plant material, and possibly on dead arthropods. Fertilization is external and may involve courtship. Compared to other invertebrate orders found in Hawaiʻi, Archaeognatha is represented by very few native species. The order is poorly known in Hawaiʻi.

DISTRIBUTION: Bristletails are known from all MHI except Kahoʻolawe and Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Bristletails occupy a variety of habitats including leaf litter on forest floors, rotting logs and stumps, dead tree fern fronds, bunch grass, caves, and lava tubes.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward bristletails should include:
- Conduct surveys to determine the distribution and abundance of known bristletails and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:
Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawaiʻi Press.

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Photo: James Liebherr, *Blackburnia* spp. Photo: *Rhyncogonus* spp.

Beetles

Order Coleoptera

ORDER INCLUDES:
26 Native families
87 Native genera
1,348 Native Species
1,337 Endemic Species

GENERAL INFORMATION: The order Coleoptera is the largest order of animals in the world, containing well over a million species. Beetles can be found in all habitats and fill a huge variety of ecological niches. In Hawaiʻi, beetles have undergone extensive adaptive radiations and are the dominant insects in most habitats. Carabid beetles are the dominant predatory insects in native wet forests, and species in the family Curculionidae (weevils) are the dominant herbivorous insects in all habitats. Different species of beetles also feed on fungus, some specialize on particular plant parts and others are detritivores. Diversity within most families is generally highest on Maui, Oʻahu, and Kauaʻi. The most specious families include: Carabidae (5 genera/239 spp.), Curculionidae (10 genera/169 spp.), Aglycyderidae (*Proterhinus*/158 spp.), Anobiidae (3 genera/138 spp.), Cerambycidae (3 genera/128 spp.), Nitidulidae (7 genera/93 spp.), and Staphylinidae (12 genera/92 spp.). Many species are little known, especially in the families Aglycyderidae and Staphylinidae; substantial research has not been conducted on either family in over 100 years. As an example of the diversity of Hawaii's beetles, two genera are briefly outlined below. *Blackburnia* (Family: Carabidae) are nocturnal, occupy a variety of ecological niches, and nearly all species are flightless and restricted to single islands or volcanoes. Endangered or threatened species in this genus are mostly known from shrublands and mesic koa forest. Recent research has discovered 38 new species (29% of the species in the genus), and non-native ants are a particular threat to this genus. *Rhyncogonus* (Family: Curculionidae weevils) are flightless, nocturnal weevils; most adults are herbivorous. Nearly all are endemic to single islands and are known from all the MHI and the NWHI. Members of the genus are the dominant leaf-chewing beetle group in Hawaiʻi, and many species are specific to particular plant communities where they feed on a narrow range of host plants. Threats to this genera include habitat degradation by pigs (*Sus scrofa*), and by habitat-modifying non-native invasive plants, predation by ants, and human disturbance. All species in this genus are considered to be of concern. Recent research has discovered 15 new species (31% of the species in the genus).

DISTRIBUTION: Beetles are known from all the MHI and the NWHI.

ABUNDANCE: As a group unknown. A lack of systematic surveys prevents accurate population estimates. However, the loss and degradation of native habitats likely means that species within the order are declining. Based on extensive collecting effort in suitable habitats abundance of common species is estimated minimally at 5,000 adult individuals per hectare. In contrast, the rarest species are collected or observed once per decade. Comparing modern collections with those from the 1890s indicates that abundance in mesic koa (*Acacia koa*) forests, *Sophora-Deschampsia* shrublands, and low elevation mesic ʻōhiʻa (*Metrosideros polymorpha*) forests has declined precipitously. These habitats are often those most heavily impacted by alien predaceous, social Hymenoptera (e.g., ants and vespid wasps), other alien arthropods such as non-native isopoda (sowbugs), and invasive weeds.

LOCATION AND CONDITION OF KEY HABITAT: Beetles are among the most ecologically diverse group and occur in most terrestrial and aquatic habitats. Key habitat requirements of individual species are poorly known.

THREATS:

- Loss and degradation of habitat due to habitat-modifying invasive plants, browsing and grazing by non-native ungulates, and logging.
- Non-native predaceous ants (Formicidae) and wasps (Vespidae) as well as non-native competitors such as non-native sowbugs (Isopoda) and the black twig borer (*Xylosandrus compactus*; Scolytidae; Coleoptera) are negatively affecting native beetle populations.
- Insufficient information, especially for rare species, hampers conservation efforts.
- Collecting certain showy or large beetles for sale may affect populations, especially in the genus *Plagithmysus* (Cerambycidae).
- Biocontrol agents or organisms may affect some native species.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward beetles should include:

- Baiting and control of Argentine ant (*Linepithema humile*) in Haleakalā shrublands.
- Rehabilitation of mesic koa forests on Oʻahu, Maui, Molokaʻi, and the island of Hawaiʻi.
- Control of weeds in wet and mesic forests, especially species of *Miconia*, *Clydemia*, *Tibouchina*, *Alsophila*, and *Passiflora*.
- Improve commercial shipment inspections to prevent further introduction of alien invertebrates harmful to native species.
- Initiate studies on life history, distribution, and critical habitats to better direct conservation measures.
- Conduct surveys to determine distribution and abundance of known coleopterans and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Support and expand existing monitoring efforts.
- Establish new monitoring for priority species that are not currently monitored.

RESEARCH PRIORITIES:

- Initiate targeted searches for species not recently collected or observed.
- Initiate studies to determine species' distributions to determine areas supporting large numbers of native species.
- Initiate efforts to locate and identify new species.
- Initiate studies to determine the effects of biocontrol organisms on beetle populations.

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Photo not available

Springtails

Order Collembola

ORDER INCLUDES:
5 Native Families
32 Native Genera
95 Native Species
95 Endemic Species

GENERAL INFORMATION: Springtails are primitive, wingless insects. Springtails can be carnivores, scavengers, or fungivores; some also feed on dead (i.e., detritivores) and living plant material (i.e., herbivores). They go through a slight metamorphosis and usually grow to less than five millimeters (0.2 inches). Ants and spiders are known to prey on springtails. The order is poorly known in Hawaiʻi.

DISTRIBUTION: Springtails are known from all MHI except Kahoʻolawe and Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Because they are hydrophiles (i.e., water lovers) springtails are most often found in damp habitats. They occur in a wide range of habitats, primarily in soil and leaf litter. Species also can be found in trees, lava tubes, and in the cold desert-like habitat at the summit of Mauna Kea.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward springtails should include:
- Conduct surveys to determine the distribution and abundance of known springtails and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Young FN, Kritksy G. 2002. A survey of entomology. Lincoln, (NE): Writers Club Press. 308 pp.

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Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Photo not available

Earwigs

Order Dermaptera

ORDER INCLUDES:
1 Native Family
3 Native Genera
10 Native Species
9 Endemic Species

GENERAL INFORMATION: Earwigs have slender, flattened bodies and are easily recognized by the pair of large pincers at the tip of their abdomens. Earwigs are nocturnal and most are carnivorous, although some species are omnivorous. Females lay eggs in the soil, under objects, or in other protected places, and guard eggs and care for young until they are able to find food for themselves. Earwigs hatch from eggs and molt as they grow, obtaining more antennal segments and progressively more developed wings with each molt (i.e., anamorphic growth). Earwigs are considered harmless to people, although some species emit a foul smelling substance when disturbed. All native earwigs are members of the family Carcinophoridae. Six endemic species in the genus *Anisolabis* represent an adaptive radiation from a marine littoral ancestor, probably *A. maritima*, which is indigenous to Hawaiʻi. *A. maritima* and *Euborellia eteronoma* are widespread and populations appear stable. *A. perkinsi*, known only from Kauaʻi, has apparently declined. *A. howarthi* is restricted to caves on Hawaiʻi Island. It is rarely seen and each cave may harbor a distinct population. The other four *Anisolabis* species have not been recollected for at least 75 years and may be extinct. Two species were known from Oʻahu, one was endemic to Maui, and one was known from the island of Hawaiʻi. Earwigs are not considered pests in Hawaiʻi, although they are elsewhere in the world.

DISTRIBUTION: Earwigs are known from all the MHI and the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Earwigs occur in a variety of habitats including caves, coastal and marine littoral areas, mesic and sometimes wet forests, and possibly recent lava flows.

THREATS:
- Invasive predators and parasites.
- Possibly alien diseases.
- Loss or degradation of habitat.
- Possible disease.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward earwigs should include:

- Conduct surveys to determine the distribution and abundance of known earwigs and to document and identify new species.
- Conserve areas supporting native species, especially cave habitats.
- Conduct surveys searching for populations of species thought to be extinct.

MONITORING:

- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:

- Determine the status and population trends of *A. perkinsi* and initiate studies designed to determine the causes of its decline.
- Conduct studies to document the biology, habitat requirements, and life history of native species.
- *A. maritima* and *A. howarthi* populations possess geographic variation. Initiate studies to determine whether populations are distinct species.

References:

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Photo: David Foote; *Drosophila heteroneura*

Terrestrial Invertebrates

True Flies

Order Diptera

ORDER INCLUDES:
25 Native Families
87 Native Genera
2,000+ Native Species
1,061+ Endemic Species

GENERAL INFORMATION: All flies, except wingless species, have two pairs of wings; one pair is functional, the other (known as halteres) is highly modified. Because of their importance in genetic research, Dipterans are well-studied. The initial founders of Hawaiian populations are believed to have reached the islands on birds or by being caught in wind currents. Numerous adaptive shifts and unusual evolutionary developments characterize the species found in Hawaiʻi, and close to one-fifth of the world's known species of *Drosophila* are endemic to Hawaiʻi. The most specious genera include *Campsicnemus*, *Drosophila*, *Scaptomyza*, and *Lispocephala*. Species in the genus *Drosophila* are perhaps the best-known dipterans because of the scientific interest in the group's genetics and adaptive radiations. Most species are found in native wet forests at an elevation of approximately 925 meters (3,000 feet). The species in the genus are specialized microbivores that rely on over 40 families of native plants, with 37 percent of the species in the genus dependent on plants in the family Araliaceae. Recent declines within the genus are associated with the loss of these host plants. Pigs (*Sus scrofa*) degrade habitat and facilitate the spread of non-native *Drosophila*. Non-native western yellow jacket (*Vespula pensylvanica*) also prey on native *Drosophila*. Currently 12 species are candidates for federally listed as endangered. Successful conservation efforts include pig removal from native forests.

DISTRIBUTION: Dipterans are known from all the MHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Flies occur in a variety of freshwater and terrestrial habitats.

THREATS:
- Habitat loss and degradation due to conversion for agriculture, logging, grazing, and disturbance by a suite of non-native ungulates, and the introduction of invasive plants.
- Non-native predators, including ants, wasps, crustaceans, and fish.
- Insufficient information, especially for rare species hampers conservation efforts.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward flies should include:

- Conduct surveys to determine the distribution and abundance of known fly species and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.
- Initiate studies on life history, distribution, and critical habitats to better direct conservation measures.

MONITORING:

- Continue surveys to monitor status of known populations in order to asses their stability and trends.

RESEARCH PRIORITIES:

- Survey for additional, new populations.
- Survey to determine status of species believed to be extinct.
- Conduct studies to document the biology, habitat requirements, and life history of poorly-known, native species.

References:

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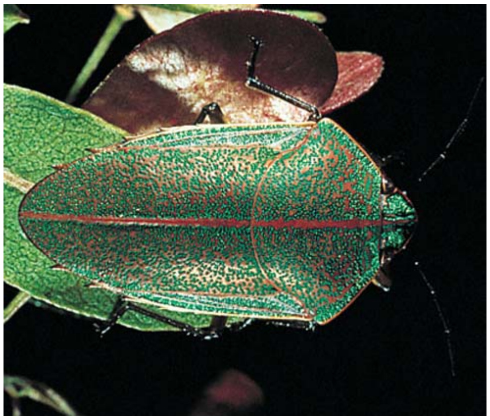

Photo: W. P. Mull; *Coleotichus blackburniae; Koa bug*

True bugs

Order Heteroptera

ORDER INCLUDES:
12 Native Families
39 Native Genera
418 Native Species
415 Endemic Species

GENERAL INFORMATION: Heteroptera is a large and diverse order that includes terrestrial and aquatic species. Most species are small and feed on plants; however, some are predaceous and others are scavengers. Members of the order also are known as true bugs, and the most familiar members of the order are assassin bugs (Reduviidae), stink bugs (Pentatomidae), and water bugs (Belostomatidae). The largest number of native species occurs in the families Lygaeidae (i.e., seed bugs) and Miridae (i.e., plant bugs), many of the latter of which are still poorly studied and understood. Of the 415 endemic species, 39 have not been collected in over 50 years. As an example of the diversity of Hawaii's true bugs, three genera are briefly outlined below. Most species in the genus *Nesiomiris* (Miridae) are endemic to single islands. The 50 described native species are known from all the MHI and feed only on the host plants in the following genera: *Cheirodendron, Reynoldsia, Tetraplasandra, Munroidendron,* and *Ilex*. All species in the genus *Orthotylus* (Miridae) are all endemic to single islands. The 63 native species described are known from all the MHI. Overall, species within the genus feed on a wide variety of native host plants, although most individual species depend on a single host plant or several closely related species, with plants in Rubiaceae being particularly important. All but one of the 40 described native species in the genus *Sarona* (Miridae) are endemic to single islands, and most depend on a single host plant, often in the genus *Melicope*.

DISTRIBUTION: True bugs are known from all the MHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining with populations occurring in dry and mesic forests are believed to be declining rapidly.

LOCATION AND CONDITION OF KEY HABITAT: True bugs occur in aquatic (both marine and freshwater) and terrestrial habitats, including high-elevation alpine areas and caves.

THREATS:
- Loss or degradation of habitat, especially dry lowland habitats and coastal zones.
- Loss of host-specific plants.
- Insufficient information for species assessments.
- Predation and parasitism by invasive non-native insects including ants (Formicidae), the southern green stinkbug (*Nezara viridula*), parasitoid flies (Diptera) and wasps (Hymenoptera), and generalist egg predators.
- Displacement by non-native congeners (e.g., invasive members of the family Lygaeidae).

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward true bugs should include:

- Control of fire in dry and mesic forest habitats.
- Outplanting of native plants, especially those that are hosts to declining heteropteran species.
- Protect coastal strand habitats from off-road vehicles and excessive foot traffic in areas where native vegetation remains.
- Conduct surveys to determine the distribution and abundance of known true bugs and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:

- Initiate studies of the genera *Orthotylus*, *Koanoa*, *Sulamita*, *Kalania* and *Pseudoclerada*, all of which appear to have many undescribed species.
- Initiate efforts to relocate 39 species that have not been observed in at least 50 years.

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Photo not available

Aphids, Hoppers, Whiteflies, Mealybugs, Scale Insects

Order Homoptera

ORDER INCLUDES:
6 Native Families
38 Native Genera
393 Native Species
393 Endemic Species

GENERAL INFORMATION: Homoptera is a large and diverse order, particularly rich in Hawaiʻi. All members of the order are phytophagous and feed on sap from plant tissue. The most specious families in Hawaiʻi include: Cicadellidae, Cixiidae and Delphacidae; undescribed species likely occur in each family. Unfortunately, even in these diverse families, the constituent species are generally represented by few specimens, and their life history is poorly known. As an example of the diversity of Hawaii's leaf and tree hoppers, three endemic species are outlined. The endemic genus *Nesophrosyne* (Family: Cicadellidae) is comprised of 62 described species and subspecies. All are likely endemic to individual islands, and most species depend on a narrow range of host plants. Eighty-two described species and subspecies comprise the endemic genus *Nesosydne* (Family: Delphacidae). All are likely endemic to individual islands, and most species depend on a narrow range of host plants. The endemic genus *Oliarus* (Family: Cixiidae) is comprised of 82 described species and subspecies, most of which are endemic to a single island. Unlike the previous genera, members of this genus are not dependent on specific host plants and are found in caves.

DISTRIBUTION: Members of the order Homoptera are found on all the MHI.

ABUNDANCE: As a group unknown. A lack of systematic surveys prevents any population estimate. However, the loss and degradation of native habitats, especially the loss of native host plants, likely means that species within the order are declining. Species that are dependent on plant species of dryland forests, as in the genus *Dictyophorodelphax*, are believed to be declining because of the almost total loss of native dry forests. The most abundant species appear to be found in the genus *Nesophrosyne* and their tolerance to non-native ants (Formicidae) likely explains their abundance.

LOCATION AND CONDITION OF KEY HABITAT: True bugs are a very ecologically diverse group and occur in most terrestrial habitats. Key habitat requirements of individual species are poorly known.

THREATS:

- Habitat loss and degradation due to conversion for agriculture, logging, grazing and soil disturbance by a suite of non-native ungulates, and the introduction of invasive plants.
- Loss of native host plants.
- Insufficient information, especially for rare species, hampers conservation efforts.
- Predatory non-native ants.
- Non-native parasitoid wasps (Vespidae) may adversely affect some species in the family Coccoidea.
- Biocontrol agents to control the non-native two-spotted leafhopper (*Sophonia rufofascia*) and glassy winged sharpshooter (*Homalodisca coagulate*) have the potential to adversely affect native members of the family Cicadellidae.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward homoptera should include:

- Conduct surveys to determine distribution and abundance of known homoptera and to document and identify new species.
- Outplanting of native host plants that support rare Homoptera.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue monitoring the status of known populations to detect declines in native species and to detect new non-native species.

RESEARCH PRIORITIES:

- Initiate studies to determine species' distributions to determine areas supporting large numbers of native species.
- Initiate efforts to locate and identify new species.
- Initiate studies to determine the effects of biocontrol organisms on species in the family Cicadelliade.
- The genus *Nesophrosyne* (Cicadellidae), which is comprised of many undescribed species that depend on rare native host plants, should be reviewed and revised as appropriate.

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Photo: Forest and Kim Starr and Karl Magnacca, *Hylaeus* spp.

Bees and Wasps

Order Hymenoptera

ORDER INCLUDES:
17 Native Families
60 Native Genera
650+ Native Species
650+ Endemic Species

GENERAL INFORMATION: The order Hymenoptera is large and diverse, and is best known because of the social behavior of ants, bees, and wasps. Hawaii's native Hymenoptera fauna, however, is comprised of non-social bees and wasps and does not include any native ants. The most specious genus is *Sierola* (Bethylidae) with approximately 180 species. Several species in each of the genera *Hylaeus* (Colletidae), *Ectemnius* (Spnecidae), and *Odynerus* (Vespidae) including *H. chlorostictus*, *H. difficilis*, *H. pubescens*, *E. nesiotes*, *E. polynesialis*, *O. peles*, and *O. scoriaceus* are common and relatively abundant. However, the status of many other species in these genera, as well as species in the genera *Enicospilus* (Ichneumonidae), *Sclerodermus* (Bethylidae), *Sierola* (Bethylidae), is unknown. As elsewhere, Hawaiian bees and wasps have played an important role in keeping other insects, particularly herbaceous species, in check and in pollinating plants. The family Colletidae or native yellow-faced bees are important pollinators for many native plants. Most of the native wasps are arthropod parasites, often specific to particular taxa. For example, species in the family Mymaridae parasitize small insects and insect eggs, species in the family Encyrtidae prey on scale insects (Homoptera); species in the family Eucoilidae lay their eggs on fly (Diptera) pupae, and species in the families Vespidae and Bethylidae prey on Lepidoptera caterpillars. As an example of the diversity of Hawaii's hymenopterans, two genera are briefly outlined. The approximately 60 species in the bee genus *Hylaeus* occur on all the MHI. Female are inseminated as young adults and utilize the stored sperm throughout their life. Most of the species on Kauaʻi and Hawaiʻi are endemic, while only five species are endemic to Oʻahu and Maui and one to Molokaʻi. They nest in hollow stems, holes in trees, under bark, in crevices, or in burrows in soil. Potential threats include non-native bees (*Ceratina* spp.) found in the native coastal habitats used by *Hylaeus* species, and competition with the European honeybee (*Apis mellifera*) for nectar and pollen. Confirmed threats include introduced ants (Formicidae) which compete with *Hylaeus* for nesting sites, and the big-headed ant (*Pheidole megacephala*) and Argentine ant (*Linepithema humile*) which prey on the native bees. Since *Hylaeus* bees pollinate native plants, their loss would be detrimental to recovery of native plants. Wasps in the genus *Sierola* are found worldwide, but over 90 percent of the known species are endemic to Hawaiʻi. They are small, black wasps found primarily in wet and mesic forest. Fullway (1920) described 171 species, with 119 from Oʻahu and 44 from the island of Hawaiʻi. Possibly hundreds of species remain to be described, and it is not uncommon to find greater than ten morphospecies (i.e., species established solely on morphological characteristics) at a single site. These species are difficult to collect, and many morphospecies are found in very low numbers; this may be an artifact of collection methods or due to their rarity. Similar to other wasps, females find a Lepidoptera larva, sting and paralyze it, and lay an egg on it. Once the egg hatches the larva feeds on the caterpillar.

DISTRIBUTION: Hymenopterans are found on all the MHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Hymenopterans occur in most terrestrial habitats.

THREATS:
- Competition with non-native wasps and ants.
- Predation by non-native insects.
- Loss or degradation of habitat, especially the loss of native host plants for bees.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward hymenopterans should include:
- Conduct surveys to determine the distribution and abundance of known hymenopterans and to document and identify new species.
- Preserve, maintain, and restore habitat for existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct systematic and taxonomic assessments of poorly known taxa.
- Conduct studies to document the biology, habitat requirements, and life history of endemic species.
- Refine methods for conducting quantitative survey.

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Photo: Jim Denny; *Udara Blackburn;* Blackburn's Blue

Terrestrial Invertebrates

Moths and Butterflies

Order Lepidoptera

ORDER INCLUDES:
Blackburn's Sphinx Moth -
Federally listed as Endangered
State listed as Endangered
18 Native Families
60 Native Genera
957 Native Species
600+ Endemic Species

GENERAL INFORMATION: The beauty and popularity of many species of butterflies and moths makes Lepidoptera perhaps the best known insect order. Hawaiʻi supports 955 native species of moths, but only two native butterfly species: Blackburn's blue (*Udara blackburni*; Lycaenidae), and Kamehameha butterfly (*Vanessa tameamea*; Nymphalidae), the latter is Hawaii's state insect. This disparity in numbers is likely the result of the fact that moths are typically generalists, while most butterflies are dependent on specific host plants. Native moths are very small, with most only having a wingspan of one centimeter (.39 inches) or less, and most are poorly known. Approximately 350 species of native moths are in the genus *Hyposmocoma*, and twice as many are likely undescribed. The species comprising *Hyposmocoma* are the second most diverse animal genus in Hawaiʻi (flies in the genus *Drosophila* being the most diverse). These moths inhabit a wide range of habitats, although some species are restricted to single stream or river drainages. As a genus they are mostly herbivorous, feeding on plant debris and lichens. In 2005, however, a new species (*H. molluscivora*) was discovered on Maui, the larva of which feeds on snails. Less than one percent of the world's known moths and butterflies are carnivorous.

DISTRIBUTION: Lepidopterans are known from all the MHI and the NWHI.

ABUNDANCE: As a group unknown. A lack of systematic surveys prevents accurate population estimates. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Butterflies and moths occur in all native habitats from sea level to alpine deserts. Host material is widely varied and includes native plants, lichens, algae, and fungi. Some species feed only in the decaying wood of particular plant species.

THREATS:

- Habitat loss and degradation due to conversion for agriculture, logging, grazing, and soil disturbance by a suite of non-native ungulates, and the introduction of invasive plants.
- Loss of native host plants.

- Insufficient information, especially for rare species, hampers conservation efforts.
- Non-native species, including ants (Formicidae), especially the big-headed ant (*Linepithema humile*), and several species of parasitic flies (Diptera) and wasps (Hymenoptera) prey on both larvae and adult moths.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward moths and butterflies should include:

- Improve commercial shipment inspections to prevent further introduction of alien invertebrates harmful to native species.
- Initiate studies on life history, distribution, and critical habitats to better direct conservation measures.
- Conduct surveys to determine the distribution and abundance of known moths and butterflies and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Support and expand existing monitoring efforts.
- Establish new monitoring for priority species that are not currently monitored.

RESEARCH PRIORITIES:

- Initiate targeted searches for species not recently collected or observed.
- Initiate studies to determine species' distributions to locate areas supporting large numbers of native species.
- Initiate efforts to locate and identify new species.
- Systematic review of the order.

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Photo not available

Lacewings and Antlions

Order Neuroptera

ORDER INCLUDES:
4 Native Families
5 Native Genera
50 Native Species
50 Endemic Species

GENERAL INFORMATION: Lacewings and antlions are predaceous, feeding on other insects. Most adult species have four large, net-veined, colorful wings. Despite this, most are poor fliers; a few species are flightless (e.g., *Pseudopsectra lobipennis* and *Nesothauma haleakalae*). The largest number of Hawaiian endemic species is found in the genera *Anomalochrysa* and *Micromus*.

DISTRIBUTION: Neuropterans are known from all the MHI except for Kahoʻolawe and Niʻihau. Members of this order also are known from the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Mostly unknown. However, lacewings and antlions appear to occur in a wide range of habitats.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward lacewings and antlions should include:
- Conduct surveys to determine the distribution and abundance of known lacewings and antlions and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

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Photo: David Preston; *Megalagrion pacificum*

Terrestrial Invertebrates

Damselflies and Dragonflies

Order Odonata

ORDER INCLUDES:
3 Native Families
4 Native Genera
33 Native Species
31 Endemic Species

GENERAL INFORMATION: Dragonflies are an ancient insect group that coexisted with dinosaurs, and are part of an easily recognized and well-known insect order (Odonata). All members of the order are predaceous, have large compound eyes, two pairs of large membranous wings, and a long, thin abdomen. No dragonfly or damselfly stings and all have an aquatic larval form (i.e., nymph). The order consists of two suborders, one contains the damselflies and the other the dragonflies. Damselflies are weak fliers, and at rest most hold their wings close to the body. Dragonflies are strong fliers, and at rest hold their wings away from the body. Because of the diversity and extensive adaptive radiation, the native damselfly genus *Megalagrion* is particularly well-studied. Many *Megalagrion* species are endemic to single islands or ridges, and at least ten of the 23 species in the genus are considered at risk. *M. oahuenses* is one of the few truly terrestrial damselflies in the world. Also notable is the endemic dragonfly, *Anax strenuous*. It is the largest Hawaiian native insect with a wingspan of 15 centimeters (6 inches).

DISTRIBUTION: Dragonflies and damselflies are known from all the MHI except for Kahoʻolawe.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Larvae and adult odonates occur in or near a wide range of aquatic habitats (e.g., streams, plunge pools, reservoirs, anchialine pools, lowland swamps and marshes), montane forests and bogs, and lowland habitats, many of which are threatened by habitat change and loss. The following areas are key habitats for four species of *Megalagrion*, all of which are candidates for federal listing: East Wailua Iki Stream on Maui (*M. nesiotes*), Tripler Army Medical Center on Oʻahu (*M. xanthomelas*), Waiawa, North Hālawa, Kahana and Maʻakua Streams on Oʻahu (*M. leptodemas*), and headwaters and upper mid-reaches of all drainages in the windward Koʻolau Mountains from Kaluanui to Kahawainui (*M. oceanicum*).

THREATS:

- Loss or degradation of habitat such as from water diversions or disturbance caused by feral ungulates.
- Non-native invasive invertebrates, fish and frogs prey on nymphs.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward dragonflies and damselflies should include:

- Identify and protect streams currently free of non-native species and human alterations, particularly in lowland areas.
- Conduct surveys to determine distribution and abundance of known dragonfly and damselfly populations and to document and identify new species.
- Enhanced protection of key watersheds.
- Support captive breeding and relocation/translocation of *Megalagrion xanthomelas* on O'ahu.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue monitoring of known populations to assess population trends.
- Survey for additional, new populations.
- Conduct surveys for species believed to be extinct.

RESEARCH PRIORITIES:

- Conduct studies to determine the cause(s) of decline of stream-breeding species, particularly on O'ahu.
- Assess potential haplotype differences among island populations of widespread species to determine the importance of protecting populations on individual islands.

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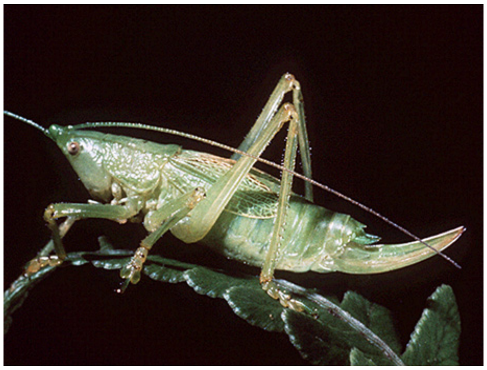


Photo: Bishop Museum; *Banza nitida*

Crickets and Katydids

Order Orthoptera

ORDER INCLUDES:
2 Native Families
10 Native Genera
260 Native Species
259 Endemic Species

GENERAL INFORMATION: Crickets and katydids are well-known because of their jumping and singing abilities. In general, members of the order are herbivores, but many species are omnivores. Some of the best examples of cryptic coloration and mimicry are found in this group, with some species being shaped like leaves or being colored to match their background. The number of endemic Hawaiian crickets is twice the number of species that can be found in the entire continental United States. The largest number of endemic species is found in the genus *Trigonidium*.

DISTRIBUTION: Crickets and katydids are known from all the MHI except for Kahoʻolawe. Members of this order also are known from the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Crickets and katydids occur in a wide range of habitats including dry and wet forests.

THREATS:

- Loss or degradation of habitat.
- Non-native invasive parasitoid species.
- Habitat-modifying non-native plants.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward crickets and katydids should include:

- Conduct surveys to determine distribution of known crickets and katydids and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:

- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Photo not available

Lice

Order Phthiraptera

ORDER INCLUDES:
2 Native Families
25 Native Genera
57 Native Species
5 Endemic Species

GENERAL INFORMATION: Lice are wingless parasites of birds or mammals. Unlike other parasites, lice cannot live long if removed from their host. Eggs or nits are glued directly to the feathers or hair of hosts. Most lice rely on a single species to serve as a host. Lice are poorly known in Hawaiʻi.

DISTRIBUTION: Lice are known from the island of Hawaiʻi, Maui, and Oʻahu, as well as the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Poorly understood. However, since Hawaiian lice are typically bird parasites, those habitats that support healthy populations of various bird species should support lice populations.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward lice should include:
- Conduct surveys to determine the distribution and abundance of known lice and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Photo not available

Bark lice and Psocids

Order Psocoptera

ORDER INCLUDES:
5 Native Families
6 Native Genera
93 Native Species
90 Endemic Species

GENERAL INFORMATION: Most bark lice and psocids are scavengers or feed on lichen found on woody vegetation. Bark lice and psocids are an important food source for native birds and other insect-eaters. The largest number of endemic species occurs within the genera *Ptycta*, *Palistreptus*, and *Kilauella,* respectively.

DISTRIBUTION: Bark lice and psocids are known from all the MHI except for Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Found mostly on woody vegetation.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward bark lice and psocids should include:
- Conduct surveys to determine the distribution and abundance of known bark lice and psocids and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:
Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawaiʻi Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Photo not available

Fleas

Order Siphonaptera

ORDER INCLUDES:
1 Native Family
1 Native Genus
1 Native Species
1 Endemic Species

GENERAL INFORMATION: Fleas are typically parasites feeding on the blood of their vertebrate hosts. Larvae are free living and feed on organic matter. One endemic species, *Parapsyllus laysanensis*, is known in Hawai'i and is a seabird parasite. This order is poorly known in Hawai'i.

DISTRIBUTION: Hawaii's one species of flea is known only from Laysan Island in NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. However, habitats supporting breeding colonies of seabirds are likely key to this species' survival.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward *P. laysanensis* should include:
- Conduct surveys to determine distribution of known *P. laysanensis* populations and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of the endemic species.

References:
Davies RG. 1988. Outlines of entomology. New York, (NY): Chapman and Hall. 408 pp.

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Thrips

Order Thysanoptera

ORDER INCLUDES:
2 Native Families
9 Native Genera
29 Native Species
29 Endemic Species

GENERAL INFORMATION: Thrips are herbivorous, fungivorous, or predaceous, preying on insects and mites, although most are herbivore sap-suckers. Some species are capable of producing young without the contribution of sperm (i.e., parthenogenic). Metamorphosis is intermediate and thrips rarely grow to be more than four millimeters (0.2 inches). Thrips are gregarious and are usually found in large colonies. This order is poorly known in Hawaiʻi.

DISTRIBUTION: Thrips are known from all the MHI except for Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Thrips occur in a variety of habitats ranging from dry, lowland areas to wet, high-elevation forests. Fungivores and predaceous thrips are more likely to occur in wetter habitats. Individuals are often found in trash, under bark, and other well-protected locations.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward thrips should include:
- Conduct surveys to determine the distribution and abundance of known thrips and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Zimmerman EC. 1948. Insects of Hawaii: Volume 2. Honolulu: University of Hawai'i Press. 475 pp.

Zimmerman EC. 2001. Insects of Hawaii: Volume 1 Introduction. Honolulu: University of Hawai'i Press.

Photo not available

Pillbugs, Sowbugs, Woodlice, Isopods

Order Isopoda (Terrestrial)

ORDER INCLUDES:
5 Native Families
10 Native Genera
19 Native Species
18 Endemic Species

GENERAL INFORMATION: Pillbugs, sowbugs, woodlice, and isopods have a variety of feeding habits. They can be carnivores, herbivores, or scavengers. Females carry eggs until they hatch, and larvae are not pelagic. This order is poorly understood in Hawaiʻi.

DISTRIBUTION: Pillbugs, sowbugs, woodlice, and isopods occur on all the MHI with the exception of Niʻihau, and on all the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the order are declining.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial members of this order occupy a wide range of habitats ranging from marine and freshwater habitats to terrestrial habitats. Pillbugs and sowbugs are terrestrial. Isopods occur in marine littoral zones, rain forests, and caves.

THREATS:
- Competition from non-native species.
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward pillbugs, sowbugs, woodlice, and isopods should include:
- Conduct surveys to determine the distribution and abundance of known isopods and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:

- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Brusca R. 1997. Tree of life project [Internet]. Available at: http://tolweb.org/tree?group=Isopoda&contgroup=Peracarida.

Photo not available

Centipedes

Orders Geophilomorpha, Lithobimorpha

ORDERS INCLUDE:
5 Native Families
10 Native Genera
12 Native Species
11 Endemic Species

GENERAL INFORMATION: Centipedes have elongated and segmented bodies. Worldwide, there are five divergent orders of centipedes; only two occur in Hawaiʻi (Geophilomorpha and Lithobimorpha). Species in the order Geophilomorpha hatch with the full complement of adult legs and segments (i.e., epimorphic growth), females care for eggs and young, and individuals move very slowly. In contrast, species in the order Lithobiomorpha obtain additional segments and legs with each molt (i.e., anamorphic growth), females do not care for eggs or young, and individuals move very rapidly. Both orders are poorly understood in Hawaiʻi.

DISTRIBUTION: Centipedes are known from Kauaʻi, Oʻahu, Molokaʻi, Maui, and the island of Hawaiʻi as well as the NWHI.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the orders are declining.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. However, centipedes occur in most Hawaiian habitats.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward centipedes should include:

- Conduct surveys to determine the distribution and abundance of known centipedes and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:

- Continue monitoring the status of known populations.

RESEARCH PRIORITIES:

- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:
Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawaiʻi Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Shelley RM. 1999. Centipedes and millipedes with emphasis on North America fauna. The Kansas School Naturalist 45(3). Available at: http://www.emporia.edu/ksn/v45n3-march1999/intro.htm.

Photo not available

Millipedes

Orders Polyxenida, Spirostreptida

ORDER INCLUDES:
2 Native Families
2 Native Genera
16 Native Species
16 Endemic Species

GENERAL INFORMATION: Most millipedes are detritivores (i.e, feeding on decaying organic material) and play a role in breaking down decaying plant material. A few species are carnivorous, and a few others eat moist, living plant material. Millipedes hatch from eggs and molt as they grow, obtaining more segments and legs with each molt (i.e., anamorphic growth). Millipedes lack poisonous fangs and do not bite, but will emit poisonous or foul-smelling substances to deter predators. Of the 15 orders of millipedes found worldwide, only two are found in Hawaiʻi, and both are poorly known.

DISTRIBUTION: Millipedes are known from all the MHI except for the islands of Hawaiʻi and Niʻihau.

ABUNDANCE: Unknown. A lack of systematic surveys prevents any population estimate. However, the loss of native habitats likely means that species within the orders are declining.

LOCATION AND CONDITION OF KEY HABITAT: Mostly unknown. Several blind species inhabit caves. Other species occur along shorelines.

THREATS:
- Loss or degradation of habitat.
- Insufficient information for species assessments.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. In addition to common statewide and island conservation actions, specific management directed toward millipedes should include:
- Conduct surveys to determine distribution of known millipedes and to document and identify new species.
- Preserve, maintain, and restore habitats supporting existing populations.

MONITORING:
- Continue monitoring the status of known populations.

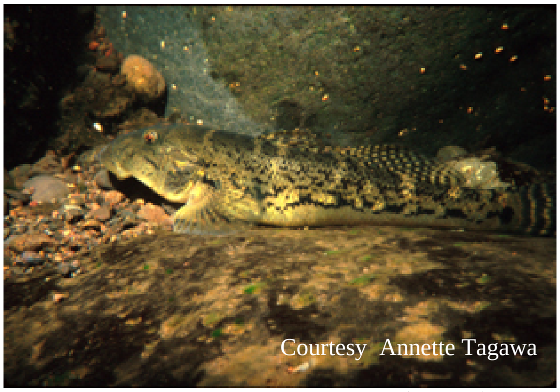
RESEARCH PRIORITIES:
- Conduct studies to document the biology, habitat requirements, and life history of native species.

References:

Howarth FG, Mull WP. 1992. Hawaiian insects and their Kin. Honolulu: University of Hawai'i Press.

Nishida GM editor. 2002. Hawaiian terrestrial arthropod checklist, 4th edition. Honolulu (HI): Biological Survey, Bishop Museum.

Shelley RM. 1999. Centipedes and millipedes with emphasis on North America fauna. The Kansas School Naturalist 45(3). Available at: http://www.emporia.edu/ksn/v45n3-march1999/intro.htm.



Freshwater Fishes

ʻOʻopu nākea
Awaous guamensis

SPECIES STATUS:
IUCN Red List – Data Deficient

SPECIES INFORMATION: The indigenous ʻoʻopu nākea (*Awaous guamensisi)* is the largest of Hawaii's indigenous gobies, reaching a length of up to 36 centimeters (14 inches). It is also the most common. They are omnivores feeding on benthic algae, aquatic insects and insect larvae, worms, and crustaceans, but not fishes. They may feed on suspended food particles in the water column as well. ʻOʻopu nākea display sexual dimorphism and elaborate courtship rituals. Spawning occurs from August to November when annual spawning runs to the stream mouths are triggered by freshets. Large spawning aggregations are formed at the first riffle before the estuary. This is the only goby that migrates downstream to spawn. Males make and guard nests in crevices of the stream bed where an attracted female will lay her eggs. Females probably produce one clutch a year and also help guard nests. Eggs are one millimeter (0.04 inches) in diameter and tens of thousands make up a nest. Eggs hatch in one day, travel to the ocean over four days and spend five to six months at sea. Post-larvae or hinana are indiscriminately recruited back to streams between December and July. They can be found in schools just after recruitment to estuaries. Adult ʻoʻopu nākea are relatively good climbers and swimmers, and post-larvae use tidal inundation to move upstream. The ʻoʻopu nākea will often burrow under rocks leaving only its eyes showing.

DISTRIBUTION: Historically, ʻoʻopu nākea were found on all the Main Hawaiian Islands. Today, they are found in streams on the island of Hawaiʻi, Kauaʻi, Molokaʻi, Maui, and Oʻahu. ʻOʻopu nākea usually are found in the middle to lower reaches of streams, with a larger range in larger streams. Post-larvae are found in oceanic waters, but little is known of its oceanic distribution.

ABUNDANCE: Abundant on Kauaʻi. Populations reduced on Oʻahu.

LOCATION AND CONDITION OF KEY HABITAT: ʻOʻopu nākea are primarily found in the middle and lower reaches of streams. If a river has steep waterfalls, they cannot climb these and thus will only be found in the lower reaches. Areas of slow, deep waters with gravel or fine sediment are key habitat for them. Riffles at stream mouths are critical spawning grounds. The majority of already degraded key habitat is located on Oʻahu, although 58 percent of the 366 perennial streams in the State have been altered in some way. Specific areas that can also be considered degraded due to water diversions are streams such as Waikolu on Molokaʻi and ʻĪao on Maui. In free flowing streams, such as Pelekunu on Molokaʻi or larger rivers such as Hanalei, Waimea, and Wainiha on Kauaʻi, ʻoʻopu nākea habitat is in a more stable condition. For specific information on stream biota, the Division of Aquatic Resources of the Department of Land and Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, dams, pollution, and the introduction of exotic species and parasites. Water diversions, stream channelization, and dams result in habitat degradation through altered stream flows that lead to: the destruction of key water characteristics such as freshets, riffles and runs; higher water temperatures; and lower dissolved oxygen levels. The reduced water flows from water diversions and dams also can limit larvae from reaching the ocean and recruiting back into streams. Channelization leads to a decrease in riparian vegetation that causes a loss of shelter and erosion control;
- Non-point source water pollution, such as nutrients, sedimentation, and chemicals may threaten the ʻoʻopu nākea. The consequence of these pollutants is relatively unknown and needs to be further studied;
- Exotic species such as tilapia are another important threat to the ʻoʻopu nākea. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fishes prey on native fishes, out compete native fishes for food, and spread parasites and diseases;
- Fishing could be come a more severe threat in combination with the above threats, because ʻoʻopu nākea are abundant in Kauaʻi rivers and are fished during their spawning migration.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common statewide and island conservation actions, specific actions include:

- Improve altered or diverted streams;
  - Modify or remove gratings or diversions to allow for instream passage of fish;
  - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
  - Remove alien species;
  - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Work to clean streams with significant pollution;
- Use science-based management of recreational fishing;
- Continue developing GIS database and making it web-accessible;
- Increase education and outreach efforts, particularly on issues of fishing-related life history, water pollution, and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;

- Monitor number of returning hinana;
- Monitor number of fish taken in recreational fishing each year.

RESEARCH PRIORITIES:

- Determine effects of pollution on populations;
- Better understand the role of estuaries in species ecology;
- Continue research efforts on marine life stage;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Continue researching effects of stream channelization and diversion;
- Research effect of fishing on total population size and distribution.

References:

Brasher AM. 1997. Habitat use by fish (ʻoʻopu), snails (hihiwai), shrimp (ʻopae) and prawns in two streams on the island of Moloka`i. Technical Report. Honolulu HI: Cooperative National Park Resources Studies Unit University of Hawaii at Manoa. Report no 116. 92 pp.

Brasher AM. 2003. Impacts of human disturbances on biotic communities in Hawaiian streams. BioScience 53 (11): 1052-1060.

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Hau, S. 1996. Post-larval migration of three native gobies (*Lentipes concolor, Awaous guamensis,* and*Sicyopterus stimpsoni*) in Iao stream on the island of Maui. Proceedings of the October 1994 Hawaii Stream Restoration Symposium; 1994; Hawaiʻi. State of Hawaiʻi, Department of Land and Natural Resources, Division of Aquatic Resources. 159 pp.

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Kinzie RA III. 1990. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region; Report 3, Amphidromous macrofauna of island streams. Technical Report EL-89-10. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

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‘O‘opu ‘akupa or Sandwich Island sleeper

Eleotris sandwicensis

SPECIES STATUS:
IUCN Red List – Data Deficient
Endemic

SPECIES INFORMATION: ‘O‘opu ‘akupa or Sandwich Island sleeper (*Eleotris sandwicensis)* is Hawaii’s only endemic eleotrid. Adult ‘o‘opu ‘akupa are ambush predators that feed on a variety of invertebrates and fishes, including other native adult and post-larval gobies and some exotic fishes. One study shows that they are also opportunistic feeders. It can grow to 33 centimeters (13 inches) in length. Unlike Hawaii’s native gobies, its pelvic fins are not fused into a disc. Without this sucking disc, they are unable to hold on to substrates and are not good climbers. Spawning occurs in freshwater; nests are made in crevices at the stream bottom. Eggs hatch within a day and are washed to the sea where they spend a few months as oceanic plankton. Post-larvae or hinana recruit to streams indiscriminately, and they depend on waves and currents to bring them inshore. This recruitment occurs year round but is most prevalent in the spring and usually takes place during nighttime hours. ‘O‘opu ‘akupa usually stay hidden, but can be seen darting and diving into leaf litter or mud or searching for shelter in rocks. There are two head morphs of the species.

DISTRIBUTION: Historically, ‘o‘opu ‘akupa were found on all the Main Hawaiian Islands. Today, they also are found on all the Main Hawaiian Islands in the lower reaches of streams and in estuaries below all man-made obstructions. Post-larvae are found in oceanic waters, but little is known of its oceanic distribution, but post-larvae do not show natal stream fidelity.

ABUNDANCE: Most common on O‘ahu. One study shows that ‘o‘opu ‘akupa are present in Pelekunu stream but rare in Waikolu stream, both on Moloka‘i. ‘O‘opu ‘akupa populations are stable in both altered and unaltered streams.

LOCATION AND CONDITION OF KEY HABITAT: ‘O‘opu ‘akupa are found only in estuaries and the lower reaches of streams. Their feeding habitat is primarily on the bottom of these streams and estuaries. Although they prefer clear, cool streams like the other gobies, they are better adapted than most gobies to live in degraded habitat. They can often be found living in cans and other trash items at the bottom of streams. Condition of key habitat varies depending on whether streams flow through protected or forested areas versus urban areas, but ‘o‘opu ‘akupa populations are stable in both altered and unaltered streams. For specific information on stream biota, the Division of Aquatic Resources of the Department of Land and

Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, and dams. Water diversion, stream channelization, and dams result in habitat degradation through altered stream flows, which also causes a loss of riparian vegetation, shelter and erosion control; higher water temperatures; and lower dissolved oxygen levels. Because of their higher tolerance to stress, ʻoʻopu ʻakupa are not as threatened by altered streams as other Hawaiian gobies. However, reduced water flows can still limit larvae from reaching the ocean and recruitment back into streams;
- Non-point source water pollution such as nutrients, sedimentation, and chemicals may threaten ʻoʻopu ʻakupa; however, the consequence of these pollutants is relatively unknown and needs to be further studied;
- Introduction of exotic species, diseases and parasites such as tilapia are significant threats to ʻoʻopu ʻakupa. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fish species prey on native fish, they compete native fish for food, and spread parasites and diseases;
- Fishing for ʻoʻopu ʻakupa occurs today and it is used as bait. In conjunction with the above threats, overfishing could become a threat in the future.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common state-wide and island conservation actions, specific actions include:

- Improve altered or diverted streams;
  - Modify or remove gratings or diversions to allow for instream passage of fish;
  - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
  - Remove alien species;
  - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Work to clean streams with significant pollution;
- Continue developing GIS database and making it web-accessible;
- Use science-based management of recreational fishing;
- Increase education and outreach efforts, particularly on issues of fishing related life history, water pollution, and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;
- Monitor number of returning hinana;

- Monitor number of fish taken in recreational fishing each year.

RESEARCH PRIORITIES:

- Determine effects of pollution on population;
- Better understand the role of estuaries in species ecology;
- Continue researching effects of stream channelization and diversion-specifically how this goby is able to have high numbers in altered streams;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Research effect of fishing on total population size and distribution.

References:

Brasher AM. 1997. Habitat use by fish (ʻoʻopu), snails (hihiwai), shrimp (ʻopae) and prawns in two streams on the island of Moloka`i. Technical Report. Honolulu HI: Cooperative National Park Resources Studies Unit University of Hawaii at Manoa. Report no 116. 92 pp.

Hau S. 1996. Post-larval migration of three native gobies (*Lentipes concolor, Awaous guamensis,* and*Sicyopterus stimpsoni*) in Iao stream on the island of Maui. Proceedings of the October 1994 Hawaii Stream Restoration Symposium; 1994; Hawaiʻi. State of Hawaiʻi, Department of Land and Natural Resources, Division of Aquatic Resources. 159 pp.

Kinzie RA III. 1990. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region; Report 3, Amphidromous macrofauna of island streams. Technical Report EL-89-10. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

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Yamamoto M, Tagawa A. 2000. Hawaii’s native and exotic freshwater animals. Honolulu, HI: Mutual Publishing. 200 pp.

Freshwater Fishes

‘O‘opu ‘alamo‘o

Lentipes concolor

SPECIES STATUS:
IUCN Red List – Data Deficient
Endemic

SPECIES INFORMATION: The endemic ‘o‘opu‘ alamo‘o (*Lentipes concolor*) can be distinguished from Hawaii’s other endemic gobies by their extraordinary abilities to climb vertical waterfalls. Male ‘o‘opu‘ alamo‘o can be distinguished from females by their displays of striking sexual dimorphism with a range of color patterns that depend on its activities. Additionally, males are territorial, while females are not. ‘O‘opu‘ alamo‘o are omnivores, feeding on algae and small aquatic animals. Adults feed primarily on small aquatic animals including atyid shrimps and may graze on microalgae while they move. Juveniles feed more on plant material. Additionally, they will swim through the water column to collect drift particles or insects. ‘O‘opu‘ alamo‘o breed in upstream areas from late fall to early spring and are cued by freshets. Nests are made under rocks and in crevices away from the main river channel. Eggs hatch within two to three days of being laid and are carried to the ocean with the current. They have four days to reach the ocean or the larvae will not survive. Postlarvae or hinana remain part of the oceanic plankton for a few months and then recruit indiscriminately to a freshwater source with the incoming tide, usually after sunrise. This recruitment occurs year round but is most prevalent in the spring. They swim directly upstream spending no longer than one day in an estuary. ‘O‘opu‘ alamo‘o travel at speeds of 90 meters (295 feet) per hour. Although they cannot swim up through flowing water and must use a substrate, they are very able climbers using their suction discs to hold on to the surface and their pectoral fins to move them upwards.

DISTRIBUTION: ‘O‘opu‘ alamo‘o has been found in streams on all main islands historically. They are currently found in streams on the island of Hawai‘i, Kaua‘i, Maui, Moloka‘i, and in seven streams on O‘ahu. Although, not as common, it is very likely that ‘o‘opu‘ alamo‘o exist in more streams on O‘ahu, in areas of high elevation and where habitat is not affected as a result of human population growth and pollution. Previously, thought only to be located on windward streams, ‘o‘opu‘ alamo‘o recently has been discovered in the upper reaches of leeward perennial streams as well. They also can be found above Akaka Falls on the island of Hawai‘i. Dams and stream obstructions can limit their presence in upper reaches that they previously occupied. Larvae spend time in the ocean as plankton, but not much is known of their oceanic distribution.

ABUNDANCE: Abundance throughout the islands is unknown; however, populations are decreasing on O‘ahu and Maui.

LOCATION AND CONDITION OF KEY HABITAT: ʻOʻopuʻ alamoʻo do best in unobstructed, cool, fast-moving streams. They spend the majority of their life in freshwater in the upper reaches of streams. ʻOʻopuʻ alamoʻo are very well suited to the naturally variable characteristics of Hawaii's streams. However, where natural stream habitat has been altered, including decreases in forest cover, ʻoʻopuʻ alamoʻo populations have decreased. The majority of already degraded key habitat is located on Oʻahu, although 58 percent of the 366 perennial streams in the State have been altered in some way. Interestingly, the amount of plant cover within a stream affects the location of ʻoʻopuʻ alamoʻo in a stream, with fish density being the highest where plant cover is the lowest. For more information on specific stream biota, the Division of Aquatic Resources of the Department of Land and Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, dams, pollution, and the introduction of exotic species and parasites. Water diversions, stream channelization, and dams result in habitat degradation through altered stream flows that lead to: the destruction of key water characteristics such as freshets, riffles and runs; higher water temperatures; and lower dissolved oxygen levels. The reduced water flows from water diversions and dams also can limit larvae from reaching the ocean and recruiting back into streams. Channelization leads to a decrease in riparian vegetation that causes a loss of shelter and erosion control;
- Non-point source water pollution such as nutrients, sedimentation, and chemicals may threaten ʻoʻopuʻ alamoʻo; however, the consequence of these pollutants is relatively unknown and needs to be further studied;
- Exotic species such as tilapia are another important threat to the ʻoʻopuʻ alamoʻo. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fishes prey on native fish species, out compete native fishes for food, and spread parasites and diseases.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common statewide and island conservation actions, specific actions include:

- Improve altered or diverted streams;
    - Modify or remove gratings or diversions to allow for instream passage of fish;
    - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
    - Remove alien species;
    - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Work to clean streams with significant pollution;
- Continue developing GIS database and making it web-accessible;
- Use science-based management of recreational fishing;

- Increase education and outreach efforts, particularly on issues of water pollution and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;
- Monitor number of returning hinana.

RESEARCH PRIORITIES:

- Determine effects of pollution on population;
- Better understand the role of estuaries in species ecology;
- Continue research efforts on marine life stage;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Continue researching effects of stream channelization and diversion.

References:

Brasher AM. 2003. Impacts of human disturbances on biotic communities in Hawaiian streams. BioScience 53 (11): 1052-1060.

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Hau S. 1996. Post-larval migration of three native gobies (*Lentipes concolor, Awaous guamensis,* and*Sicyopterus stimpsoni*) in Iao stream on the island of Maui. Proceedings of the October 1994 Hawaii Stream Restoration Symposium; 1994; Hawai'i. State of Hawai'i, Department of Land and Natural Resources, Division of Aquatic Resources. 159 pp.

Keith P. 2003. Biology and Ecology of amphidromous Gobiidae of the Indo-Pacific and the Caribbean regions. Journal of Fish Biology 63: 831-847.

Kinzie RA III. 1990. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region; Report 3, Amphidromous macrofauna of island streams. Technical Report EL-89-10. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

McRae MG. Louisiana State University. Personal communication.

Way CM et al. 1998. Reproductive Biology of the Endemic Goby, *Lentipes concolor*, from Malamaka'ole Stream, Maui and Waikolu Stream, Moloka'i. Environmental Biology of Fishes 51: 53-65.

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Freshwater Fishes

ʻOʻopu nōpili

Sicyopterus stimpsoni

SPECIES STATUS:
IUCN Red List – Near Threatened
Endemic

SPECIES INFORMATION: Both male and female ʻoʻopu nōpili (*Sicyopterus stimpsoni*) vary in color based on age and activity and display elaborate courtship rituals. They feed at a lower trophic level than *Lentipes concolor*. Of all the Hawaiian gobies, ʻoʻopu nōpili post-larvae often migrate into estuaries in large schools and are most often found in schools at stream mouths. They do not recruit back to the same stream where they were born. Spawning occurs between August and March and eggs are deposited in crevices under rocks and pebbles. Nests are laid in territories defended by males. Eggs hatch within two to three days and larvae are washed out to sea, spending approximately five months as oceanic plankton. Recruitment of post-larvae or hinana occurs year round but is most prevalent in the spring. Post-larvae can be found in schools just after recruitment. After recruitment ʻoʻopu nōpili remain in estuaries for at least 48 hours before they begin migrating upstream. During this time, they undergo a significant metamorphosis. Their snouts enlarge and lengthen and their heads increase in size. Their upper lip also enlarges and their mouths move to a sub-terminal position. This metamorphosis allows the ʻoʻopu nōpili to climb waterfalls using its suction cup and lips. Prior to this metamorphosis, the post-larvae are omnivorous, but after the metamorphosis the sub-terminal mouth is better suited to scraping algae from rocks with a unique feeding behavior.

DISTRIBUTION: Historically, ʻoʻopu nōpili were found in streams on all of the Main Hawaiian Islands. Today, they also are located on all main islands, primarily in the middle reaches of streams, although they can be found in the lower reaches. On Oʻahu they commonly are found in unaltered streams such as Kaluanui, Kahana, and Waimea. Upstream distribution is limited by instream obstructions. Individual distribution within accessible stream reaches is determined based on displays of aggression during migration and establishment of territories. ʻOʻopu nōpili develop aggressive signaling colors at different rates. Those that develop them early establish territories first. These ʻoʻopu nōpili displace other non-colored ʻoʻopu nōpili further upstream. Post-larvae are found in oceanic waters, but little is known of its oceanic distribution.

ABUNDANCE: Abundant where present on all main islands except for Oʻahu where its numbers are greatly reduced from historical times.

LOCATION ANDCONDITION OF KEY HABITAT: ʻOʻopu nōpili do best in the middle reaches of streams utilizing areas with high stream velocities such as riffles and runs. Areas that are undisturbed, with high water quality and high discharge rates, are key to their survival. The majority of already degraded habitat is located on Oʻahu, although 58 percent of the 366 perennial streams in the State have been altered in some way. Additionally, ʻoʻopu nōpili have been used as an "indicator species" to signify high water quality in streams and the possible presence of ʻoʻopu ʻalamoʻo, which is rarer than the ʻoʻopu nōpili. For specific information on stream biota, the Division of Aquatic Resources of the Department of Land and Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, dams, pollution, and the introduction of exotic species and parasites. Water diversions, stream channelization, and dams result in habitat degradation through altered stream flows that lead to: the destruction of key water characteristics such as freshets, riffles and runs; higher water temperatures; and lower dissolved oxygen levels. The reduced water flows from water diversions and dams also can limit larvae from reaching the ocean and recruiting back into streams. Channelization leads to a decrease in riparian vegetation that causes a loss of shelter and erosion control;
- Non-point source water pollution such as nutrients, sedimentation, and chemicals may threaten ʻoʻopu nōpili; however, the consequence of these pollutants is relatively unknown and needs to be further studied;
- Exotic species such as tilapia are another important threat to ʻoʻopu nōpili. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fishes prey on native fish species, out compete native fishes for food, and spread parasites and diseases.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common statewide and island conservation actions, specific actions include:

- Improve altered or diverted streams;
  - Modify or remove gratings or diversions to allow for instream passage of fish;
  - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
  - Remove alien species;
  - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas
- Work to clean streams with significant pollution;
- Continue developing GIS database and making it web-accessible;
- Use science-based management of recreational fishing;
- Increase education and outreach efforts, particularly on issues of water pollution and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;
- Monitor number of returning hinana.

RESEARCH PRIORITIES:

- Determine effects of pollution on population;
- Better understand the role of estuaries in species ecology;
- Continue research efforts on marine life stage;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Continue researching effects of stream channelization and diversion.

References:

Brasher AM. 1997. Habitat use by fish (ʻoʻopu), snails (hihiwai), shrimp (ʻopae) and prawns in two streams on the island of Moloka`i. Technical Report. Honolulu HI: Cooperative National Park Resources Studies Unit University of Hawaii at Manoa. Report no 116. 92 pp.

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Tate DC. 1997. The role of behavioral interactions of immature Hawaiian stream fishes (Pisces: Gobiodei) in population dispersal and distribution. Micronesica 30 (1): 51-70.

Yamamoto M, Tagawa A. 2000. Hawaii's native and exotic freshwater animals. Honolulu, HI: Mutual Publishing. 200 pp.

Freshwater Fishes

‘O‘opu naniha

Stenogobius hawaiiensis

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: ‘O‘opu naniha (*Stenogobius hawaiiensis*) are a smaller goby reaching ten to 13 centimeters (four to five inches) in length. As an omnivore, it feeds on algae, worms, crustaceans, and insect larvae that it takes from the bottom sediments using their snouts. ‘O‘opu naniha display sexual dimorphism and elaborate courtship rituals. Spawning occurs year round. Average-sized ‘o‘opu naniha will lay 6,000-8,000 eggs in crevices guarded by males. Eggs hatch after one day and are carried out to sea. Within five days they will develop enough to be able to begin feeding. They spend approximately 135 days as oceanic plankton. Post-larvae or hinana recruit indiscriminately back to freshwater streams during all hours, utilizing the incoming tide. Recruitment is most prevalent in the spring. ‘O‘opu naniha are poor climbers and swimmers compared to the other native gobies.

DISTRIBUTION: Historically, ‘o‘opu naniha were found on all the Main Hawaiian Islands. Today, they also are found on all the Main Hawaiian Islands in the lower reaches of streams and in estuaries that are not blocked by man-made obstructions. Post-larvae are found in oceanic waters, but little is known of its oceanic distribution.

ABUNDANCE: Most common on O‘ahu. Abundance has declined in many areas and is affected by the threats listed below.

LOCATION AND CONDITION OF KEY HABITAT: Key habitat for ‘o‘opu naniha is along margins of streams and in low flow areas in the lower reaches of streams and stream mouths. Although they prefer clear, cool streams like the other gobies, they are better adapted than most gobies to live in soft substrates in degraded habitat. For specific information on stream biota, the Division of Aquatic Resources of the Department of Land and Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, and dams. Water diversion, stream channelization, and dams result in habitat degradation through altered stream flows, which also causes a loss of riparian vegetation, shelter and erosion control; higher water temperatures; and lower dissolved oxygen levels. ‘O‘opu naniha are not as threatened by altered streams as other Hawaiian gobies, although reduced water flows still can limit larvae from reaching the ocean and recruiting back into streams;

- Non-point source water pollution, such as nutrients, sedimentation, and chemicals may threaten ʻoʻopu naniha; however, the consequence of these pollutants is relatively unknown and needs to be further studied;
- Introduction of exotic species, diseases and parasites such as tilapia are significant threats to ʻoʻopu naniha. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fish species prey on native fish, outcompete native fish for food, and spread parasites and diseases;
- Fishing for ʻoʻopu naniha occurs and could become a more severe threat in combination with the above threats.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common state-wide and island conservation actions, specific actions include:

- Improve altered streams;
  - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
  - Remove alien species;
  - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Work to clean streams with significant pollution;
- Continue developing GIS database and making it web-accessible;
- Use science-based management of recreational fishing;
- Increase education and outreach efforts, particularly on issues of fishing-related life history, water pollution, and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;
- Monitor number of returning hinana.

RESEARCH PRIORITIES:

- Research conservation-relevant biology and ecology;
- Better understand the role of estuaries in species ecology;
- Determine effects of pollution on population;
- Continue research efforts on marine life stage;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Continue researching effects of stream channelization and diversion, specifically how this goby is able to have high numbers in altered streams;
- Research effect of fishing on total population size and distribution.

References:

Brasher AM. 1997. Habitat use by fish (‘o‘opu), snails (hihiwai), shrimp (‘opae) and prawns in two streams on the island of Moloka`i. Technical Report. Honolulu HI: Cooperative National Park Resources Studies Unit University of Hawaii at Manoa. Report no 116. 92 pp.

Hau S. 1996. Post-larval migration of three native gobies (*Lentipes concolor, Awaous guamensis,* and*Sicyopterus stimpsoni*) in Iao stream on the island of Maui. Proceedings of the October 1994 Hawaii Stream Restoration Symposium; 1994; Hawai‘i. State of Hawai‘i, Department of Land and Natural Resources, Division of Aquatic Resources. 159 pp.

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Tate DC. 1997. The role of behavioral interactions of immature Hawaiian stream fishes (Pisces: Gobiodei) in population dispersal and distribution. Micronesica 30 (1): 51-70.

Yamamoto, M, Tagawa A. 2000. Hawaii’s native and exotic freshwater animals. Honolulu, HI: Mutual Publishing. 200 pp.

Photo not available

Freshwater Invertebrates

Flatworm

Oahuhawaiiana kazukolinda

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: Little is known about this species biology. It is a planarian flatworm.

DISTRIBUTION: The species was described from samples collected in Manoa, Oʻahu stream. They reproduce by producing a cocoon that has about four developing young.

ABUNDANCE: Unknown. No formal monitoring occurs.

LOCATION AND CONDITION OF KEY HABITAT: Manoa Stream, unkown habitat preferences.

THREATS: None identified.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Continue developing GIS database and making it web-accessible;
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Continue on-going partnerships focused on environmental education and conservation and expand partnerships with other Pacific Islands agencies;
- Restoration of potential habitat.

MONITORING:

- Establish survey schedule to determine population size and distribution.

RESEARCH PRIORITIES:

- Improve understanding of the life history of this snail and the factors that limit their abundance and distribution.

References:

Kawakatsu M, Mitchell R. 1984. *Oahuhawaiiana kazukolinda*, a new genus, new species turbellaria (Tricladia, Maricola): a new freshwater planarian from Honolulu Island [sic] Hawaii USA. Zoological Science (Tokyo) 1(3):487-500.

Anchialine Pond Shrimps

Antecaridina lauensis
Calliasmata pholidota
ʻŌpae ʻula or *Halocaridina rubra*
Halocaridina palahemo
Metabetaeus lohena
Procaris hawaiana
Palaemonella burnsi
Vetericaris chaceoru

Metabetaeus lohena
Courtesy Karl Magnacca

SPECIES STATUS:
All Federally Listed as Candidates except *Halocaridina*
All State Listed as Candidates except *Halocaridina*
IUCN Red List - Not considered
All Endemic except *Antecaridina*, *Calliasmata*, *Metabeteus*

SPECIES INFORMATION: This group of species live in underground (hypogeal) environments and in anchialine ponds which have a mix of freshwater and seawater through underground connections to the sea. All of the species except *A. lauensis*, *C. pholidota*, and *M. lohena* are endemic to Hawaii. ʻŌpae ʻula reaches 1.5 centimeters (one-half inch) in length and is an herbivore that grazes on algal, bacterial, and diatom films growing on rocks and other hard substrates. They can also filter feed in mid-water and at the surface. The other species are all larger (up to five cm or two inches long) and some are predatory. *M. lohena* is a snapping shrimp and feeds on ʻōpae ʻula. *C. pholidota* feeds on crustaceans and polychaetes, while *P. hawaiana* has been seen feeding on shrimp. All have red color and reduced appendages. ʻŌpae ʻula carry about 12 fertilized eggs under their abdomen for a brood period of about 38 days. They reproduce one to two times per year. Lifespan of ʻōpae ʻula is long, up to 20 years in captivity. Less is known about the life history of the other species, but they are relatively long-lived for species in their taxa. *A. lauensis* and *M. lohena* can live six years. *C. pholidota* is blind. *A. lauensis,* ʻōpae ʻula and *M. lohena* occur in salinities of two to 36 ppt. The rarer species are all found in pools with higher salinities, usually above 15 ppt. All occur in water temperatures above 20° C. ʻōpae ʻula also has an unusual amount of intraspecific variability that has been quantified from location to location suggesting the preserving genetic diversity may be an issue. Unpublished genetic analyses indicate *H. palahemo* and ʻōpae ʻula may not be separate species but part of a genetically diverse cryptic species complex.

DISTRIBUTION: Historic distribution includes 600 to 700 anchailine pools on Oʻahu, Maui, Molokaʻi, and the island of Hawaiʻi and an unknown underground distribution. Currently they occur in fewer anchialine ponds on Maui and Hawaiʻi, and ʻōpae ʻula occurs in an artificially created anchialine pond on Kahoʻolawe and natural and artificial habitats on Oʻahu and Molokaʻi. ʻŌpae ʻula has also been found in the ocean near a freshwater extrusion. Two of the species (*V. chaceorum* and *H. palahemo*) only occur in a single pool each (on Hawaiʻi). Only ʻŌpae ʻula and *M. lohena* have a widespread distribution. The other four species occur in no more than four pools each. Six of these eight species can be found in both the Ahihi-Kinaʻu (Maui) and Manuka (Hawaiʻi) Natural Area Reserves (NARs). Some species occur in Wainapanapa Maui; the Waikoloa Anchialine Pond Preserve in North Kona, Hawaiʻi, the Ka Lae area near South Point Hawaiʻi on Department of Hawaiian Home Lands property, and in the Kaloko-Honokohau National Historic Park and Hawaii Volcanoes National Park, all on Hawaiʻi. ʻŌpae ʻula is known from Barbers Point, Flat Island, Waianae, and an aquaculture facility in Kahuku, all on Oʻahu.

ABUNDANCE: Abundance of anchialine shrimps in the Waikolao area has been constant, except for increases in ʻŌpae ʻula abundance since 1996. ʻŌpae ʻula is the most abundant anchialine shrimp species, and in good habitat, densities can be hundreds of individuals per square meter. Only a handful of *V. chaceorum* have ever been seen. *H. palahemo* has not been seen in recent surveys. Because many of the species occur in the interstitial crevices it is difficult to determine the full population size or even spatial extent of populations of these species and no quantitative abundance estimates exist. Overall populations may have declined because many pools have been filled or suffered from introduced fishes.

LOCATION AND CONDITION OF KEY HABITAT: Anchialine pond shrimp are found in underground (hypogeal) salt waters and in anchialine ponds, which are found in geologically young lava fields near the coast. The lava in these areas has fissures that connect the ponds to the ocean. Thus these ponds are always close to the sea and have varying salinity levels and tidal influence. Most ponds are less than 100 square meters (1000 square feet) in size and less than 1.5 meters (five feet) in depth. Anchialine pond shrimp are found in the water column and on the substrate of anchialine ponds as well as in the interstitial spaces that are part of the system linking the pond's water to oceanic influences. Many ponds have been filled or had non-native species introduced. One pond was created accidentally by a large bomb explosion on Kahoʻolawe and subsequently colonized by ʻŌpae ʻula through unknown mechanisms as the nearest anchialine ponds are at least ten kilometers (6 miles) away. Possibilities include transport by birds or an already existing underground population. Another pond was created for use in aquaculture industry and was colonized by ʻŌpae ʻula that turn out to be of a unique genetic make-up, suggesting that the shrimps may have colonized from a previously unknown, but nearby underground source. Thus it is very unclear the extent to which anchialine ponds are necessary for the survival of ʻŌpae ʻula. The ponds may be a source of increased primary productivity to the anchialine shrimp and associated community as the underground habitat is likely low in productivity without these connections.

THREATS:

- Habitat destruction has reduced available habitat for anchialine pond shrimps. On the island of Hawaiʻi much development has occurred in the major area for anchialine pools between Kawaihae and Kailua-Kona leading to the filling in of many pools. A monitoring system was set up at Waikaloa to assess the impacts of development there;

- A number of introduced species may compete with them for food or prey on them. Introduced fishes (Tilapia, koi, mosquitofish and guppies) and Tahitian prawns are a major predatory threat and alter the habitat use of remaining shrimp. Over 90 percent of the anchialine ponds in the Kona coast of Hawaiʻi are contaminated with non-native species. The presence of introduced fishes leads the shrimps to retreat into crevices in the substrate. As a result the ponds become overgrown with algae, leading to greatly accelerated debris accumulation and decay of the ponds, suggesting ʻŌpae ʻula is a keystone species;
- Pollution of pools by refuse and human use of the water;
- Anchialine pools themselves may thus serve as conduits for pollutants and predatory impacts to the underground areas that may be the primary habitat of these species;
- Collectors taking ʻŌpae ʻula to sell for aquarium use or fish feed threaten some ponds.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Fencing the pools in ʻAhihi Kinaʻu NAR, and possibly elsewhere;
- Educating people to the value of, threats to and conservation actions to protect the ponds;
- Restoration of habitat by removal of introduced species;
- Creation of man-made pools should be explored;
- Maintain healthy populations with appropriate fishing regulations and education;
- Closure and rerouting of a portion of the road adjacent to 49 pools in Manuka NAR has been proposed.

MONITORING:

- Continue surveys of population and distribution in known and likely habitats;
- Develop quantitative survey methods.

RESEARCH PRIORITIES:

- Improve understanding of life history of anchialine pond shrimps including the importance of ponds vs. underground habitats to the existence and size of shrimp populations;
- Understand the ecological importance of interactions with introduced competitors and predators;
- Research the life history of introduced competitors and predators to develop removal or control strategies;
- Partner with the Environmental Protection Agency to develop acceptable alternatives to, or methods to use rotenone in removing introduced fishes.

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Anchialine Pond Amphipods

Gamarella (=Nuuanu) amikai
Grandidierella koa
Grandidierella palama
Liagoceradocus lonomaka
Parhyale hawaiensis
Paramoera lokowai
Paramoera paakai
Paramoera rua
Rotomelita ana
Rotomelita lokoa
Carnarimelita janstocki

Parhyale hawaiensis
Courtesy Alivia Price, Nipam Patel

SPECIES STATUS:
IUCN Red List - Not considered
All Endemic except *Parahyale*

SPECIES INFORMATION: This group of species lives in anchialine ponds and lava tube caves which have a mix of freshwater and seawater. *Gamarella* and *Parhyale* have been found in the open seas as well. All species are endemic except *P. hawaiensis*. *R. ana, P. lokowai,* and *L. lonomaka* are blind. Little is known about the biology or ecology of these species though *C. janstocki* is unusual in being predatory, apparently in part on the anchialine pond shrimp *Halocaridinia rubra*. It is found in pools with a salinity of around 14 parts per thousand. None of the species have Hawaiian or English common names.

DISTRIBUTION: Currently they are known to occur in a few anchialine ponds on Maui and the island of Hawaiʻi, though specific research on these species ecology is rare. *G. amikai* has been found in an artificial pond on Kahoʻolawe. *R. ana, P. rua,* and *G. palama* occur in a single lava tube cave in eastern Maui near Wainapanapa. *C. janstocki* is found in a number of pools in the Kohanaika area of west Hawaiʻi. *R. lokoa* and *P. paakai* have the most widespread distribution on the island of Hawaiʻi.

ABUNDANCE: Abundance of anchialine amphipods appears to have never been recorded.

LOCATION AND CONDITION OF KEY HABITAT: Anchialine ponds are found in geologically young lava fields. The lava in these areas has fissures that connect the ponds to the ocean. Lava tubes can also have anchialine pools. Thus these ponds are always close to the sea and have varying salinity levels and tidal influence. Most ponds are less than 100 square meters (1000 square feet) in size and less than 1.5 m (five feet) in depth. Many ponds have been filled or had non-native species introduced. One pond was created accidentally by a large bomb explosion on Kahoʻolawe and subsequently colonized. It is not clear to what extent these amphipods use hypogeal (underground) habitats so the relative importance of these two habitat types is unknown. All ponds are important but key ones include those in ʻAhihi-Kinaʻu Natural Area Reserve (NAR) and Wainapapa area state lands on Maui; Manuka NAR, Waikoloa Anchialine Pond Preserve, the Ka Lae area near South Point on Department of Hawaiian Home Lands property, and in the Kaloko-Honokohau National Historic Park and Hawaii Volcanoes National Park, all on the island of Hawaiʻi.

THREATS:

- Habitat destruction has reduced available habitat for anchialine pond amphipods. On the island of Hawaiʻi much development has occurred in the major area for anchialine pools between Kawaihae and Kailua-Kona leading to the filling in of many pools;
- Pollution of pools by refuse and human use of the water;
- Introduced fishes (Tilapia, koi, mosquitofish and guppies) and Tahitian prawns may be a major predatory threat and alter the habitat use of remaining amphipods. Over 90 percent of the anchialine ponds on the Kona coast of Hawaiʻi are contaminated with non-native species.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:

- Fencing the pools in ʻAhihi Kinaʻu NAR, and possibly elsewhere;
- Educating people to the value of, threats to and conservation actions to protect the ponds;
- Restoration of habitat by removal of introduced species;
- Creation of man-made pools should be explored.

MONITORING:

- Develop surveys of population and distribution in known and likely habitats;
- Develop quantitative abundance survey methods.

RESEARCH PRIORITIES:

- Improve understanding of life history and biology of anchialine pond amphipods and the role of interstitial underground waters;
- Understand the ecological importance of interactions with introduced competitors and predators;
- Research the life history of introduced competitors and predators to develop removal or control strategies;
- Partner with the Environmental Protection Agency to develop acceptable alternatives to, or methods to use rotenone in removing introduced fishes.

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Other baleen whales

Balaenoptera acutorostrata (NT)
Balaenoptera borealis (EN)
Balaenoptera edeni (DD)
Balaenoptera musculus (EN)
Balaenoptera physalus (EN)
Eubalaena japonica (EN)

SPECIES STATUS:
Four Federally Listed Endangered
IUCN Red List - Various (see abbreviations below)
IUCN Data Deficient (DD)
IUCN Near Threatened (NT)
IUCN Endangered (EN)

SPECIES INFORMATION: Baleen whales are filter feeders and the largest whales found in Hawai`i. They are the: minke whale (*B. acutorostrata*), sei whale (*B. borealis*), Bryde's whale (*B. edeni*), blue whale (*B. musculus*), fin whale (*B. physalus*) and northern right whale (*E. japonica*). Bryde's whale (*Balaenoptera edeni*) is the only baleen whale in Hawai'i that is non-migratory. The others most likely feed at higher latitudes and migrate to Hawai'i seasonally. Minke, Bryde's, blue, and fin whales feed in separate events, most often lunging at large schools of fish. They are known as "gulpers." Minke, Bryde's, and fin whales feed on large schools of fish and krill, while the sei whale has a more diverse diet consisting of small fish, krill, squid and copepods. The sei whale is the only baleen whale that uses both the skimming and gulping methods to feed. Northern right whales are known as "skimmers" constantly taking in water as they move and filtering out their food. The blue whale and northern right whale feed exclusively on plankton. Reproduction is relatively similar for these whales, although the mating behaviors of most of these whales are unknown. Northern right whales breed in winter months when females may mate with more than one male at a time. The others give birth in winter months and have calving intervals of two to three years. Gestation periods range from ten to twelve months. Females may mate with more than one male at a time. Calves are weaned between six and eight months. Baleen whales rarely form large social groups and are most often seen alone or in small groups, although each species may congregate in larger groups for feeding.

DISTRIBUTION: The distributions of the minke whale, sei whale, blue whale, and northern right whale in Hawai'i are unknown because there have been very few sightings. Bryde's whales are most often sighted to the northwest of the Main Hawaiian Islands. Most sightings of fin whales have been off the North Coast of O'ahu, although there have been sightings off the north coast of Kaua'i and south of Honolulu as well as a stranding on Maui.

ABUNDANCE: Barlow (2003) estimates population abundances in Hawaii's Exclusive Economic Zone as follows: sei whale 77, Bryde's whale 493, and fin whale 174. There are no abundance estimates for the minke whale, blue whale, and northern right whale.

LOCATION AND CONDITION OF KEY HABITAT: The minke, fin, and northern right whale primarily inhabit coastal and shelf waters, but also can be found in offshore waters. Key habitat for the sei whale and blue whale are coastal, shelf, and oceanic waters.

THREATS:

- Fishery interactions such as entanglement in fishing gear are a significant threat to all of these whales. Large baleen whales such as the northern right whale were hunted for hundreds of years, while whales such as the minke, sei, blue, and fin were harvested only within the last hundred years as technology improved. This hunting has diminished populations around the globe;
- Ships often collide into baleen whales due to their size and habitat use causing injury or death;
- Scientific and aboriginal hunting occurs for minke and Bryde's whales outside of the Hawaii's EEZ;
- Marine debris such as accumulated tiny, plastic particles that contain PCBs and DDEs is an important threat. This is particularly dangerous for baleen whales as they take in large quantities of water at a time. Only those that are feeding are at risk. Additionally, when these particles are ingested they also can cause a variety of effects such as internal injury and intestinal blocking. Marine debris such as derelict fishing gear can also harm the whales when they become entangled in it;
- Man-made noise from the many commercial, private, and military vessels traveling through Hawaiian waters using sonar can interfere with acoustic signals that are critical to whales' reproduction. Man-made noises have also been shown to cause disturbance responses from far away, hearing loss and physical harm. Feeding, breeding and social behaviors can be disrupted by close range, high volume vessel traffic and more studies need to be conducted to quantify this threat.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Establish a systematic fisheries monitoring system for interactions with baleen whales;
- Continue working to decrease marine debris;
- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing marine mammal harassment and disturbance;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with partners to decrease pollutants and chemicals in the marine environment;
- Work with and assist local conservation organizations working on cetacean conservation, education and marine debris clean-up;
- Establish a system of reporting and rescuing whales from ship collisions.

MONITORING:

- Cooperate in surveys of population structure and distribution of baleen whales;
- Monitor the number of whales entangled or otherwise impacted by fishery bycatch or marine debris.

RESEARCH PRIORITIES:

- Initiate studies to determine threats and minimize their impacts;
- Research habitat use and other biological characteristics;
- Study impacts of noise from ships on baleen whales.

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Marine Mammals

Other Toothed Whales


Peponocephala electra
Courtesy Keoki Stender

Feresa attenuata (DD)
Grampus griseus (DD)
Indopacetus pacificus (DD)
Kogia breviceps (LC)
Kogia sima (LC)
Lagenodelphis hosei (DD)
Mesoplodon densirostris (DD)
Orcinus orca (LR)
Peponocephala electra (LC)
Physeter macrocephalus (VU)
Stenella coeruleoalba (LR)
Steno bredanensis (DD)
Ziphius cavirostris (DD)

SPECIES STATUS:
IUCN Red List - Various (see abbreviations below)
IUCN Data Deficient (DD)
IUCN Lower Risk/Conservation Dependent (LR)
IUCN Lowest Concern (LC)
IUCN Vulnerable (VU)
Sperm whale is a U. S. and HI Endangered Species

SPECIES INFORMATION: The other toothed whales of Hawai‘i besides the spotted, bottlenose, and spinner dolphins and false killer and short-finned pilot whales, which are considered in separate fact sheets, are: pygmy killer whales (*Feresa attenuata*), Risso's dolphins (*Grampus griseus*), Longman's beaked whales (*Indopacetus pacificus*), pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), Fraser's dolphins (*Lagenodelphis hosei*), Blainville's beaked whales (*Mesoplodon densirostris*), killer whales (*Orcinus orca*), melon-headed whales (*Peponocephala electra*), sperm whale (*Physeter macrocephalus*), striped dolphins *(Stenella coeruleoalba)*, nai‘a or rough-toothed dolphins (*Steno bredanensis*), and Cuvier's beaked whales (*Ziphius cavirostris*). None of the other species have Hawaiian names. The sperm whale is the only toothed-whale in Hawai‘i that is a federally listed endangered species. Most of these species except striped dolphins, dwarf sperm whales, and killer whales live only in deep, oceanic waters but can occur within state waters, especially in areas with steep drop-offs like off much of Hawai‘i and Southwest Maui County. Feeding habits vary for these toothed whales. The sperm whale feeds on anything from large squid to sharks, demersal rays and bony fish, while the pygmy and dwarf sperm whales feed on smaller cephalopods and crustaceans. The beaked whales and the majority of the ocean dolphins feed on squid and small fishes. Some also feed on crustaceans. They differ, however, in their foraging behaviors. The sperm whales, naiʻa, Fraser's, and Risso's dolphins and Cuvier's beaked and melon-headed whales all feed in deep waters. The striped dolphin has a more diverse diet and eats any where in the water column. Killer whales have the most diverse diet of all the toothed whales. They feed on anything from schooling fish and squid to sharks and large baleen whales; they also feed cooperatively. There is almost no reproduction information available for approximately half of these whales, except for pygmy sperm whales, dwarf sperm whales, melon-headed whales, sperm whales, and striped dolphins. Gestation lasts for one year for the pygmy and dwarf sperm whales, the striped dolphin, and the melon-headed whale. The killer whale and sperm whale reach maturity slowly, usually after 11 years of age. The sperm whale breeds in the tropics and gives birth in the spring. Killer whales are only occasional visitors to Hawaiʻi. Killer whale calves are nursed for a year. Calving intervals for the striped dolphin are four years. Striped dolphins also provide care for their young in groups of about 30. Additionally, most species have a single baby at a time. Some of these whales such as the pygmy and dwarf sperm whales are solitary, while others such as the Fraser's dolphin and the melon-headed whale form large social groups. Still others such as the sperm whale and Longman's beaked whale form strong social bonds, while killer whales form social groups also with strong social bonds.

DISTRIBUTION: The pygmy killer whale has been sighted off Niʻihau, Oʻahu, Maui, and the island of Hawaiʻi. Risso's dolphins are rare and have been sighted off the coast of Kona. Longman's beaked whales and Fraser's dolphins have not been recorded in State waters, but they occur nearby and may be occasional visitors; thus, they are considered here. Pygmy and dwarf sperm whales, Blainsville's and Cuvier's beaked whales, and naiʻa are found throughout the Main Hawaiian Islands. Pygmy and dwarf sperm whales strand frequently on Maui. Killer whales have been sighted off Kauaʻi, the Waiʻanae coast of Oʻahu, southwest Lānaʻi, and off Kona, Hawaiʻi. Melon-headed whales are common throughout the Main Hawaiian Islands, with groups sighted off of the Waiʻanae coast, southwest Lānaʻi, and Kona. The Sperm whale is found throughout all the Main Hawaiian Islands and the Northwestern Hawaiian Islands. The striped dolphin has been spotted off Niʻihau and west of Oʻahu.

ABUNDANCE: All estimates are from Barlow (2003) for the entire Exclusive Economic Zone of Hawaiʻi. Abundance estimates are the following: pygmy killer whale 817, Risso's dolphin 2,351, Longman's beaked whale 766, Fraser's dolphin 18,836, Blainsville's beaked whale 2,138, killer whale 430, melon-headed whale 2,947, sperm whales 7,080, striped dolphin 10,385, naiʻa 19,900, and Cuvier's beaked whale 12,728. Pygmy and dwarf sperm whales abundance estimates are 7,251 and 19,172 respectively. There is no evidence of decline in Hawaiian waters.

LOCATION AND CONDITION OF KEY HABITAT: The primary habitat for these whales is deep waters of 100 meters (3300 feet) or so. Other toothed whales also live in the open ocean's deep waters, but they have more specific habitat requirements.

THREATS:

- Entanglement in fishing gear such as drift gillnets, longlines and purse seines is a major threat to all of these toothed whales. They get entangled in both operational and derelict fishing gear. Specifically, the killer whale and naiʻa have been recorded as stealing bait and catch from longlines. Longline hooks can injure the whales leading to death;

- Ship collisions can injure or kill the whales. Sperm whales most notably have had problems with ship collisions;
- Man-made noise is a threat that results from high vessel traffic and military vessels that use Hawaiian waters for operations involving sonar. This man-made noise can interfere with acoustic signals critical to dolphins' reproduction and feeding. Man-made noises also have been shown to cause disturbance responses from far away, hearing loss and physical harm. Cuvier's and Blainville's beaked whales, and killer whales are especially sensitive to noise;
- Pollution in the marine environment and its effects on whales are difficult to assess and quantify. In Hawaiʻi, a specific threat is plastic particles that accumulate in the Archipelago. Not only do these particles contain harmful chemicals such as PCBs and DDE, but when ingested they also can cause a variety of effects such as internal injury and intestinal blocking.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Continue working to decrease derelict fishing gear and other marine debris;
- Establish a system of reporting and rescuing whales from ship collisions;
- Collaborate with partners to decrease pollutants and chemicals in the marine environment;
- Continue on-going research on stock structure, population sizes and ecology of these toothed whales;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with and assist local conservation organizations working on cetacean conservation, education and marine debris clean-up.

MONITORING:

- Survey nearshore habitat for detailed population size and distribution;
- Monitor the number of toothed whales entangled or otherwise impacted by marine debris and taken as fisheries bycatch.
- Monitor number of whales injured by ship collisions.

RESEARCH PRIORITIES:

- Continue researching habitat use, feeding behaviors and other biological information;
- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Determine impacts of tourism related activities on toothed whales;
- Study impacts of noise from ships on toothed whales.

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Marine Mammals

Short-finned pilot whale

Globicephala macrorhynchus

SPECIES STATUS:
IUCN Red List - Lower Risk/Conservation Dependent

SPECIES INFORMATION: Short-finned pilot whales (*Globicephala macrorhynchus*) feed primarily on squid, but they may also feed on octopus and fish, all from moderately deep water. When they are swimming and probably looking for food, pilot whales form ranks that can be over a kilometer (one mile) long. They are polygynous and are often found in groups with a ratio of one mature male to about every eight mature females. Females have gestation periods of approximately 15 months and lactate for at least two years. The last calf born to a mother may be nursed for as long as 15 years. The calving interval is five to eight years, but older females do not give birth as often as younger females. These whales form schools of 15 to 50. Additionally, they commonly associate with other cetaceans, such as the bottlenose dolphin.

DISTRIBUTION: Short-finned pilot whales are found throughout Hawai‘i. Possible resident populations are located off the coast of Kona on the island of Hawai‘i and off southwest Lāna‘i.

ABUNDANCE: The 2002 NOAA Stock Assessment Report estimates short-finned pilot whale abundance at 1,700, but this number underestimates the total population because it does not include the Northwestern Hawaiian Islands and only includes short-finned pilot whales within 25 nautical miles offshore. Barlow (2003), however, estimates population abundance for the entire Hawaiian Exclusive Economic Zone at 8,800.

LOCATION AND CONDITION OF KEY HABITAT: Short-finned pilot whales are found primarily in the deep waters off of the Main Hawaiian Islands. Areas with high density of squid are their primary foraging habitats. Currently their key habitat condition can be considered stable, with no habitat issues of concern.

THREATS:

- Fishery bycatch is a threat to short-finned pilot whales in Hawai‘i. They interact with the longline fishery, the bottomfish fishery, and squid fisheries that use drift and gill nets and seines in the NWHI, but whether these interactions result in death or injury are unknown. This threat needs to be further investigated. They also steal bait and catch from fisherman, which can result in intentional killing of these whales;
- Marine debris, such as tiny plastic particles that accumulate in the Hawaiian Archipelago, is a significant threat to short-finned pilot whales. Not only do these particles contain harmful chemicals such as PCBs and DDEs, but when ingested they also can cause a variety of effects such as internal injury and intestinal blocking. Marine

debris such as derelict fishing gear can entangle whales, often resulting in injury or death;
- Man-made noise is a threat that results from high vessel traffic and military vessels that use Hawaiian waters for operations involving sonar and explosions. This man-made noise can interfere with acoustic signals critical to reproduction and feeding. Man-made noises also have been shown to cause disturbance responses from far away, hearing loss, and physical harm;
- Interactions with whale watching tours may impact these whales; however, these are few tours focusing on this species.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:
- Establish a systematic fisheries monitoring system for interactions with short-finned pilot whales;
- Continue working to decrease marine debris;
- Work with partners to decrease pollutants and chemicals in the marine environment;
- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing marine mammal harassment and disturbance;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with and assist local conservation organizations on cetacean conservation, education, and marine debris clean-up.

MONITORING:
- Survey nearshore habitat for detailed population size and distribution;
- Monitor the number of short-finned pilot whales entangled or otherwise impacted by marine debris and taken as fisheries bycatch.

RESEARCH PRIORITIES:
- Continue researching habitat use, feeding behaviors, and other biological information;
- Improve understanding of impacts from tourism related activities on short-finned pilot whales;
- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Initiate studies to determine threats and minimize their impacts.

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Humpback whale or Koholā

Megaptera novaeangliae

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State recognized as Indigenous
IUCN Red List - Vulnerable

SPECIES INFORMATION: Koholā or humpback whales (*Megaptera novaeangliae*) migrate to Hawaiʻi in the winter to mate, give birth, and nurse their young. Gestation is 11 to 12 months. Females give birth every two to three years generally. Young are usually weaned in eight to twelve months. Females reach maturity at about five to seven years of age and the whales live to about 45 years of age or more. Males sing long duration and potentially long-distance songs that may aid in reproduction or other social communication. Little feeding is thought to occur while in Hawaiian waters.

DISTRIBUTION: The North Pacific population feeds in summer off Alaska, Russia, and British Columbia. Reproduction and birthing largely occur in Hawaiʻi, Mexico, Central America, and off Japan. Hawaiʻi has the largest sub-population, though there is some movement between breeding grounds among and even within seasons. The majority of the population occurs in the area between the islands of Maui Nui and on Penguin Banks off Molokaʻi. Most koholā are found in Hawaiʻi from December through April, but individuals can be seen from September through June.

ABUNDANCE: In 1992, there were approximately 4,000 individuals in the Central North Pacific population that visited Hawaiʻi, but this estimate is outdated. Projections based on observed calves put the current number at about 7,000. A multi-partner study is underway with the acronym of SPLASH to provide an up-to-date estimate. Single individuals may stay in Hawaiian waters for as little as six weeks during the approximately six-month whale season. Thus, at any one time the abundance in Hawaiʻi is less than the total population size. An analysis based on aerial surveys estimates that the population of Hawaii's humpbacks is increasing at an annual rate of seven percent.

LOCATION AND CONDITION OF KEY HABITAT: Koholā seem to prefer breeding areas that have warm and shallow waters with flat seabeds near deep water. This is part of what makes Hawaiʻi appealing to them. This preference probably makes conditions easier for young calves in their first weeks of life and may also decrease the risk of predation from large sharks, which may be less abundant in shallow water.

THREATS:

- Kohalā were historically threatened by commercial and aboriginal whaling, but neither type of whaling occurs today in large amounts;
- Injuries from boat strikes and marine debris entanglement are probably the main causes of human-induced kohalā mortality. In addition there is potential new mortality from proposed high-speed inter-island ferry;
- Underwater noise from sonars, vessel traffic, and unintentional harassment from ocean users may adversely affect kohalās' ability to communicate and use optimal habitat. This may stress individuals and decrease growth and reproduction or lead to alterations in habitat use.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Kohalā are protected internationally by the prohibition on commercial whaling of the International Whaling Commission. Kohalā were protected by the Endangered Species Act in 1973 and conservation actions have been implemented since then, including the Final Recovery Plan in 1991. A Take Reduction Plan was implemented in the North Pacific in 1997 to reduce entanglements with fishing gear. In addition, kohalā in Hawaiʻi receive extra protection. Federal regulations prohibit approaches closer than 100 yards (91 meters) by any means. The Hawaiian Islands Humpback Whale National Marine Sanctuary is a partnership between the State and Federal government that provides greater whale protections within the Sanctuary including stiffer fines for violations of federal protections, and support for research and educational efforts. The Final Recovery Plan lists detailed conservation actions that can also be consulted. In addition to common statewide and island conservation actions, specific current and future actions include:

- Identify and reduce direct human-related injury and mortality, especially;
  - Vessel strikes;
  - Marine debris entanglement.
- Restoration of Hawaiian habitat;
- Continue Federal-State partnership for conservation, most visibly in the form of the Hawaiian Islands Humpback Whale National Marine Sanctuary;
- Improve administration and coordination of recovery program for humpback whales.

MONITORING:

- Continue surveys of population and distribution;
- Develop protocol to monitor physical and chemical factors that could decrease habitat suitability;
- Monitor parasite loads and toxin levels in whales.

RESEARCH PRIORITIES:

- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Improve understanding of vessel-whale interactions;
- Continue to measure and monitor key population parameters;
- Continue studies to determine threats and minimize their impacts.

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Marine Mammals

Īlio-holo-i-ka-uaua or Hawaiian monk seal

Monachus schauinslandi

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State recognized as indigenous
IUCN Red List – Endangered
Endemic

SPECIES INFORMATION: Īlio-holo-i-ka-uaua or Hawaiian monk seals (*Monachus schauinslandi*) feed on reef fishes, octopus, squid, and lobsters over many substrates up to depths of 305 meters (1000 feet). Juveniles feed on a higher proportion of nocturnal fish species. Food seems to be a limiting factor for population growth at this time. Īlio-holo-i-ka-uaua are usually solitary except when on preferred beaches when they may be close together and interact. Mating occurs in the spring and early summer. Gestation is approximately one year. Pupping occurs in late winter and spring. Weaning lasts five to six weeks, happening in late spring, and pups and moms stay ashore until weaned. Foster parenting occurs. Most females only mate every other year, with one third or so breeding in consecutive years. Females and males reach sexual maturity at around five to nine years of age, and earliest is at Laysan. They are the only endangered marine mammal that occurs exclusively within the United States. Īlio-holo-i-ka-uaua live to 20 to 25 years of age.

DISTRIBUTION: Occurs in all of the Hawaiian Islands, although the majority of the population and pupping occurs in the middle of the Northwestern Hawaiian Islands (NWHI) chain. Pupping has recently been recorded from all the Main Hawaiian Islands. Some individuals and one birth have occurred at Johnston Atoll and 20 individuals have been translocated there.

ABUNDANCE: Currently, abundance is estimated at about 1300 individuals. About 50 individuals have been identified in the main islands, which is a large increase from more than 10 years ago. Populations have been decreasing recently, especially in the population around French Frigate Shoals.

LOCATION AND CONDITION OF KEY HABITAT: There are six main breeding sites in the NWHI (French Frigate Shoals, Laysan and Lisianski Islands, Pearl and Hermes Reef, and Kure and Midway Atolls). The loss of some islands in the NWHI, possibly due to sea level rise and climate change, may be hurting reproduction. Critical habitat has been defined under the U. S. Endangered Species Act as all waters out to 20 fathoms of depth and beaches (including sand spits and islets) and beach vegetation to its deepest inland extent around the six breeding sites plus Maro Reef, Gardner Pinnacle, Necker, and Nihoa Islands. The only exceptions are Sand Island and the harbor at Midway Atoll. Feeding occurs both within the atoll lagoon systems and on the reef slope outside the reef crest within 200 kilometers (124 miles) of the islands or atoll systems. They also forage on the submarine ridges connecting the atoll systems and on the seamounts of the NWHI area. Terrestrial habitat is used about one-third of the time and requirements there include haul-out areas for pupping, nursing, and resting, primarily on sandy beaches, but virtually all substrates are used. Beachside vegetation is used for protection from wind and rain.

THREATS:

- Historically, capture by humans and disturbance from government installations in the NWHI were major threats;
- Conflicts with commercial fishing also occurred but recent regulations limiting longline fishing near the NWHI has decreased this problem there;
- Hooking and entanglement occur in the main islands gill net and ulua slide-bait fisheries;
- Entanglement from marine debris is a major threat;
- Storms and climate change has resulted in a loss of pupping islands;
- Disease threats included canine distemper, Leptospirosis, and Brucellosis. A non-native elephant seal was removed from Hawaiian waters to decrease the possibility of canine distemper being introduced to monk seal populations;
- Predation by some sharks appears to have focused on seal pups causing increased mortality;
- Human disturbance, especially of mothers with calves, may be a threat. Conflicts and interactions with a variety of ocean and beach users are becoming more frequent and significant in the main islands;
- Other threats. There is low pup survival rate at French Frigate Shoals which appears to be associated with poor feeding but the exact cause of the problems there are unclear; Low genetic variability could threaten or make more difficult long-term conservation of the species.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Some conservation is in place in the five Fishery Management Plans of the Western Pacific Fisheries Management Council. Other protections result from the reduction in fishing from the Executive Order creating the NWHI Coral Reef Ecosystem Reserve within 50 miles of the atolls and islands. Detailed recommendations are made in the Recovery Plan. In addition to common state-wide and island conservation actions, specific actions include:

- Use the Incidental Take Permit process to minimize fishery interactions in the Main Hawaiian Islands;
- Continued restoration and protection of habitat and prey base;
- Continued removal of beach and reef marine debris in the NWHI;
- Continue removal of sharks that cause significant predation of pups;
- Expand efforts to reduce the probability of the inadvertent introduction of infectious diseases into the seal population;
- Continue and expand education and outreach programs and better coordinate these efforts;

- "Head starting" of juveniles may need to be reconsidered;
- Translocation of problem males and pups from low survival areas to bolster other subpopulations could be continued as needed;
- Maintain current field presence in NWHI to monitor and manage the seal population;
- Ensure continued growth of the main islands population through conservation actions and especially coordination among agencies and stakeholders.

MONITORING:
- Continue surveys of population and distribution in known and likely habitats;
- Continue pup tagging and adult identification program.

RESEARCH PRIORITIES:
- Improve understanding of basic biology, ecology to improve survival and population growth;
- Research causes of low juvenile survival;
- Continue habitat use and diet studies.

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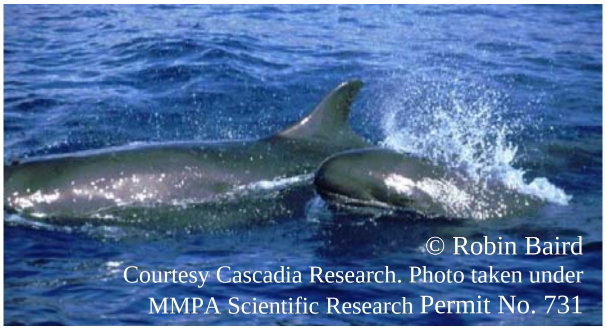

Marine Mammals

False killer whale

Pseudorca crassidens

SPECIES STATUS:
IUCN Red List - Lower Risk/ Conservation Dependent
National Marine Fisheries Service Strategic Stock

SPECIES INFORMATION: False killer whales (*Pseudorca crassidens*) can be found at the broadest range of depths of all the cetaceans in Hawaiʻi. In Hawaiʻi, false killer whales feed primarily on mahi mahi and yellowfin tuna. They discard the internal organs, gills, and tail. To increase success of finding prey, these whales travel in a broad band that can be up to several kilometers (miles) wide. Food sharing has been documented, and they feed during the day and at night. False killer whales have a breeding season that lasts several months. Gestation periods range from 14 to 16 months and lactation occurs for one and a half to two years. False killer whales have low reproduction rates with calving intervals of approximately seven years. These whales are gregarious and form strong social bonds. They are usually found in groups of ten to twenty that belong to much larger groups of up to 40 individuals in Hawaiʻi and 100 individuals elsewhere. They also are found with other cetaceans, most notably the bottlenose dolphin. False killer whales in Hawaiʻi may be reproductively isolated from other populations in the Pacific; however, there are no island resident populations.

DISTRIBUTION: They are found throughout the Hawaiian Islands in both shallow and deep water. In the Main Hawaiian Islands, a recent study found them off the island of Hawaiʻi, Oʻahu, and the island group of Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe.

ABUNDANCE: Barlow (2003) estimates population abundance at 268 in the entire Hawaiian Exclusive Economic Zone. False killer whales are rarely seen in Hawaiian waters. There is no clear abundance trend.

LOCATION AND CONDITION OF KEY HABITAT: False killer whales inhabit both shallow and deep oceanic waters in Hawaiʻi.

THREATS:

- Fisheries bycatch is a major threat to false killer whales in Hawaiʻi. Specifically, false killer whales have been recorded interacting with Hawaii's longline fisheries and bottomfish fisheries off the NWHI. These types of interactions can result in injury such as dorsal fin disfigurement or death. Dorsal fin disfigurement may affect reproduction and survival. False killer whales also have been documented stealing yellowfin tuna and mahi mahi off trolling lines from large commercial fisheries. Intentional death may result from this interaction as fishermen want to decrease their competition for fish;
- Marine debris, in the form of small plastic particles, accumulates in the Hawaiian Archipelago. These plastic particles contain harmful chemicals such as PCBs and DDEs. False killer whales not only ingest these particles, but the plastic can also cause intestinal

injury or blockage. Derelict fishing gear is another marine debris problem in the Hawaiian Islands as it can entangle false killer whales;

- Man-made noise caused by the many commercial, military and private vessels that enter Hawaiian waters ships has been documented to disrupt cetacean's foraging and nursing behavior and possibly feeding and breeding behaviors as well;
- Disturbance from whale-watching tours and marine pollutants are two other threats that may affect the false killer whales.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Establish a systematic fisheries monitoring system for interactions with false killer whales;
- Continue working to decrease marine debris;
- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing marine mammal harassment and disturbance;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with partners to decrease pollutants and chemicals in the marine environment;
- Work with and assist local conservation organizations working on cetacean conservation, education and marine debris clean-up.

MONITORING:

- Survey nearshore habitat for detailed population size and distribution;
- Monitor the number of false killer whales entangled or otherwise impacted by marine debris and taken as fisheries bycatch.

RESEARCH PRIORITIES:

- Continue researching habitat use, feeding behaviors, and other biological information;
- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Initiate studies to determine threats and minimize their impacts.
- Study potential impacts of whale-watching and other tourism related activities on false killer whales.

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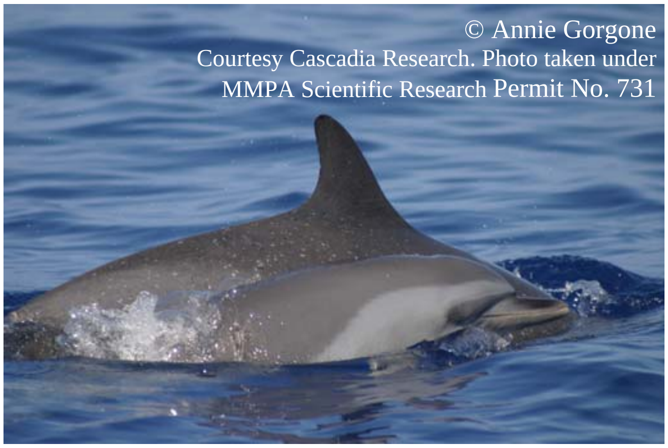

Marine Mammals

Naiʻa or Spotted dolphin

Stenella attenuata

SPECIES STATUS:
IUCN Red List - Lower Risk/ Conservation Dependent

SPECIES INFORMATION: Naiʻa or the spotted dolphin (*Stenella attenuata*) found in Hawaiian waters is considered one of three subspecies of *Stenella attenuata*. The diet of spotted dolphins in Hawaiʻi has been studied very little, but it appears that they feed primarily on mesopelagic cephalopods and fish. A recent study shows that although spotted dolphins may forage during the day, they appear to be more active feeders at night, diving deeper and longer. Spotted dolphins can be associated with yellowfin tuna, however, not as tightly as spotted dolphins in the Eastern Tropical Pacific. Spotted dolphins give birth to calves year-round with a few seasonal peaks. They have an 11 month gestation period. Lactation often takes place for two years, but also can last for only one year. At three to six months, however, calves will begin taking solid food. Calving intervals depend on the population, but range from two and a half to four years. During the day, spotted dolphins usually remain in shallower, nearshore waters around Maui ranging from 100 to 300 meters (330 to 1000 feet) deep, but they primarily stay within the top ten meters (33 feet) of the water column. Around the other islands they occur at 1500-2000m (5000 to 6300 feet) deep during daylight (Robin Baird, personal communication). They also are less active during this time. They are usually in small groups averaging approximately 40 individuals.

DISTRIBUTION: They are found throughout the Hawaiian Islands, often off leeward coasts. They have small home ranges and may not move between islands.

ABUNDANCE: The 2002 NOAA Stock Assessment estimates spotted dolphins abundance at approximately 2,900, but this number underestimates the total population because it does not include the Northwestern Hawaiian Islands and only includes dolphins within 25 nautical miles offshore. Barlow (2003) estimated population abundance for the entire Hawaiʻi Exclusive Economic Zone at approximately 10,300. It is important to note that within Hawaiʻi there may be distinct spotted dolphins populations that do not intermingle. There is no data to determine a clear trend in abundance.

LOCATION AND CONDITION OF KEY HABITAT: Spotted dolphins spend the majority of their day in nearshore, shallower water habitats typically between 90 to 300 meters (300 to 1,000 feet) deep. They can be found in deeper water habitats off of the island of Hawaiʻi, Kauaʻi, Lānaʻi, and Niʻihau. At night they move further off shore into deeper waters to search for prey and dive to deeper depths than they do during the day. They are often found in locations that have the highest prey density. The condition of their habitat is currently stable with no known habitat concerns.

THREATS: Spotted dolphins face a variety of threats similar to other cetaceans in Hawai'i; however, direct and indirect take of spotted dolphins in Hawaiian fisheries appears minimal, but these interactions are rarely reported and could be underestimated. Significant threats include the following:

- Tourism related interactions with dolphins such as tour boats and swim-with-dolphin programs represent a threat. Feeding, breeding, and social behaviors can be disrupted by the close range, high volume vessel traffic and the large numbers of swimmers, especially since spotted dolphins rest during the daytime. More studies need to be conducted to quantify this threat;
- Marine debris, such as tiny plastic particles that accumulate in the Hawaiian Archipelago, is a significant threat to spotted dolphins. Not only do these particles contain harmful chemicals such as PCBs and DDEs, but when ingested they also can cause a variety of effects such as internal injury and intestinal blocking. Marine debris such as derelict fishing gear entangles the dolphins often resulting in injury or death;
- Man-made noise is a threat that results from high vessel traffic and military vessels that use Hawaiian waters for operations involving sonar. This man-made noise can interfere with acoustic signals critical to dolphins' reproduction and feeding. Man-made noises also have been shown to cause disturbance responses, hearing loss and physical harm;
- Habitat degradation from coastal development and run-off is also a threat as spotted dolphins can live in nearshore waters.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Establish a systematic fisheries monitoring system for interactions with spotted dolphins;
- Continue working to decrease marine debris;
- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing marine mammal harassment and disturbance;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with partners to decrease pollutants and chemicals in the marine environment;
- Work with and assist local conservation organizations working on cetacean conservation, education and marine debris clean-up;
- Continue collaboration with NOAA on education and outreach activities, such as the "Ocean Etiquette" program, to promote dolphin-friendly ecotourism activities.

MONITORING:

- Survey nearshore habitat for detailed population size and distribution;
- Monitor the number of pantropical spotted dolphins entangled or otherwise impacted by marine debris and taken as fishery bycatch.

RESEARCH PRIORITIES:

- Continue researching habitat use, feeding behaviors, and other biological information;
- Initiate studies to determine further threats and minimize their impacts;
- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Improve understanding of impacts from tourism related activities on spotted dolphins;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Study impacts of noise from marine vessels on spotted dolphins.

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Marine Mammals

Naiʻa or Spinner dolphin

Stenella longirostris

SPECIES STATUS:
IUCN Red List - Lower Risk/ Conservation Dependent

SPECIES INFORMATION: Naiʻa or spinner dolphins (*Stenella longirostris*) congregate into large groups and swim offshore to depths of 200 to 300 meters (650 to 1,000 feet) to feed on mesopelagic prey that includes squid, fish and shrimp. Although in large groups, they also feed in cooperative pairs or groups of pairs offshore. This foraging begins in late afternoon and continues throughout the night as the "deep scattering layer" moves closer to the surface. Recent research shows that this food source is close to shore early in the night so the spinner dolphins follow them inshore for awhile. During the day, they expend less energy resting or socializing in nearshore, shallow waters such as bays and lagoons surrounded by reef. They also may stay in their nearshore habitat to avoid predators such as sharks and killer whales. The change in group size from daytime activities to nighttime feeding is unique to Hawaii's spinner dolphins. Although spinner dolphins are able to give birth at any time during the year, they typically show one or more seasonal peaks. Multiple males may mate with one female in short, consecutive intervals. Gestation lasts approximately ten and a half months and lactation occurs for one to two years. The calving interval is approximately three years. Additionally, the spinner dolphin is very notable for its ability to leap high out of the water while also spinning multiple times on its longitudinal axis.

DISTRIBUTION: Historically, spinner dolphins were located throughout Hawaiʻi. Today, spinner dolphins are still located throughout the entire Hawaiian Archipelago. These dolphins travel along the coast of each island. A large "resident" population occurs off the coast of Kona on the island of Hawaiʻi and asmaller group off Kahena on the east side. On Oʻahu, dolphins are found off the west coast of Waiʻanae, but they also travel between Waiʻanae and the southern shores. On Lānaʻi, the dolphins are primarily found on the South Shore, specifically spending time in Mānele Bay, and on Maui, groups can be found around Honolua and La Perouse bays.

ABUNDANCE: Abundance estimates vary. The 2002 NOAA Stock Assessment Report estimates the Kona population at approximately 2,300 and total population abundance in Hawaiʻi at approximately 3,200. The total population abundance estimate underestimates the total population size because it does not include the Northwestern Hawaiian Islands and only includes dolphins within 25 nautical miles offshore of the Main Hawaiian Islands. Barlow (2003) estimates spinner dolphin abundance throughout Hawaii's Exclusive Economic Zone at approximately 2,800. Ostman Lind et al. (2004) crudely estimate about 1,000 individuals in the population off Kona. There is no known data on whether the population is increasing or decreasing.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiʻi spinner dolphins are found in nearshore habitats such as bays and lagoons during the day and deeper, offshore waters for feeding at night. They feed in water depths of 200 to 300 meters (650 to 1000 feet) and along edges of banks. Conditions of nearshore habitat are location dependent, but generally stable; however, development, pollution run off, and other habitat altering conditions could negatively affect their daily activities. The condition of their feeding ground habitat is less well known. Studies have shown that dolphins use nearshore habitat opportunistically; thus, they can shift their locations based on disturbance to the area, making them relatively able to survive changes to habitat. However, the long-term implications of such changes on the life history of local populations are presently poorly understood.

THREATS:

- The tourism industry's swim-with-dolphin and dolphin-watching programs pose a significant threat to spinner dolphins in Hawaiʻi due to the close range interaction with the dolphins by humans and boats. These interactions have been shown to disrupt critical resting behaviors. This reduction in rest can result in decreased energy reserves that in turn affect abilities to forage efficiently and provide care for their young. Spinner dolphins may also abandon their habitats as a result of being repetitively disturbed by swim-with-dolphin and other tourism related interactions;
- Fishery bycatch of spinner dolphins in inshore monofilament gillnets (laynets) is another important threat. The extent of this threat is unknown and needs to be further investigated;
- Marine debris, such as tiny plastic particles that accumulate in the Hawaiian Archipelago, is a significant threat to spinner dolphins. Not only do these particles contain harmful chemicals such as PCBs and DDEs, but when ingested they also can cause a variety of effects such as internal injury and intestinal blocking. Marine debris such as derelict fishing gear entangles the dolphins leading to injury or death;
- Man-made noise is a threat that results from high vessel traffic and military vessels that use Hawaiian waters for operations involving sonar. This man-made noise can interfere with acoustic signals critical to dolphins' reproduction and feeding. Man-made noises also have been shown to cause disturbance responses, hearing loss, and physical harm;
- Vessel collisions are also a threat. High volumes of commercial traffic as well as recreational traffic throughout the Main Hawaiian Islands can lead to increased collisions with marine mammals. Additionally, a high speed ferry that will travel through the Main Hawaiian Islands may be approved in the near future;
- Habitat degradation from coastal development and run-off is also a threat particular to spinner dolphins as they primarily live in nearshore waters.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:

- Continue collaboration with NOAA on education and outreach activities, such as the "Ocean Etiquette" program, to promote dolphin-friendly ecotourism activities;

- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing dolphin harassment and disturbance;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering new species or areas for inclusion in the HIHWNMS;
- Continue working to decrease marine debris;
- Work to decrease pollutants and chemicals in the marine environment;
- Work with and assist local conservation organizations working on cetacean conservation, education, and marine debris clean-up;
- Support other public outreach and education efforts focusing on the effects of fisheries bycatch, marine debris, pollutants, and noise on spinner dolphins.

MONITORING:

- Continue surveys of population and distribution in known and potential habitats, along impacted coasts to determine the level of impact and project future trends;
- Monitor the number of spinner dolphins entangled or otherwise impacted by marine debris or taken as fishery bycatch to determine if education efforts are successful.

RESEARCH PRIORITIES:

- Improve understanding of impacts from tourism related activities on spinner dolphins in Hawaiʻi;
- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Determine correlations between marine debris accumulations with shipping lanes and currents to better target efforts;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Study impacts of noise from ships on spinner dolphins.

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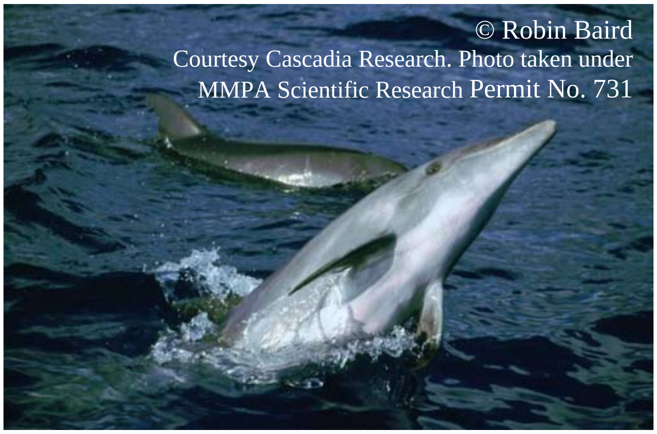

Marine Mammals

Naiʻa or Bottlenose dolphin

Tursiops truncatus

SPECIES STATUS:
IUCN Red List - Data Deficient

SPECIES INFORMATION: Naiʻa or bottlenose dolphins (*Tursiops truncatus*) feed primarily on fish and invertebrates that live near the bottom of the ocean. They feed cooperatively or alone and obtain their prey using methods such as "fish whacking" and steering fish onto mudflats. Like other dolphins, bottlenose dolphins give birth year round and gestation lasts approximately a year. Calves may not be weaned until they are 18 to 20 months old. Calves may also remain with their mothers for several years after they are weaned. The minimal calving interval is three years. Bottlenose dolphins often associate with other cetaceans, specifically pilot whales and koholā or humpback whales. They like to surf in all types of waves and are bow riders, which can affect their interactions with humans. Recent studies show that there may be island or island group resident populations.

DISTRIBUTION: Bottlenose dolphins are found throughout the Hawaiian Archipelago. Throughout the Main Hawaiian Islands, they are found in shallow, inshore waters as well as in the deeper channels between islands. In the Northwestern Hawaiian Islands, however, they are primarily found in the shallower inshore waters.

ABUNDANCE: The 2002 NOAA Stock Assessment estimates abundance of bottlenose dolphins at 743, but this number underestimates the total population because it does not include the Northwestern Hawaiian Islands and only includes dolphins within 25 nautical miles offshore. Barlow (2003) estimates 3,263 animals in Hawaii's Exclusive Economic Zone. There is no data to determine a population trend.

LOCATION AND CONDITION OF KEY HABITAT: Bottlenose dolphins in Hawaiʻi have key habitat in moderately shallow waters. Their primary foraging areas are benthic habitats. Currently, their habitats are stable with no issues of concern. Because they live closer to shore than other cetaceans, their nearshore habitat could become compromised with an increase of nearshore development and pollution runoff.

THREATS:

- Fisheries bycatch is a significant threat for bottlenose dolphins in Hawaiʻi, specifically in longline fisheries. The dolphins typically ingest the longline hooks leading to injury or death. Additionally, these dolphins are known to take bait and catch from Hawaiian recreational and commercial fisheries, including the day handline fishery for tuna and mackerel scad (opelu), the troll fishery for billfish and tuna, and the inshore set gillnet fishery. Whether injury or death results from these interactions is unknown, but these interactions are on the rise and need to be investigated further;

- Close range interaction with the tourism industry's swim-with-dolphin and dolphin-watching programs is another significant threat to bottlenose dolphins in Hawai'i. These interactions have been shown to disrupt critical social and resting behaviors in other areas. This reduction in rest can result in decrease energy reserves that in turn affect abilities to forage efficiently and provide care for their young. Altered social interactions can inhibit mating;
- Marine debris, such as tiny plastic particles that accumulate in the Hawaiian Archipelago, is a significant threat to bottlenose dolphins as well. Not only do these particles contain harmful chemicals such as PCBs and DDEs, but when ingested they also can cause a variety of effects such as internal injury and intestinal blocking. Marine debris such as derelict fishing gear entangles the dolphins often resulting in injury or death;
- Man-made noise is a threat that results from high vessel traffic and military vessels that use Hawaiian waters for operations involving sonar and explosions. This man-made noise can interfere with acoustic signals critical to dolphins' reproduction and feeding. Man-made noises also have been shown to cause disturbance responses from far away, hearing loss and physical harm;
- Habitat degradation results from coastal development and runoff into estuaries and bays where bottlenose dolphins are found.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Establish a systematic fisheries monitoring system for interactions with bottlenose dolphins;
- Continue collaboration with NOAA on education and outreach activities, such as the "Ocean Etiquette" program, to promote dolphin-friendly ecotourism activities;
- Continue to collaborate with NOAA on enforcement of the Marine Mammal Protection Act as it relates to preventing marine mammal harassment and disturbance;
- Continue working to decrease marine debris;
- Continue collaboration with NOAA, agency partners and stakeholders in the process of considering species for inclusion in the HIHWNMS;
- Work with partners to decrease pollutants and chemicals in the marine environment;
- Work with and assist local conservation organizations working on cetacean conservation, education and marine debris clean-up.

MONITORING:

- Survey nearshore habitat for detailed population size and distribution;
- Monitor the number of bottlenose dolphins entangled or otherwise impacted by marine debris and taken as fishery bycatch.

RESEARCH PRIORITIES:

- Collaborate with NOAA to understand interactions with nearshore fisheries;
- Improve understanding of impacts from tourism related activities on bottlenose dolphins in Hawai'i;

- Continue researching habitat use, feeding behaviors and other biological information;
- Initiate studies to determine threats and minimize their impacts;
- Research impacts and toxicity of small plastic pellet debris on marine mammals;
- Study impacts of noise from ships in Hawaiʻi on bottlenose dolphins.

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Loggerhead sea turtle

Caretta caretta

For photo see:
http://www.nmfs.noaa.gov/prot_res/species/turtles/loggerhead.html

Species Status:
Federally Listed as Threatened
State Listed as Threatened
IUCN Red list – Threatened

SPECIES INFORMATION: Mature males are distinguished by longer and thicker tails. Little information exists on the feeding behavior of post-hatchlings living in pelagic habitats, but most likely they are exclusively carnivorous (e.g., invertebrates and fish eggs). Juveniles and adults feed on benthic invertebrates and occasionally fishes. Loggerheads display slow growth rates with an average annual growth rate of approximately one centimeter per year for subadults. Turtles likely reach sexual maturity at 20 to 30 years of age. Females generally breed once every three or more years. Females may lay clutches of about 120 eggs every 14 days during the nesting season. Incubation time is close to 70 days. Sex determination is temperature dependent.

DISTRIBUTION: Historically, loggerhead sea turtles may have inhabited all the Hawaiian Islands. Today, juveniles are only very rarely seen in the Hawaiian Islands and generally north of 22 degrees latitude. Most nesting occurs in Japan. Post-hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution.

ABUNDANCE: An unknown number of adults make up the breeding population. Some beach nesting surveys occur in other countries but there are too few to survey in Hawaiʻi. There is no clear trend in abundance.

LOCATION and CONDITION OF KEY HABITAT: Loggerhead sea turtles are most often found in pelagic waters in Hawaiʻi. Nesting areas are extremely critical to the survival of the loggerhead sea turtle and are likely in Japan for this population.

THREATS:
- Threats to nesting in other jurisdictions are a problem and are addressed in the recovery plan;
- In the ocean the main threats are marine debris and incidental and directed take in pelagic fisheries. Incidental Take Permits are in-place for the Hawaiʻi longline fisheries. Another important threat is the direct take of adult and juvenile turtles in other jurisdictions.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past efforts have included a threatened listing by the State of Hawaiʻi and U. S. government and resultant ban on capturing sea turtles; and various partnerships with local and national public and private organizations. The Western Pacific Regional Fisheries Management Council has implemented rules to decrease incidental take in the longline fishery. In addition to common state-wide and island conservation actions, specific actions include:

- Cooperate with jurisdictions where nesting occurs to restore nesting habitat;
- Collaborate with the National Marine Fisheries Service through the nearshore Incidental Take Permit process and otherwise to protect and manage turtles in the marine environment including both pelagic and foraging habitats to decrease incidental and direct takings;
- Work to reduce the amount of marine debris in nearshore and breeding habitats;
- Increase education and outreach efforts, particularly to address threats such as marine debris;
- Continue turtle stranding response partnerships;
- Continue on-going partnerships with local conservation groups to monitor and conserve turtles as well as conduct research and outreach programs.

MONITORING:
- Continue partnership to monitor turtles harmed or killed by marine debris;
- Monitor number of turtles stranded or taken as bycatch to determine if education and law enforcement efforts are successful.

RESEARCH PRIORITIES:
- Continue research on ways to decrease bycatch;
- Determine distribution, abundance and status of juveniles in the marine environment.

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Marine Reptiles

Honu or Green sea turtle

Chelonia mydas

Species Status:
Federally Listed as Threatened
State Listed as Threatened
State Recognized as Indigenous
IUCN Red list - Endangered

SPECIES INFORMATION: Mature males are distinguished from females by their longer, thicker tails. Little information exists on the feeding behavior of post-hatchlings and juveniles living in pelagic habitats, but most likely they are exclusively carnivorous (e.g., soft-bodied invertebrates and fish eggs). Subadult and adult turtles residing in nearshore benthic environments are almost completely herbivorous; feeding primarily on select macroalgae and sea grasses. Hawaiian honu display slow growth rates, even compared to other populations, with an average annual growth rate of approximately one to five centimeters (one-half to two inches) per year. Turtles often reach sexual maturity at 35 to 40 years of age. Females migrate to French Frigate Shoals in the Northwestern Hawaiian Islands (NWHI) to breed approximately once every two or more years, while male turtles may migrate to NWHI to breed every year. Honu mate at sea and approximately 25 to 35 days after mating females swim onshore to excavate a nest and lay eggs. Females may lay up to six clutches per season, often returning to the same site for each clutch every 12 to 15 days. Each clutch contains 100 eggs and sex determination is temperature dependent. Incubation takes about 60 days. Recent research suggests green sea turtles in the Caribbean are a keystone species that, when abundant, had a major effect on the structure of the ecosystem. A unique behavioral characteristic of both male and female green sea turtles living in Hawaii is that they often haul out in the NWHI during inter-nesting intervals and on a couple of places in the main islands to bask in the sun.

DISTRIBUTION: Historically, honu most likely inhabited the waters around the all Hawaiian Islands. Today, they still live and forage around all the Hawaiian Islands. Important foraging areas are located along the coastlines of Oʻahu, Molokaʻi, Maui, Lānaʻi, Hawaiʻi, Lisianski Island, and Pearl and Hermes Reef. Before European settlement, nesting also occurred at the south eastern end of the archipelago. Today, although nesting occurs on all islands, 90 percent of the nesting occurs on French Frigate Shoals of the NWHI. Low levels of nesting have been documented on Laysan Island, Lisianski Island, Pearl and Hermes Reef, and Kure Atoll. Male and females migrate to French Frigate Shoals to mate. Evidence shows that Hawaiian turtles only migrate throughout the 2,450 kilometer (1,500 mile) expanse of the Hawaiian Archipelago, and so make up a discrete population. Post-hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution.

ABUNDANCE: Approximately 200-700 females nest annually. Abundance appears to be increasing locally and globally.

LOCATION and CONDITION OF KEY HABITAT: Honu are most often found in shallow, protected or semi-protected, water around coral reefs and coastal areas. These habitats contain critical foraging areas consisting of sea grasses and algae and they provide some shelter from predators such as tiger sharks. Key foraging habitat can be found around most of the Hawaiian Islands, but turtles often return to the same resident foraging areas after a breeding season. Conditions of foraging habitats vary, but degradation of foraging habitat is documented on the south coast of Molokaʻi; Kāneʻohe Bay, Oʻahu; Hanalei Bay, Hanamaulu Bay, and Nawiliwili Harbor, Kauaʻi; Maalaea Bay, Kihei, and Lahaina, Maui; and Hilo Bay, Hawaiʻi. Cleaning stations and resting habitats are important habitats for turtles as well but have not been mapped. Nesting areas are extremely critical to the survival of the honu. They prefer sandy beaches that are minimally disturbed. The condition of nesting sites on French Frigate Shoals is relatively good compared to other nesting sites for turtles throughout the world, because French Frigate Shoals is inhabited by less than ten humans with little development. Predation on eggs and hatchlings is low as well.

THREATS:

- A significant threat to the honu in Hawaii is the prevalence of the tumor disease Fibropapilloma (FP). FP tumors can grow to large sizes and often occur on the axial regions of the flippers and around the eyes. As such, the tumors can inhibit swimming, eating, breathing, vision and reproduction. If these critical functions are severely impaired, then the turtle may not survive. Infection rates are highest off Oʻahu with an estimated infection rate of up to 90 percent. Away from Oʻahu, infections rates are lower with the lowest rate of infection off Hawaiʻi. A herpes virus has been implicated as the cause of FP, and a parasitic worm and saddleback wrasses (which clean green sea turtles) are known to be carriers of the virus and potential vectors;
- Alien seaweeds are displacing important foraging, resting, and cleaning habitats of the turtles;
- Another important threat is the indirect take of adult and juvenile turtles as fisheries bycatch. Incidental Take Permits are in-place for the Hawaii longline fisheries;
- Predation is also a moderate threat especially for hatchlings in the open ocean; however, the exact impact is unknown;
- The impact on turtles from snorkeling and other human recreational activities are threats that need to be further investigated;
- Other threats include marine debris that entangles turtles or is ingested by them; the loss or degradation of foraging habitats along coastal areas due to development, sedimentation, soil erosion or sewage; nest predation, and boat collisions.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past efforts have included a threatened listing by the State of Hawaii and U. S. government, establishment of state parks, the Hawaiian National Wildlife Refuge complex, and Marine Life Conservation Districts that protect important nesting or foraging grounds; permits to control nearshore development; and various partnerships with local and national public and private organizations. The Western Pacific Regional Fisheries Management Council has implemented rules to decrease incidental take in the longline fishery. In addition to common state-wide and island conservation actions, specific actions include:

- Restore nesting habitat, especially altered main islands beaches;
- Improve protection and management of turtles; nesting, foraging, and resting habitats; and cleaning stations;
- Determine the specific cause of, and a cure for, Fibropapilloma tumors;
- Collaborate with the National Marine Fisheries Service through the nearshore Incidental Take Permit process and otherwise to protect and manage turtles in the marine environment including both pelagic and foraging habitats to decrease incidental and direct takings;
- Work to reduce the amount of marine debris in nearshore feeding and breeding habitats;
- Increase education and outreach efforts, particularly to address threats such as fishing interactions, marine recreation interactions, and marine debris;
- Continue turtle stranding response partnerships;
- Continue on-going partnerships with groups such as Western Pacific Fisheries Management Council, University of Hawaii Sea Grant Program, The Honu Project, The Ocean Conservancy and local conservation groups to monitor and conserve turtles as well as conduct research and outreach programs.

MONITORING:

- Continue to monitor nesting sites for population of nesting turtles;
- Continue to monitor breeding sites to collect biological information on turtles;
- Continue to monitor population and distribution trends;
- Monitor the occurrence and effects of FP;
- Continue partnership to monitor turtles harmed or killed by marine debris;
- Monitor number of turtles stranded or taken as bycatch to determine if education and law enforcement efforts are successful.

RESEARCH PRIORITIES:

- Research the pathology and epidemiology of Fibropapilloma as well as other parasites and infectious agents;
- Continue research on ways to decrease bycatch;
- Research effects of tourism-related activities on turtles;
- Determine distribution, abundance and status of post-hatchlings, juveniles and adults in the marine environment.

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Leatherback sea turtle

Dermochelys coriacea

For photo see:
http://www.nmfs.noaa.gov/prot_res/species/turtles/leatherback.html

Species Status:
Federally Listed as Endangered
State Listed as Endangered
IUCN Red list – Critically Endangered

SPECIES INFORMATION: Little information exists on the feeding behavior of post-hatchlings and juveniles living in pelagic habitats, but most likely they are exclusively carnivorous. Leatherbacks are the only sea turtle in which adults are also pelagic and carnivorous on jellyfishes, siphonophores, and salps. Growth rates are largely unknown in the wild. Reproduction is seasonal with two to three years between nestings. Incubation lasts about 60 days. Long migrations are likely. Sex determination is temperature dependent. Genetic analysis of individuals incidentally caught in the Hawaiʻi-based longline fishery reveals that 12 out of 14 sampled came from the west Pacific. The remaining two, which were caught in the southern part of the fishery's range, originated from nesting beaches in the eastern Pacific.

DISTRIBUTION: Today, leatherback turtles are transient visitors around the Hawaiian Islands. The entire population of the Pacific may be highly interconnected. Nesting occurs in Mexico, China, SE Asia, Australia, and some Pacific islands with one (infertile) nesting reported from Hawaiʻi. Post-hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution.

ABUNDANCE: Rare in Hawaiʻi. No trend of increase or decrease has been noted.

LOCATION and CONDITION OF KEY HABITAT: Leatherback sea turtles are most often found in deeper pelagic habitats. Nesting areas are extremely critical to the survival of the leatherback sea turtle but occur outside Hawaiʻi.

THREATS:

- Threats to nesting in other jurisdictions are a problem and are addressed in the recovery plan;
- In the ocean the main threats are marine debris and incidental and directed take in pelagic fisheries. Incidental Take Permits are in-place for the Hawaiʻi longline fisheries. Another important threat is the direct take of adult and juvenile turtles in other jurisdictions.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past efforts have included an endangered listing by the State of Hawaii and U. S. government and resultant ban on capturing sea turtles; and various partnerships with local and national public and private organizations. The Western Pacific Regional Fisheries Management Council has implemented rules to decrease incidental take in the longline fishery. In addition to common state-wide and island conservation actions, specific actions include:

- Cooperate with jurisdictions where nesting occurs to restore nesting habitat;
- Collaborate with the National Marine Fisheries Service through the nearshore Incidental Take Permit process and otherwise to protect and manage turtles in the marine environment including both pelagic and foraging habitats to decrease incidental and direct takings;
- Work to reduce the amount of marine debris in nearshore habitats;
- Continue turtle stranding response partnerships;
- Increase education and outreach efforts, particularly to address threats such as marine debris.

MONITORING:

- Continue partnership to monitor turtles harmed or killed by marine debris;
- Monitor number of turtles stranded or taken as bycatch to determine if education and law enforcement efforts are successful.

RESEARCH PRIORITIES:

- Continue research on ways to decrease bycatch;
- Determine distribution, abundance and status of post-hatchlings, juveniles and adults in the marine environment, especially foraging grounds.

References:

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Courtesy Stuart Robbens

Marine Reptiles

Hawksbill sea turtle

Eretmochelys imbricata

Species Status:
Federally Listed as Endangered
State Listed as Endangered
IUCN Red list – Critically Endangered

SPECIES INFORMATION: Little information exists on the feeding behavior of post-hatchlings and juveniles living in pelagic habitats, but most likely they are exclusively carnivorous (e.g., invertebrates and fish eggs) near the surface. They then switch to feeding in benthic reef areas as they grow. They appear to focus particularly on sponges which are not digestible by many other animals. At Honokowa, Maui they also feed on the algae *Hypnea*. As they age they dive to deeper and deeper reef areas. Hawksbill turtles display slow growth rates with an average annual growth rate of approximately two to five centimeters per year for juveniles that slows to almost no somatic growth in adults. Hawksbill turtles often reach sexual maturity at 30 to 50 years of age. Females generally breed once every two or more years. Turtles mate at sea. Nesting occurs from late May through November. Females may lay up to six clutches per season, often returning to the same site for each clutch every 14 to 20 days or so. Each clutch contains about 140 eggs and sex determination is temperature dependent. Incubation lasts about 60 days.

DISTRIBUTION: Historically, hawksbill sea turtles probably inhabited the coasts of all Hawaiian Islands. Today, turtles live around the Main Hawaiian Islands only but they are rare. Individuals are regularly seen off West Maui. Nesting occurs on all the main islands only, especially along the east coast of Hawaiʻi. The Northwestern Hawaiian Islands (NWHI) may have been used in the past. A black-sand beach in the Halawa River Valley of east Molokaʻi, and Kamehame Beach, Hawaiʻi are also used consistently. A few beaches on Maui are used occasionally. Post-hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution or range or migrations. Some individuals have been recaptured over 1600 kilometers (1000 miles) from where they were tagged, so long distance movement is possible and genetic studies show foraging areas consist of individuals from different genetic stocks.

ABUNDANCE: Sixty or so female adults make up the breeding population. There is no current obvious trend to the population size.

LOCATION and CONDITION OF KEY HABITAT: Hawksbill sea turtles are most often found in shallow water around reefs, bays and inlets. Key foraging habitat can be found around most of the Main Hawaiian Islands, especially the north coasts. Nesting areas are extremely critical to the survival of the hawksbill sea turtle. The species appears to prefer areas with woody cover for nesting. Sand is not necessary but often used. Nests are usually within five meters (15 feet) of the high water line. Two nesting beaches (Halape and Apua Point) are located within Hawaii Volcanoes National Park and receive more protection.

THREATS:

- The main threats statewide to nesting beaches are from construction and human presence including vehicles at Punaluu and Kawa, beach erosion, artificial lighting, nest predation, and exotic vegetation;
- Marine debris from active and ghost fishing lines and lay nets is an incidental take
- Pollutants and sediments and boat collisions may be a threat;
- Another important threat is the direct take of adult and juvenile turtles which still occasionally occurs in the state;
- Predation and disease is also a moderate threat; however, the exact impact is unknown. In addition to natural predators, introduced mongooses, feral cats, rats, and pigs threaten hawksbills;
- Fibropapilloma has not been found in hawksbills.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past efforts have included an endangered listing by the State of Hawaii and U. S. government and resultant ban on capturing sea turtles; establishment of state parks, the Hawaiian National Wildlife Refuge complex, and Marine Life Conservation Districts that protect important nesting and foraging grounds; permits to control nearshore development; and various partnerships with local and national public and private organizations. In addition to common state-wide and island conservation actions, specific actions include:

- Restore nesting habitat, especially altered main islands beaches;
- Continue to protect and manage turtles and nests on nesting beaches;
- Collaborate with the National Marine Fisheries Service through the nearshore Incidental Take Permit process and otherwise to protect and manage turtles in the marine environment including both pelagic and foraging habitats to decrease incidental and direct takings;
- Work to reduce the amount of marine debris in nearshore feeding and breeding habitats;
- Increase education and outreach efforts, particularly to address threats such as marine debris;
- Continue on-going partnerships with local conservation groups to monitor and conserve turtles as well as conduct research and outreach programs.

MONITORING:

- Continue to monitor nesting sites for population of nesting turtles;
- Continue to monitor breeding sites to collect biological information on turtles;
- Continue to monitor population and distribution trends;
- Continue turtle stranding response partnerships;
- Continue partnership to monitor turtles harmed or killed by marine debris;
- Monitor number of turtles stranded or taken as bycatch to determine if education and law enforcement efforts are successful.

RESEARCH PRIORITIES:

- Identify population stock structure and home ranges using DNA analysis;

- Continue research on ways to decrease bycatch;
- Determine distribution, abundance and status of post-hatchlings, juveniles and adults in the marine environment;
- Research effects of tourism-related activities on turtles.

References:

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International Union for the Conservation of Nature and Natural Resources. Threatened Red List. Available from: http://www.redlist.org/search/search-expert.php (Accessed May 2005).

King CS, Gilmartin WG, Hau S, Bernard HJ, Canja SM, Nakai G, Grady MJ, Williams S, Hebard AG. In Press. Nesting hawksbill turtles (*Eretmochelys imbricata*) on the Island of Maui, Hawai'i from 1996-2003. Proceedings of the Twenty-fourth Annual Symposium on Sea Turtle Biology and Conservation.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (US) [NMFS and USFWS]. 1998. Recovery plan for U.S. Pacific Populations of the hawksbill sea turtle (*Eretmochelys imbricata*). Silver Springs, MD: National Marine Fisheries Service. 95 pp.

Marine Reptiles

Olive ridley sea turtle

Lepidochelys olivacea

Species Status:
Federally Listed as Threatened
State Listed as Threatened
IUCN Red list – Threatened

SPECIES INFORMATION: Mature males are distinguished by longer, thicker tails an elongated carapace, and one enlarged, hooked claw. Olive ridleys are the smallest and most abundant sea turtle, with adult carapace lengths of 60 to 70 centimeters (about two feet). Little information exists on the feeding behavior of post-hatchlings and juveniles living in pelagic habitats, but most likely they are exclusively carnivorous (e.g., invertebrates and fish eggs). Juveniles and adults eventually feed on a wide variety of benthic organisms. Growth is unknown and age at sexual maturity is seven to 15 years. Females often return to the same site to lay additional clutches every month and do so *en masse*. Incubation lasts 46 to 65 days. Each clutch contains about 100 eggs and sex determination is temperature dependent. Genetic analysis of olive ridley turtles taken in the Hawai'i-based longline fishery shows that about two-thirds of the animals came from the eastern Pacific, while the remaining one-third originated in the western Pacific or Indian Ocean. Thus Hawai'i represents a point of convergence for these source areas.

DISTRIBUTION: Historically, olive ridley sea turtles may have inhabited the coasts of all Hawaiian Islands. Today, they are rarely but more commonly seen around the Hawaiian Islands. Nesting has only been recorded once in Hawai'i, on Maui in 1985. Post-hatchlings and juveniles live in pelagic waters, but little is known of their specific distribution.

ABUNDANCE: There is no clear trend in abundance.

LOCATION and CONDITION OF KEY HABITAT: Olive ridley sea turtles are most often found in shallow water around reefs, bays and inlets. Nesting areas are extremely critical to the survival of the olive ridley sea turtle. Most nesting is on continental beaches. Preferred nesting habitat is mid-level beaches free of debris.

THREATS:

- Incidental take from longline fisheries is the main threat. An excess catch of turtles in the Hawai'i deep-set longline fishery (mostly for tuna) has resulted in a Section 7 consultation under the Endangered Species Act that is ongoing. A number of turtles have also been found dead and entangled in marine debris. Incidental or directed take in other jurisdictions is a threat;
- Nesting habitat degradation is a threat in other jurisdictions.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past efforts have included a threatened listing by the State of Hawaiʻi and U. S. government and resultant ban on capturing sea turtles; and various partnerships with local and national public and private organizations. In addition to common state-wide and island conservation actions, specific actions include:

- Cooperate with jurisdictions where nesting occurs to restore nesting habitat;
- Collaborate with the National Marine Fisheries Service through the nearshore Incidental Take Permit process and otherwise to protect and manage turtles in the marine environment including both pelagic and foraging habitats to decrease incidental and direct takings;
- Continue to protect and manage turtles and nests on nesting beaches;
- Work to reduce the amount of marine debris in nearshore and breeding habitats;
- Increase education and outreach efforts, particularly to address threats such as marine debris;
- Continue on-going partnerships with local conservation groups that monitor and conserve turtles as well as conduct research and outreach programs.

MONITORING:

- Continue to monitor nesting sites for population of nesting turtles;
- Continue turtle stranding response partnerships;
- Continue partnership to monitor turtles harmed or killed by marine debris;
- Monitor number of turtles stranded or taken as bycatch to determine if education and law enforcement efforts are successful.

RESEARCH PRIORITIES:

- Continue research on ways to decrease bycatch;
- Determine distribution, abundance and status of post-hatchlings, juveniles and adults in the marine environment.

References:

Earth Tech, Inc. 2005. Preliminary draft EIS: issuance of an ESA Incidental Take Permit to the State of Hawaii. Honolulu, HI: Earth Tech, Inc.

Gulko D, Eckert K. 2003. Sea turtles: an ecological guide. Honolulu, HI: Mutual Publishing. 128 pp.

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National Marine Fisheries Service and U.S. Fish and Wildlife Service. (US) [NMFS and USFWS]. 1998. Recovery plan for U.S. Pacific populations of the olive ridley turtle (*Lepidochelys olivacea*). Silver Springs, MD: National Marine Fisheries Service. 95 pp.

Marine Reptiles

Yellow-bellied sea snake

Pelamis platurus

SPECIES STATUS:
State recognized as indigenous
IUCN Red List – Not Considered

SPECIES INFORMATION: This sea snake is pelagic and feeds on small fishes and eels. It breeds year-round with a several month long gestation period. They give birth to live young with litter sizes of one to eight. Maturity may take two years. They can occur in large aggregations. They are venemous, but have a small mouth and fangs and are generally un-aggressive unless harassed.

DISTRIBUTION: They occur in tropical and subtropical areas of the Indian and Pacific Oceans. Specific distribution in Hawaiʻi is poorly known.

ABUNDANCE: No estimates or surveys of abundance exist because they are pelagic and rare.

LOCATION AND CONDITION OF KEY HABITAT: Occur in water from 22 to 30 degrees C and especially in shallow inshore waters. They can dive to depths of 15 meters (50 feet) and are often found around flotsam or debris. Not common in Hawaiʻi.

THREATS:
- Boat strikes;
- Fishery bycatch.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:
- Restoration of habitat;
- Maintain healthy populations with adequate fishery regulation.

MONITORING:
- Initiate surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: None identified.

References:
Gulko D, Eckert K. 2003. Sea turtles: an ecological guide. Honolulu, HI: Mutual Publishing. 128 pp.

NatureServe. [Internet]. 2005. NatureServe Explorer: An online encyclopedia of life. Version 4.3. Arlington, VA: NatureServe. Available from: http://www.natureserve.org/explorer. (Accessed: March, 2005).

Manta
Courtesy NMFS

Marine Fishes

Sharks and Rays

Great white shark
Niuhi
Carcharodon carcharias

Whale shark
Lele waʻa
Rhincodon typus

Manta ray
Hāhālua
Manta alfredi or *Manta birostris*

SPECIES STATUS:
IUCN Red List – sharks are Vulnerable, Manta ray is Data Deficient
None Endemic

SPECIES INFORMATION: Great whites (niuhi) are predators on large fishes, marine mammals, and some sea turtles and larger invertebrates. Whale sharks filter feed on planktonic schooling fishes, squids, and crustacean larvae and adults. Manta rays are planktonic filter feeders in coastal waters. These species have slow growth rates and low fecundity that limit their recovery from threats. The sharks travel widely and may only be occasional visitors to Hawaiʻi. Recent tagging of great white sharks off California found that many took unexpectedly large migrations into the Central Pacific Ocean, including one individual that made it all the way to Hawaiʻi for a few months. Manta taxonomy is confused so it cannot be determined whether our species is alfredi or birostris at this time.

DISTRIBUTION: All species are likely to occur throughout the Hawaiian Islands but great whites (niuhi) have been noted in the main islands through Laysan Island, and whale sharks have been recorded throughout the main islands.

ABUNDANCE: There are no systematic survey efforts for these species.

LOCATION AND CONDITION OF KEY HABITAT: All species can be found in shallow water depths. A tagged great white shark spent most of its time in very deep water however. All are wide ranging. Manta rays can be predictably found off parts of the west coast of the island of Hawaiʻi.

THREATS:

- These species are threatened by fisheries bycatch and directed catch in other parts of the world for food, medicinal and other commercial uses;
- Tourism to see manta rays occurs on the Kona Coast of the island of Hawaiʻi. Tourism for great white and whale sharks occurs elsewhere but their presence here is too unpredictable to make tourism feasible.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. These sharks are listed in Appendix II of the Convention on International Trade in Endangered Species (CITES). In addition to common statewide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution.

References:

Crow GL, Crites J. 2002. Sharks and rays of Hawaii. Honolulu, HI: Mutual Publishing. 203 pp.

International Union for the Conservation of Nature and Natural Resources. [Internet] Threatened Red List. Available from: http://www.redlist.org/search/search-expert.php (Accessed May 2005).

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Marine Fishes

Eels

Muraenidae

Anarchias sp.
Enchelycore pardalis
Gymnothorax nuttingi
Gymnothorax polyspondylus
Gymnothorax steindachneri

Ophichthidae

Callechelys lutea
Ichthyapus platyrhynchus
Ophichthus fowleri
Ophichthus kunaloa
Scolecenchelys puhioilo

Congridae

Acromycter alcocki
Bathycongrus aequorea
Gorgasia hawaiiensis


Enchelycore pardalis
Courtesy Keoki Stender

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: Morays and snake eels (ophicthids) are carnivores of fishes and invertebrates. Morays are often nocturnal. Hawaiian garden eel (*Gorgasia*) is a planktivore. Other conger eels are largely nocturnal carnivores. Many moray eels are hermaphrodites of one form or another. The species common names and Hawaiian names are *Anarchias* sp. (no common name), *Enchelycore pardalis* (dragon eel, puhi-kauila), *Gymnothorax nuttingi* (Nutting's moray), *Gymnothorax polyspondylus* (many-vertebrate moray), *Gymnothorax steindachneri* (Steindachner's moray, puhi), *Callechelys lutea* (yellow-spotted snake eel, puhi), *Ichthyapus platyrhychus* (no common name), *Ophichthus fowleri* (Fowler's snake eel), *Ophichthus kunaloa* (no common name), *Scolecenchelys phuioilo* (no common name), *Acromycter alcocki* (no common name), *Bathycongrus aequorea* (no common name), and *Gorgasia hawaiiensis* (Hawaiian garden eel, puhi).

DISTRIBUTION: The many-vertebrate moray has been found off Oʻahu only. Steindachner's moray has been found from Oʻahu through the Northwestern Hawaiian Islands (NWHI). Fowler's snake eel occurs off Maui, Lānaʻi, and Oʻahu. *Ophichthus kunaloa* is found from the island of Hawaiʻi to Oʻahu. *Scolecenchelys puhioilo* is known from only two specimens from Oʻahu and Maro Reef. *Acromycter alcocki* has been collected from Maui to Oʻahu. *Bathycongrus* occurs from the island of Hawaiʻi to Kauaʻi and maybe further northwest. Hawaiian garden eels occur from the island of Hawaiʻi to Oʻahu. The other species occur throughout the Hawaiian Islands.

ABUNDANCE: The shallow water species are surveyed for in surveys of coral reef fishes in the Main and NWHI, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources and data are available online.

LOCATION AND CONDITION OF KEY HABITAT: All species except Nutting's moray, many-vertebrate moray, *Ophichthus kunaloa, Scolecenchelys, Acromycter,* and *Bathycongrus* are found in shallow water. Nutting's moray is found deeper than 110 meters (350 feet), the many-vertebrate moray was collected deeper than 180 meters (600 feet), and *Ophichthus kunaloa* and *Scolecenchelys puhioilo* are collected only greater than 210 meters (700 feet) deep. *Acromycter* and *Bathycongrus* have been collected only deeper than 300 meters (1,000 feet). Steindachner's moray is only found deeper than 30 meters (100 feet) in the main islands. Snake eels and Hawaiian garden eels occur in sandy habitat. The rest are found throughout coral reef habitats. Puhi-kauila (dragon eel) is more common in the NWHI.

THREATS:
- Puhi-kauila *(*dragon eel) and Hawaiian garden eels are prized by aquarists;
- Hawaiian garden eels may be threatened by habitat alteration.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Commercial licenses are required for aquarium collectors. In addition to common statewide and island conservation actions, specific actions include:
- Restoration of habitat;
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:
- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:
- Improve understanding of factors affecting the species population size;
- Support aquaculture research to develop captive breeding for species used in the aquarium trade.

References:
Gulko D. 2004. Hawaiian marine species for Endangered Species Act candidate listing, revised candidate list 2004. Honolulu, HI: Hawaiʻi Division of Aquatic Resources. 21 pp.

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Marine Fishes

Active Reef Fishes


Chaetodon tinkeri
Courtesy Keoki Stender

Chaetodontidae
Chaetodon fremblii
Chaetodon tinkeri
Prognathodes sp.

Pomacanthidae
Apolemichthys arcuatus
Centropyge fisheri
Centropyge loricula
Genicanthus personatus

Pomacentridae
Chromis hanui
Chromis ovalis
Chromis struhsakeri
Plectroglyphidodon sindonis


Geniacanthus personatus male
Courtesy Keoki Stender

Priacanthidae
Priacanthus meeki

Cheilodactylidae
Cheilodactylus vittatus

Ammodytidae
Ammodytoides pylei
Lepidammodytes macrophthalamus

Monacanthidae
Cantherhines verecundus

Thamnaconus garretti

Ostraciidae

Ostracion whitleyi

Tetraodontidae

Torquigener randalli

SPECIES STATUS:
IUCN Red List – Not considered
All Endemic except *Chaetodon tinkeri*, *Apolemichthys*, *Centropyge loricula,* and *Ostracion*

SPECIES INFORMATION: The Hawaiian rock damselfish (*Plectroglyphidodon*) is territorial. *Chaetodon* and *Centropyge* feed on invertebrates and algae. *Apolemichthys* prefers sponges. Masked Angelfish (*Genicanthus*) is a protogynous sex changer and primarily feeds on zooplankton and algae. The *Chromis* species and the ammodytids (sand lances) are also planktivores and often feed in groups. Hawaiian rock damselfish (*Plectroglyphidodon*) mostly feeds on algae and occasionally on invertebrates. ʻĀweoweo (*Priacanthus*) is nocturnal and feed on larger zooplankton and may school on occasion. Hawaiian morwong (*Cheilodactylus*) and Randall's pufferfish (*Torquigener*) feed on invertebrates. The monacanthids (filefishes) are omnivorous. The eggs of the damselfishes (Pomacentridae) are demersal and guarded by males until hatching. Male Whitley's boxfish are rare in Hawaiʻi. All of these fishes are 30 centimeters (one foot) or less in size except Hawaiian morwong (*Cheilodactylus*) which can reach 40 centimeters (16 inches). The species common names and Hawaiian names are *Chaetodon fremblii* (bluestriped butterflyfish, kīkākapu), *Chaetodon tinkeri* (Tinker's butterflyfish), *Prognathodes* sp. (orange-margin butterflyfish), *Apolemichthys arcuatus* (bandit angelfish), *Centropyge fisheri* (Fisher's angelfish), *Centropyge loricula* (Hawaiian flame angelfish), *Genicanthus personatus*, (masked angelfish), *Chromis hanui* (chocolate-dip chromis), *Chroims ovalis* (oval chromis), *Chromis struhsakeri* (Struhsaker's chromis), *Plectroglyphidodon sindonis* (Hawaiian rock damselfish), *Priacanthus meeki* (Hawaiian bigeye, ʻāweoweo), *Cheilodactylus vittatus* (Hawaiian morwong, kīkākapu), *Ammodytoides pylei* (Pyle's sand lance), *Lepidammodytes macrophthalamus* (no common name), *Cantherhines verecundus* (shy filefish, ʻoʻili), *Thamnaconus garretti* (no common name), *Ostracion whitleyi* (Whitley's boxfish), and *Torquigener randalli* (Randall's pufferfish).

DISTRIBUTION: Tinker's butterflyfish is found from Hawaiʻi Island through Oʻahu. Orange-margin butterflyfish and Hawaiian flame angelfish occur from French Frigate Shoals southeast through the rest of the chain. Hawaiian morwong, (ʻoʻili*),* and Randall's pufferfish occur from Oʻahu through Kure Atoll. Pyle's sand lance occurs from Maui through all of the NWHI and *Lepidammodytes* has been collected from Maui through Maro Reef. All the other species occur throughout the Hawaiian Islands.

ABUNDANCE: The shallow water species are surveyed for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources and data are available online. Masked Angelfish were not found in the main islands WCRP survey. ʻĀweoweo commercial catch has gone from over 2,270 kilograms (5,000 pounds) in the late 1990s to 950 kilograms (2,100 pounds) in 2003.

LOCATION AND CONDITION OF KEY HABITAT: All species except Tinker's butterflyfish, orange-margin butterflyfish and Struhsaker's chromis can be found in shallow water depths. Tinker's butterflyfish is found deeper than 30 meters (100 feet). Orange-margin butterflyfish and Struhsaker's chromis occurs at depths greater than 100 meters (300 feet). Hawaiian flame angelfish prefers finger coral at depths of 60 feet or more. The masked angelfish occurs only at 20 meters (60 feet) depth or greater and prefers drop offs. *Thamnaconus* occurs at least 60 meters (200 feet) deep. Chocolate-dip chromis prefer ledges, walls, or the sides of coral heads. Hawaiian rock damselfish is restricted to shallow surge zones. ʻĀweoweo are often found in caves and under ledges during the day. The sand lances occur over sandy habitats. Randall's pufferfish is found over sandy habitats usually 15 meters (50 feet) or deeper. The rest are found throughout coral reef habitats.

THREATS:

- These species are almost all prized by aquarists except for Hawaiian rock damselfish, ʻāweoweo, and Hawaiian morwong, and the ammodytids. Masked angelfish in particular command a very high price;
- ʻĀweoweo is fished recreationally and commercially.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Commercial licenses are required for aquarium collectors. In addition to common statewide and island conservation actions, specific actions include:

- Restoration of habitat;
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution;
- Support aquaculture research to develop captive breeding for species used in the aquarium trade.

References:

Gulko D. 2004. Hawaiian marine species for Endangered Species Act candidate listing, revised candidate list 2004. Honolulu, HI: Hawaiʻi Division of Aquatic Resources. 21 pp.

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Howe JC. 1993. A comparative analysis of the feeding apparatus in pomacanthids, with special emphasis of oesophageal papillae in *Genicanthus personatus.* J. Fish Biology 43(4):593-602.

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Randall JE. 1998. Shore fishes of Hawaii. Honolulu, HI: University of Hawaii Press. 216 pp.

Liopropoma aurora
Courtesy Keoki Stender

Marine Fishes

Sex Changing Reef Fishes

Serranidae

Liopropoma aurora
Pseudanthias thompsoni
Pseudogramma polyacanthum hawaiiensis

Anampses chrysocephalus male
Courtesy Keoki Stender

Labridae

Ammolabrus dicrus
Anampses chrysocephalus
Bodianus sp.
Coris flavovittata
Coris venusta
Cymolutes lecluse
Iniistius umbrilatus

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: These fishes belong to the sea bass and wrasse families. These species are all carnivorous; Hawaiian anthias (*Pseudanthias*) more on zooplankton than the others, which feed in sand or on animals in the reef matrix. Most are less than 30 centimeters (one foot) long. It is likely that all are protogynous hermaphrodites. Many have males with haremic territories. The species common names and Hawaiian names are: sunset basslet (*Liopropoma*), Hawaiian anthias (*Pseudanthias*), palespotted podge (*Pseudogramma*), sand wrasse (*Ammolabrus*), psychedelic wrasse (*Anampses chrysocephalus*), Hawaiian pigfish (*Bodianus*), yellowstripe coris (*Coris flavovittata*, hilu), elegant coris (*Coris venusta*), Hawaiian knifefish (*Cymolutes*), and blackside razorfish (*Iniistius*, lae-nihi).

DISTRIBUTION: Hawaiian anthias have been reported from Molokaʻi throughout the rest of the chain to the northwest. Palespotted podge has been found from the island of Hawaiʻi to Oʻahu. The sand wrasse has only been found off Oʻahu. Lae-nihi have only been found from the island of Hawaiʻi to Necker Island. All the other species occur throughout the Hawaiian Islands.

ABUNDANCE: The shallow water species are surveyed for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources and data are available online.

LOCATION AND CONDITION OF KEY HABITAT: All species except the sunset basslet and the Hawaiian pigfish species can be found in shallow water depths. Sunset basslets occur in deeper water, usually over 60 meters (200 feet) but sometimes to SCUBA diving depths. The undescribed species of Hawaiian Pigfish has only been found in depths greater than 140 meters (450 feet). Psychedelic wrasse terminal phase males are usually only found in depths greater than 15 meters (50 feet). Hawaiian anthias can often be found around reef ledges and drop offs while palespotted podge are more common on coral and rubble substrates. Sand wrasses, Hawaiian knifefish, and blackside razorfish spend most of their time over sandy substrates and the last two can dive into the sand to avoid predators. The rest are found throughout coral reef habitats.

THREATS:

- These species are almost all prized by aquarists except for palespotted podge, sand wrasses, and Hawaiian knifefish. Many of these species have different color phases for each sex and also juveniles, and in particular the juvenile color phases are often targeted by collectors.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Commercial licenses are required for aquarium collectors. In addition to common statewide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size;
- Support aquacultural research to develop captive breeding for species used in the aquarium trade.

References:

Gulko D. 2005. Hawaii Endemic Species Status Chart spreadsheet. Honolulu, HI: Hawaiʻi Division of Aquatic Resources.

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Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.

Marine Fishes

Cryptic Reef Fishes


Apogon maculiferus
Courtesy Keoki Stender

Apogonidae

Apogon maculiferus

Bleniidae

Cirripectes obscurus
Enchelyurus brunneolus
Entomacrodus marmoratus
Entomacrodus strasburgi
Istiblennius zebra
Plagiotremus ewaensis
Plagiotremus goslinei

Callionymidae

Callionymus caeruleonotatus
Callionymus comptus
Callionymus decoratus
Draculo pogognathus
Synchiropus hawaiiensis
Synchiropus kinmeiensis

Gobiidae

Cabillus caudimacula
Eviota rubra
Eviota susanae
Oxyurichthys heisei
Oxyurichthys lonchotus
Pleurosicya larsonae
Psilogobius mainlandi

Tripterygiidae
Enneapterygius atriceps

Antennariidae
Antennarius commerson

Caracanthidae
Caracanthus typicus

Scorpaenidae
Pterois sphex
Scorpaena pele
Scorpaenopsis altirostris
Scorpaenopsis brevifrons
Scorpaenopsis cacopsis
Scorpaenopsis pluralis

Synodontidae
Synodus falcatus
Synodus janus

SPECIES STATUS:
IUCN Red List – Not considered
All Endemic except *Antennarius*

SPECIES INFORMATION: These are mostly small (less than 18 centimeters or seven inches) site-attached reef fishes. Decorated dragonets (*Callionymus decoratus*) reach 28 centimeters (eleven inches) in length as does Commerson's frogfish (*Antennarius*), and some of the scorpionfishes are also large. ʻUpāpalu (*Apogon*) is a zooplanktivore. The blennies mostly feed on algae except for the *Plagiotremus* species which feed on mucus and skin tissue of other fishes. The callionymids (dragonets) and gobies are carnivorous on small invertebrates. The Hawaiian triplefin (*Enneapterygius*) is omnivorous. Commerson's frogfish (*Antennarius*) is a sit-and-wait predator using a modifield dorsal fin spine as a fishing lure. The scorpionfishes (Scorpaenidae) and lizardfishes (Synodontidae) are ambush predators of fishes and invertebrates. ʻUpāpalu (*Apogon*) males brood young in their mouths until hatching. Male blennies and gobies of most species guard demersal eggs until hatching. Mainland's goby (*Psilogobius*) lives in commensal burrows with an alpheid shrimp and *Oxyurichthys lonchotus* may do the same. Hawaiian orbicular velvetfish (*Caracanthus*) may be a protogynous hermaphrodite. The species common names and Hawaiian names are: *Apogon maculiferus* (spotted cardinalfish, ʻupāpalu), *Cirrepecetes obscurus* (gargantuan blenny, paoʻo), *Enchelyurus brunneolus* (no common name), *Entomacrodus marmoratus* (marbled blenny, paoʻo), *Entomacrodus strasburgi* (Strasburg's blenny), *Istiblennius zebra* (zebra blenny, paoʻo), *Plagiotremus ewaensis* (Ewa blenny), *Plagiotremus goslinei* (scale-eating blenny), *Callionymus caeruleonotatus* (bluespotted dragonet), *Callionymus comptus* (ornamented dragonet), *Callionymus decoratus* (longtail dragonet), *Draculo pogognathus* (no common name), *Synchiropus hawaiiensis* (no common name), *Synchiropus kinmeiensis* (no common name), *Cabillus caudimacula* (no common name), *Eviota rubra* (no common name), *Eviota susanae* (no common name), *Oxyurichthys heisei* (ribbon goby), *Oxyurichthys lonchotus* (no common name), *Pleurosicya larsonae* (no common name), *Psilogobius mainlandi* (Mainland's goby), *Enneapterygius atriceps* (Hawaiian Triplefin), *Antennarius commerson* (Commerson's frogfish), *Caracanthus typicus* (Hawaiian orbicular velvetfish), *Pterois sphex* (Hawaiian turkeyfish, nohu pinao), *Scorpaena pele* (no common name), *Scorpaenopsis altirostris* (no common name), *Scorpaenopsis brevifrons* (shortnose scorpionfish), *Scorpaenopsis cacopsis* (titan scorpionfish, nohu), *Scorpaenopsis pluralis* (no common name), *Synodus falcatus* (no common name), and *Synodus janus* (no common name). *Synchiropus hawaiiensis* and *Synchiropus kinmeiensis* may be the same species. Bruce Mundy (National Marine Fisheries Service (NMFS)) reports that Jack Randall (Bishop Museum) will publish a manuscript reporting that *S. janus* is a junior synonym of *S. falcatus* so these are probably just a single species.

DISTRIBUTION: *Enchelyurus* occurs from Oʻahu to Lisianski. *Entomacrodus strasburgi* occurs from Molokaʻi to Oʻahu. Zebra blennies occur from Hawaiʻi Island to Lisianski. The scale-eating blenny occurs from the island of Hawaiʻi to Pearl and Hermes Atoll. Bluespotted dragonets occur in the main islands only. Ornameneted dragonet, Mainland's goby, and *Scorpaena pele* have been found from Maui to Oʻahu. The longtail dragonet is found from Maui to Pearl and Hermes Atoll. *Draculo* has been found from Molokaʻi to Kauaʻi. *Synchiropus hawaiiensis* has been found from Maui to Molokaʻi. *Synchiropus kinmeiensis* has been collected from Maro Reef through Kure Atoll and the Emperor Seamounts. *Cabillus,* the two *Eviota* species, and *Pleurosicya* have only been found off Oʻahu. The ribbon goby is found off Lānaʻi and Molokaʻi. *Oxyurichthys lonchotus* has been collected from Hawaiʻi Island to Oʻahu. Hawaiian orbicular velvetfish have been found from Oʻahu through Midway Atoll. *Scorpaenopsis altirostris* is found from the island of Hawaiʻi to Molokaʻi. *Scorpaenopsis pluralis* is known only from the holotype from near Laysan. *Synodus falcatus* has been found from Molokaʻi through Laysan Island. *Synodus janus* is only known from the holotype collected off the island of Hawaiʻi. All the other species occur throughout the Hawaiian Islands.

ABUNDANCE: The shallow water species are surveyed for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands (NMWHI), both by NMFS and the Division of Aquatic Resources and data are available online. Nohu pinao (Hawaiian turkeyfish) and titan scorpionfish may have declined from historic levels and a few hundred pounds of titan scorpionfish are reported in State commercial catch data each year.

LOCATION AND CONDITION OF KEY HABITAT: All species except bluespotted dragonet, the two *Synchiropus* species, ribbon goby, *Synodus falcatus, Scorpaena pele,* and *Scorpaenopsis altirostris* can be found in shallow water depths. *Callionymus coeruleonotatus* is found in depths over 45 meters (150 feet), *Oxyurichthys heisei,* the *Synchiropus species* and *Scorpaenopsis altirostris* and *Scorpaenopsis pluralis* occur over 90 meters (300 feet) deep, *S. falcatus* has only been found in depths greater than 30 meters (100 feet), and *Scorpaena pele* has been found deeper than 150 meters (500 feet). ʻUpāpalu (spotted cardinalfish) occurs in caves during the day and feeds nocturnally over a wider area. The gargantuan blenny lives on rocky shores exposed to wave action. Zebra blennies and the *Entomacrodus* species live in shallow, rocky surge zones and can even leap from pool to pool. *Enchelyurus* occupies dead coral heads. Most callionymids, *Cabillus*, *Oxyurichthys lonchotus,* and the lizardfishes occur in sandy or muddy habitats. The two *Eviota* species have been found around Kāneʻohe Bay, *E. rubra* from deeper spur and groove and *E. susanae* from shallow waters inside the bay. The Hawaiian orbicular velvetfish occurs among the branches of live coral. The scorpionfishes are often found hidden or under ledges. The rest are found throughout coral reef habitats.

THREATS:

- Only a few of these species are prized by aquarists. These are gargantuan blenny, zebra blenny, Commerson's frogfish, Hawaiian orbicular velvetfish, and nohu pinao *(*Hawaiian turkeyfish);
- Titan scorpionfish are fished commercially and recreationally;
- Many species have restricted ranges within the State (see above).

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Commercial licenses are required for aquarium collectors. In addition to common statewide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size;
- Support aquaculture research to develop captive breeding for species used in the aquarium trade.

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Etelis coruscans
Courtesy Keoki Stender

Marine Fishes

Bottomfishes

Ulua aukea or Giant ulua
Caranx ignobilis

Black ulua
Caranx lugubris

Butaguchi or Thick or Pig ulua
Pseudocaranx dentex

Kahala or Amberjack
Seriola dumerii

Giant grouper
Epinephelus lanceolatus

Hāpuʻu or Hawaiian grouper
Epinephelus quernus

Lehi
Aphareus rutilans

Uku or Jobfish
Aprion virescens

Ulaʻula or Ehu
Etelis carbunculus


Epinephelus quernus
Courtesy Keoki Stender

Ulaʻula koaʻe or Onaga
Etelis coruscans

Goldflag jobfish
Pristipomoides auricilla

Opakapaka
Pristipomoides filamentosus

Kalekale
Pristipomoides seiboldii

Ukikiki or Gindai
Pristipomoides zonatus

SPECIES STATUS:
IUCN Red List – Vulnerable (giant grouper)
Near Threatened (Hawaiian grouper)
Others Not considered

SPECIES INFORMATION: Ulua aukea, black ulua, butaguchi, and kahala are jacks (Lutjanidae); the giant grouper and hāpuʻu are sea basses (Serranidae); and onaga, ehu, kalekale, opakapaka, gindai, goldflag jobfish, lehi, and uku are snappers (Lutjanidae). All of these bottomfishes are included in the Western Pacific Regional Fisheries Management Council's (WPRFMC) Bottomfish and Seamount Fisheries Management Plan. This plan also includes the snapper *Lutjanus kasmira* or taʻape; however, this is an introduced species in Hawaiʻi and thus is not included in our Species of Greatest Conservation Need list. All jacks are agile, strong swimming predators. The ulua aukea is a "near-apex" predator that feeds on a large array of prey including parrotfishes, ʻōpelu, wrasses, big eyes, eels, cephalopods, and crustaceans. They primarily feed nocturnally, but may also feed to a lesser extent during the day. Black ulua feed primarily on fish, while kahala feed on octopus and other bottom dwelling prey in the Northwestern Hawaiian Islands and feed within the water column in the Main Hawaiian Islands. Groupers are ambush predators of other fishes and crustaceans. Snappers also are carnivorous and their diets consist primarily of fishes, crustaceans and cephalopods. Some species such as the kalekale, opakapaka, and onaga have a broader diet. Onaga feed close to the bottom and are morning feeders as are the ehu. Opakapaka are nocturnal feeders and uku are daytime feeders. Most bottomfishes are slow-growing and long-lived; however, the jacks are relatively fast growing. Female ulua aukea and kahala are reproductive at four years of age. Male and female ulua aukea spawn in pairs. Spawning occurs during new and full moon periods, and peaks in summer from May to August. Kahala spawn from February to June. More than one clutch may be produced in a year for both ulua aukea and kahala. Ulua aukea eggs hatch 24 to 48 hours after spawning and larvae are pelagic. Juvenile ulua aukea can recruit into estuaries and can be found in areas with salinities as low as 1.5 parts per thousand. Groupers are often protogynous hermaphrodites, starting life as female and changing sex to male later in life. For most snappers, maximum spawning occurs during the summer months and peaks from July to August. Opakapaka, onaga, uhu and uku, however, may spawn "serially" over an extended time period. Ehu have the shortest and most defined spawning period lasting from July to September. Snapper eggs are small and pelagic, hatching 17 to 36 hours after spawning. Larvae are estimated to remain in pelagic waters from 25 to 47 days. These species range in size from the kalekale that reaches a maximum of 55 centimeters (two feet) to the giant grouper that can reach 2.7 meters (nine feet).

DISTRIBUTION: All species can be found throughout the State, although they are currently much rarer, especially the giant grouper. Ulua aukea are more abundant and larger in the Northwestern Hawaiian Islands (NWHI). Butaguchi are also more common in the NWHI.

ABUNDANCE: Ulua are looked for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration (NOAA) and the Division of Aquatic Resources (DAR). Commercial landings have varied over the past few years for ulua aukea and black ulua, but show no overall decrease, though longer-term declines have occurred. From 1999 to 2003, ulua aukea landings range from a low of approximately 2,700 kilograms (6,000 pounds) in 2000 to a high of 5,000 kilograms (11,000 pounds) in 2003. black ulua landings range from a low of approximately 120 kilograms (260 pounds) in 1998 to a high of 680 kilograms (1,500 pounds) in 2003. Butaguchi landings are highly variable but average around 13,600 kilograms (30,000 pounds) per year with no declining trend. Kahala commercial landings also have varied but have shown a decrease from 2000 to 2003 with landings of approximately 6,600 kilograms (14,500 pounds) and 2,540 kilograms (5,600 pounds), respectively.

Groupers also are looked for in surveys of coral reef fishes in the MHI and NWHI, both by NOAA and DAR. A recent survey in shallow reefs of the main islands found no individuals of either grouper species. Commercial landings in recent years have been about 18,000 kilograms (40,000 pounds) a year for the hāpuʻu. Overall landings in the past few years are lower in the main islands and the Hoomalu zone. Catch Per Unit Effort (CPUE) has been decreasing for the past 40 years in the main islands. Size of fish caught in the main islands is 30 to 40 percent less than those caught in the NWHI.

Commercial landings in recent years have been about 2,270 kilograms (5,000 pounds) a year for gindai. Uku landings have varied from approximately 53,500 kilograms (118,000 pounds) in 1998 to 50,800 kilograms (112,000 pounds) in 2001 to 61,700 kilograms (136,000 pounds) in 2003. Other species have shown declines in commercial catch. Opakapaka commercial landings have decreased each year for the past six years from 102,500 kilograms (226,000 pounds) in 1998 to 60,300 kilograms (133,000 pounds) in 2003. Ehu landings have gone from approximately 18,100 kilograms (40,000 pounds) 1998 to 10,900 kilograms (24,000 pounds) in 2003. Lehi and kalekale landings have been declining since 2000, although less dramatically. Onaga and goldflag jobfish values were not recorded over this time period by DAR. Over the last 40 to 50 years partial CPUE's for onaga, ehu and hāpuʻu has been reduced to half of what is was.

LOCATION AND CONDITION OF KEY HABITAT: Jacks have a variety of habitat preferences. Ulua aukea key habitat includes all nearshore habitats from rocky shores to embayments and reefs. They also occur in deeper waters up to 100 meters (300 feet) deep. Shallow waters over reefs and open waters are key foraging habitats. Juveniles prefer protected habitats such as sand flats and lagoons; however, many juveniles also utilize estuaries, although they are not "estuarine-dependent." Black ulua key habitat is off reef slopes in waters deeper than 30 meters (100 feet). Butaguchi occur in deep waters around the MHI and prefer banks and deep slopes. Key foraging grounds are near the bottom of deeper waters. Kahala inhabit areas with a large range of depth from nearshore to waters over 350 meters (1,100 feet). Hāpuʻu were probably historically found in shallower water but are now are only found in water deeper than 100 meters (300 feet) in the Main Hawaiian Islands with occasional sightings of juveniles in diving depths. In the NWHI, juveniles and adults have been seen as shallow as five meters (15 feet). Giant grouper are usually found from 12 meters to 60 meters (40 to 200 feet) deep. They can often be found in caves or overhangs. Most snappers inhabit intermediate to deep waters ranging anywhere from 30 meters to 4,570 meters (100 feet to 15,000 feet). Specifically, they prefer areas of high relief and deep slope with hard substrates and complex structures. Uku, however, are found in shallower waters than any of the other snappers. Opakapaka are known to migrate to shallower waters from 30 to 80 meters (100 to 250 feet) at night. Onaga often prefer areas close to or on the bottom of vertical drop-offs, pinnacles and ledges. Key habitat for juvenile snappers varies. Juvenile opakapaka, onaga and lehu prefer flat areas of shallower waters with few features, while ehu juveniles prefer habitats with carbonate, basalt, or mudstone substrate.

THREATS:

- Localized heavy fishing pressure threatens these bottomfishes. All jacks are fished commercially and recreationally; however, kahala is not of high commercial value due to its toxicity from ciguatoxin. Ulua aukea are also fished for subsistence by Native Hawaiians. Ulua aukea populations in the Main Hawaiian Islands are documented as depressed. Hāpuʻu are fished commercially and recreationally, while giant grouper are too rare to be targeted commercially. Size of groupers caught in the Main Hawaiian Islands (MHI) is about half that of those caught in the less-intensively fished NWHI. The protogynous sex-change in this family makes them particularly vulnerable to fishing pressure. All eight snapper species also are fished commercially and recreationally; however, the gindai is not a considerable part of the commercial bottomfish fishery. Ehu and onaga are considered locally depleted in the MHI, while all bottomfish populations are considered "relatively healthy" in the NWHI. Additionally, NMFS recently made a declaration of "overfishing" for all of Hawaii's bottomfish;
- Additionally, coastal water quality may negatively affect uluas, especially juveniles that spend time in estuaries;
- Global climate change has been suggested to affect their abundance and their prey.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Since 1998, seven species of bottomfish have been managed by DAR under special Hawaiʻi

Administrative Rule 13-94. The rule limits fishing to hand lines only and establishes zones where bottomfishing is prohibited. Kahoʻolawe has its own fishing regulations. In the NWHI, the bottomfish are managed under the WPRFMC Bottomfish Fishery Management Plan, which limits fishing there. Additionally, in response to NMFS declaration of "overfishing" for Hawaii's bottomfish, the WPRFMC has resolved to review a variety of different management alternatives and will probably decide to take action on these at their meeting in March 2006. In addition to common statewide and island conservation actions, specific actions include:

- Collaborate with the Western Pacific Regional Fisheries Management Council to decrease fishing effort in response to the declaration by NMFS of "overfishing" for Hawaii's bottomfish;
- Increase and improve data gathering on recreational bottomfish fishery;
- Consider increasing the number or location of Marine Protected Areas to protect bottomfishes;
- Improve coastal water quality to protect juvenile habitat;
- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting population size and basic ecology and biology of these species.

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Marine Fishes

Ijimaia plicatellus
Courtesy Chris Kelley

Deep Fishes

Ateleopodiformes

Ijimaia plicatellus

Beryciformes

Aulotrachichthys heptalepis

Gadiformes

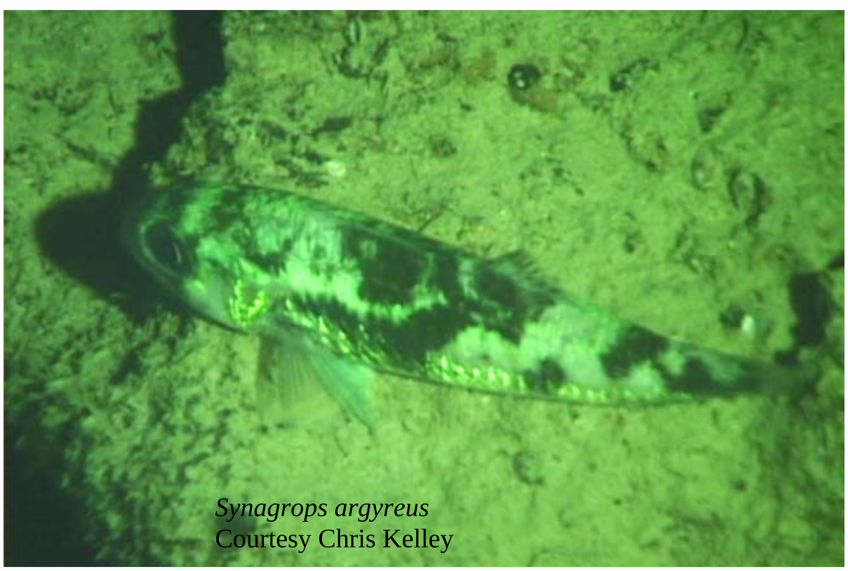
Caelorinchus doryssus
Caelorinchus gladius
Hymenocephalus antraeus
Hymenocephalus tenuis
Kumba hebetata
Malacocephalus hawaiiensis
Nezumia ectenes
Nezumia holocentra
Sphagemacrurus gibber
Ventrifossa ctenomelas
Gadella molokaiensis
Physiculus sterops
Bathygadus bowersi

Gonorynchiformes

Gonorynchus moseleyi

Lophiiformes

Halieutaea retifera
Linophryne escaramosa
Lophiodes bruchius
Solocisquama erythrina



Synagrops argyreus
Courtesy Chris Kelley

Ophidiiformes

Luciobrotula lineata
Pycnocraspedum armatum
Cataetyx hawaiiensis
Grammonus waikiki
Microbrotula rubra
Saccogaster hawaii

Osmeriformes

Glossanodon struhsakeri

Perciformes

Champsodon fimbriatus
Epigonus devaneyi
Epigonus glossodontus
Osopsaron incisum
Synagrops argyreus

Squaliformes

Etmopterus villosus

Stomiiformes

Araiophos gracilis
Argyripnus brocki
Eustomias albibulbus
Eustomias bulbiramis
Eustomias magnificus

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: Deep fishes usually live on soft sediment substrates and feed on fishes and invertebrates in or above those sediments. The grenadiers (gadiformes) are elongate fishes with tails that end in a point. The lophiiformes use a modified dorsal fin spine as a lure to catch prey. Males are permanent parasites of females in *Linophryne*. The bythitids (last four Ophidiiformes) are live-bearers. Struhsaker's deep-sea smelt (*Glossanodon*) is a midwater pelagic planktivore. *Champsodon* is also a vertically migrating and schooling predator. The stomiiformes have bioluminescent organs. The *Eustomias* species are mesopelagic and vertically migrate diurnally. None of the species have Hawaiian names and only some have common names. The species with common names are: *Ijimaia plicatellus* (deep water ateleopid), *Caelorinchus doryssus* (spear-nosed grenadier), *Caelorinchus gladius* (sharp-snouted grenadier), *Hymenocephalus antraeus* (common big-eyed grenadier), *Hymenocephalus tenuis* (slender grenadier), *Kumba hebetate* (dull grenadier), *Malacocephalus hawaiiensis* (Hawaiian softhead grenadier), *Nezumia ectenes* (elongated grenadier), *Nezumia holocentra* (Cramer's grenadier), *Sphagemacrurus gibber* (humped grenadier), *Ventrifossa ctenomelas* (Hawaiian grenadier), *Bathygadus bowersi* (Bower's grenadier), *Gonorynchus moseleyi* (beaked salmon), *Halieutaea retifera* (net bat fish), *Solocisquama* (red bat fish), *Glossanodon* (Struhsaker's deep-sea smelt), *Champsodon fimbriatus* (fringed champsodontid), *Etmopterus* (Hawaiian lanternshark), and *Argyripnus brocki* (Brock's bristlemouth).

DISTRIBUTION: *Ijimaia,* common big-eyed grenadier, *Physiculus*, *Pycnocraspedum, Epigoinus glossodontus* and *Argyripnus* have been found from the island of Hawaiʻi to Oʻahu. *Aulotrachichthys* has been found from Maui to Maro Reef. The spear-nosed grenadier has been found from Maui through the Northwestern Hawaiian Islands (NWHI). The sharp-snouted grenadier and *Ventrifossa* are found in the Main Hawaiian Islands (MHI). The slender grenadier, dull grenadier, elongated grenadier, and *Linophryne* are known only from holotypes collected off Oʻahu; and Cramer's grenadier, *Grammonus, Microbrotula, Saccogaster*, and the *Eustomias* species have also only been collected off Oʻahu. The Hawaiian softhead grenadier and the humped grenadier are found from the island of Hawaiʻi to French Frigate Shoals. Bower's grenadier is found from Kauaʻi to French Frigate Shoals. Beaked salmon have been collected from Maui to Oʻahu. *Lophiodes* is found from Maui to Necker Island. Red bat fish are found from Maui to Kauaʻi. *Luciobrotula* and *Cataetyx* are known only from the island of Hawaiʻi. *Epigonius devaneyi* has been found from Necker Island to Maro Reef. *Osopsaron* occurs from Maui to Laysan Island. *Synagrops* occurs from the island of Hawaiʻi to Laysan Island. *Araiophos* is known from the island of Hawaiʻi to St. Rogatien Bank. All the other species occur throughout the Hawaiian Islands.

ABUNDANCE: Little abundance data appears to exist for these species and trends are unknown. The common big-eyed grenadier is the most common macrourid.

LOCATION AND CONDITION OF KEY HABITAT: All species except *Aulotrachichthys*, *Physiculus*, beaked salmon, Net bat fish, *Grammonus*, *Microbrotula, Epigonius devaneyi, Araiophos,* and Brock's bristlemouth can be found in water depths greater than 300 meters (1,000 feet). *Aulotrachichthys* is found from 45 to 275 meters (150 to 900 feet) deep. *Physiculus*, net bat fish and *Epigonius devaneyi* are found from about 100 to 300 meters (300 to 1,000 feet) deep. Beaked salmon are found from 110 to 180 meters (350 to 600 feet) deep. *Grammonus* and *Microbrotula* are known from a few specimens caught in shallow reef habitat. *Araiophos*, *Eustomias albibulbus* and *Eustmoais bulbiramis* have been collected from the surface to 400 meters (1,300 feet) deep. *Eustomias magnificus* has been collected from the surface to 1,800 meters (6,000 feet). Brock's bristlemouth has been collected from 180 to 300 meters (600 to 1,000 feet) deep. *Ijimaia* can be found as shallow as 240 meters (800 feet) as well as deeper than 300 meters (1,000 feet). *Gadella* and Struhsaker's deep-sea smelt can also be found as shallow as 180 meters (600 feet). *Gadella* can be found in rocky crevices. *Synagrops* can be found as shallow as 75 meters (250 feet) deep.

THREATS: Deep offshore aquaculture may become a threat in the future.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:

- Maintenance of habitat.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size.

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Flatfishes

Bothidae

Bothus thompsoni
Engyprosopon hawaiiensis
Engyprosopon xenandrus
Parabothus chlorospilus
Taeniopsetta radula

Pleuronectidae

Poecilopsetta hawaiiensis

Samaridae

Samariscus corallinus

Soleidae

Aseraggodes borehami
Aseraggodes holcomi
Aseraggodes therese

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: Flatfishes usually live on soft sediment substrates and feed on fishes and invertebrates in those sediments. None of these species has a Hawaiian name. The species common names are: *Bothus thompsoni* (Thompson's flounder), *Engyprosopon hawaiiensis* (no common name), *Engyprosopon xenadrus* (Gilbert's small flounder), *Parabothus chlorospilus* (green-spotted flounder), *Taeniopsetta radula* (round-bodied flounder), *Poecilopsetta hawaiiensis* (no common name), *Samariscus corallinus* (coralline-red flounder), *Aseraggodes borehami* (Boreham's sole), *Aseraggodes holcomi* (no common name), and *Aseraggodes therese* (Therese's sole).

DISTRIBUTION: Thompson's flounder occurs from Maui to Maro Reef. Gilbert's small flounder and the round-bodied flounder occur from the island of Hawai'i to Laysan Island. The coralline-red flounder occurs from Moloka'i to Maro Reef. Boreham's sole has been found from the island of Hawaiʻi to Oʻahu. *Aseraggodes holcomi* has only been collected off Oʻahu. All the other species occur throughout the Hawaiian Islands.

ABUNDANCE: Little abundance data appears to exist for these species.

LOCATION AND CONDITION OF KEY HABITAT: All species except Thompson's flounder, green-spotted flounder, round-bodied flounder, *Poecilopsetta,* and the coralline-red flounder can be found in shallow water depths. Thompson's flounder, round-bodied flounder, *Poecilopsetta,* and the coralline-red flounder are found in depths over 80 meters (250 feet), and the green-spotted flounder is found in depths over 120 meters (400 feet). These fishes live on soft sediment substrates though the coralline-red flounder has been found on live sponge bottoms and Therese's sole has been found over reef and rubble.

THREATS: None identified.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:

- Restoration of habitat;
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size.

References:

Mundy B. In press. A checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletin of Zoology, B. P. Bishop Museum Press. 1340 ms. pages.

Randall JE. 1998. Shore fishes of Hawaii. Honolulu, HI: University of Hawaii Press. 216 pp.

Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.


Atherinomorus insularum
Courtesy Keoki Stender

Marine Fishes

Hawaiian surf sardine
Iso hawaiiensis

‘Iao or Hawaiian silverside
Atherinomorus insularum

Nehu or Hawaiian anchovy
Encrasicolina purpurea

SPECIES STATUS:
IUCN Red List – Not Considered
Endemic

SPECIES INFORMATION: These are all relatively small, silvery, schooling planktivores. ‘Iao and Hawaiian surf sardines are athereinids that attach their eggs by filaments to aquatic plants. Nehu (Hawaiian anchovy) lay oval, floating eggs that hatch in a couple of days.

DISTRIBUTION: They are found throughout the State.

ABUNDANCE: ‘Iao are looked for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands by the National Oceanic and Atmospheric Administration. The others are not formally surveyed. There is little quantitative evidence of decline.

LOCATION AND CONDITION OF KEY HABITAT: They all occur in shallow water near the shoreline. Nehu especially can also be found in estuaries.

THREATS:
- They are fished commercially and recreationally;
- Introduced baitfish species may compete with the native species for resources;
- Coastal water quality may also be a threat in many areas but needs research.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Regulations set maximum catch at one gallon (four liters) for Nehu and nets over 50 feet (15 meters) are allowed only for commercial fishers. In addition to common statewide and island conservation actions, specific actions include:

- Restoration of habitat;
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Continue and expand surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size.

References:

Gulko D. 2005. Hawaii Endemic Species Status Chart spreadsheet. Honolulu, HI: Hawai‘i Division of Aquatic Resources.

Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.

Calotomus zonarchus male
Courtesy Keoki Stender

Marine Fishes

Spectacled parrotfish
Uhu
Chlorurus perspicillatus

Yellowbar parrotfish
Uhu
Calotomus zonarchus

SPECIES STATUS:
IUCN Red List – Not considered
Endemic, except spectacled parrotfish which also occurs at Johnston Atoll

SPECIES INFORMATION: These species are herbivorous and reach over 30 centimeters (one foot) in length. They are protogynous hermaphrodites. Terminal phase males maintain haremic territories. These species have relatively fast growth and maturity. They graze algae from rock and coral surfaces. Young can sometimes be aggregated.

DISTRIBUTION: Spectacled parrotfish occur throughout the State. Yellowbar parrotfish occur from O'ahu and northwest throughout the Northwestern Hawaiian Islands.

ABUNDANCE: They are surveyed for in surveys of coral reef fishes in the Main and NWHI, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources and available online. Spectacled parrotfish numbers have declined in the populated areas of the main islands.

LOCATION AND CONDITION OF KEY HABITAT: Both species occur in coral reef areas. Spectacled parrotfish occur from the surface to over 60 meters (200 feet) deep, while yellowbar parrotfish only occur deeper than ten meters (35 feet).

THREATS:
- They are fished commercially and recreationally. They are sensitive to night-time spear fishing because members of this family rest at night in exposed reef crevices protected by a thin mucus covering they produce across the opening to the crevice.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Regulations set minimum catch size at 12 inches (30 centimeters). In addition to common statewide and island conservation actions, specific actions include:
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size.

References:

Gulko D. 2004. Hawaiian marine species for Endangered Species Act candidate listing, revised candidate list 2004. Honolulu, HI: Hawai'i Division of Aquatic Resources. 21 pp.

Gulko D. 2005. Hawai'i Endemic Species Status Chart spreadsheet. Honolulu, HI: Hawai'i Division of Aquatic Resources.

Hoover J. 1993. Hawaii's fishes. Honolulu, HI: Mutual Publishing. 183 pp.

Mundy B. In press. A checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletin of Zoology, B. P. Bishop Museum Press. 1340 ms. pages.

Randall JE. 1998. Shore fishes of Hawaii. Honolulu, HI: University of Hawaii Press. 216 pp.

Marine Fishes

Hawaiian sea moth
Eurypegasus papilio

Ball's pipefish
Cosmocampus balli

Redstripe pipefish
Doryrhampus baldwini

Edmondson's pipefish
Halicampus edmondsoni

Fisher's seahorse
Hippocampus fisheri

Spiny seahorse
Hippocampus histrix

Yellow seahorse
Hippocampus kuda

SPECIES STATUS:
IUCN Red List – Not considered except:
Hippocampus fisheri and *H. histrix*, and *Eurypegasus* listed as Data Deficient
H. kuda listed as vulnerable
All Endemic except *Hippocampus histrix* and *H. kuda*

SPECIES INFORMATION: These species all share a body structure made of bony rings. The pipefishes and seahorses have sex-role reversal where the males accept and guard eggs in internal pouches or on their skin until the young hatch. This takes from ten to 50 days. They are predators that feed mostly on small crustaceans. The Hawaiian sea moth is a deeper water species. Redstripe pipefish often occur in small groups of mixed age. They have also been observed cleaning other fishes. Fisher’s seahorse is apparently pelagic, attaching to floating algae. All species are less than 30 centimeters (one foot) in length and mostly half of that.

DISTRIBUTION: Hawaiian sea moths and Edmondson’s pipefish are found statewide. Ball’s pipefish has been found from O‘ahu to Kaua‘i. The redstripe pipefish has only been found from the island of Hawai‘i to O‘ahu. Fisher’s seahorse is found from Maui to the island of Hawai‘i but may be more widespread. The spiny seahorse is only known from a specimen from Maui. The Yellow seahorse is found in the main islands and up to Necker Island.

ABUNDANCE: These species (except the deep Hawaiian sea moths) are looked for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources. A recent survey in the main islands found that seahorses and pipefishes were rare.

LOCATION AND CONDITION OF KEY HABITAT: Seahorses use plants to anchor themselves by their tails. Pipefishes often use the area under ledges. They all occur in moderately shallow water, except the sea moth which occurs in water over 60 meters (200 feet) deep, often in algal beds. Juvenile Hawaiian sea moths can be found in shallow water. Edmondson’s pipefish can often be found in tidepools. The Yellow seahorse can be found in brackish waters.

THREATS:
- These species are prized by aquarists, and seahorses are used in some Asian cultures for medicinal and other purposes. Aquaculture research collection may also be a threat.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Seahorses are listed in CITES Appendix II and pipefishes are being considered for such protection. Commercial licenses are required for aquarium collectors.   In addition to common state-wide and island conservation actions, specific actions include:
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:
- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:
- Improve understanding of factors affecting the species population size;
- Support aquacultural research to develop captive breeding for species used in the aquarium trade.

References:
Gulko D. 2004. Hawaiian marine species for Endangered Species Act candidate listing, revised candidate list 2004. Honolulu, HI: Hawai‘i Division of Aquatic Resources. 21 pp.

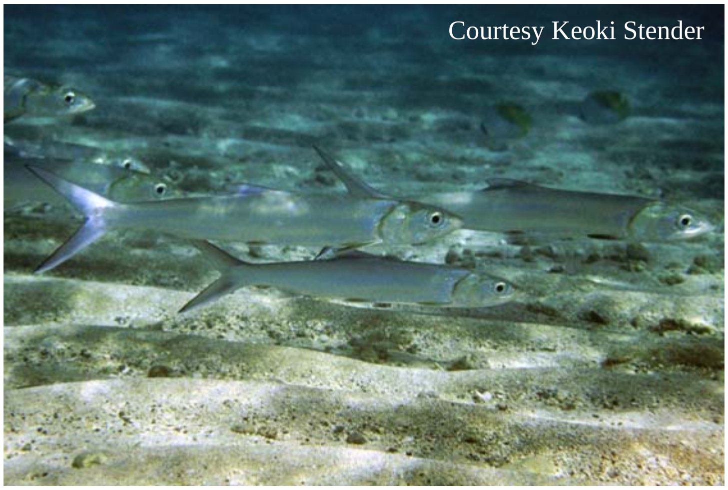
Gulko D. 2005. Hawai‘i Endemic Species Status Chart spreadsheet. Honolulu, HI: Hawai‘i Division of Aquatic Resources.

Hoover J. 1993. Hawaii’s fishes. Honolulu, HI: Mutual Publishing. 183 pp.

International Union for the Conservation of Nature and Natural Resources. [Internet] Threatened Red List. Available from: http://www.redlist.org/search/search-expert.php (Accessed May 2005).

Mundy B. In press. A checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletin of Zoology, B. P. Bishop Museum Press. 1340 ms. pages.

Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.



Marine Fishes

Hawaiian ladyfish
Awaʻaua

Elops hawaiensis

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: The awaʻaua is one of the most primitive bony fish. They are often confused with mullet. Spawning takes place offshore. The larvae are leptocephalus (eel-like) and as they develop they move into inshore waters and can be found in tidal streams, salt water marshes, and canals. It feeds on fishes and crustaceans. They swim in schools. They are noted for their hard-fighting nature when caught.

DISTRIBUTION: Found throughout the State and especially common at Hanauma Bay, Oʻahu.

ABUNDANCE: Commercial landings in the Main Hawaiian Islands have been about 225 kilograms (500 pounds) a year in recent years. No other abundance data are available.

LOCATION AND CONDITION OF KEY HABITAT: Awaʻaua prefer shallow waters around the shoreline or shallow protected waters over sandy or silty bottoms. They may also be found in brackish water as well as fish ponds.

THREATS:
- Localized heavy fishing pressure and susceptibility to nearshore pollution and runoff.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:
- Restoration of habitat through reduction in pollution;
- Restore healthy populations with appropriate fishing regulations and education.

MONITORING:
- Survey populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:
- Improve understanding of factors affecting population size, ecology, and basic biology of this species.

References:
Fishbase. [Internet] online data. http://fishbase.sinica.edu.tw/Summary/SpeciesSummary .cfm?genusname =Elops&speciesname=hawaiensis (accessed May 2005).

Hoover J. 1993. Hawaii’s fishes. Honolulu, HI: Mutual Publishing. 183 pp.

Randall JE. 1998. Shore fishes of Hawaii. Honolulu, HI: University of Hawaii Press. 216 pp.

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Western Pacific Fishery Information Network. online data. Available from: http://www.pifsc.noaa.gov/wpacfin/ (accessed May 2005).


Courtesy Keoki Stender

Marine Fishes

Hawaiian flagtail
Āholehole
Kuhlia xenura

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: Āholehole in Hawaiʻi used to be considered a single species in the species *Kuhlia sandvicensis* but have recently been determined to be two species. One of those species is endemic and thus qualifies under the CWCS criteria. This is *K. xenura,* sometimes now called the big eyed mullet. They reach about nine inches in length. They may be found in schools. They are planktivores, primarily nocturnally. They facultatively use streams as well. When in streams they feed on fishes, invertebrates, and insects.

DISTRIBUTION: They are found throughout the State.

ABUNDANCE: They are looked for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources. Commercial landings for both *Kuhlia* spp. in the Main Hawaiian Islands have averaged about 1,350 kilograms (3,000 pounds) a year in recent years, except there was a decrease to less than 900 kilograms (2,000 pounds) in 2003, the most recent year of data.

LOCATION AND CONDITION OF KEY HABITAT: Young *K. xenura* can be found in shallow water along the coast and in tide pools and estuaries, where this species is denser than *K. sandvicensis*, which prefers higher salinity. Adults are found along the outer edge of the reefs. They can often be found in areas of high surge. At night they spread out to feed on plankton.

THREATS:
- They are fished commercially and recreationally;
- Historically they were important in Native Hawaiian religious ceremonies.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Regulations set minimum catch size at five inches. In addition to common statewide and island conservation actions, specific actions include:
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:
- Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size.

References:

Benson, Lori. Personal communication.

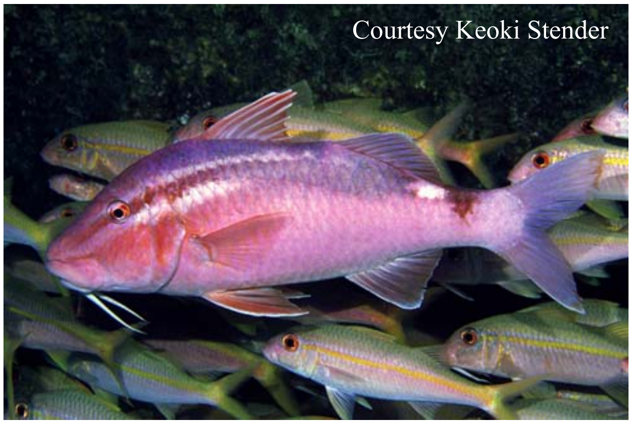
Benson LK, Fitzsimons JM. 2002. Life history of the Hawaiian fish *Kuhlia sandvicensis* as inferred from daily growth rings of otoliths. Environmental Biology of Fishes. 65(2):131-137.

Hawaiʻi Division of Aquatic Resources, State of Hawaii. Commercial marine landings data. 1997 – 2003. Honolulu, HI: Division of Aquatic Resources.

Hoover J. 1993. Hawaii's fishes. Honolulu, HI: Mutual Publishing. 183 pp.

Mundy B. In press. A checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletin of Zoology, B. P. Bishop Museum Press. 1340 ms. pages.

Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.



Marine Fishes

Whitesaddled goatfish
Kūmū

Paurupeneus porphyreus

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: Kūmū are goatfish that feed on invertebrates in the sediments around reefs. They reach about 38 centimeters (15 inches) in length. They may be found in schools during the day.

DISTRIBUTION: They are found throughout the State.

ABUNDANCE: They are looked for in surveys of coral reef fishes in the Main and Northwestern Hawaiian Islands, both by the National Oceanic and Atmospheric Administration and the Division of Aquatic Resources. Commercial landings in the Main Hawaiian Islands have dropped from about 1,800 to 2,300 kilograms (4,000 to 5,000 pounds) a year to 1,040 kilograms (2,300 pounds) in 2003, the most recent year of data.

LOCATION AND CONDITION OF KEY HABITAT: Young are common in shallow water in the summer. Adults can be found throughout reef habitats.

THREATS:
- They are fished commercially and recreationally. In traditional Native Hawaiian culture they were sometimes substituted for pigs when certain offerings were called for. They could only be consumed by men.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Regulations set minimum catch size at ten inches (25 centimeters). In addition to common statewide and island conservation actions, specific actions include:
- Maintain healthy populations with appropriate fishing regulations and education.

MONITORING:
- Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES:
- Improve understanding of factors affecting the species population size.

References:
Hawaiʻi Division of Aquatic Resources, State of Hawaii. Commercial marine landings data. 1997 – 2003.

Honolulu, HI: Division of Aquatic Resources.

Hoover J. 1993. Hawaii’s fishes. Honolulu, HI: Mutual Publishing. 183 pp.

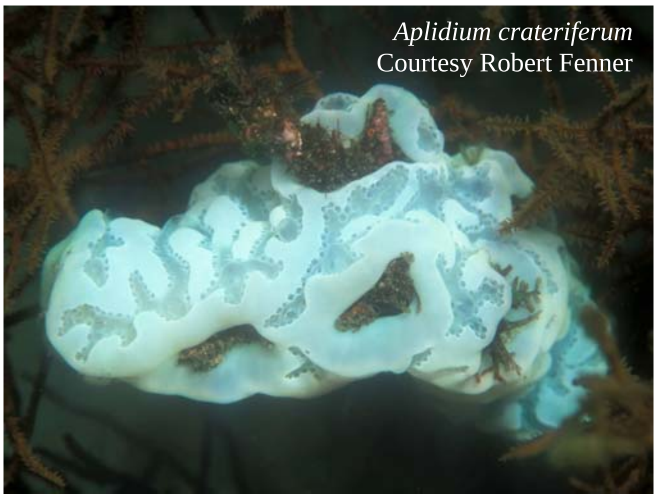
Tinker S. 1978. Fishes of Hawaii. Honolulu HI: Hawaiian Service, Inc. 532 pp.

Marine Invertebrates

Miscellaneous Filter Feeders

Brachiopod

Lingula reevii



Yellow crust bryozoan

Parasmittina sp.

Ascidians

Aplidium crateriferum
Aplidium sp.

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: All of these species are filter-feeders. *Lingula reevii* reproduces asexually and has low dispersal potential. Like other *Lingula,* it resides in burrows in sand or mud. Yellow crust bryozoan (*Parasmittina sp.*), cratered aplidium (*Aplidium crateriferum*), and gold ring aplidium (*Aplidium sp.*) are part of the "fouling community" that grows especially well on boat hulls and other man-made structures. Yellow crust bryozoan is colonial and also reproduces asexually. The ascidians are hermaphrodites and brood their eggs internally. Once the eggs hatch, the next stage is a tadpole-like larvae.

DISTRIBUTION: *Lingula reevii* is found only in Kāne'ohe Bay, O'ahu. The yellow crust bryozoan is found throughout the Main Hawaiian Islands, but is abundant at Molokini Islet, Maui. Cratered aplidium is found throughout the Main Hawaiian Islands and the Northwestern Hawaiian Islands, but it is most common on the North Shore of O'ahu. Gold ring aplidium is found at Makena and Molokini Islet, Maui.

ABUNDANCE: *Lingula reevii* is declining based on Division of Aquatic Resources surveys in Kāne'ohe Bay, but abundances are unknown for the other species.

LOCATION AND CONDITION OF KEY HABITAT: *Lingula reevii* primary habitat is the sandy reef flats of Kāne'ohe Bay, O'ahu, and this habitat is degraded. Yellow crust bryozoan primary habitat includes corals, shells, and stones onto which they encrust. Cratered aplidium prefers crevices and the underside of overhangs on vertical walls that are exposed. Gold ring aplidium occurs at "scuba depths."

THREATS:

- Habitat degradation due to urbanization and sedimentation of Kāneʻohe Bay, Oʻahu threatens *Lingula reevii*;
- Aquarium trade collectors harvest *Lingula reeviii*.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Restore habitat of *Lingula*;
- Maintain healthy populations with appropriate aquarium fishing regulations, enforcement, and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution;
- Support aquaculture research to develop captive breeding for *Lingula*'s use in the aquarium trade.

References:

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawai`i.

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Cephalopods

He‘e or Hawaiian octopus

Octopus hawiiensis

Mūhe‘e or Bobtail squid

Euprymna scolopes

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: He‘e or Hawaiian octopus (*Octopus hawaiiensis*) and mūhe‘e or bobtail squid (*Euprymna scolopes*) are endemic cephalopods. Both are nocturnal predators using venoms or poisons to capture and kill their prey. Hawaiian octopus feed primarily on crabs and other mollusks and occasionally on fish. Mūhe‘e feed mainly on the shrimp *Palemon debilis*, but also feed on small worms. He‘e and mūhe‘e have complex mating behaviors. Males use a specially modified arm to insert sperm into the female's mantle cavity. Eggs are laid on the bottom of the ocean in clusters. He‘e guards their eggs. Larvae are pelagic. Mūhe‘e bury themselves during the day. They protect themselves from predators on moonlit nights by masking their silhouette using organs that contain bioluminescent bacteria. Little is known of the habits of Hawaiian octopus.

DISTRIBUTION: Both species are found throughout the Hawaiian Islands.

ABUNDANCE: Not known for either species.

LOCATION AND CONDITION OF KEY HABITAT: Hawaiian octopus primary habitat is rocky substrate in waters ranging from approximately five to nine meters (15 to 30 feet) deep. Mūhe‘e are found in sand and mud flats in shallow waters. This habitat is important to the squid, because it uses the substrate during the day to burrow, and its main prey is found in this area. Its habitat is in decline, especially in areas like Kāne‘ohe Bay, O‘ahu where the bay is affected by urbanization and sedimentation.

THREATS:

- Habitat degradation is the primary threat to the mūheʻe and results from urbanization, runoff, and sedimentation. These threats not only alter its habitat but may negatively affect prey availability;
- Recreational collectors fish for Hawaiian octopus;
- Aquarium and research fishing pressure also is a concern for mūheʻe.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Restore and maintain habitat, especially for mūheʻe;
- Cooperate with other agencies to minimize pollution in areas such as Kāneʻohe Bay;
- Enforce regulations for aquarium trade and recreational collectors.

MONITORING:

- Continue and expand surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Research life history and biological characteristics to better understand management needs.

References:

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawaiʻi.

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Marine Invertebrates

Other Crustaceans

Unauna or Hermit crabs

Aniculus hopperae
Calcinus hazletti
Calcinus laurentae

Dromia dormia
Courtesy Keoki Stender

Crabs

Aethra edentata
Carpilius maculatus
Dromia dromia
Ligia hawaiensis
Lybia edmondsoni
Pseudopalicus oahuensis

Shrimps

Cinetorhynchus hawaiiensis
Cinetorhynchus hendersoni
Gnathophyllum precipuum
Hymenocera picta
Levicaris mammilata
Liomera supernodosa
Metapenaeopsis sp.
Rhynchocinetes rathbunae
Stenopus earlei

Hymenocerca picta
Courtesy Keoki Stender

SPECIES STATUS:
IUCN Red List - Not considered
All Endemic except for *Carpilius*, *Dromia*, and *Hymenocera*

SPECIES INFORMATION: The following are the Hawaiian, common, and scientific names for the Unauna or hermit crabs, true crabs, and shrimps: Hopper's hermit crab (*Aniculus hopperae*), Hazlett's hermit crab (*Calcinus hazletti*) and Laurent's hermit crab (*Calcinus laurentae*); flat elbow crab (*Aethra edentata*), alakuma or 7-11 crab *(Carpilius maculates)*, makua-o-ka-lipoa or sponge crab (*Dromia dormia)*, *Ligia hawaiensis* (no common name), kūmimi pua or Hawaiian pom pom crab or (*Lybia edmondsoni*), and button crab (*Pseudopalicus oahuensis*); Hawaiian hinge-beaked shrimp (*Cinetorhynchus hawaiiensis*), Henderson's hinge-beaked shrimp (*Cinetorhynchus hendersoni*), Hawaiian cave shrimp (*Gnathophyllum precipuum*), harlequin shrimp (*Hymenocera picta*), red pencil urchin shrimp (*Levicaris mammilata*), knotted liomera (*Liomera supernodosa*), bicolor sand shrimp (*Metanpenaeopsis sp.*), Rathbun's hinge-beaked shrimp (*Rhynchocinetes rathbunae*), and Earl's coral shrimp (*Stenopus earlei*). The unauna, alakuma, button crab, hinge-beaked shrimp, Hawaiian cave shrimp, and the bicolor sand shrimp are nocturnal. Hermit crabs are scavengers, Earl's coral shrimp are cleaners, alakuma crush other crustaceans and snails, button crabs feed on algae, and kūmimi pua use anemones on their claws to capture prey and feed on invertebrates. Harlequin shrimp are predators of seastars, including crown-of-thorns starfish. It is also monogamous and pair-bonding. Specific feeding information for the other species is unknown, but they are likely scavengers. All species have separate sexes and reproduce through copulation. All females brood eggs under their tails, except for the bicolor sand shrimp that releases eggs directly into the ocean. Newly hatched larvae are part of the plankton community for weeks to months. Makua-o-ka-lipoa is the largest sponge crab in the world. Rathbun's hinge-beaked shrimp is known as the mandarin shrimp in the aquarium trade.

DISTRIBUTION: Earl's coral shrimp is found off O'ahu and Kaua'i. The other species are found throughout the Hawaiian Islands. Knotted liomera is found throughout the Main Hawaiian Islands, but it is more common in the Northwestern Hawaiian Islands.

ABUNDANCE: Unknown. Henderson's hinge-beak shrimp are found throughout the islands, but they are abundant of the coast of Kona, Hawai'i. Earl's coral shrimp is rare.

LOCATION AND CONDITION OF KEY HABITAT: Most of these crustaceans are bottom dwellers. Hopper's hermit crab has primary habitat in caves and under ledges, but on exposed rocky shores from three feet to seventy feet (one to 21 meters). Hazeltt's and Laurent's hermit crabs live below the intertidal zone from six meters (20 feet) or deeper and occur on branching corals. The flat elbow crab is found on sandy bottom areas and kūmimi pua is found under stones in sand or on rubble in waters from approximately a meter to 30 meters (few feet to 100 feet) deep. The button crab is found on rocky bottom habitat. The shrimp species inhabit a large range of areas. Hawaiian hinge-beak shrimp inhabit finger coral; Henderson's hinge-beak shrimp inhabit shallow, sheltered reefs; and Rathbun's hinge-beak shrimp prefer rocky substrates. Hawaiian cave shrimp are found only in caves. Red pencil urchin shrimp live commensally with the sea urchin *Heteroentrotus mammillatus*. The knotted liomera is found on reef and reef flats. Bicolor sand shrimp prefer sandy rubble while Earls' coral shrimp inhabit caves, crevices and under ledges. Hinge-beak shrimp live on reefs.

THREATS:

- Aquarists collect alakuma, kūmimi pua, and makua-o-ka-lipoa, the hinge-beaked shrimps, and harlequin shrimp.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population sizes and distributions;
- Support aquaculture research to develop captive breeding for species used in the aquarium trade.

References:

Fiedler GC. 2002. The influence of social environment on sex determination in harlequin shrimp (*Hymenocera picta*: Decapoda, Gnathophyllidae). Journal of Crustacean Biology 22 (4): 750-761.

Gulko D. 2005. Hawaiʻi endemic species status chart spreadsheet. Honolulu, HI: Hawaiʻi Division of Aquatic Resources.

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawai`i.

Hoover JP. 1998. Hawaii's sea creatures: A guide to Hawai`i's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawaii, section 4: Mollusca. Honolulu, HI: Bishop Museum Press. 653 pp.

Marine Invertebrates

Ula poni or Spiny lobster

Panulirus marginatus

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: Ula poni or the spiny lobster (*Panulirus marginatus*) lacks large pincers on its first pair of legs and has one pair of antennae that is often bigger than its other antennae. Ula poni feed across sandy bottom areas that are next to reefs. They are carnivorous and feed at night on mollusks, echinoderms, crustaceans and fish. They may spawn up to four times a year from May to August and November to December. Females can produce up to half a million bright orange eggs each time they spawn. The mass of eggs is held in the female's swimmerets under her abdomen. They hatch in four weeks and go through various pelagic larval stages that last almost a year. After a year in the open ocean, they return to the reef. Juveniles are usually a few centimeters (one inch) long.

DISTRIBUTION: Historically, ula poni were distributed throughout the Hawaiian Archipelago. Today, they are still are found throughout the Archipelago. Pelagic larval distribution is not well understood, but one study shows that larvae move with ocean currents northwest along the ridge of the Archipelago to the southeast and then southwest.

ABUNDANCE: Numbers can be relatively high in pristine areas; however, numbers are greatly reduced from historic abundance due to over-fishing. Over the past four years, commercial catch has continued a long decline, slipping below 4,500 kilograms (10,000 pounds) for the past three years. The recreational fishery catch is unknown.

LOCATION AND CONDITION OF KEY HABITAT: Ula poni are found in crevices and caves, as well as under ledges. They may be found in shallow waters of approximately a meter (three feet) or in areas up to 180 meters (600 feet) deep. Key foraging habitats are sandy areas next to coral reefs. Healthy coral reefs are important habitat. Not much is known of the pelagic lifecycle of ula poni larvae.

THREATS: Ula poni were traditionally eaten by Native Hawaiians and were taken commercially in the trap fishery from the mid-1970s to 1999 in the Northwestern Hawaiian Islands (NWHI), specifically at Necker Island and Maro Reef. Populations experienced a serious decline in the early 1990s that continued until the late 1990s.

- Localized heavy fishing pressure remains a serious threat in the commercial and recreational fishery, although the fishery is closed in the NWHI and regulated in the Main Hawaiian Islands. Young are also collected for the aquarium trade;
- Habitat alteration such as degradation to coral reefs may also be an issue.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Continue to monitor population size to determine if fishing regulations and other conservation actions are successful.

RESEARCH PRIORITIES:

- Continue studies of larval distribution;
- Improve understanding of factors affecting the species population size and distribution.

References:

Gulko D. 2005. Hawai'i Endemic Species Status Chart spreadsheet. Hawai'i Division of Aquatic Resources.

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kanciruk P. 1980. Ecology of juvenile and adult Palinuridae (spiny lobsters). pp. 59-66 In: JS Cobb and BF Phillips, editors. The Biology and Management of Lobsters. Volume II.

Polovina JJ, Kleiber P, and Kobayashi DR. 1999. Application of TOPEX-POSEIDON Satellite Altimetry to Simulate Transport Dynamics of Larvae of Spiny Lobster, *Panulirus marginatus*, in the Northwestern Hawaiian Islands, 1993-1996. Fisheries Bulletin 97: 132-143.

Marine Invertebrates

Pūpū moʻo or chitons

Acanthochiton viridis
Ischnochiton petaloides

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: Pūpū moʻo or chitons are primitive seashore molluscs. They both feed by browsing on algae adhered to hard substrates. Both the kuakulu or green chiton (*A. viridis*) and the flat chiton (*I. petaloides*) have separate sexes and external fertilization. The adult kuakulu, 28 millimeters long (one inch), is larger than the adult flat chiton (10 millimeters long or one-half inch).

DISTRIBUTION: They occur on rocky and hard substrates throughout the islands.

ABUNDANCE: Unknown

LOCATION AND CONDITION OF KEY HABITAT: Key habitat for both the kuakulu and flat chiton are reef flats and tidepools. Kuakulu, however, prefers small depressions on limestone reef flats and holes or areas underneath the rubble of tidepools. Flat chitons prefer areas under rocks in both tidepools and reef flats.

THREATS: None identified.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Ensure healthy habitat is maintained.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

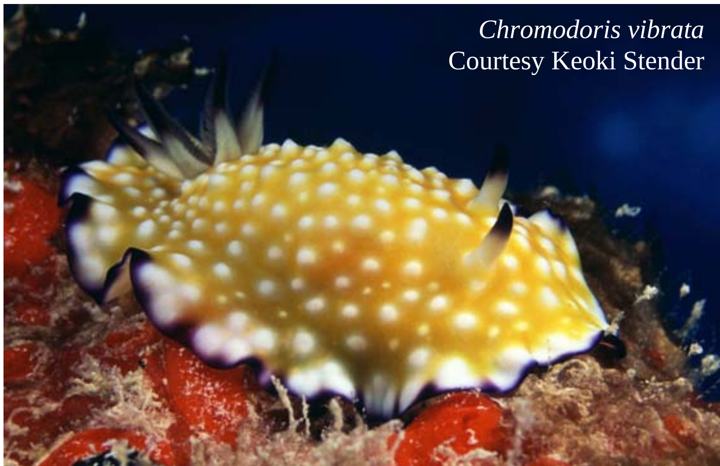
RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution.

References:

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawaii, section 4: Mollusca. Honolulu, HI:Bishop Museum Press. 653 pp.



Chromodoris vibrata
Courtesy Keoki Stender

Halgerda terramtuentis
Courtesy Keoki Stender

Marine Invertebrates

Nudibranchs

Aldisa pikokai
Ardeadoris scottjohnsoni
Chromodoris vibrata
Glossodoris poliahu
Halgerda terramtuentis
Hypselodoris andersoni
Melibe megaceras
Peltodoris fellowsi
Sclerodoris paliensis

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: The pitted nudibranch (*Aldisa pikokai*), Scott Johnson's nudibranch (*Ardeadoris scottjohnsoni)*, trembling nudibranch (*Chromodoris vibrata*), snow goddess nudibranch (*Glossodoris poliahu*), gold lace nudibranch (*Halgerda terramtuentis*), Anderson's nudibranch (*Hypselodoris andersoni*), *Melibe megaceras* (no common name*)*, Fellow's nudibranch (*Peltodoris fellowsi*), and pali nudibranch (*Sclerodoris paliensis*) are carnivores and feed on a variety of organisms ranging from sponges, hydroids, and corals to other nudibranchs. The only nocturnal feeder is the pitted nudibranch. All nudibranchs are hermaphroditic and mate through mutual insemination. Eggs are laid in coiled ribbons. Eggs hatch and trochopore larvae develop into planktonic veligers that lose their shell once they settle. Most nudibranchs do not live longer than one year. It is interesting to note that nudibranchs have few natural predators. They are usually toxic, although they do not produce their own toxins, but recycle those of their prey.

DISTRIBUTION: Most species are found throughout the Hawaiian archipelago; however, the gold lace nudibranch is only found in the Main Hawaiian Islands.

ABUNDANCE: Snow goddess nudibranch is uncommon. There is little quantitative abundance or trend data for any of the species.

LOCATION AND CONDITION OF KEY HABITAT: The pitted nudibranch's key habitat is in waters two to nine meters (six to 30 feet), but they can be found in waters up to 24 meters (80 feet) deep. They prefer areas with stones and crevices. Primary habitat for the trembling nudibranch is sea level to water down to 24 meters (80 feet) deep. Gold lace nudibranchs are found around caves in waters from approximately five to 30 meters (15 to 100 feet). Anderson’s nudibranch’s primary habitat is in caves as well as under overhangs on exposed rocky shores from five to 18 meters (15 to 60 feet). Anderson’s nudibranchs also live on the yellow sponge *Luffariella metachromia*. Additionally, they occasionally have been found in shallower waters of harbors and boat channels. Fellow’s nudibranch is found at the entrance of caves from six to fifteen meters (20 to 50 feet) or more and live on sponges. The pali nudibranch’s primary habitat is waters from two to six meters (six to 20 feet) deep. Specific habitat for the other species has not been delineated.

THREATS:

- The aquarium trade targets gold lace, Fellow’s, and pali nudibranchs.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate aquarium fishing regulations, enforcement, and education.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

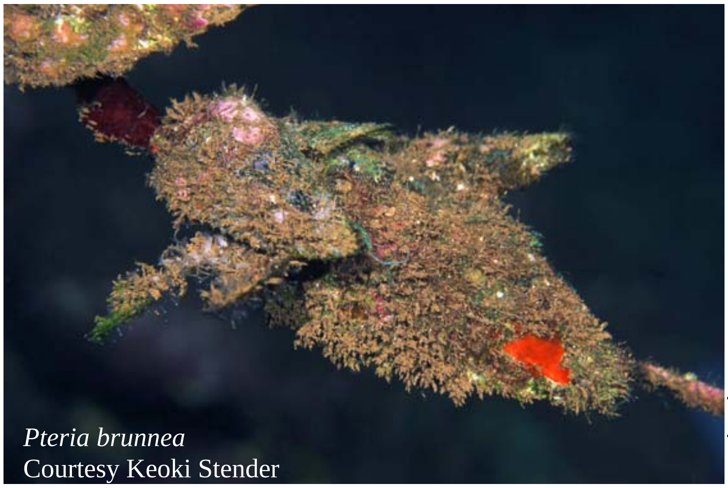
- Improve understanding of factors affecting the species population sizes and distributions.

References:

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawai`i.

Hoover JP. 1998. Hawaii’s sea creatures, A guide to Hawaii’s marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawaiʻi, section 4: Mollusca. Honolulu, HI: Bishop Museum Press. 653 pp.



Pteria brunnea
Courtesy Keoki Stender

Marine Invertebrates

Bivalves

Judd's scallop
Haumea juddi

Nahawele liʻi liʻi or Hawaiian mussel
Brachidontes crebristriarus

Isognomon californicum
Courtesy Keoki Stender

Pa or Pearl oyster
Pinctada margaritifera

Winged pearl oyster
Pteria brunnea

Nahawele or Black purse shell
Isognomon californicum

SPECIES STATUS:
IUCN Red List - Not considered
All Endemic except for *Pinctada*

SPECIES INFORMATION: Judd's scallop (*Haumea juddi*), nahawele liʻi liʻi or the Hawaiian mussel (*Brachidontes crebristriarus*), the winged pearl oyster (*Pteria brunnea*) and nahawele or the black purse shell (*Isognomon californicum*) are endemic, filter feeding bivalves, while pa or the pearl oyster (*Pinctada margaritifera*) is a widespread species. All have separate sexes and external fertilization. Both nahawele liʻi liʻi and pa attach to their substrates using strong byssal threads, while nahawele can move using its large foot. Judd's scallop can swim by clapping its shells.

DISTRIBUTION: All species were historically distributed throughout the state. Today they are found throughout the Hawaiian Archipelago; however, nahawele is most abundant around

Maui and the island of Hawaiʻi. Nahawele liʻi liʻi is primarily found on the windward or Main Hawaiian Islands.

ABUNDANCE: Pearl oysters were harvested at Pearl and Hermes Atoll in the Northwestern Hawaiian Islands, the only place they were common, but overfishing in the 1930s led to their decline and regulations limiting their harvest. The National Marine Fisheries Service surveyed Pearl and Hermes recently and found that pearl oysters were not rare, but would still not support a commercial fishery. Abundance is unknown for the rest of the species.

LOCATION AND CONDITION OF KEY HABITAT: Judd's scallop's primary habitat is on sandy ocean bottoms at depths of eight to 100 meters (26 to 328 feet). They are situated so their open shells face into the current with their top shell thinly covered with sand. If disturbed, they have been documented to swim two to three meters (six to ten feet). Both Judd's scallop and nahawele liʻi liʻi form patches or beds. Nahawele liʻi liʻi primary habitat is limestone shoreline at the low tide mark. However, in shoreline areas where freshwater and salt water mix they grow to their largest size. They can also be found on basalt shorelines, although in lower densities. Pa is found in shallow waters in between corals. The winged pearl oyster's primary habitat is on species of black coral; however, they also can cluster on wire corals. They may also host bryozoans on their shells. Nahawele form clusters in crevices at the high tide mark and prefer brackish waters. Nahawele on islands other than Maui and the island of Hawaiʻi are found individually in more saline waters.

THREATS:
- Historically, pearl oysters were threatened by harvesting them for their pearls;
- Pollution is a direct threat to these species, because they are filter feeders. This also makes them potentially good indicators of water quality in their habitats.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:
- Collaborate to reduce nearshore pollution;
- Maintain healthy habitat.

MONITORING:
- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:
- Improve understanding of factors affecting the species population size and distribution.

References:

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawai`i's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawaii, section 4: Mollusca. Honolulu, HI: Bishop Museum Press. 653 pp.

Cellana sandwicensis
Courtesy Keoki Stender

Marine Invertebrates

ʻOpihi or Limpets

Cellana exarata
Cellana melanostoma
Cellana sandwicensis
Cellana talcosa

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: The endemic ʻopihi makaiauli or black foot ʻopihi (*C. exarata*), the green foot ʻopihi (*C. melanostoma*), the ʻopihi ʻalinalina or yellow foot ʻopihi (*C. sandwicensis*), and the ʻopihi koʻele or giant ʻopihi (*C. talcosa*) are all protected by fishing regulations. All ʻopihi graze on algae and most may creep about to graze, but return to their "home scar" after feeding. Both ʻopihi ʻalinalina and ʻopihi koʻele often are covered with seaweed. Gametes are shed into the water where fertilization is external. Veligers have a short planktonic life. Spawning occurs mainly in December and January for ʻopihi makaiauli and ʻopihi ʻalinalina. Spawning information is unknown for the green foot ʻopihi and ʻopihi koʻele. ʻOpihi makaiauli grows to 40 millimeters (1.6 inches) in diameter, the green foot ʻopihi to 43 millimeters (1.7 inches), the ʻopihi ʻalinalina to 32 millimeters (1.3 inches), and ʻopihi koʻele to 90 millimeters (3.5 inches). Besides eating them, native Hawaiians used the shells as scrapers and tools.

DISTRIBUTION: The primary ranges for the ʻopihi makaiauli, ʻopihi ʻalinalina, and ʻopihi koʻele are along the basalt shorelines of the Main Hawaiian Islands; however, the ʻopihi makaiauli has been found on La Perouse Pinnacle and ʻopihi ʻalinalina on Necker and Nihoa. The green foot ʻopihi is found primarily in the Northwestern Hawaiian Islands, but it has been occasionally collected from Kauaʻi. Historically, it was found on Oʻahu and Maui as well.

ABUNDANCE: The abundance of ʻopihi makaiauli and ʻopihi ʻalinalina have declined in the past decades. ʻOpihi koʻele is rare, especially so on Kauaʻi and Oʻahu. About 3,175 kilograms (7,000 pounds) of ʻopihi were collected in the commercial fishery in 2003, which is a decline of about 2,268 kilograms (5,000 pounds) from recent years. The recreational fishery catch is unknown.

LOCATION AND CONDITION OF KEY HABITAT: Primary habitat for all ʻopihi is the intertidal zone to ten feet deep waters. ʻOpihi makaiauli thrives in the spray zone, although it may be found seaward to the calcareous algal zone. It is well suited for this variable environment due to its ability to ventilate its mantle cavity when it is dry. ʻOpihi ʻalinalina are found on and below the zero tide mark where there is a steady splash, and they are often on coralline algae. ʻOpihi koʻele are found below the tide mark from 0.5 to three meters (one to ten feet) deep, often between boulders.

THREATS:

- Localized heavy fishing pressure is the most significant threat to all ʻopihi species, especially ʻopihi koʻele. Populations in the wild have decreased greatly and this can impact their reproductive success;
- Climate change, habitat disturbance, and nearshore pollution are also potential threats.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common statewide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education;
- Restore habitat.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Research the impact of nearshore habitat disturbance and destruction;
- Improve understanding of factors affecting the species population size and distribution, especially for green foot and giant ʻopihi.

References:

Gulko D. 2005. Hawaiʻi endemic species status chart spreadsheet. Honolulu, HI: Hawaiʻi Division of Aquatic Resources.

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawai`i.

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawaii, section 4: Mollusca. Honolulu, HI: Bishop Museum Press. 653 pp.

Duplicara gouldi
Courtesy Keoki Stender

Nerita polita
Courtesy Keoki Stender

Marine Invertebrates

Snails

Charonia tritonis
Chicoreus insularum
Conus abbreviatus
Cypraea burgessi
Cypraea gaskoini
Cypraea granulate
Cypraea mauiensis
Cypraea ostergaardi
Cypraea rasleighana
Cypraea semiplota
Cypraea sulcidentata
Cypraea tessellata
Cypraea tigris
Duplicara gouldi
Epitonium ulu
Nerita picea
Nerita plicata
Nerita polita
Smaragdia bryannae
Strombus vomer hawaiiensis
Turbo sandwicensis

SPECIES STATUS:
IUCN Red List - Not considered
All Endemic except for *Charonia*, *Cypraea tigris*, and *Nerita polita*

SPECIES INFORMATION: The species common names and Hawaiian names are: pu or triton's trumpet (*Charonia tritonis*), burnt murex (*Chicoreus insularum*), pūpū‘ala or abbreviated cone (*Conus abbreviatus*), Burgess' cowry (*Cypraea burgessi*), leho or Gaskoin's cowry (*C. gaskoini*), leho or granulated cowry, (*C. granulate*), leho or Maui cowry (*C. mauiensis*), leho or Ostergaard's cowry (*C. ostergaardi*), leho or Rasleigh's cowry (*C. rasleighana*), puleholeho or half-swimmer cowry (*C. semiplota*), leho or groove-toothed cowry (*C. sulcidentata*), leho or checkered cowry (*C. tessellata*), tiger cowry (*C. tigris*), pūpū loloa or Gould's auger (*Duplicara gouldi*), fungiid wentletrap (*Epitonium ulu*), pipipi or black nerite (*N. picea*), *N. plicata* (none), kūpeʻe or polished nerite (*N. polita*), Hawaiian seagrass snail (*Smaragdia bryannae*), alīlea or Hawaiian stromb (*Strombus vomer hawaiiensis*), and pūpū mahina or Hawaiian turban (*Turbo sandwicensis*). Pu reaches twenty inches in length (second largest snail in the Pacific) and feeds on sea stars and sea urchins, including crown-of-thorns starfish. *Chicoreus* and pūpūʻala are carnivores. *Chicoreus* feeds exclusively on bivalves drilling through the bivalve's shell and inserts a digestive enzyme and ingests the tissues through its proboscis. Pupuʻala feeds exclusively on polychaete worms using its teeth that are connected to a venom gland and paralyzes its prey and swallows it whole. Leho or cowries are nocturnal and can be herbivores and omnivores as well as sponge feeders (*C. gaskoini* and Puleholeho). Hawaiian individuals of *C. tigris* are the largest in the world. Pūpū loloa feed solely on the yellow acorn worm (*Ptychodera flava*). The fungiid wentletrap (*Epitonium*) is associated with a solitary coral *Fungia scutaria*. Nerites (*Nerita* and *Smaragdia*) and alīlea are exclusively herbivores and feed on algae. Kūpeʻe is nocturnal. Pūpūʻala egg capsules are laid in clusters ranging from 80 to 1000 eggs. Female leho lay eggs in triangular capsules that are attached to the substrate. Eggs develop for one to two weeks. The fungiid wentletrap pelagic stage lasts about 39 days. Nerites lay eggs in capsules that adhere tightly to the surface of rocks and shells. Settlement of nerite veligers peaks in the winter.

DISTRIBUTION: Pu, the burnt murex, *Conus*, lehos, pipipi and kūpeʻe, alīlea, pūpū mahina, and pūpū loloa are found throughout the Archipelago; however, pūpū loloa is rare or possibly absent on the island of Hawaiʻi. The fungiid wentletrap is found only in Kāneʻohe Bay, Oʻahu. *Nerita plicata* is found only on the Northwestern Hawaiian Islands and S*maragdia byrannae* is found specifically at Anini, Kauaʻi; Kāneʻohe Bay, Oʻahu; and near Kaunakakai, Molokaʻi.

ABUNDANCE: Specific abundance for cowries is unknown, but many are rare such as pu, *Cypraea mauiensis*, *C. ostergaardi,* and *C. tigris*. Alīlea is also very rare today.

LOCATION AND CONDITION OF KEY HABITAT: The burnt murex is found at depths of 18 meters (60 feet) or more. Pūpūʻala key habitat is on benches and sandy substrate of reef platforms. Most Lehos including (*C. gaskoni, C. granulata,* Pulholeho, and *C. tessellata*) are found in shallow waters to 60 meters (200 feet). *C. mauiensis* is restricted to shallow waters, while *C. rashleighana* and *C. sulcidentata* are found in more moderately deep waters. *C. ostergaardi* is the only cowry found exclusively in deep waters. *C. mauiensis* has additional key breeding habitat on the leeward side of Maui. Pūpū loloa inhabits the casting of large acorn worms. The fungiid wentletrap lives on a solitary coral *Fungia scutaria* in Kāneʻohe Bay, an area that has been severely degraded. Key habitat for both pipipi and *N.plicata* is intertidal areas, but kūpeʻe is found under sand at the high tide line. *Smaragdia bryannae* is found on fringing and patch reefs only in association with the marine angiosperm *Halophila hawaiiana*. Alīlea lives up to 25 meters (80 feet) deep in sand. Pūpū mahina is common to 18 meters (60 feet) deep.

THREATS:

- Localized excessive harvesting of these species for their shells by collectors and for cultural uses is the primary threat to these snail species. Kūpeʻe was eaten by native Hawaiians and used in shell lei. *Cyprea mauiensis* is extremely rare due to over collection;
- Pollution is another threat for those found in intertidal areas and shallow waters.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution.

References:

Gulko D. 2005. Hawai‘i endemic species status chart spreadsheet. Honolulu, HI: Hawai‘i Division of Aquatic Resources.

Gulko D. 2004. Hawaiian marine species for ESA Candidate listing revised Candidate list. Honolulu, HI: Division of Aquatic Resources, State of Hawai`i.

Hoover JP. 1998. Hawaii’s sea creatures: A guide to Hawai`i’s marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Kay AE. 1979. Hawaiian marine shells reef and shore fauna of Hawai‘i, section 4: Mollusca. Honolulu, HI: Bishop Museum Press. 653 pp.

No photo available

Marine Invertebrates

Hawaiian oyster

Ostraea sandvicensis

SPECIES STATUS:
IUCN Red List – Not considered
Endemic

SPECIES INFORMATION: This is an oyster endemic to Hawai'i. Little else is known about their life history.

DISTRIBUTION: Unknown.

ABUNDANCE: Unknown.

LOCATION AND CONDITION OF KEY HABITAT: Unknown.

THREATS: None identified.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Work to clean estuaries with significant pollution;
- Restore habitat.

MONITORING:

- Establish survey schedule to determine population size and distribution.

RESEARCH PRIORITIES:

- Improve understanding of the life history, biology, and ecology of these oysters.

References:
None identified.

No Photo available

Marine Invertebrates

Black reef sponge

Spongia oceania

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: The black reef sponge is a filter feeder, using its collar cells to filter out organic material from the water passing through its cells. The black reef sponge is hermaphroditic. Most often it reproduces asexually through budding or fragmentation; however, sexual reproduction does occur. Gametes are produced at different times within a sponge; therefore, sponges depend on another sponge for fertilization. Sperm is released into the open ocean and other sponges retrieve the sperm to fertilize their eggs internally. These fertilized eggs hatch into free-swimming larvae. Although the black reef sponge has no spicules, it is still too hard to be exploited commercially.

DISTRIBUTION: Once widespread, the black reef sponge is primarily found in Hanauma Bay, Oʻahu and along the Kona Coast on the island of Hawaiʻi.

ABUNDANCE: Previously, it was the most common large sponge in the Hawaiian Islands and was very abundant in Hanauma Bay, Oʻahu in the 1940s. Today, numbers have decreased significantly.

LOCATION AND CONDITION OF KEY HABITAT: The black reef sponge primary habitat is in shallow waters on hard substrate that is in open areas with a strong surge or current. Its habitat is threatened by pollution and degradation from trampling of tourists.

THREATS: Although this sponge is not suitable for commercial use, it has severely declined since the 1940s.

- Pollution or degradation from human interactions such as trampling may have caused the decline.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Restore habitat.

MONITORING:

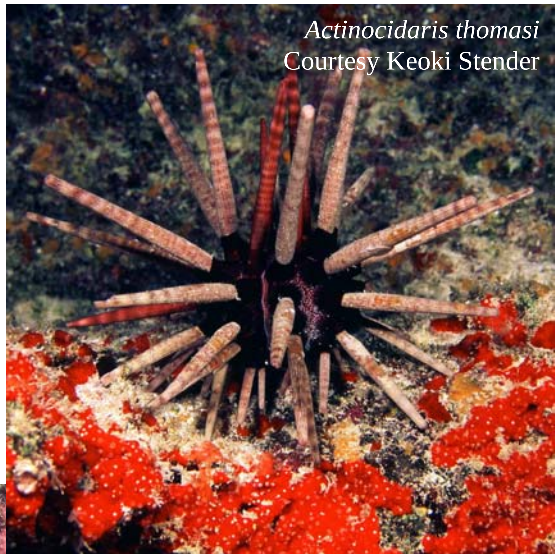
- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

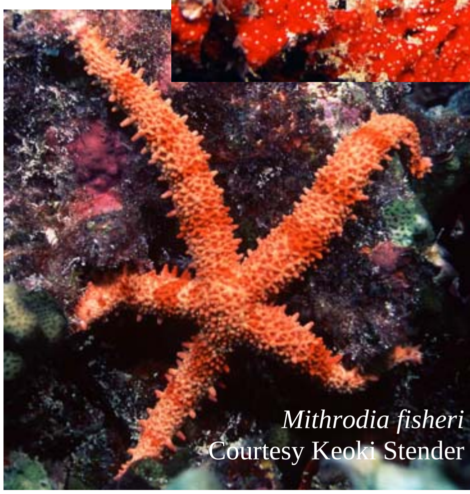
- Improve understanding of factors affecting the species population size and distribution.

References:

Hoover JP. 1998. Hawaii’s sea creatures: A guide to Hawaii’s marine invertebrates. Honolulu, HI: Mutual Publishing. 366 p.



Actinocidaris thomasi
Courtesy Keoki Stender



Mithrodia fisheri
Courtesy Keoki Stender

Marine Invertebrates

Echinoderms

Echinoids

Actinocidaris thomasi
Lissodiadema purpureum
Lovenia hawaiiensis

Asteroid

Mithrodia fisheri

Holothuroids

Stichopus sp.1
Stichopus sp. 2

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: Thomas' sea urchin (*Actinocidaris thomasi*), fined spined urchin (*Lissodiadema purpureum, Leptodiadema* is a junior synonym), Hawaiian lovenia (*Lovenia hawaiiensis*), the sea star *Mithrodia fisheri*, the Hawaiian spiny sea cucumber (*Stichopus sp. 1*), and Hawaiian yellow-tip sea cucumber (*Stichopus sp. 2*) are all endemic. Specific feeding habits are known for two species: the fine spined sea urchin grazes on algae and *M. fisheri* probably feeds on sponges, bryozoans, and other sessile organisms. Little is known on the feeding habits of the two sea cucumbers as they have not been scientifically described. Thomas's urchin may host small molluscs in shallower waters and barnacles in deeper waters. The fine spined sea urchin hosts a commensal shrimp. They all have separate sexes and reproduce by releasing eggs and sperm into the water. Larvae are part of the planktonic community for a few days to weeks and then they settle to mature.

DISTRIBUTION: All species occur throughout Hawai'i.

ABUNDANCE: Unknown

LOCATION AND CONDITION OF KEY HABITAT: Thomas's sea urchin primarily is found in deeper waters, but may be found in waters as shallow as 9 meters (30 feet). It stays under coral slabs and in crevices during the day. Fine spined urchins live on rocky substrates from approximately 6 to over 46 meters (20 to over 150 feet). Small fine spined urchins are most often found under stones, while larger ones in caves and crevices. Hawaiian lovenia lives in the sand. Hawaiian spiny sea cucumbers are found out in the open beside coral reefs in sand and rubble. They also can also be found on steep slopes from approximately 15 to 46 meters (50 to 150 feet). Hawaiian yellow-tip sea cucumbers prefer areas under stones during the day. *M. fisheri* primary habitat is on cave ceilings and walls.

THREATS:

- Aquarium collectors harvest Thomas's and fine spined sea urchins.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population size and distribution.

References:

Gulko, D. 2005. Hawaiʻi Endemic Species Status Chart spreadsheet. Honolulu, HI: Hawaiʻi Division of Aquatic Resources.

Hoover JP. 1998. Hawaii's sea creatures, A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Pseudobiceros sp. 2
Courtesy Jerry Kane
SeaLifeImages.smugmug.com

Marine Invertebrates

Worms

Annelid worm
Vermiliopsis torquata

Flatworms
Pericelis hymanae
Pseudobiceros sp. 2

Koʻe kai or Ribbon worm
Baseodiscus cingulatus

SPECIES STATUS:
IUCN Red List - Not considered
Endemic

SPECIES INFORMATION: *Vermiliopsis torquata* (no common name), Hyman's flatworm (*Percelis hymanae*), the Hawaiian spotted flatworm (*Pseudobiceros sp. 2*), and koʻe kai or banded ribbon worm (*Baseodiscus cingulatus*) are all endemic worms. All are carnivores and nocturnal. The koʻe kai uses its long proboscis to attack and entrap their prey. Hyman's and Hawaiian spotted flatworms are hermaphroditic. Fertilization is internal and eggs are laid in a gelatinous material. Eggs develop into free-swimming larvae or directly into small flatworms. The koʻe kai has separate sexes and eggs are laid in a gelatinous material and are fertilized externally. Both the flatworms and koʻe kai reproduce asexually by fragmentation or budding.

DISTRIBUTION: All species are found throughout the Hawaiian Archipelago.

ABUNDANCE: Unknown. Hyman's flatworm is common at Black Point, Oʻahu.

LOCATION AND CONDITION OF KEY HABITAT: Hyman's flatworm prefers shallow waters and is commonly found under stones. They may also associate with the brown purse shell (*Isognomon perna*). Like Hyman's flatworm, the Hawaiian spotted flatworm is found under stones; however, it is found from the shoreline to waters down to 15 meters (50 feet) deep. Koʻ kai has a large range of primary habitat. It has been found as deep as 76 meters (250 feet), but also lives in shallow waters and tidepools.

THREATS: None identified.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. In addition to common state-wide and island conservation actions, specific actions include:

- Maintain healthy habitats.

MONITORING:

- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population sizes and distributions.

References:

Barnes RD. 1980. Invertebrate zoology, 4th edition. Philadelphia, PA: Saunders College Publishing.

Hoover JP. 1998. Hawaii's sea creatures: A guide to Hawaii's marine invertebrates. Honolulu, HI: Mutual Publishing. 366 pp.

Other Anthozoans

Octocorals

Acabaria bicolor
Anthelia edmondsoni
Sinularia molokaiensis

ʻŌkole or Anemones

Cladactella manni
Heteractis malu

Zoanthids

Palythoa psammophilia
Palythoa toxica
Parazoanthus sp.
Zoanthus kealakekuaensis

SPECIES STATUS:
IUCN Red List - Not considered
All Endemic except *Heteractis*

SPECIES INFORMATION: Bicolor gorgonian (*Acabaria bicolor*), blue octocoral (*Anthelia edmondsoni*), Molokaʻi leather coral (*Sinularia molokaiensis*), Mann's anemone or ʻōkole (*Cladactella manni*) are all endemic anthozoans with common names, and the Hawaiian sand anemone or ʻōkole (*Heteractis malu*) is not endemic. The zoanthids have no common names except for *Parazoanthus*, which is the commercially valuable deep water gold coral. The bicolor gorgonian, the blue octocoral, and the Molokaʻi leather coral have less stinging cells than other cnidarians, and they feed on planktonic plant cells or other types of small particles. The blue octocoral also harbors symbiotic zooxanthellae. Mann's anemone feeds on small bottom-dwelling organisms and plankton, and they also have symbiotic zooxanthellae. Like corals, zoanthids use their nematocysts to capture and sting prey, while also utilizing the sugars produced by zooxanthellae for nutrition. All of the anthozoan species lack a medusa life stage. The octocoral animals have eight-tentacled polyps with an internal skeleton. The bicolor gorgonian forms colonies that are five centimeters (two inches) across and three centimeters (one and a half inches) high. Blue octocoral polyps grow to one centimeter (one quarter inch) and colonies are eight to 30 centimeters (three to 12 inches) across, while leather corals can grow to about the same size, and Mann's anemones are solitary. Mann's anemones can be either hermaphroditic or single-sexed. Sperm and eggs are released through the mouth. Asexual reproduction is achieved by fission or detaching pieces of tissue, most often from the foot, that regenerate into another organism. They grow to five centimeters (two inches) high and ten centimeters (four inches) across. *Palythoa psammophilia, Palythoa toxica*, and *Zoanthus kealakekuaensis* are colonial and lack a hard skeleton. *P. toxica* contains toxins that can affect people, but also have anti-cancer properties.

DISTRIBUTION: Moloka'i leather coral only occurs on the southeast side of Moloka'i. Hawaiian sand anemone is mostly found in Kāne'ohe Bay, Laie, and Kahuku, O'ahu, and Maalaea Bay, Maui. *Palythoa psammophilia* occurs in Kāne'ohe Bay only, *Palythoa toxica* is found only off Maui and O'ahu, *Parazoanthus* occurs off O'ahu, and *Zoanthus kealakekuaensis* only occurs in Kealakekua Bay on the island of Hawai'i. All other species are found throughout the Hawaiian Archipelago.

ABUNDANCE: Unknown.

LOCATION AND CONDITION OF KEY HABITAT: Bicolor gorgonians prefer rocky crevices in areas that are "surgy" or directly in the current. They occur from depths of two to 430 meters (six to 1,400 feet). The primary habitat of blue octocoral includes both hard and soft surfaces that are exposed. Moloka`i leather coral colonies encrust on limestone and volcanic rocks in waters approximately 35 meters (115 feet) or deeper; however, they also can be located in shallow water areas. Mann's anemones live in intertidal areas on rocky shores in crevices, pockets or ledges that are constantly washed by waves. Zoanthids usually prefer shallow waters.

THREATS:
- Use in the marine ornamental trade is the primary threat to *Heteractis* and *Cladectella* and for use in the precious coral trade (*Parazoanthus* sp.);
- Habitat degradation from shoreline development such as nutrient and freshwater runoff and sedimentation threatens these anthozoans;
- Introduced algae are also a threat. Hawaiian sand anemone is particularly susceptible, because its main population is in Kāne'ohe Bay, and it is out competed by introduced algae.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Precious coral harvesting in federal waters is managed under a Fisheries Management Plan of the Western Pacific Regional Fisheries Management Council. In addition to common state-wide and island conservation actions, specific actions include:
- Maintain healthy populations with appropriate fishing regulations, enforcement, and education;
- Work with partners to minimize nutrient loading and other pollution from land-based sources;

- Continue to remove alien species, specifically alien algae using established effective techniques;
- Prevent alien species from entering the ecosystem by preventative measures, education, and rapidly responding to new intruders.

MONITORING:

- Monitor alien macroalgae and removal operations to determine impacts on these species;
- Implement comprehensive disease monitoring statewide;
- Survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Improve understanding of factors affecting the species population sizes and distributions.

References:

Gulko D. 2005. Hawaiʻi endemic species status chart spreadsheet. Honolulu, HI: Hawaiʻi Division of Aquatic Resources.

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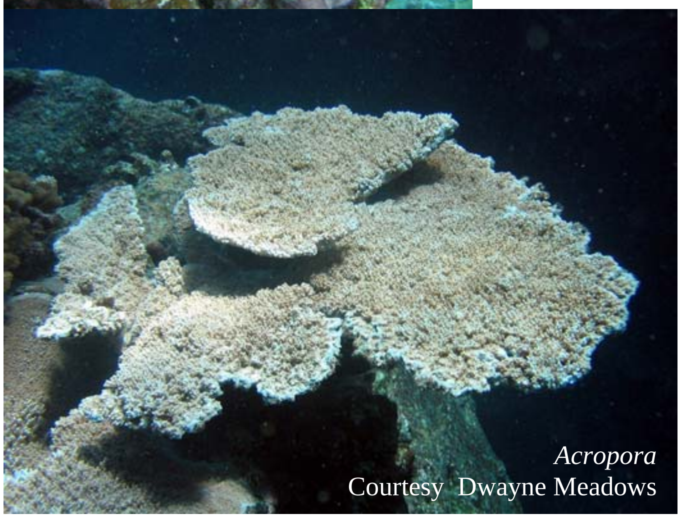
Russo R. 1994. Hawaiian Reefs. California, USA: Wavecrest Publications. 174 pp.

Western Pacific Fisheries Management Council. Fishery Management Plan for the precious coral fisheries of the Western Pacific Region. Honolulu, HI: Western Pacific Fisheries Management Council. Available from: http://www.wpcouncil.org/precious.htm.

Pavona Courtesy NMFS



Acropora
Courtesy Dwayne Meadows

Marine Invertebrates

All Stony Corals

(All species listed in text)
Acroporidae
Agariciidae
Astrocoeniidae
Balanophyllidae
Caryophyllidae
Dendrophylliidae
Faviidae
Fungiidae
Pocilloporidae
Poritidae
Siderastreadae

SPECIES STATUS:
IUCN Red List - Not considered
Some Endemic (see text for details)

SPECIES INFORMATION: All stony corals feed on small plankton or dissolved organic matter that is in the waters. Most corals use their nematocysts on their tentacles to capture and sting their prey and feed at night. Others such as *Pavona duerdenni* are suspension feeders. Stony corals with symbiotic zooxanthellae can get up to 98 percent of their nutrition from the sugars produced by the algae. *Balanophyllia* and *Tubastrea* lack zooxanthellae. Stony corals lack a polyp stage, but reproduce both sexually and asexually. A particular combination of day length, tide, and moonlight prompts spawning events. Other corals such as the *Pocillopora sp.* and *Porites sp.* brood their eggs and release the larvae or planulae completely formed. Asexual reproduction is achieved through budding or when pieces are broken off and grow into new colonies. *Porites spp.* are important habitat for many reef species such as juvenile fishes, shrimps and other invertebrates. All stony corals are protected under the Convention on International Trade in Endangered Species (CITES). Fenner (2005) has recently questioned the endemic status and taxonomy of many species. We have chosen to retain the taxonomy that has been in place for some time until Fenner's work can be evaluated and accepted by the wider community.

The following are the endemic stony corals of Hawaii and their common and Hawaiian names: serpentine cup coral (*Dendrophyllia serpentine,* also known as *Eguchipsammia serpentina*), Hawaiian plate coral (*Leptoseris hawaiiensis*), rice coral (*Montipora capitata*), irregular rice coral (*Montipora dilatata*), blue rice coral (*Montipora flabellata*), sandpaper rice coral (*Montipora patula*), branching rice coral (*Montipora studeri*, also known as *M. incrassata*), *Montipora verrilli* (no common name), flat lobe coral (*Pavona duerdeni*), Moloka'i cauliflower coral (*Pocillopora molokaiensis*), Brigham's coral (*Porites brighami*), pohaku puna or compressed coral (*Porites compressa*), thick finger coral (*Porites duerdeni*), pohaku puna or Evermann's coral (*Porites evermanni*, also known as *P. lutea*), *Porites pukoens*is (no common name), and Verrill's lump coral (*Psammocora verrilli*).

The following are the non-endemic stony corals from shallower waters of Hawaii: table coral (*Acropora cytheria*), *Acropora gemmifera* (no common name), finger staghorn coral (*Acropora humilis*), branching staghorn coral (*Acropora nasuta*), fuzzy table coral (*Acropora paniculata*), bushy staghorn coral (*Acropora valida*), *Anacropora sp.* (no common name), oval cup coral (*Balanophyllia sp.*, also called *Cladopsammia eguchii*), Wells' coral (*Coscinaraea wellsi*), fragile mushroom coral (*Cycloseris fragilis*, also called *Diaseris fragilis*), humpback coral (*Cycloseris hexagonalis*, also called *C. vaughani*), ocellated coral (*Cyphastrea ocellina*), distorted mushroom coral (*Diaseris distorta*), granulated mushroom coral (*Fungia granulosa*), mushroom coral (*Fungia scutaria*), *Fungia sp.* (no common name), honeycomb coral (*Gardineroseris planulata*), Bewick's coral (*Leptastrea bewickensis*), *Leptastrea bottae* (no common name, also known as *L. hawaiiensis* and *Cyphastrea agassizi*), spotted coral (*Leptastrea pruinosa*), crust coral (*Leptastrea purpurea*), transverse coral (*Leptastrea transversa*), foliose coral (*Leptoseris foliosa*), swelling coral (*Leptoseris incrustans*), ridge coral (*Leptoseris myctoseroides*), papyrus coral (*Leptoseris papyracea*), rough plate coral (*Leptoseris scabra*), tube coral (*Leptoseris tubulifera*), hidden orange coral (*Madracis pharensis*), *Montipora tuberculosa* (no common name), lumpy rice coral (*Montipora turgescens*), *Pavona pollicata* (no common name, also known as *P. maldivensis*), corrugated coral (*Pavona varians*), Lace coral (*Pocillopora damicornis*), antler coral (*Pocillopora eydouxi*), thin cauliflower coral (*Pocillopora ligulata*), cauliflower coral (*Pocillopora meandrina*), nodule coral (*Porites* cf. *annae*), false lichen coral (*Porites bernardi*), plate and knob coral *(Porites convexa*, also known as *P. monticulosa*), lichen coral (*Porites lichen*), lobe coral (*Porites lobata*), plate and pillar coral (*Porites rus*, also known as *Porites irregularis*), solid coral (*Porites solida*), deep lobe coral (*Porites studeri*), flat coral (*Psammocora explanulata*), Haime's lump coral (*Psammocora haimeana*), Nierstrasz's coral (*Psammocora nierstraszi*), stellar coral (*Psammocora stellata*), superficial coral (*Psammocora superficialis*), Verrill's lump coral (*Rhizopsammia verrilli*), tiny cup coral (*Tethocyathus minor*), colonial cup coral (*Tubastraea coccinea*), and black cup coral (*Tubastraea diaphana*).

The following are deep water scleratinian corals from Hawaii (none have common names): *Anisopsammia ampheiliodes*, *Anthemiphyllia pacifica*, *Balanophyllia desmophylloides*, *Balanophyllia diomedeae*, *Balanophyllia hawaiiensis*, *Balanophyllia laysanensis*, *Bathyactis hawaiiensis*, *Caryophyllia alcocki*, *Caryophyllia octopalli*, *Ceratotrochus laxus*, *Cyathoceras diomedae*, *Deltocyathus andamanicus*, *Dendrophyllia oahensis*, *Desmophyllum cristagallis, Endopachys oahensis, Flabellum deludens, Flabellum pavoninum, Gardineria hawaiensis, Madracis kauaiensis, Madrepora kauaiensis, Paracyathus gardineri, Paracyathus mauiensis, paracyathus molokensis, Paracyathus tenuicalyx, Placotrochus fuscus, Stephanophyllia formosissima, and Trochocyathus oahensis.*

DISTRIBUTION: *A. cytheria* is found in the Northwestern Hawaiian Islands (NWHI) around French Frigate Shoals and a few colonies were identified off Kaua'i, but are no longer there. Fossils show that historically it was widespread throughout the islands. *Acropora gemmifera, Acropora humilis*, *Acropora paniculata, Acropora valida* and *Montipora turgescens* are known only from the NWHI. *Anacropora* has only been found off Maui. An unnamed *Fungia sp.* has been found off of the island of Hawai'i. *Gardineroseris* is found only from the island of Hawai'i through Oʻahu. *Leptoseris foliosa* is only known from Maui. *Montipora dilitata* is found only within Kaneʻōhe Bay. *Porites annae* is known from Maui. *Porites duerdeni* is found only in Kāneʻohe Bay and possibly South Maui. *Porites lichen* is only common near Kure Atoll and Oʻahu. *Porites pukoensis* is found only near Molokaʻi. *Psammocora verrilli* occurs off Oʻahu and Molokaʻi only. No reliable distribution data exists for the deep water corals. Distribution of the other species is statewide.

ABUNDANCE: The stony corals are extensively monitored by the Division of Aquatic Resources, National Marine Fisheries Service, and the Coral Reef Assessment and Monitoring Program partnership including the University of Hawaii. All groups maintain data accessible to managers. There is no evidence of widespread decline for any species, though localized declines from habitat alteration, shipwrecks, runoff, and coral bleaching in the NWHI have been documented.

LOCATION AND CONDITION OF KEY HABITAT: Readers should refer to the coral guides below for specific information on the location of key habitat for these corals. *Leptoseris papyracea* and *P. studeri* occurs in water over 30 meters (100 feet) deep. The really deep water corals that occur over 91 meters (300 feet) deep are listed in a special paragraph above.

THREATS: Threats vary in character and severity between the Main Hawaiian Islands (MHI) and the NWHI. Primary threats to the coral reefs of the MHI are the following:

- Pollution such as high levels of nutrients, sediments, and freshwater all negatively impact coral reefs in nearshore areas. Water pollution results from urbanization, stream channelization, paving of coastal and upland roads and inadequate land-use practices;
- Tourism activities can lead to coral damage when tourists trample and walk on the coral and when boats anchor on reefs or spill fuel;
- Alien species such as macroalgae or snowflake coral (*Carijoa*) can quickly dominate coral reef habitat and form floating mats;
- Marine debris gets stuck on coral reefs and can break off large pieces of colonies. Corals also are important to the aquarium trade;
- Taking or harvesting stony corals is prohibited by law; however, they are still removed;
- Marine debris is a threat to coral, especially in the NWHI. The debris, primarily derelict fishing gear, entangles pieces of coral and it scours the reef as it moves around in the waves;
- Climate change may be linked to recent events of coral bleaching in the NWHI in 2002 and 2004;
- Disease is a potential threat in all areas but has not yet caused serious mortality of corals in Hawaiʻi.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Stony corals are protected under Appendix II of the Convention on International Trade in Endangered Species (CITES). Many organizations work to protect coral reefs in Hawaiʻi through research and conservation such as the Hawaiian Coral Reef Initiative. In addition to common state-wide and island conservation actions, specific actions include:

- Work with partners to minimize nutrient loading and other pollution from land-based sources;

- Increase education and outreach effort, specifically to tourists and tourism programs on the effects of trampling and walking on corals;
- Continue to remove alien species, specifically alien algae using established effective techniques;
- Prevent alien species from entering the ecosystem by preventative measures, education, and rapidly responding to new intruders;
- Enforce existing regulations and educate public on regulations that prohibit the collection and trade of aquarium species;
- Expand on existing MPAs and look for priority areas for new MPAs;
- Restore habitat where feasible;
- Establish rapid response team to deal with shipwrecks, oil spills, disease, hurricanes, and other acute impacts;
- Continue working to remove marine debris.

MONITORING:

- Monitor alien macroalgae and removal operations to determine impacts on coral;
- Implement comprehensive disease monitoring statewide;
- Continue monitoring coral populations and expand to unsurveyed areas such as is being done with the new MHI RAMP cruises in partnership of DAR and NMFS.

RESEARCH PRIORITIES:

- Research the compounded effects of threats such as water pollution, harvesting of coral, and alien species on coral health;
- Continue researching most effective means for removing invasive macroalgae.

References:

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Myriopathes
Courtesy Keoki Stender

ʻekaha kū moana or Black corals

Order Antipatharia
Antipathidae
Leiopathidae
Myriopathidae
Schizopathidae

SPECIES STATUS:
IUCN Red List - Not considered
Only *A. grandis* is Endemic

SPECIES INFORMATION: The whole taxonomic order of Black Corals is listed as a "Species of Greatest Conservation Need." The common names of the species that occur in Hawai`i are: branching black coral (*Antipathes dichotoma*), grand black coral (*Antipathes grandis*), small feathery black coral (*Antipathes intermedia*), *Antipathes punctata* (no common name), *Antipathes subpinnata* (no common name), *Antipathes undulata* (no common name), common wire coral (*Cirrhipathes anguina*), *Bathypathes patula* (no common name), *Cirrhipathes spiralis* (no common name), *Leipoathes glaberrima* (no common name), feathery black coral (*Myriopathes ulex*), *Parantipathes sp.* (no common name), and *Schizopathes conferta* (no common name). Dense feathery black coral (*Myriopathes* cf. *japonica*) and red wire coral (*Stichopathes* cf. *echinulata*) may also be present. Many symbiotic species of bryozoans, fishes, shrimps, and winged pearl oysters live on or in the branches of these corals. Black corals lack a polyp stage, but reproduce both sexually and asexually. Their group, the antipatharians, has flexible, horny skeletons, usually with six unbranched tentacles. They lack symbiotic zooxanthellae. Only their skeletons are black, the skin covering the skeleton can also be red, yellow, green, white, or brown. Growth is slow and they are long-lived. Fenner (2005) believes *A. dichotoma* is another *Antipathes* species. *M. japonica* is a tentative identification of a second form of what used to be called *A. ulex*. Fenner (2005) reports that there is a deeper water species that is definitely *S. echinulata*, and a shallow water form may also be this species.

DISTRIBUTION: *A. intermedia*, *A. punctata*, *A. subpinnata, A. undulata, Parantipathes,* and *Schizopathes* are known from off Oʻahu only. *C. spiralis,* and *Leiopathes* occurs from Oʻahu through Kauaʻi. Distribution of the other species is statewide. Black coral beds that are commercially harvested occur between Maui and Lānaʻi and other beds off Kauaʻi and the island of Hawaiʻi have been harvested in the past.

ABUNDANCE: The precious black coral beds are monitored every few years by researchers working for the Western Pacific Fisheries Management Council, and the state has recently conducted a survey with collaborators. There is concern of a possible decrease in recruitment and a decrease in size of harvested black corals.

LOCATION AND CONDITION OF KEY HABITAT: All species prefer deeper areas with current. *A. dichotoma* can be found as shallow as 18 meters (60 feet) and *C. anguina* can be found as shallow as nine meters (30 feet). *A. intermedia, A. punctata, A. subpinnata, A. undulata, C. spiralis, Leiopathes,* and *Schizopathes* only occur deeper than 185 meters (600 feet).

THREATS:

- Overharvesting is a significant threat to black corals. *A. dichotoma, A. grandis,* and *A. ulex* are sought after in the shallow water precious coral fishery that currently uses SCUBA. Black corals are protected under Appendix II of the Convention on International Trade in Endangered Species (CITES). The IUCN listed black corals as commercially threatened in 1983 under older listing criteria;
- Introduced species threaten black corals. Alien species such as snowflake coral (*Carijoa*) may dominate black coral habitat. Disease is a potential threat in all areas but has not yet caused serious mortality of corals in Hawaii.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Black corals are protected under Appendix II of the Convention on International Trade in Endangered Species (CITES). Precious coral harvesting in federal waters is managed under a Fisheries Management Plan of the Western Pacific Regional Fisheries Management Council. In addition to common state-wide and island conservation actions, specific actions include:

- Work to adopt fishing regulations that correspond to regulations enacted in federal waters and that ease and maximize enforceability;
- Prevent alien species from entering the ecosystem by preventative measures, education, and rapidly responding to new intruders;
- Participate in black coral workshop to develop actions and research needed to conserve these species;
- Collaborate with the Western Pacific Fisheries Management Council on a black coral workshop to continue successful management of this fishery including possible MPAs,
- Maintain healthy populations with appropriate fishing regulations, enforcement, and education.

MONITORING:

- Continue to survey for populations and distribution in known and likely habitats.

RESEARCH PRIORITIES:

- Cooperate with the Western Pacific Fisheries Management Council in understanding the relationship between colony height and basal diameter and the effect of *Carijoa*;
- Improve understanding of factors affecting the species population sizes and distributions.

References:

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CHAPTER 8: MONITORING, IMPLEMENTATION, AND ADAPTIVE MANAGEMENT

The need for monitoring is a consistent theme throughout Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS) and is referenced in several previous chapters (Chapters 4, 5, 6, and 7). Chapter 8 addresses monitoring specifically in the following ways: it provides a summary of current monitoring efforts at both the taxa and habitat levels; it outlines monitoring needs and recommendations; it discusses the implementation, monitoring, and evaluation of statewide conservation objectives as defined in Chapter 4, including adaptive management; and it outlines processes for the ten year revision of the CWCS. In doing so, this Chapter addresses required elements 5, 6, and 7.

PURPOSE AND VALUE OF MONITORING

A well planned and executed monitoring program is key to the success of conservation efforts, especially in light of the scarcity of personnel and funds needed to protect and recover native wildlife resources in Hawaiʻi. Monitoring programs are essential to guide plans and implement adaptive changes to those plans, and for management and recovery programs to be most cost-effective and achieve their goals. Monitoring does this by providing ways to track population trends, to assess threats and limiting factors, and to evaluate progress of actions to improve native wildlife status. Monitoring programs are also tools with which to communicate conservation achievements, helping to develop support for conservation actions with decision-makers such as legislators, funding organizations, non-profit organizations, and the general public.

CURRENT ASSESSMENT OF MONITORING

Monitoring is integral to most existing conservation programs and partnerships in Hawaiʻi. Monitoring protocols are varied and depend upon the nature of the resource being monitored, set objectives and goals, and staff and funding capabilities and commitments. This assessment distinguishes between taxa-based programs and habitat-based programs and identifies the current monitoring programs and plans that are in place.

SUMMARY OF MONITORING EFFORTS AND CHALLENGES IN THE STATE

Monitoring in Hawaiʻi is conducted at multiple scales by various entities and at differing levels of frequency and quality. Monitoring, both at the taxa and habitat levels, is conducted by State and Federal agencies. Examples include monitoring of State and Federal fisheries, the statewide waterbird surveys, and the Forest Bird Surveys. Monitoring of taxa and habitats by State and Federal agencies also occurs on a program or area specific level and often as part of the management plan for managed areas. Examples include monitoring in Natural Area Reserves, State Wildlife Sanctuaries, National Parks, National Wildlife Refuges, military lands, marine managed areas, the National Marine Sanctuary, and the Coral Reef Ecosystem Reserve. Private landowners involved with conservation also conduct monitoring on their lands. Examples include private preserves managed by the Nature Conservancy of Hawaiʻi and Maui Land and Pineapple, Inc. and private landowners involved in conservation programs such as the State's Landowner Incentive Program and Federal programs managed by the Natural Resources

Conservation Service and the U.S. Fish and Wildlife Service (USFWS). Public-private partnerships such as the watershed partnerships also conduct monitoring. All of these areas are considered managed lands. Additionally, monitoring is conducted by academic researchers as well as organizations such as the island invasive species committees.

Species-specific monitoring in the State generally takes place as a part of implementing USFWS and National Marine Fisheries Service recovery plans for endangered species or as part of management plans for both listed and non-listed species (usually for State, Federal, private, and public-private partnership lands and waters mentioned previously). Often, these plans are developed for five to ten year cycles, with mid-term evaluation points for assessments and adaptive management purposes.

Finally, there are also citizen monitoring programs. Examples include the Hawaiʻi Audubon Society, which has conducted annual Christmas bird counts on Oʻahu, Kauaʻi, Maui, Hawaiʻi, Midway, Laysan and French Frigate Shoals, the yearly whale counts conducted by the Hawaiian Islands Humpback Whale National Marine Sanctuary and the Pacific Whale Foundation during the months of January-March, and the monitoring of reef fishes by Reefcheck.

The State has several tools and resources available to assist with monitoring. Examples include databases and information warehouses such as the Hawaiʻi Biodiversity and Mapping Program (formerly the Hawaiʻi Natural Heritage Program) and the Pacific Basin Information Node. There are also inter-agency efforts such as the Western Pacific Fisheries Information Network, Coral Reef Information Service, and the Hawaiʻi Forest Bird Interagency Database Project, which analyzes information collected during yearly forest bird surveys to determine conservation needs of these species.

The challenges facing implementation of effective monitoring are similar to those challenges faced in implementing conservation actions as discussed in Chapter 4: inadequate funds, lack of trained personnel to carry out monitoring, insufficient tools for monitoring (e.g., practical or standardized monitoring protocols), inability to use the information collected (e.g., survey forms are never entered into a database for later data analysis), and gaps in information sharing. The biggest challenge to monitoring, however, is being able to balance staff effort, cost, and issues of what to monitor in order to best measure the effectiveness of conservation actions and achieve objectives and goals. For example, while monitoring relatively populous species can be fairly straightforward, the cost and difficulty of monitoring rare or highly fluctuating populations presents difficult trade-offs between money applied toward gaining precise knowledge of population status and money needed for species and habitat improvement or restoration.

TAXON MONITORING

Most monitoring in the State consists of counting individuals and nests. For many taxa, appropriate monitoring programs are specified in recovery or management plans. The level of detail of management recommendations provided in the plans varies among taxa. The following outlines existing monitoring efforts and resources for taxa as well as identifies gaps and needs.

Terrestrial Mammal
The ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* [Hawaiian hoary bat]) is the only land mammal native to the Hawaiian archipelago. The USFWS recovery plan for the bat was developed in 1998 and outlines the monitoring requirements for this species. Specific recommendations center on the need for island-wide surveys and monitoring to determine bat population levels and distribution, as well as associated key habitats and potential threats affecting populations. To date, no systematic surveys of the bat have been conducted. Most monitoring has occurred on island specific areas and at different times of the year. Additionally, its wide range of habitat and the limited technology available to detect bat presence makes monitoring this species difficult. However, efforts are underway by the Hawaiian Bat Research Cooperative and Hawai‘i Volcanoes National Park to improve monitoring of this species.

Forest Birds
Hawaii’s native forest birds are perhaps the best monitored species in the State. However, monitoring efforts for even these species could be improved, particularly life history monitoring for specific species. Standardized forest bird surveys have been conducted annually since 1976 by agencies and private landowners including the State Division of Forestry and Wildlife (DOFAW), USFWS, National Park Service (NPS) and National Wildlife Refuges (NWR), Kamehameha School, and the Nature Conservancy of Hawai‘i. Additionally, monitoring is guided by the USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds, which also includes five-year implementation plans identifying monitoring needs for identified critical species. Elements of monitoring from these plans are conducted by the USFWS and its partners; however, the full range of monitoring recommendations has yet to be implemented. For non-endangered forest birds such as ‘i‘iwi (*Vestiaria coccinea*), ‘apapane (*Himatione sanguinea*), and ‘amakihi (*Hemignathus virens*), no plans have been developed, though monitoring does occur for these species during the forest bird surveys and monitoring conducted on managed lands. However, their potential dispersal in lower elevations may require different monitoring protocols.

There are no wild populations of ‘alalā (*Corvus hawaiiensis* [Hawaiian crow]) and all existing populations are in captive propagation facilities which are closely monitored by staff. Monitoring protocols for the release of ‘alalā into the wild have been developed. The ‘alalā also has a USFWS Draft Revised Recovery Plan, part of which captive propagation is an element.

Raptors
There is no systematic island-wide monitoring for pueo (*Asio flammeus sandwichensis* [Hawaiian short-eared owl]) or ‘io (*Buteo solitarius* [Hawaiian hawk]). Population assessments are based on surveys conducted on more opportunistic or piece-meal basis, such as research by graduate students, surveys of species on various managed lands, or during the Hawai‘i Audubon counts.

Waterbirds
All endemic Hawaiian waterbirds have existing USFWS recovery plans outlining monitoring needs and actions. An updated, revised recovery plan for the nēnē (*Branta sandvicensis* [Hawaiian goose]) is currently being developed by the USFWS and should be available in December 2005. The USFWS has also recently finalized an updated Draft Revised Recovery

plan for Hawaiian waterbirds addressing the monitoring needs of koloa maoli (*Anas wyvilliana* [Hawaiian duck]), ʻalae ʻula (*Gallinula chloropus sandvicensis* [Hawaiian moorhen]), ʻalae keʻokeʻo (*Fulica alai* [Hawaiian coot]), and aeʻo (*Himantopus mexicanus knudseni* [Hawaiian stilt]). Elements of monitoring from these plans are conducted by the USFWS and its partners; however, the full range of monitoring recommendations has yet to be implemented. DOFAW also conducts twice annual statewide waterbird surveys, covering both private and public land, that include these species as well as the ʻaukuʻu (*Nycticorax nycticorax* [black-crowned night-heron]). Additionally, these species are monitored on various managed lands such as National Wildlife Refuges, military special management areas, and State Wildlife Sanctuaries as part of ongoing management or as part of research.

Seabirds
The majority of Hawaii's seabird populations are in the Northwestern Hawaiian Islands and monitoring of these species is conducted by USFWS at Midway, Laysan, and French Frigate Shoals and DOFAW at Kure Atoll. For the Main Hawaiian Islands, seabirds nest mostly on offshore islands and islets, and monitoring of these populations is conducted on some islands by DOFAW as well as by the Offshore Island Restoration Committee, an interagency organization. Seabirds are also monitored in known nesting areas on managed lands and by DOFAW's twice annual statewide waterbird surveys. Citizen monitoring occurs via the Hawaiʻi Audubon counts. Additionally, the USFWS has developed a Pacific Region Seabird Conservation Plan that also details monitoring needs at a larger scale and addresses inter-state and international levels. Elements of monitoring from these plans are currently being developed for implementation; however, the full range of monitoring recommendations has yet to be implemented. DOFAW has been awarded a grant to support future collaboration with other U.S. Pacific Islands for monitoring of shared species such as seabirds.

Migratory shorebirds and waterfowl
Regular migrants are monitored under existing programs already mentioned for other avian species groups. Examples include DOFAW's twice annual statewide waterbird surveys, Hawaiʻi Audubon counts, and monitoring occurring on various managed lands. Additionally, the USFWS has developed a Pacific Islands Regional Shorebird Conservation Plan that also details monitoring needs at a larger scale that addresses inter-state and international levels. Elements of monitoring from these plans are currently being developed for implementation; however, the full range of monitoring recommendations has yet to be implemented. DOFAW has been awarded a grant to support future collaboration with other U.S. Pacific Islands for monitoring of shared species such as migratory shorebird and waterfowl species.

Northwestern Hawaiian Islands passerines and waterbird
Given the small population levels and restricted range of these species, monitoring of these species is intensively conducted by the USFWS through the National Wildlife Refuge system. In addition, monitoring associated with translocation programs for several of these species provide further information relating to species distribution, abundance, and condition. A USFWS Draft Revised Recovery Plan for the Laysan duck (*Anas laysanensis*) also exists, from which some monitoring elements are implemented.

Terrestrial invertebrates

In contrast to the limited, but relatively consistent monitoring of terrestrial vertebrates, terrestrial invertebrate populations are not adequately monitored. Sixty to 80 percent of Hawaii's invertebrate species have yet to be surveyed. Limited baseline densities have been obtained for some taxa in a few locations. Inventories of some areas have been conducted by the Bishop Museum. Some surveys and monitoring have been conducted for certain threatened and endangered species on U.S. Army lands at Mākua, at the Nature Conservancy's Honouliuli Preserve, within certain DOFAW Natural Area Reserves and Wildlife Sanctuaries, and on National Park and National Wildlife Refuge lands. Surveys have also been conducted by academic researchers. USFWS draft recovery plans exist for O'ahu tree snails (*Achatinella* spp.), Blackburn's sphinx moth (*Manduca blackburni*), and the Kaua'i cave arthropods (*Adelocosa anops* and *Spelaeorchestia koloana*). The challenge of adequately monitoring terrestrial invertebrates lies in the sheer number of species (over 5,000) that exist in Hawai'i, the fact that these species are quite small (averaging less than five millimeters in size), and the limited number of individuals trained to identify these species. Efforts are currently being discussed as to the best approach for monitoring of these species (e.g., monitoring for species' suites in habitats) along with possible development of a statewide terrestrial invertebrates strategy.

Plants and algae
There is no systematic monitoring of rare plant populations. Instead, various land managers individually monitor the status of the plants on their lands. In highly managed areas, the existence and condition of rare plants may be well known (e.g., rare plants within fenced enclosures in a Natural Area Reserve or rare plants within Special Ecological Units in a National Park). For more remote or less actively managed areas under protection (e.g., Forest Reserves), there may be historical surveys indicating the previous existence of rare plants, but their current status is unknown. Finally, information regarding rare plant distribution or abundance is not always shared with the Hawai'i Biodiversity and Mapping Program (formerly the Hawai'i Natural Heritage Program) and may remain solely within the control of the land management agency. The USFWS has established a Hawai'i and Pacific Plants Recovery Coordinating Committee which recently completed a third draft of an Integrated Plan for the Conservation of Hawaii's Unique Plants and Their Ecosystems. This Draft Plan recognizes the importance of monitoring for rare plant conservation and identifies areas needing further field surveys to determine the current status of rare plants, totaling approximately 13 percent of the State (202,000 hectares or 500,000 acres). Marine algae are only systematically monitored in the Northwestern Hawaiian Islands by the National Oceanic and Atmospheric Administration (NOAA). There is no monitoring for the two marine plants or freshwater algae.

Freshwater species
The State Division of Aquatic Resources (DAR) surveys some streams across Hawai'i for monitoring and management purposes. Surveys include information on native and non-native species of fish, crustaceans, mollusks, insects and algae. However, there is no systematic survey of freshwater species.

Anchialine-pond fauna
Although assessments of many anchialine pond fauna and habitat have occurred over the years, no systematic monitoring takes place.

Marine species

Sea turtle nesting and monk seal pupping are monitored by NOAA. The Hawaiian Islands Humpback Whale National Marine Sanctuary is responsible for long-term monitoring of humpback whales in Hawaiʻi. NOAA and the Western Pacific Fisheries Management Council monitor commercial fisheries species. DAR monitors fishes in Marine Life Conservation Districts and other marine managed areas and surveys people for gamefish catch. Species-specific programs are in place for ulua, bottomfishes, and precious corals. Reefcheck and other volunteer organizations gather data on reef fishes. However, no systematic surveys exist for non-commercially regulated marine invertebrates and deep water species.

HABITAT MONITORING

The underlying philosophy concerning habitat monitoring is to preserve native habitats and monitor for area coverage and quality of intactness. Monitoring of the ten terrestrial habitat types outlined in Chapter 3 is conducted on managed lands through existing management plans for these areas. Most management entities monitor habitat as it relates to native habitat preservation and restoration, rare plant management, threats such as encroachment by invasive species (e.g., plants, mammalian predators, or ungulates), or management actions such as ungulate removal and fencing. Additionally, habitat monitoring related to species specific needs as outlined in USFWS draft recovery plans also exists. For many of these managed areas and species, habitat monitoring centers on threat assessments for invasive plants, ungulates, and wildfires. Managed areas with existing management plans and monitoring efforts are discussed in Chapters 5 and 6 in the Management Needs sections.

For habitats that are not in managed areas or recovery plans, the land coverage analysis developed by the Hawaiʻi Gap Analysis Program (HI-GAP) will be an essential tool for monitoring habitats once completed. However, monitoring gaps will exist for habitats such as streams, lava tube and cave systems, and anchialine ponds that are not identified by HI-GAP due to technological limitations related to mapping of these habitats.

DAR monitors selected stream areas and lakes while the State Department of Health and the U.S. Environmental Protection Agency monitor water quality. NOAA monitors coral reefs in the Northwestern Hawaiian Islands and collaborates with DAR to monitor less accessible areas of the Main Hawaiian Islands. DAR monitors many coral reef areas in the Main Hawaiian Islands. The Coral Reef Assessment and Monitoring Program (CRAMP), a multi-agency and University of Hawaiʻi collaboration, monitors other coral reef areas. NOAA and the Western Pacific Fisheries Management Council must ensure areas designated as "Essential Fish Habitat" for managed commercial fisheries are not harmed. Monitoring programs are beginning for this relatively new legislative requirement. Currently, there is no monitoring of estuaries, sandy bottoms, and pelagic habitats.

Additional habitat monitoring efforts include systematic invasive species monitoring conducted by the Invasive Species Committees on each island for targeted species, and project-based monitoring conducted in connection with various work, such as the vegetation monitoring along forest bird transects.

MONITORING NEEDS AND RECOMMENDATIONS

Though Hawai‘i has a foundation for monitoring of species and habitats, this foundation needs to be expanded by strengthening existing efforts and developing new ones. Specific monitoring needs at the taxa level are identified in Chapter 7 and at the habitat level in Chapters 5 and 6 in the Management Needs sections. Additionally, monitoring needs are also outlined in Chapter 4 in the threats and statewide objectives and strategies sections.

However, this section addresses specific monitoring gaps for species groupings as well as statewide initiatives. Where new efforts are required, the approach will be to focus on relevant, realistic, and effective monitoring and evaluation that is cost-effective, sustainable, and has minimal adverse impacts on native ecosystems. The recommendations are as follows:

DEVELOP MONITORING WORKING GROUP

The establishment of a statewide monitoring working group to facilitate the development and implementation of recommended monitoring actions will provide a valuable vehicle to guide monitoring of species and habitats in the State. The statewide monitoring working group would be responsible for identifying monitoring gaps, prioritizing needs, developing strategies and recommended actions to address monitoring issues, and guiding implementation of monitoring actions.

IMPROVE MONITORING FOR ALL TAXA

The following monitoring needs, based on the species' groupings discussed in the taxon monitoring section, are listed in order from those groups with no systematic monitoring to those needing improved monitoring efforts. Most terrestrial invertebrate populations are neither well-characterized nor adequately monitored. Coordinated efforts are needed to develop and implement plans to increase inventory and monitoring statewide. Taxa requiring these efforts include terrestrial arthropods, land snails, anchialine pond species, non-coral and non-regulated marine invertebrates, and deep water species. For host-specific terrestrial invertebrates, rare plant surveys are necessary. For the fishes and aquatic invertebrates, systematic monitoring needs to be expanded to all important watersheds and areas. For plants, coordination of different efforts and development of survey priorities is needed. For anchialine pond fauna, monitoring of populations and distribution in known and likely habitats should continue as well as development of quantitative survey methods and methods to monitor associated interstitial and hypogeal habitats. For the bat, established methods and protocols for larger scale monitoring of bat populations are needed. For avian species, improvements are needed to expand scope, frequency, data management and analysis, and reporting (e.g., demographic data that will allow the construction of population models, reproductive data that will allow the determination of greatest threat to productivity). For migratory species such as shorebirds, marine mammals, marine reptiles, and seabirds, monitoring needs to be coordinated at regional and international levels.

Development of standardized survey methods, particularly for inadequately monitored species, should explore the use of cost-effective partnerships with landowners, volunteers, and citizen monitoring programs, such as the Audubon Christmas bird count, community-based monitoring in marine areas, and educational programs.

IMPROVE MONITORING FOR ALL HABITATS

Priority habitat monitoring needs are to support monitoring efforts already underway, to identify additional informational needs, and to expand resources for increased monitoring at appropriate geographic and spatial levels. Additionally, for habitats in less-managed areas, mechanisms need to be identified to monitor the quantity and quality of these habitats and the importance of these habitats to species' survival. Other habitats that need consistent monitoring include anchialine pools, tidepools, sandy bottom habitats, and deep water habitats. Monitoring of land use adjacent to stream channels is also needed.

IMPROVE ECOSYSTEM MONITORING

One goal for managers is to go beyond post-hoc monitoring towards ecological prediction and forecasting. Though most monitoring is conducted on a species and habitat level, some additional monitoring occurs for abiotic factors and the emergent properties of ecosystems. More attention needs to be focused on these levels, integrating information from different sources to evaluate trends and assess threats or conservation actions. For example, comprehensive habitat monitoring will need to consider integration of indicators of global climate change. Similarly, the use of remote sensing and indicators of ecosystem properties needs to be better utilized. For terrestrial monitoring, a related issue of improving integration of monitoring is encouraging the use of inter-disciplinary teams in fieldwork (e.g., including botanists and entomologists during forest bird surveys).

DEVELOP STANDARDIZED MONITORING PROTOCOLS

Due to insufficient coordination, non-standardized monitoring efforts exist that affect comparisons among sites and the ability to estimate the size and trend of species' abundance. There is a lack of appropriate data management at appropriate geographic scales, and monitoring at the island and statewide levels is typically non-existent and a critical gap. The first step is to develop standardized monitoring protocols that will allow data collected by researchers, managers, and landowners to analyze island and statewide trends. Existing efforts that can assist this process (but need additional coordination) are the recently developed Inventory and Monitoring program developed by the National Park Service, Pacific Basin Information Node, Hawai‘i Forest Bird Interagency Database Project, the Hawai‘i Biodiversity and Mapping Program (formerly the Hawai‘i Natural Heritage Program), and HI-GAP. Nationwide initiatives such as the U.S. Geological Service's (USGS) monitoring locator and protocols library can help provide information on monitoring and inventorying protocols. The establishment of a statewide monitoring working group will facilitate the development of this initiative.

FACILITATE INFORMATION SHARING STATEWIDE

Effective monitoring of species or habitats often requires cooperation between adjacent landowners to determine what is happening to the population without regard to property boundaries. Support and participation in existing forums, such as the Hawai‘i Conservation Conference, the biennial aquatics conference, and the annual Watershed Partnership Symposium, and the development of new forums on specific topics as needed provide opportunities for the sharing of information and enhance the ability for adaptive management.

IMPLEMENTATION OF HAWAII'S CWCS

Implementation of certain elements of Hawaii's CWCS has already begun. As outlined in Chapters 5 and 6 in the discussion on current management of species and habitats, multiple partners in conservation are already taking actions that protect Hawaii's Species of Greatest Conservation Need and implement the CWCS. These efforts will be continued and enhanced where possible during implementation of the CWCS using a variety of funding sources.

In the coming years, the State Wildlife Grants (SWG) program will specifically fund projects to implement the following objectives:

1) Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive:

- Urban wetland restoration on O'ahu;
- Sanctuary perimeter fencing repair and maintenance on Maui;
- Seabird habitat management on Lāna'i.

2) Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication:

- Predator control for O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*) and seabirds on O'ahu.

3) Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs:

- Analysis of information from statewide forest bird surveys to determine population status and trends;
- Endangered forest bird research and management on Maui, Kaua'i, O'ahu, and Hawai'i;
- Surveys for nest colony locations of 'ua'u (*Pterodroma sandwichensis* [Hawaiian petrel]) and 'a'o (*Puffinus auricularis newelli* [Newell's shearwater]);
- Research on Blackburn's sphinx moth (*Manduca blackburni*) populations.

In addition, other sources of State and Federal funding are being used to address all seven objectives in the next fiscal year. For example, the State Natural Area Reserves fund supports management of existing Natural Area Reserves and watershed management projects, and the State Legislature included a line-item of four million dollars in the State budget for each of Fiscal Years 2005 and 2006 to address invasive species issues. Federal funds through grant programs administered by the USFWS, NOAA, U.S. Environmental Protection Agency, and Natural Resources Conservation Service are used to protect habitat and control invasive species. A variety of funding sources are used to support research and outreach efforts.

Once the Strategy is approved, one of the first steps for implementation will be to identify existing efforts that can be expanded and key partners willing to take the lead on implementing specific strategies and identifying needed conservation actions. Building on this first step, Hawaii's CWCS will be incorporated into overall DOFAW management as part of implementation. Additionally, in evaluating potential DOFAW funded projects outside of SWG, Hawaii's CWCS will be incorporated as an evaluation criteria (e.g., will this project accomplish one or more objectives as outlined by the CWCS?) to further enable effective implementation of the CWCS.

ADAPTIVE MANAGEMENT AND THE TEN-YEAR REVISION

Evaluation of Hawaii's CWCS is linked to practicing adaptive management. Adaptive management results in effective monitoring and evaluation of the Strategy because it allows for structured learning by doing and altering strategies in response to changing circumstances (e.g., political, environmental, economic, etc.) to ensure success in achieving conservation objectives. It is also important to recognize that there are barriers to implementation that must be accounted for as part of adaptive management. Institutional barriers include the slow nature of changing policy and regulations, difficulties in getting conservation tools approved in a timely manner, and special interests preventing implementation of needed conservation actions.

As a part of the adaptive management process, the State DOFAW and DAR will jointly conduct annual reviews to assess Hawaii's CWCS and determine if any changes need to be made. This review will include consideration of potential additions or removals to the list of Species of Greatest Conservation Need, identification of new or altered threats, review of recent surveys, data, research, evaluation of the effectiveness of conservation actions, and consideration of issues that are preventing implementation of the CWCS. This annual review will also include the annual process of determining priorities for utilizing SWG funding. The CWCS website and partner contact database are tools that will be used to update and continue the engagement of partners in implementing, monitoring, and evaluating Hawaii's CWCS.

Part of measuring the success of and adaptively managing Hawaii's CWCS also includes the formal ten-year revision. The ten-year review and revision will be initiated by the Department of Land and Natural Resources and will involve many of the same steps as the first iteration of the Strategy - comprehensive review of management plans and research, working closely with partners, and engaging the public. In addition, ongoing monitoring and the annual reviews by DOFAW and DAR will assist in identifying necessary revisions. The ten-year revision should begin no later than fall 2013, with one year devoted to a full review of the Strategy, first internally then with partners and interested parties. This review will consist of analyzing the strengths and weaknesses of the initial CWCS, identifying barriers that prevented successful implementation, updating species and habitat information, assessing and updating the primary threats, and evaluating the continued viability of the identified conservation objectives and strategies. The second year should focus on revising the Strategy, again with partners and interested parties. The ten-year revision will provide the opportunity for continued adaptive management to ensure preservation of Hawaii's Species of Greatest Conservation Need and native habitats and to expand the vision of *malama ʻāina* (protecting the land) for future generations.

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GLOSSARY

Ahupua'a: land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by the image of a pig (*pua'a*), or because the pig or other tribute was laid on the altar as a tax to the chief.

Ballast Water: water carried in ballast tanks in the hold of ships to help keep the ship stable. Water is usually discharged and taken up in port, which can facilitate the spread of invasive species.

Biological Diversity or Biodiversity: the variety of all biological life – plants, animals, fungi, and microorganism – and the ecosystems on land or in water where they live; the diversity of life on earth or in a particular location.

Biological Integrity: defined by the Environmental Protection Agency as "the ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region."

Congener: belonging to the same genus.

Conspecific: belonging to the same species.

Critical Habitat: term defined in the Endangered Species Act. Critical habitat is defined as (1) the specific areas within the geographic area occupied by a species at the time it is listed, on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations and (2) specific areas outside the geographical area occupied by the species at the time it is listed upon a determination that such areas are essential for the conservation of the species. Section 7 of the Endangered Species Act prohibits the destruction or adverse modification of critical habitat with regard to actions carried out, funded, or authorized by a Federal agency.

Depredate: prey on.

Ecosystem: an ecological unit that is composed of interacting organisms in their environment.

Endemic: adjective or noun used to describe species found only within a specified region or locality and thus unique to that area.

Epiphytes: a plant growing on another plant for support or anchorage rather than for water or nutrients.

Euryhaline: adjective indicating ability to tolerate a large range of salinities.

Eutrophication: water pollution caused by excessive nutrients that stimulate excessive plant growth.

Extant: alive, existing, not extinct.

Extirpate: not existing, extinct, wipe out or destroy completely.

Feral: adjective used to describe domesticated animal that has reverted to an untamed state.

Habitat: the area or type of environment where an organism or a biological population lives or occurs.

Holotype: the single specimen for which a species is named and described.

Hull Fouling: the attachment and/or colonization of ship hulls by organisms such as barnacles and mussels; can be a major vector for invasive species introduction.

Hypogeal: underground. Used to describe the underground, water-filled spaces where anchialine fauna live in addition to anchialine ponds.

Indigenous: species that occur naturally in a particular area (e.g., not introduced by humans or human activity). All endemic species are considered indigenous species; however, the term “indigenous” is sometimes used to describe native species that are not endemic or whose endemic status is unknown.

Interstitial: space between structures. Used to refer to the spaces where anchialine fauna are found in the hypogeal environment.

Introduced Species: species that do not arrive into ecosystems through natural means (e.g., air, wind, water, animals), but through human-assisted activities. The terms “alien,” “non-native,” or “exotic” species may also be used interchangeably with introduced species.

Invasive Species: an animal pest or weed that negatively impacts indigenous species and ecosystems.

Kupuna: grandparent, ancestor, relative or close friend of the grandparent's generation, grandaunt, granduncle.

Loʻi: irrigated terrace, especially for taro, but also for rice: paddy.

Maui Nui: the islands of Molokaʻi, Lānaʻi, Maui, and Kahoʻolawe.

Native: species that occur naturally in a particular area (e.g., not introduced by humans or human activity). The term “native” is commonly used to describe both endemic and non-endemic indigenous species.

Niche: the function or role of an organism in an ecosystem or the habitat an organism occupies in the ecosystem.

Non-Point Source Pollution: water pollution that comes from many diffuse sources rather than from a specific point, such as an outfall pipe, and is often the result of human activities.

Phenology: temporal aspects of a species’ biology (e.g., timing of a species’ reproductive cycle).

Philopatry: the characteristic of remaining near or returning to a particular area (e.g., natal territory). Used to describe species that tend to remain in, or return to, their home area.

Phytophagous: same as herbivorous (plant eating), but often associated with insects that pierce and suck liquids from plants.

Phytoremediation: the process of cleaning up pollutants especially in water or soil using plants.

Point Source Pollution: pollution from any discernible, confined, or discrete conveyance from which pollutants are or may be discharged, including, (but not limited to) pipes, ditches, channels, tunnels, conduits, wells, containers, rolling stock, concentrated animal feeding operations, or vessels.

Precocial: offspring that exhibit a high level of independent activity from hatching. Usually applies to birds or mammals.

Recovery Habitat: term used by the U.S. Fish and Wildlife Service for areas identified in Recovery Plans and determined to be necessary for long-term survival and recovery of endangered species.

Shield Volcano: defined by the U.S. Geological Service to refer to volcanoes with broad, gentle slopes, built by the eruption of fluid basalt lava.

Species: a group of closely related, interbreeding organisms that produce fertile offspring.

Stochastic: unpredictable or by chance.

Subsidence: the downward movement of the earth’s surface in relation to a reference point such as sea level.

Taxa (plural of taxon): groupings of organisms given formal taxonomic names such as species, genus, family, etc.

Ungulates: hooved animals such as cattle, goats, deer, sheep, and pigs.

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[1] The Hawai‘i Natural Heritage Program is dependent on the research and observations of many scientists and individuals. In most cases this information is not the result of comprehensive site-specific field surveys, and is not confirmed by the Heritage staff. Many areas in Hawai‘i have never been thoroughly surveyed, and new plants and animals are still being discovered. Database information should never be regarded as final statements or substituted for on-site surveys required for environmental assessments. Data provided by the Heritage Program do not represent a position taken by the Center for Conservation Research and Training or The Nature Conservancy of Hawai‘i . Heritage information is only for the intended use of the individual or organization who requested it. It may not be distributed in any way without the consent of the Hawai‘i Natural Heritage Program.

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APPENDIX A: WILDLIFE (FAUNA) SPECIES OF GREATEST CONSERVATION NEED

Species						*Island Distribution (Current (bold) and historic (unbold))*								
Group	Habitat*	Scientific Name	Common Name	Hawaiian Name	Fact sheet	Kauaʻi	Niʻihau	Oʻahu	Molokaʻi	Lānaʻi	Maui	Kahoʻolawe	Hawaiʻi	NWHI
Mammals	T	*Lasiurus cinereus semotus*	Hawaiian hoary bat	ʻōpeʻapeʻa	ʻŌpeʻapeʻa	**X**		**X**	**X**		**X**		**X**	
Forest Birds	T	*Moho braccatus*	Kauaʻi ʻōʻō	ʻōʻō ʻāʻā	Kauaʻi ʻōʻō	X								
Forest Birds	T	*Moho bishopi*	Bishop's ʻōʻō	ʻōʻō	Bishop's ʻōʻō				X		X?			
Forest Birds	T	*Corvus hawaiiensis*	Hawaiian crow	ʻalalā	Hawaiian Crow								X	
Forest Birds	T	*Chasiempis sandwichensis sclateri*	Kauaʻi ʻelepaio	ʻelepaio	Kauaʻi ʻelepaio	**X**								
Forest Birds	T	*Chasiempis sandwichensis ibidis*	Oʻahu ʻelepaio	ʻelepaio	Oahu ʻelepaio			**X**						
Forest Birds	T	*Chasiempis sandwichensis sandwichensis*	Hawaiʻi ʻelepaio	ʻelepaio	Hawaiʻi ʻelepaio								**X**	
Forest Birds	T	*Myadestes myadestinus*	Large Kauaʻi thrush	kāmaʻo	Kāmaʻo	X								
Forest Birds	T	*Myadestes lanaiensis*	Molokaʻi thrush	olomaʻo	Olomaʻo			X?	X	X	X?			
Forest Birds	T	*Myadestes obscurus*	Hawaiʻi thrush	ōmaʻo	Ōmaʻo								**X**	
Forest Birds	T	*Myadestes palmeri*	Small Kauaʻi thrush	puaiohi	Puaiohi	**X**								
Forest Birds	T	*Psittirostra psittacea*	ʻōʻū	ʻōʻū	ʻŌʻū	**X**		X	X	X	X		**X**	
Forest Birds	T	*Loxioides bailleui*	Palila	palila	Palila								**X**	
Forest Birds	T	*Pseudonestor xanthophrys*	Maui parrotbill	kīkēkoa	Maui Parrotbill				X		**X**			
Forest Birds	T	*Hemignathus virens*	Hawaiʻi ʻamakihi	ʻamakihi	Hawaiʻi ʻamakihi				**X**	X	**X**		**X**	
Forest Birds	T	*Hemignathus flavus*	Oʻahu ʻamakihi	ʻamakihi	Oʻahu ʻamakihi			**X**						
Forest Birds	T	*Hemignathus kauaiensis*	Kauaʻi ʻamakihi	alawī kihi	Kauaʻi ʻamakihi	**X**								
Forest Birds	T	*Hemignathus parvus*	Lesser ʻamakihi	ʻanianiau	ʻAnianiau	**X**								
Forest Birds	T	*Hemignathus procerus*	Kauaʻi ʻakialoa	ʻakialoa	Kauaʻi ʻakialoa	X								
Forest Birds	T	*Hemignathus lucidus hanapepe*	Kauaʻi nuku puʻu	nuku puʻu	Kauaʻi nuku puʻu	X								
Forest Birds	T	*Hemignathus lucidus affinis*	Maui nuku puʻu	nuku puʻu	Maui nuku puʻu						X			
Forest Birds	T	*Hemignathus munroi*	ʻakiapōlāʻau	ʻakiapōlāʻau	ʻAkiapōlāʻau								**X**	
Forest Birds	T	*Oreomystis bairdi*	Kauaʻi creeper	ʻakikiki	ʻAkikiki	**X**								
Forest Birds	T	*Oreomystis mana*	Hawaiʻi creeper	none	Hawaiʻi creeper								**X**	
Forest Birds	T	*Paroreomyza maculata*	Oʻahu creeper	ʻalauahio	Oʻahu ʻalauahio			**X**						
Forest Birds	T	*Paroreomyza flammea*	Molokaʻi creeper	kākāwahie	Molokaʻi creeper				X					
Forest Birds	T	*Paroreomyza montana*	Maui creeper	ʻalauahio	Maui ʻalauahio					X	**X**			
Forest Birds	T	*Loxops caeruleirostris*	Kauaʻi ʻākepa	ʻakekeʻe	ʻAkekeʻe	**X**								

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Species						*Island Distribution (Current (bold) and historic (unbold))*								
Group	*Habitat**	*Scientific Name*	*Common Name*	*Hawaiian Name*	*Fact sheet*	*Kaua'i*	*Ni'ihau*	*O'ahu*	*Moloka'i*	*Lāna'i*	*Maui*	*Kaho'olawe*	*Hawai'i*	*NWHI*
Forest Birds	T	*Loxops coccineus ochraceus*	Mau'i 'ākepa	'ākepa	Maui 'ākepa						X			
Forest Birds	T	*Loxops coccineus coccineus*	Hawai'i 'ākepa	'ākepa	'Ākepa								**X**	
Forest Birds	T	*Vestiaria coccinea*	'i'iwi	'i'iwi	'I'iwi	**X**		**X**	**X**	X	**X**	X?	**X**	
Forest Birds	T	*Palmeria dolei*	Crested honeycreeper	'ākohekohe	'Ākohekohe				X		**X**			
Forest Birds	T	*Himatione sanguinea*	'apapane	'apapane	'Apapane	**X**		**X**	**X**	**X**	**X**		**X**	
Forest Birds	T	*Melamprosops phaeosoma*	Po'ouli	po'ouli	Po'ouli						**X**			
Raptors	T	*Buteo solitarius*	Hawaiian hawk	'io	Hawaiian Hawk	X			X				**X**	
Raptors	T	*Asio flammeus sandwichensis*	Hawaiian short-eared owl	pueo	Pueo	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**
Waterbirds	T/F/A	*Nycticorax nycticorax hoactli*	Black-crowned night heron	'auku'u	Black-crowned Night Heron	**X**	**X**	**X**	**X**	**X**	**X**		**X**	
Waterbirds	T/F	*Branta sandvicensis*	Hawaiian goose	nēnē	Hawaiian goose	**X**	X		**X**	X	**X**	X	**X**	
Waterbirds	T/F	*Anas wyvilliana*	Hawaiian Duck	koloa maoli	Hawaiian Duck	**X**	**X**	**X?**	X		**X?**		**X**	
Waterbirds	T/F	*Anas laysanensis*	Laysan Duck	none	Laysan Duck	X		X	X		X		X	**X**
Waterbirds	T/F	*Gallinula chloropus sandvicensis*	Hawaiian common moorhen/gallinule	'alae 'ula	Hawaiian moorhen	**X**	X	**X**	**X?**		X		X	
Waterbirds	T/F	*Fulica alai*	Hawaiian coot	'alae ke'oke'o	Hawaiian coot	**X**	**X**	**X**	**X**	**X**	**X**		**X**	
Waterbirds	T/F/A	*Himantopus mexicanus knudseni*	Hawaiian stilt	ae'o	Hawaiian stilt	**X**	**X**	**X**	**X**	**X**	**X**		**X**	
Seabirds	T	*Phoebastria immutabilis*	Laysan albatross	mōlī	Laysan Albatross	**X**		**X**						**X**
Seabirds	T	*Phoebastria nigripes*	Black-footed albatross	ka'upu	Black-footed Albatross			**X**						**X**
Seabirds	T	*Phoebastria albatrus*	Short-tailed albatross	none	Short-tailed Albatross									**X**
Seabirds	T	*Pterodroma sandwichensis*	Hawaiian petrel	'ua'u	Hawaiian Petrel	**X**		**X**	**X**	**X**	**X**	**X**	**X**	
Seabirds	T	*Pterodroma hypoleuca*	Bonin petrel	none	Bonin Petrel	X		X	X	X	X	X	X	**X**
Seabirds	T	*Bulweria bulwerii*	Bulwer's petrel	'ou	Bulwer's Petrel	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**
Seabirds	T	*Puffinus pacificus*	Wedge-tailed shearwater	'ua'u kani	Wedge-tailed Shearwater	**X**		**X**	**X**	**X**	**X**		**X**	**X**
Seabirds	T	*Puffinus nativitatis*	Christmas shearwater	none	Christmas Shearwater	**X**		**X**						**X**

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Seabirds	T	*Puffinus auricularis newelli*	Newell's shearwater	ʻaʻo	Newell's Shearwater	**X**		**X?**	**X**	**X?**	**X?**		**X**	
Seabirds	T	*Oceanodroma castro*	Band-rumped storm petrel	ʻakēʻakē	Band-rumped Storm Petrel	**X**		X	X	X	**X**	**X**	**X**	
Seabirds	T	*Oceanodroma tristrami*	Tristram's storm petrel	none	Tristram's Storm Petrel									**X**
Seabirds	T	*Phaethon lepturus*	White-tailed tropicbird	koaʻe kea	White-tailed Tropicbird	**X**		**X**	**X**	**X**	**X**		**X**	**X**
Seabirds	T	*Phaethon rubricauda*	Red-tailed tropicbird	koaʻe ʻula	Red-tailed Tropicbird	**X**		**X**		**X**		**X**		**X**
Seabirds	T	*Sula dactylatra*	Masked (blue-faced) booby	ʻā	Masked (blue-faced) Booby			**X**			**X**			**X**
Seabirds	T	*Sula leucogaster*	Brown booby	ʻā	Brown Booby	**X**		**X**						**X**
Seabirds	T	*Sula sula*	Red-footed booby	ʻā	Red-footed Booby	**X**		**X**						**X**
Seabirds	T	*Fregata minor*	Great frigatebird	ʻiwa	Great Frigatebird	**X**		**X**						**X**
Seabirds	T	*Sterna lunata*	Gray-backed tern	pākalakala	Gray-backed Tern			**X**						**X**
Seabirds	T	*Sterna fuscata*	Sooty tern	ʻewaʻewa	Sooty Tern			**X**						**X**
Seabirds	T	*Anous stolidus*	Brown noddy	noio-kōhā	Brown Noddy			**X**			**X**			**X**
Seabirds	T	*Anous minutus*	Black noddy	noio	Black Noddy	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**
Seabirds	T	*Procelsterna cerulea*	Blue-gray noddy	none	Blue-gray Noddy									**X**
Seabirds	T	*Gygis alba*	White (Fairy) tern	manu-o-Kū	White (Fairy) Tern			**X**						**X**
Migratory Birds	T/F	*Anas americana*	American wigeon	none	American Wigeon	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**
Migratory Birds	T/F	*Anas clypeata*	Northern shoveler	koloa mōhā	Northern Shoveler	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**
Migratory Birds	T/F	*Anas acuta*	Northern pintail	koloa māpu	Northern Pintail	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**
Migratory Birds	T/F	*Aythya affinis*	Lesser scaup	none	Lesser Scaup	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**
Migratory Birds	T/F/A	*Pluvialis fulva*	Pacific golden plover	kōlea	Pacific Golden Plover	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

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Migratory Birds	T/F/A	*Heteroscelus incanus*	Wandering tattler	ʻūlili	Wandering Tattler	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Migratory Birds	T/F	*Numenius tahitiensis*	Bristle-thighed curlew	kioea	Bristle-thighed Curlew	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**
Migratory Birds	T/F/A	*Arenaria interpres*	Ruddy turnstone	ʻakekeke	Ruddy Turnstone	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Migratory Birds	T/F	*Calidris alba*	Sanderling	hunakai	Sanderling	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
NWHI passerines	T	*Acrocephalus familiaris kingi*	Nihoa millerbird	none	Nihoa Millerbird									**X**
NWHI passerines	T	*Telespiza cantans*	Laysan finch	none	Laysan finch									**X**
NWHI passerines	T	*Telespiza ultima*	Nihoa finch	none	Nihoa finch									**X**
Invertebrates	T	*Achatinella spp.*	Oʻahu tree snails	none	Oʻahu Tree Snails			**X**						
Invertebrates	T	*Adelocosa anops*	Kauaʻi cave wolf spider	none	Kauai cave arthropods	**X**								
Invertebrates	T	*Spelaeorchestia koloana*	Kauaʻi cave amphipod	none	Kauai cave arthropods	**X**								
Invertebrates	T	*Manduca blackburni*	Blackburn's sphinx moth	none	Blackburn's Sphinx Moth	X		X	X		**X**	**X**	**X**	
Invertebrates - snails	T	Order Archaeogastropoda	Land snails	none	Land snails	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - snails	T	Order Stylommatophora	Land snails	none	Land snails	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	?
Invertebrates - arachnids	T	Order Acari	Mites and Ticks	none	Mites and Ticks	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - arachnids	T	Order Araneae	Spiders	none	Spiders	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	?

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Invertebrates - arachnids	T	Order Pseudoscorpionida	Pseudoscorpions	none	False Scorpions	**X**		**X**			**X**		**X**	**X**
Invertebrates - insects	T	Order Archaeognatha	Bristlethighs	none	Bristlethighs	**X**		**X**	**X**	**X**	**X**		**X**	?
Invertebrates - insects	T	Order Coleoptera	Beetles	none	Beetles	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Collembola	Springtails	none	Springtails	**X**		**X**	**X**	**X**	**X**		**X**	**X**
Invertebrates - insects	T	Order Dermaptera	Earwigs	none	Earwigs	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Diptera	True flies	none	True flies	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Heteroptera	True bugs	none	True bugs	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Homoptera	Aphids, plant hoppers, leaf hoppers, psyllids, whiteflies, mealybugs, scales, etc.	none	Aphids, Hoppers, Whiteflies, Mealybugs, Scale Insects	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Hymenoptera	Ants, bees, and wasps	none	Bees and Wasps	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Lepidoptera	Moths, butterflies, and hyposmocoma	none	Moths and Butterflies	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - insects	T	Order Neuroptera	Lacewings, antlions	none	Lacewings and antlions	**X**		**X**	**X**	**X**	**X**	**X**	**X**	?
Invertebrates - insects	T	Order Odonata	Damselflies, dragonflies	none	Damselflies and Dragonflies	**X**	**X**	**X**	**X**	**X**	**X**		**X**	?
Invertebrates - insects	T	Order Orthoptera	Grasshoppers, crickets, katydids	none	Crickets and Katydids	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**
Invertebrates - insects	T	Order Phthiraptera	Lice	none	Lice			**X**			**X**		**X**	**X**

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Invertebrates - insects	T	Order Psocoptera	Bark Lice, psocids	none	Bark lice and Psocids	**X**		**X**	**X**	**X**	**X**	**X**	**X**	?
Invertebrates - insects	T	Order Siphonaptera	Fleas	none	Fleas									**X**
Invertebrates - insects	T	Order Thysanoptera	Thrips	none	Thrips	**X**		**X**	**X**	**X**	**X**	**X**	**X**	?
Invertebrates - crustaceans	T	Order Isopoda	Pill-bugs, sowbugs	none	Pill-bugs, Sowbugs, Woodlice, Isopods	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - myriapods	T	Order Geophilomorpha	Centipedes	none	Centipedes	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Invertebrates - myriapods	T	Order Lithobimorpha	Centipedes	none	Centipedes			**X**		**X**			**X**	**X**
Invertebrates - myriapods	T	Order Polyxenida	Millipedes	none	Millipedes			**X**						
Invertebrates - myriapods	T	Order Spirostreptida	Millipedes	none	Millipedes	**X**		**X**	**X**	**X**	**X**	**X**		?
Fishes	F	*Awaous guamensis*	none	ʻōʻopu nākea	Awaous guamensis	**X**		**X**	**X**		**X**		**X**	
Fishes	F	*Eleotris sandwicensis*	Hawaiian sleeper	ʻōʻopu akupa	Eleotris sandwicensis	**X**		**X**	**X**		**X**		**X**	
Fishes	F	*Lentipes concolor*	ʻOʻopu alamoʻo	ʻōʻopu alamoʻo	Lentipes concolor	**X**		**X**	**X**		**X**		**X**	
Fishes	F	*Sicyopterus stimpsoni*	ʻOʻopu nōpili	ʻōʻopu nōpili	Sicyopterus	**X**		**X**	**X**		**X**		**X**	
Fishes	F	*Stenogobius hawaiiensis*	ʻOʻopu naniha	ʻōʻopu naniha	Stenogobius	**X**		**X**	**X**		**X**		**X**	
Crustaceans	F	*Atyoida bisulcata*	Mountain ʻōpae	ʻōpae kalaʻole	Mountain Shrimp	**X**		**X**	**X**		**X**		**X**	
Crustaceans	F	*Macrobrachium grandimanus*	Hawaiian prawn	ʻōpae ʻoehaʻa	HI Prawn	**X**		**X**	**X**		**X**		**X**	
Molluscs	F	*Clithon cariosus*	none	pipiwai	Clithon Neritilia	**X**		**X**	**X**		**X**		**X**	
Molluscs	F	*Clithon neglectus*	none	hihiwai, pipipi, pipipi kai, pipipi wai	Clithon Neritilia	**X**		**X**	**X**		**X**		**X**	
Molluscs	F	*Erinna aulacospira*	none	none	Erinna Lymnaea	**X**			**X**		**X**		**X**	
Molluscs	F	*Erinna newcombi*	Newcomb's snail	none	Newcomb's Snail	**X**								
Molluscs	F	*Ferrissia sharpi*	none	none	Ferressia	**X**		**X**						

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Molluscs	F	*Lymnaea producta*	none	none	Erinna Lymnaea	**?**		**?**	**?**		**?**		**?**	
Molluscs	F	*Lymnaea rubella*	none	none	Erinna Lymnaea	**?**		**?**	**?**		**?**		**?**	
Molluscs	F	*Neritina granosa*	none	hīhīwai or wi	Neritina Snails	**X**		**X**	**X**		**X**		**X**	
Molluscs	F	*Neritina vespertina*	none	hapawai or Hapakai	Neritina Snails	**X**		**X**	**X**		**X**		**X**	
Flatworm	F	*Oahuhawaiiana kazukolinda*	none	none	Worms			**X**						
Crustaceans	A	*Calliasmata pholidota*	none	none	Anchialine Shrimp						**X**		**X**	
Crustaceans	A	*Carnarimelita janstocki*	none	none	Anchialine Amphipod								**X**	
Crustaceans	A	*Grandidierella koa*	none	none	Anchialine Amphipod						**X**		**X**	
Crustaceans	A	*Grandidierella palama*	none	none	Anchialine Amphipod						**X**			
Crustaceans	A	*Halocaridina palahemo*	none	none	Anchialine Shrimp								**X**	
Crustaceans	A	*Holocaridina rubra*	none	'ōpae 'ula, 'ōpae hiki	Anchialine Shrimp			**X**	**X**		**X**	**X**	**X**	
Crustaceans	A	*Liagoceradocus lonomaka*	none	none	Anchialine Amphipod						**X**		**X**	
Crustaceans	A	*Metabetaeus lohena*	none	none	Anchialine Shrimp						**X**		**X**	
Crustaceans	A	*Nuuanu amikai*	none	none	Anchialine Amphipod							**X**		
Crustaceans	A	*Palaemonella burnsi*	none	none	Anchialine Shrimp						**X**		**X**	
Crustaceans	A	*Paramoera lokowai*	none	none	Anchialine Amphipod								**X**	
Crustaceans	A	*Paramoera paakai*	none	none	Anchialine Amphipod								**X**	
Crustaceans	A	*Paramoera rua*	none	none	Anchialine Amphipod						**X**			
Crustaceans	A	*Parhyale hawaiensis*	none	none	Anchialine Amphipod						**X**		**X**	

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Crustaceans	A	*Procaris hawaiana*	none	none	Anchialine Shrimp						**X**		**X**	
Crustaceans	A	*Rotomelita ana*	none	none	Anchialine Amphipod						**X**			
Crustaceans	A	*Rotomelita lokoa*	none	none	Anchialine Amphipod								**X**	
Crustaceans	A	*Vetericaris chaceorum*	none	none	Anchialine Shrimp								**X**	
Crustaceans	A	*Antecardina lauensis*	none	none	Anchialine Shrimp						**X**		**X**	
Molluscs	A	*Neritilia hawaiiensis*	Anchialine pond snail	none	Clithon Neritilia	**?**		**?**	**?**		**X**		**X**	
Mammals	M	*Balaenoptera acutorostrata*	Minke whale	none	Baleen Whales									
Mammals	M	*Balaenoptera borealis*	Sei whale	none	Baleen Whales									
Mammals	M	*Balaenoptera edeni*	Bryde's whale	none	Baleen Whales									
Mammals	M	*Balaenoptera musculus*	Blue Whale	none	Baleen Whales									
Mammals	M	*Balaenoptera physalus*	Fin whale	none	Baleen Whales									
Mammals	M	*Eubaleana japonica*	Northern right whale	none	Baleen Whales									
Mammals	M	*Feresa attenuata*	Pygmy killer whale	none	Toothed Whales									
Mammals	M	*Globicephala macrorhynchus*	Short-finned pilot whale	none	Pilot Whale									
Mammals	M	*Grampus griseus*	Risso's dolphin	none	Toothed Whales									
Mammals	M	*Indopacetus pacificus*	Longman's beaked whale	none	Toothed Whales									
Mammals	M	*Kogia breviceps*	Pygmy sperm whale	none	Toothed Whales									
Mammals	M	*Kogia sima*	Dwarf sperm whale	none	Toothed Whales									
Mammals	M	*Lagenodelphis hosei*	Fraser's dolphin	none	Toothed Whales									
Mammals	M	*Megaptera novaeangliae*	Humpback whale	koholā	Humpback Whale									
Mammals	M	*Mesoplodon densirostris*	Blainesville's beaked whale or densebeaked whale	none	Toothed Whales									
Mammals	M	*Monachus schauinslandi*	Hawaiian monk seal	ʻīlio-holo-i-ka-uaua	Monk Seal									
Mammals	M	*Orcinus orca*	Killer whale	none	Toothed Whales									

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Species						Island Distribution (Current (bold) and historic (unbold))								
Group	Habitat*	Scientific Name	Common Name	Hawaiian Name	Fact sheet	Kaua'i	Ni'ihau	O'ahu	Moloka'i	Lāna'i	Maui	Kaho'olawe	Hawai'i	NWHI
Mammals	M	*Peponocephala electra*	Melon-headed whale	none	Toothed Whales									
Mammals	M	*Physeter macrocephalus*	Sperm whale	none	Toothed Whales									
Mammals	M	*Pseudorca crassidens*	False killer whale	none	False Killer Whale									
Mammals	M	*Stenella attenuata*	Spotted dolphin	nai'a	Spotted Dolphin									
Mammals	M	*Stenella coeruleoalba*	Striped dolphin	none	Toothed Whales									
Mammals	M	*Stenella longirostris*	Spinner dolphin	nai'a	Spinner Dolphin									
Mammals	M	*Steno bredanensis*	Rough-toothed dolphin	nai'a	Toothed Whales									
Mammals	M	*Tursiops truncatus*	Pacific bottlenose dolphin	nai'a	Bottlenose Dolphin									
Mammals	M	*Ziphius cavirostris*	Cuvier's beaked whale	none	Toothed Whales									
Reptiles	M	*Caretta caretta*	Loggerhead sea turtle	none	Loggerhead turtle									
Reptiles	M	*Chelonia mydas*	Green sea turtle	honu	Green sea turtle									
Reptiles	M	*Dermochelys coriacea*	Leatherback sea turtle	none	Leatherback turtle									
Reptiles	M	*Eretmochelys imbricata*	Hawksbill sea turtle	none	Hawksbill turtle									
Reptiles	M	*Lepidochelys olivacea*	Olive Ridley Sea Turtle	none	Olive Ridley Turtle									
Reptiles	M	*Pelamis platurus*	Yellow-bellied sea snake	none	Sea snake									
Sharks	M	*Rhincodon typus*	Whale shark	lele wa'a	Sharks and Rays									
Sharks	M	*Carcharodon carcharias*	Great white shark	niuhi	Sharks and Rays									
Rays	M	*Manta alfredi or birostris*	Manta Ray	none	Sharks and Rays									
Fishes	M	*Acromycter alcocki*	none	none	Eels									
Fishes	M	*Ammodytoides pylei*	Pyle's sand lance	none	Active Reef Fishes									
Fishes	M	*Ammolabrus dicrus*	Sand wrasse	none	Sex Changers									
Fishes	M	*Anampses chrysocephalus*	Psychedelic wrasse	none	Sex Changers									
Fishes	M	*Antennarius commersoni*	Commerson's frogfish	none	Cryptic Reef Fishes									
Fishes	M	*Aphareus rutlians*	Lehi	none	Bottomfishes									
Fishes	M	*Apogon maculiferus*	Spotted cardinalfish	'upāpalu	Cryptic Reef Fishes									
Fishes	M	*Apolemichthys arcuatus*	Bandit angelfish	none	Active Reef Fishes									
Fishes	M	*Aprion virescens*	Green jobfish	uku	Bottomfishes									

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Species						*Island Distribution (Current (bold) and historic (unbold))*								
Group	Habitat*	Scientific Name	Common Name	Hawaiian Name	Fact sheet	*Kaua'i*	*Ni'ihau*	*O'ahu*	*Moloka'i*	*Lāna'i*	*Maui*	*Kaho'olawe*	*Hawai'i*	*NWHI*
Fishes	M	*Araiophos gracilis*	none	none	Deep Fishes									
Fishes	M	*Argyripnus brocki*	none	none	Deep Fishes									
Fishes	M	*Aseraggodes borehami*	Boreham's sole	none	Flatfishes									
Fishes	M	*Aseraggodes holcomi*	none	none	Flatfishes									
Fishes	M	*Aseraggodes therese*	Therese's sole	none	Flatfishes									
Fishes	M	*Atherinomorus insularum*	Hawaiian silverside (FAO; Randall, 1996a), Togoro (DLNR)	'iao	Baitfishes									
Fishes	M	*Aulotrachichthys heptalepis*	none	none	Deep Fishes									
Fishes	M	*Bathycongrus aequorea*	none	none	Eels									
Fishes	M	*Bathygadus bowersi*	none	none	Deep Fishes									
Fishes	M	*Bothus thompsoni*	none	none	Flatfishes									
Fishes	M	*Cabillus caudimacula*	none	none	Cryptic Reef Fishes									
Fishes	M	*Caelorinchus doryssus*	none	none	Deep Fishes									
Fishes	M	*Caelorinchus gladius*	none	none	Deep Fishes									
Fishes	M	*Callechelys lutea*	Yellowspotted snake eel	pūhi	Eels									
Fishes	M	*Callionymus caeruleonotatus*	Bluespotted dragonet	none	Cryptic Reef Fishes									
Fishes	M	*Callionymus comptus*	Ornamented dragonet	none	Cryptic Reef Fishes									
Fishes	M	*Callionymus decoratus*	Decorated dragonet	none	Cryptic Reef Fishes									
Fishes	M	*Calotomus zonarchus*	Yellowbar parrotfish	uhu	Parrotfishes									
Fishes	M	*Cantherhines verecundus*	Shy filefish	'o'ili	Active Reef Fishes									
Fishes	M	*Caracanthus typicus*	Hawaiian orbicular velvetfish	none	Cryptic Reef Fishes									
Fishes	M	*Caranx ignobilis*	Giant Ulua or Trevally	ulua aukea	Bottomfishes									
Fishes	M	*Caranx lugubrius*	Black ulua	gunkan	Bottomfishes									
Fishes	M	*Cataetyx hawaiiensis*	none	none	Deep Fishes									

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Group	Habitat*	Scientific Name	Common Name	Hawaiian Name	Fact sheet	Kaua'i	Ni'ihau	O'ahu	Moloka'i	Lāna'i	Maui	Kaho'olawe	Hawai'i	NWHI
Fishes	M	*Centropyge fisheri*	Orange angelfish (AFS), Fisher's angelfish (Hoover, 1993; Randall, 1996a)	none	Active Reef Fishes									
Fishes	M	*Centropyge loricula*	Hawaiian flame angelfish	none	Active Reef Fishes									
Fishes	M	*Chaetodon fremblii*	Bluestriped butterflyfish	kīkākapu	Active Reef Fishes									
Fishes	M	*Chaetodon tinkeri*	Tinker's butterflyfish	none	Active Reef Fishes									
Fishes	M	*Champsodon fimbriatus*	none	none	Deep Fishes									
Fishes	M	*Cheilodactylus vittatus*	Hawaiian morwong	kīkākapu	Active Reef Fishes									
Fishes	M	*Chlorurus perspicilatus*	Spectacled parrtofish	uhu	Parrotfishes									
Fishes	M	*Chromis hanui*	Chocolate-dip chromis	none	Active Reef Fishes									
Fishes	M	*Chromis ovalis*	Oval chromis	none	Active Reef Fishes									
Fishes	M	*Chromis struhsakeri*	Struhsaker's chromis	none	Active Reef Fishes									
Fishes	M	*Cirripectes obscurus*	Gargantuan blenny	pāo'o	Cryptic Reef Fishes									
Fishes	M	*Coris flavovittata*	Yellowstripe coris	hilu	Sex Changers									
Fishes	M	*Coris venusta*	Elegant coris	none	Sex Changers									
Fishes	M	*Cosmocampus balli*	Ball's pipefish	none	Syngnathiformes									
Fishes	M	*Cymolutes lecluse*	Slender razorfish, Hawaiian knifefish (Randall, 1996a; Hoover, 2003), Slender sand wrasse (Hoover, 1993, 2003)	none	Sex Changers									
Fishes	M	*Doryrhamphus baldwini*	Redstripe pipefish	none	Syngnathiformes									
Fishes	M	*Draculo pogognathus*	none	none	Cryptic Reef Fishes									
Fishes	M	*Elops hawaiensis*	Hawaiian ladyfish	awa 'aua	HI Ladyfish									
Fishes	M	*Enchelycore pardalis*	Dragon eel	pūhi-kauila	Eels									
Fishes	M	*Enchelyurus brunneolus*	none	none	Cryptic Reef Fishes									

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Species						Island Distribution (Current (bold) and historic (unbold))								
Group	**Habitat***	**Scientific Name**	**Common Name**	**Hawaiian Name**	**Fact sheet**	**Kaua'i**	**Ni'ihau**	**O'ahu**	**Moloka'i**	**Lāna'i**	**Maui**	**Kaho'olawe**	**Hawai'i**	**NWHI**
Fishes	M	*Encrasicholina purpurea*	Hawaiian anchovy	nehu	Baitfishes									
Fishes	M	*Engyprosopon hawaiiensis*	none	none	Flatfishes									
Fishes	M	*Engyprosopon xenandrus*	none	none	Flatfishes									
Fishes	M	*Enneapterygius atriceps*	Hawaiian triplefin	none	Cryptic Reef Fishes									
Fishes	M	*Entomacrodus marmoratus*	Marbled blenny	pāoʻo	Cryptic Reef Fishes									
Fishes	M	*Entomacrodus strasburgi*	Strasburg's blenny	none	Cryptic Reef Fishes									
Fishes	M	*Epigonus devaneyi*	none	none	Deep Fishes									
Fishes	M	*Epigonus glossodontus*	none	none	Deep Fishes									
Fishes	M	*Epinephelus lanceolatus*	Giant grouper	none	Bottomfishes									
Fishes	M	*Epinephelus quernus*	Hawaiian grouper	hāpuʻu	Bottomfishes									
Fishes	M	*Etelis carbunculus*	Ehu	ulaʻula	Bottomfishes									
Fishes	M	*Etelis coruscans*	Onaga	ulaʻula koaʻe	Bottomfishes									
Fishes	M	*Etmopterus villosus*	Hawaiian lanternshark	none	Deep Fishes									
Fishes	M	*Eurypegasus papilio*	Hawaiian sea moth	none	Syngnathiformes									
Fishes	M	*Eustomias albibulbus*	none	none	Deep Fishes									
Fishes	M	*Eustomias bulbiramis*	none	none	Deep Fishes									
Fishes	M	*Eustomias magnificus*	none	none	Deep Fishes									
Fishes	M	*Eviota rubra*	none	none	Cryptic Reef Fishes									
Fishes	M	*Eviota susanae*	none	none	Cryptic Reef Fishes									
Fishes	M	*Gadella molokaiensis*	none	none	Deep Fishes									
Fishes	M	*Genicanthus personatus*	Masked angelfish	none	Active Reef Fishes									
Fishes	M	*Glossanodon struhsakeri*	none	none	Deep Fishes									
Fishes	M	*Gonorynchus moseleyi*	salmon (AFS), Beaked sandfish (FAO)	none	Deep Fishes									
Fishes	M	*Gorgasia hawaiiensis*	Hawaiian garden eel	pūhi	Eels									
Fishes	M	*Grammonus waikiki*	none	none	Deep Fishes									
Fishes	M	*Gymnothorax nuttingi*	Nutting's moray	none	Eels									
Fishes	M	*Gymnothorax polyspondylus*	Manyvertebrae moray	none	Eels									
Fishes	M	*Gymnothorax steindachneri*	Steindachner's moray	pūhi	Eels									
Fishes	M	*Halicampus edmondsoni*	Edmondson's pipefish	none	Syngnathiformes									

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Fishes	M	*Halieutaea retifera*	none	none	Deep Fishes									
Fishes	M	*Hippocampus fisheri*	Fisher's seahorse	none	Syngnathiformes									
Fishes	M	*Hippocampus histrix*	Spiny seahorse	none	Syngnathiformes									
Fishes	M	*Hippocampus kuda*	Yellow seahorse	none	Syngnathiformes									
Fishes	M	*Hymenocephalus antraeus*	none	none	Deep Fishes									
Fishes	M	*Hymenocephalus tenuis*	none	none	Deep Fishes									
Fishes	M	*Ichthyapus platyrhynchus*	none	none	Eels									
Fishes	M	*Ijimaia plicatellus*	none	none	Deep Fishes									
Fishes	M	*Iniistius umbrilatus*	Blackside razorfish (Hoover, 1993, 2003; Randall, 1996a), Nabeta (DLNR)	lae-nihi	Sex Changers									
Fishes	M	*Iso hawaiiensis*	Hawaiian surf sardine	none	Baitfishes									
Fishes	M	*Istiblennius zebra*	Zebra blenny	pāo'o	Cryptic Reef Fishes									
Fishes	M	*Kuhlia xenura*	Hawaiian flagtail (Hoover, 1993, 2003; Randall, 1996a), Mountain bass (DLNR)	āholehole	Flagtail									
Fishes	M	*Kumba hebetata*	none	none	Deep Fishes									
Fishes	M	*Lepidammodytes macrophthalmus*	none	none	Active Reef Fishes									
Fishes	M	*Linophryne escaramosa*	none	none	Deep Fishes									
Fishes	M	*Liopropoma aurora*	Sunset bass (Hoover, 1994)	none	Sex Changers									
Fishes	M	*Lophiodes bruchius*	none	none	Deep Fishes									
Fishes	M	*Luciobrotula lineata*	none	none	Deep Fishes									
Fishes	M	*Malacocephalus hawaiiensis*	Hawaiian softhead grenadier	none	Deep Fishes									
Fishes	M	*Microbrotula rubra*	none	none	Deep Fishes									
Fishes	M	*Nezumia ectenes*	none	none	Deep Fishes									

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Fishes	M	*Nezumia holocentra*	none	none	Deep Fishes									
Fishes	M	*Ophichthus fowleri*	Fowler's snake eel	none	Eels									
Fishes	M	*Ophichthus kunaloa*	none	none	Eels									
Fishes	M	*Osopsaron incisum*	none	none	Deep Fishes									
Fishes	M	*Ostracion whitleyi*	Whitley''s boxfish	none	Active Reef Fishes									
Fishes	M	*Oxyurichthys heisei*	Ribbon goby	none	Cryptic Reef Fishes									
Fishes	M	*Oxyurichthys lonchotus*	none	none	Cryptic Reef Fishes									
Fishes	M	*Parabothus chlorospilus*	none	none	Flatfishes									
Fishes	M	*Parupeneus porphyreus*	Whitesaddle goatfish (AFS; Hoover, 1993, 2003; Randall, 1996a), Red goat fish (DLNR)	kūmū	Kumu									
Fishes	M	*Physiculus sterops*	none	none	Deep Fishes									
Fishes	M	*Plagiotremus ewaensis*	Ewa blenny	none	Cryptic Reef Fishes									
Fishes	M	*Plagiotremus goslinei*	Scale-eating blenny	none	Cryptic Reef Fishes									
Fishes	M	*Plectroglyphidodon sindonis*	Hawaiian rock damselfish	none	Active Reef Fishes									
Fishes	M	*Pleurosicya larsonae*	none	none	Cryptic Reef Fishes									
Fishes	M	*Poecilopsetta hawaiiensis*	none	none	Flatfishes									
Fishes	M	*Priacanthus meeki*	Hawaiian bigeye	'āweoweo	Active Reef Fishes									
Fishes	M	*Pristipomoides auricillia*	Glodflag jobfish	kali kali	Bottomfishes									
Fishes	M	*Pristipomoides filamentosus*	'Ōpakapaka	none	Bottomfishes									
Fishes	M	*Pristipomoides sieboldi*	Kalekale	none	Bottomfishes									
Fishes	M	*Pristipomoides zonatus*	Gindai	ukikiki	Bottomfishes									
Fishes	M	*Pseudanthias thompsoni*	Hawaiian anthias	none	Sex Changers									
Fishes	M	*Pseudocaranx dentex*	Thick or Pig Ulua	butaguchi	Bottomfishes									
Fishes	M	*Pseudogramma polyacanthum hawaiiensis*	Palespotted podge	none	Sex Changers									
Fishes	M	*Psilogobius mainlandi*	Mainland's goby	none	Cryptic Reef Fishes									

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Fishes	M	*Pterois sphex*	Hawaiian turkeyfish (AFS; Randall, 1996a; Hoover, 2003), Hawaiian lionfish (Hoover, 1993, 2003)	nohu pinao	Cryptic Reef Fishes									
Fishes	M	*Pycnocraspedum armatum*	none	none	Deep Fishes									
Fishes	M	*Saccogaster hawaii*	none	none	Deep Fishes									
Fishes	M	*Samariscus corallinus*	Coralline-red flounder	none	Flatfishes									
Fishes	M	*Scolecenchelys puhioilo*	none	none	Eels									
Fishes	M	*Scorpaena pele*	none	none	Cryptic Reef Fishes									
Fishes	M	*Scorpaenopsis altirostris*	none	none	Cryptic Reef Fishes									
Fishes	M	*Scorpaenopsis brevifrons*	Bigmouth scorpionfish (FAO), Shortnose scorpionfish (Randall, 1996a)	none	Cryptic Reef Fishes									
Fishes	M	*Scorpaenopsis cacopsis*	Titan scorpionfish (Hoover, 1993, 2003; Randall, 1996a), Hogo (DLNR)	nohu	Cryptic Reef Fishes									
Fishes	M	*Scorpaenopsis pluralis*	none	none	Cryptic Reef Fishes									
Fishes	M	*Seriola dumerili*	Amberjack	kahala	Bottomfishes									
Fishes	M	*Solocisquama erythrina*	none	none	Deep Fishes									
Fishes	M	*Sphagemacrurus gibber*	none	none	Deep Fishes									
Fishes	M	*Synagrops argyreus*	none	none	Deep Fishes									
Fishes	M	*Synchiropus hawaiiensis*	none	none	Cryptic Reef Fishes									
Fishes	M	*Synchiropus kinmeiensis*	none	none	Cryptic Reef Fishes									
Fishes	M	*Synodus falcatus*	none	none	Cryptic Reef Fishes									
Fishes	M	*Synodus janus*	none	none	Cryptic Reef Fishes									
Fishes	M	*Taeniopsetta radula*	none	none	Flatfishes									
Fishes	M	*Thamnaconus garretti*	None	none	Active Reef Fishes									

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Fishes	M	*Torquigener randalli*	Randall's puffer	none	Active Reef Fishes									
Fishes	M	Undescribed *Anarchias* species	none	none	Eels									
Fishes	M	Undescribed *Bodianus* species	Hawaiian Pigfish	none	Sex Changers									
Fishes	M	Undescribed *Prognathodes* species	Orange-margin butterflyfish	none	Active Reef Fishes									
Fishes	M	*Ventrifossa ctenomelas*	Hawaiian grenadier	none	Deep Fishes									
Ascideans	M	*Aplidium crateriferum*	Cratered Aplidium	none	Misc Filter Feeders									
Ascideans	M	*Aplidium sp.*	Gold Ring Aplidium	none	Misc Filter Feeders									
Brachiopoda	M	*Lingula reevii*	Brachiopod	none	Misc Filter Feeders									
Bryozoa	M	*Parasmittina sp.*	none	none	Misc Filter Feeders									
Cephalopods	M	*Euprymna scolopes*	Hawaiian Bobtail Squid	mūhe'e	Cephalopods									
Cephalopods	M	*Octopus hawaiiensis*	Hawaiian Octopus	he'e	Cephalopods									
Crustaceans	M	*Aethra edentata*	Flat elbow crab	none	Other Crustaceans									
Crustaceans	M	*Aniculus hopperae*	Hopper's hermit crab	unauna	Other Crustaceans									
Crustaceans	M	*Calcinus hazletti*	Hazlett's hermit crab	unauna	Other Crustaceans									
Crustaceans	M	*Calcinus laurentae*	Laurent's hermit crab	unauna	Other Crustaceans									
Crustaceans	M	*Carpilius maculatus*	7-11 crab	'alakuma	Other Crustaceans									
Crustaceans	M	*Cinetorhynchus hawaiiensis*	Hawaiian hinge-beak shrimp	none	Other Crustaceans									
Crustaceans	M	*Cinetorhynchus hendersoni*	Henderson's hinge-beak shrimp	none	Other Crustaceans									
Crustaceans	M	*Dromia dormia*	Sponge crab	makua-o-ka-lipoa	Other Crustaceans									
Crustaceans	M	*Gnathophyllum precipuum*	Hawaiian cave shrimp	none	Other Crustaceans									
Crustaceans	M	*Hymenocera picta*	Harlequin shrimp	none	Other Crustaceans									
Crustaceans	M	*Levicaris mammilata*	Red Pencil urchin shrimp	none	Other Crustaceans									
Crustaceans	M	*Ligia hawaiensis*	none	none	Other Crustaceans									
Crustaceans	M	*Liomera supernodosa*	Knotted liomera	none	Other Crustaceans									
Crustaceans	M	*Lybia edmondsoni*	Hawaiian pom-pom crab	kū mimi pua	Other Crustaceans									

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APPENDIX A: WILDLIFE (FAUNA) SPECIES OF GREATEST CONSERVATION NEED

Species						*Island Distribution (Current (bold) and historic (unbold))*								
Group	**Habitat***	**Scientific Name**	**Common Name**	**Hawaiian Name**	**Fact sheet**	***Kaua'i***	***Ni'ihau***	***O'ahu***	***Moloka'i***	***Lāna'i***	***Maui***	***Kaho'olawe***	***Hawai'i***	***NWHI***
Crustaceans	M	*Metapenaeopsis sp.*	Bicolor sand shrimp	none	Other Crustaceans									
Crustaceans	M	*Panulirus marginatus*	black leg spiny lobster	ula poni, ula hiwa	Black Spiny Lobster									
Crustaceans	M	*Pseudopalicus oahuensis*	Button crab	none	Other Crustaceans									
Crustaceans	M	*Rhynchocinetes rathbunae*	Rathbun's hinge beaked shrimp	none	Other Crustaceans									
Crustaceans	M	*Stenopus earlei*	Earle's coral shrimp	none	Other Crustaceans									
Molluscs	M	*Acanthochiton viridis*	Green chiton	kuakulu	Chitons									
Molluscs	M	*Aldisa pikokai*	Pitted Nudibranch	none	Nudibranchs									
Molluscs	M	*Ardeadoris scottjohnsoni*	Scott Johnson's Nudibranch	none	Nudibranchs									
Molluscs	M	*Brachidontes crebristriarus*	Hawaiian mussel	nahawele li'ili'i	Bivalves									
Molluscs	M	*Cellana exarata*	Black foot limpet	'opihi makaiauli	Limpets									
Molluscs	M	*Cellana melanostoma*	Green -foot opihi	none	Limpets									
Molluscs	M	*Cellana sandwicensis*	Yellow foot limpet	'opihi 'ālinalina	Limpets									
Molluscs	M	*Cellana talcosa*	Yellow foot limpet	'opihi kō'ele	Limpets									
Molluscs	M	*Charonia tritonis*	Triton's trumpet	pū	Snails									
Molluscs	M	*Chicoreus insularum*	Burnt murex	none	Snails									
Molluscs	M	*Chromodoris vibrata*	Trembling Nudibranch	none	Nudibranchs									
Molluscs	M	*Conus abbreviatus*	Abbreviated cone	pū pū 'alā	Snails									
Molluscs	M	*Cypraea burgessi*	Burgess' cowry	none	Snails									
Molluscs	M	*Cypraea gaskoini*	Gaskoin's cowry	leho	Snails									
Molluscs	M	*Cypraea granulata*	Granulated cowry	leho	Snails									
Molluscs	M	*Cypraea mauiensis*	Maui cowry	leho	Snails									
Molluscs	M	*Cypraea ostergaardi*	none	leho	Snails									
Molluscs	M	*Cypraea rasleighana*	Rashleigh's cowry	leho	Snails									
Molluscs	M	*Cypraea semiplota*	"Half-swimmer" cowry	pū leholeho	Snails									
Molluscs	M	*Cypraea sulcidentata*	Groove-toothed cowry	leho	Snails									
Molluscs	M	*Cypraea tessallata*	Checkered cowry	leho	Snails									
Molluscs	M	*Cypraea tigris*	Tiger cowry	none	Snails									
Molluscs	M	*Duplicaria gouldi*	Gould's Auger	pūpū loloa, 'oi'oi	Snails									

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Species						Island Distribution (Current (bold) and historic (unbold))								
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Molluscs	M	*Epitonium ulu*	Fungiid wentletrap	none	Snails									
Molluscs	M	*Glossodoris poliahu*	Snow-Goddess Nudibranch	none	Nudibranchs									
Molluscs	M	*Halgerda terramtuentis*	Gold Lace Nudibranch	none	Nudibranchs									
Molluscs	M	*Haumea juddi*	Judd's scallop	none	Bivalves									
Molluscs	M	*Hypselodoris andersoni*	Anderson's Nudibranch	none	Nudibranchs									
Molluscs	M	*Ischnochiton petaloides*	Flat chiton	pupu mo'o	Chitons									
Molluscs	M	*Isognomon californicum*	Black purse shells	nahawele	Bivalves									
Molluscs	M	*Melibe megaceras*	Dendronotid	none	Nudibranchs									
Molluscs	M	*Nerita picea*	Black Nerite	pipipi, pipipi kai	Snails									
Molluscs	M	*Nerita plicata*	none	none	Snails									
Molluscs	M	*Nerita polita*	Polished nerite	kūpe'e	Snails									
Molluscs	M	*Peltodoris fellowsi*	Fellow's nudibranch	none	Nudibranchs									
Molluscs	M	*Pinctada margaritifera*	Pearl oyster	pa	Bivalves									
Molluscs	M	*Pteria brunnea*	Winged pearl oyster	none	Bivalves									
Molluscs	M	*Sclerodoris paliensis*	Pali Nudibranch	none	Nudibranchs									
Molluscs	M	*Smaragdia bryannae*	HI sea grass snail	none	Snails									
Molluscs	M	*Strombus vomer hawaiiensis*	Hawaiian Stromb	none	Snails									
Molluscs	M	*Turbo sandwicensis*	Hawaiian Turban	'ailea	Snails									
Molluscs	M F	*Ostrea sandvicensis*	Hawaiian Oyster	none	HI Oyster									
Sponge	M	*Spongia oceania*	none	none	Sponge									
Echinoderm	M	*Actinocidaris thomasi*	Thomas's sea urchin	none	Echinoderms									
Echinoderm	M	*Lissodiadema purpureum*	Fine-spined urchin	none	Echinoderms									
Echinoderm	M	*Lovenia hawaiiensis*	Hawaiian lovenia	none	Echinoderms									
Echinoderm	M	*Mithrodia fisheri*	Fisher's star	none	Echinoderms									
Echinoderm	M	*Stichopus sp.1*	Hawaiian spiny sea cucumber	none	Echinoderms									
Echinoderm	M	*Stichopus sp.2*	Hawaiian yellow-tip sea cucumber	none	Echinoderms									

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Species						Island Distribution (Current (bold) and historic (unbold))								
Group	Habitat*	Scientific Name	Common Name	Hawaiian Name	Fact sheet	Kaua'i	Ni'ihau	O'ahu	Moloka'i	Lāna'i	Maui	Kaho'olawe	Hawai'i	NWHI
Flatworm	M	*Pericelis hymanae Poulter*	Hyman's flatworm	none	Worms									
Flatworm	M	*Pseudobiceros sp. 2*	Hawaiian spotted flatworm	none	Worms									
Annelida	M	*Vermiliopsis torquata*	none	none	Worms									
Nemertea	M	*Baseodiscus cingulatus*	Banded Ribbon Worm	ko'ekai	Worms									
Cnidaria	M	*Acabaria bicolor*	Bicolor Gorgonian	none	Other Anthozoans									
Cnidaria	M	*Acropora cytherea*	Table coral	none	Stony Corals									
Cnidaria	M	*Acropora gemmifera*	none	none	Stony Corals									
Cnidaria	M	*Acropora humilis*	Finger staghorn coral	none	Stony Corals									
Cnidaria	M	*Acropora nasuta*	Branching staghorn coral	none	Stony Corals									
Cnidaria	M	*Acropora paniculata*	Fuzzy table coral	none	Stony Corals									
Cnidaria	M	*Acropora valida*	Bushy Staghorn coral	none	Stony Corals									
Cnidaria	M	*Anacropora sp.*	none	none	Stony Corals									
Cnidaria	M	*Anisopsammia ampheiliodes*	none	none	Stony Corals									
Cnidaria	M	*Anthelia edmondsoni*	Blue soft coral	'okole	Other Anthozoans									
Cnidaria	M	*Anthemiphyllia pacifica*	none	none	Stony Corals									
Cnidaria	M	*Antipathes dichotoma*	Branching Black coral	none	Black Corals									
Cnidaria	M	*Antipathes grandis*	Grand Black coral	'ekaha kū moana	Black Corals									
Cnidaria	M	*Antipathes intermedia*	Small feathery black coral	none	Black Corals									
Cnidaria	M	*Antipathes punctata*	none	none	Black Corals									
Cnidaria	M	*Antipathes subpinnata*	none	none	Black Corals									
Cnidaria	M	*Antipathes undulata*	none	none	Black Corals									
Cnidaria	M	*Balanophyllia desmophylloides*	none	none	Stony Corals									
Cnidaria	M	*Balanophyllia diomedeae*	none	none	Stony Corals									
Cnidaria	M	*Balanophyllia hawaiiensis*	none	none	Stony Corals									
Cnidaria	M	*Balanophyllia laysanensis*	none	none	Stony Corals									
Cnidaria	M	*Balanophyllia sp.*	Oval cup coral	none	Stony Corals									
Cnidaria	M	*Bathyactis hawaiiensis*	none	none	Stony Corals									

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Species						Island Distribution (Current (bold) and historic (unbold))								
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Cnidaria	M	*Caryophyllia alcocki*	none	none	Stony Corals									
Cnidaria	M	*Caryophyllia octopalli*	none	none	Stony Corals									
Cnidaria	M	*Ceratotrochus laxus*	none	none	Stony Corals									
Cnidaria	M	*Cirrhipathes anguina*	Common wire coral	none	Black Corals									
Cnidaria	M	*Cladactella manni*	Mann's Anemone	ʻokole, ʻokola	Other Anthozoans									
Cnidaria	M	*Coscinaraea wellsi*	Wells coral	none	Stony Corals									
Cnidaria	M	*Cyathoceras diomedae*	none	none	Stony Corals									
Cnidaria	M	*Cycloseris fragilis*	Fragile mushroom coral	none	Stony Corals									
Cnidaria	M	*Cycloseris hexagonalis*	Humpback Coral	none	Stony Corals									
Cnidaria	M	*Cyphastrea ocellina*	Ocellated coral	ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Deltocyathus andamanicus*	none	none	Stony Corals									
Cnidaria	M	*Dendrophyllia oahensis*	none	none	Stony Corals									
Cnidaria	M	*Dendrophyllia serpentina*	Serpentine cup coral	none	Stony Corals									
Cnidaria	M	*Desmophyllum cristagallis*	none	none	Stony Corals									
Cnidaria	M	*Diaseris distorta*	Distorted mushroom coral	none	Stony Corals									
Cnidaria	M	*Endopachys oahensis*	none	none	Stony Corals									
Cnidaria	M	*Flabellum deludens*	none	none	Stony Corals									
Cnidaria	M	*Flabellum pavoninum*	none	none	Stony Corals									
Cnidaria	M	*Fungia granulosa*	Granulated mushroom coral	none	Stony Corals									
Cnidaria	M	*Fungia scutaria*	Mushroom coral	ākoʻakoʻakohe	Stony Corals									
Cnidaria	M	*Fungia sp.*	none	none	Stony Corals									
Cnidaria	M	*Gardineria hawaiensis*	none	none	Stony Corals									
Cnidaria	M	*Gardineroseris planulata*	Honeycomb coral	none	Stony Corals									
Cnidaria	M	*Heteractis malu*	HI sand anemone	none	Other Anthozoans									
Cnidaria	M	*Leiopathes glaberrima*	none	none	Black Corals									
Cnidaria	M	*Leptastrea bewickensis*	Bewick coral	none	Stony Corals									
Cnidaria	M	*Leptastrea bottae*	none	ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Leptastrea pruinosa*	Spotted coral	none	Stony Corals									

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Cnidaria	M	*Leptastrea purpurea*	Crust coral	none	Stony Corals									
Cnidaria	M	*Leptastrea transversa*	Transverse coral	none	Stony Corals									
Cnidaria	M	*Leptoseris foliosa*	Foliose coral	none	Stony Corals									
Cnidaria	M	*Leptoseris hawaiiensis*	Hawaiian plate coral	none	Stony Corals									
Cnidaria	M	*Leptoseris incrustans*	Swelling coral	none	Stony Corals									
Cnidaria	M	*Leptoseris myctoseroides*	Ridge coral	none	Stony Corals									
Cnidaria	M	*Leptoseris papyracea*	Papyrus coral	none	Stony Corals									
Cnidaria	M	*Leptoseris scabra*	Rough plate coral	none	Stony Corals									
Cnidaria	M	*Leptoseris tubulifera*	Tube coral	none	Stony Corals									
Cnidaria	M	*Madracis kauaiensis*	none	none	Stony Corals									
Cnidaria	M	*Madracis pharensis*	Hidden orange coral	none	Stony Corals									
Cnidaria	M	*Madrepora kauaiensis*	none	none	Stony Corals									
Cnidaria	M	*Montipora capitata*	Rice Coral	none	Stony Corals									
Cnidaria	M	*Montipora dilatata*	Irregular rice coral	none	Stony Corals									
Cnidaria	M	*Montipora flabellata*	Blue Rice Coral	none	Stony Corals									
Cnidaria	M	*Montipora patula*	Spreading Coral	none	Stony Corals									
Cnidaria	M	*Montipora studeri*	Branching rice coral	none	Stony Corals									
Cnidaria	M	*Montipora tuberculosa*	none	none	Stony Corals									
Cnidaria	M	*Montipora turgescens*	Lumpy rice coral	none	Stony Corals									
Cnidaria	M	*Montipora verrilli*	none	none	Stony Corals									
Cnidaria	M	*Myriopathes cf. japonica*	Dense feathery black coral	none	Black Corals									
Cnidaria	M	*Myriopathes ulex*	Feathery Black coral	none	Black Corals									
Cnidaria	M	*Palythoa psammophilia*	Toadstool Zoanthid	none	Other Anthozoans									
Cnidaria	M	*Palythoa toxica*	Toadstool Zoanthid	none	Other Anthozoans									
Cnidaria	M	*Paracyathus gardineri*	none	none	Stony Corals									
Cnidaria	M	*Paracyathus mauiensis*	none	none	Stony Corals									
Cnidaria	M	*Paracyathus molokensis*	none	none	Stony Corals									
Cnidaria	M	*Paracyathus tenuicalyz*	none	none	Stony Corals									
Cnidaria	M	*Parantipathes*	none	none	Black Corals									

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Cnidaria	M	*Parazoanthus sp.*	none	none	Other Anthozoans									
Cnidaria	M	*Pavona duerdeni*	Flat lobe coral	none	Stony Corals									
Cnidaria	M	*Pavona pollicata*	none	none	Stony Corals									
Cnidaria	M	*Pavona varians*	Corrugated coral	ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Placotrochus fuscus*	none	none	Stony Corals									
Cnidaria	M	*Pocillopora damicornis*	Lace coral	ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Pocillopora eydouxi*	Antler coral	none	Stony Corals									
Cnidaria	M	*Pocillopora ligulata*	Thin cauliflower coral	none	Stony Corals									
Cnidaria	M	*Pocillopora meandrina*	Cauliflower coral	none	Stony Corals									
Cnidaria	M	*Pocillopora molokensis*	Molokai cauliflower coral	none	Stony Corals									
Cnidaria	M	*Porites annae*	Nodule coral	none	Stony Corals									
Cnidaria	M	*Porites bernardi*	False lichen coral	none	Stony Corals									
Cnidaria	M	*Porites brighami*	Brighams coral	none	Stony Corals									
Cnidaria	M	*Porites compressa*	Finger coral	pō haku puna, ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Porites convexa*	Plate and knob coral	none	Stony Corals									
Cnidaria	M	*Porites duerdeni*	Thick finger coral	none	Stony Corals									
Cnidaria	M	*Porites evermanni*	Evermann's coral	pō haku puna, ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Porites lichen*	Lichen coral	none	Stony Corals									
Cnidaria	M	*Porites lobata*	Lobe coral	pō haku puna, ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Porites pukoensis*	none	none	Stony Corals									
Cnidaria	M	*Porites rus*	Plate and Pillar Coral	none	Stony Corals									
Cnidaria	M	*Porites solida*	Solid coral	none	Stony Corals									
Cnidaria	M	*Porites studeri*	Deep lobe coral	none	Stony Corals									
Cnidaria	M	*Psammocora explanulata*	Flat coral	none	Stony Corals									
Cnidaria	M	*Psammocora haimeana*	Haime's lump coral	none	Stony Corals									
Cnidaria	M	*Psammocora nierstraszi*	Nierstrasz''s coral	none	Stony Corals									

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Cnidaria	M	*Psammocora stellata*	Stellar coral	ʻākoʻakoʻa	Stony Corals									
Cnidaria	M	*Psammocora superficialis*	Superficial coral	none	Stony Corals									
Cnidaria	M	*Psammocora verrilli*	Verril's lump coral	none	Stony Corals									
Cnidaria	M	*Rhizopsammia verrilli*	Verrill's lump coral	none	Stony Corals									
Cnidaria	M	*Schizopathes conferta*	none	none	Black Corals									
Cnidaria	M	*Sinularia molokaiensis*	Hawaiian Leather Coral	none	Other Anthozoans									
Cnidaria	M	*Stephanophyllia formosissima*	none	none	Stony Corals									
Cnidaria	M	*Stichopathes cf. echinulata*	Red wire coral	none	Black Corals									
Cnidaria	M	*Tethocyathus minor*	Tiny cup coral	none	Stony Corals									
Cnidaria	M	*Trochocyathus oahensis*	none	none	Stony Corals									
Cnidaria	M	*Tubastraea coccinea*	Colonial cup coral	none	Stony Corals									
Cnidaria	M	*Tubastraea diaphana*	Black cup coral	none	Stony Corals									
Cnidaria	M	*Zoanthus kealakekuaensis*	Green mat Zoanthid	none	Other Anthozoans									

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Abutilon	*eremitopetalum*				X	X	
Abutilon	*menziesii*				X		
Abutilon	*sandwicense*				X		
Acacia	*koa*			koa			X
Acacia	*koaia*			koaia; koa oha			X
Acaena	*exigua*				X		
Achyranthes	*mutica*				X		
Achyranthes	*splendens*	var.	*rotundata*		X		
Adenophorus	*periens*				X		
Alectryon	*macrococcus*	var.	*auwahiensis*	mahoe	X	X	
Alectryon	*macrococcus*	var.	*macrococcus*		X		
Alphitonia	*ponderosa*			kauila			X
Alyxia	*oliviformis*			maile			X
Amaranthus	*brownii*				X	X	
Antidesma	*platyphyllum*			hame			X
Argyroxiphium	*kauense*				X		
Argyroxiphium	*sandwicense*	subsp.	*sandwicense*	'ahinahina	X		X
Argyroxiphium	*sandwicense*	subsp.	*macrocephalum*	'ahinahina	X		X
Asplenium	*peruvianum*	var.	*insulare*		X		
Astelia	*menziesiana*			pa'iniu			X
Astelia	*waialealae*			pa'iniu	X	X	
Athyrium	*microphyllum*			'akolea			X
Bidens	*campylotheca*	subsp.	*waihoiensis*		X		
Bidens	*hillebrandiana*	subsp.	*hillebrandiana*	ko'oko'olau		X	
Bidens	*micrantha*	subsp.	*ctenophylla*		X		
Bidens	*micrantha*	subsp.	*kalealaha*		X		
Bidens	*spp.*			kokolau, ko'oko'olau			X
Bidens	*wiebkei*				X		
Bobea	*elatio*			ahakea			X
Bobea	*mannii*			ahakea			X
Boehmeria	*grandis*						X
Bolboschoenus	*maritimus*	subsp.	*paludosus*				X
Bonamia	*menziesii*				X		
Brighamia	*insignis*			'olulu	X	X	
Brighamia	*rockii*				X		
Broussaisia	*arguta*			kanawao			X
Caesalpinia	*kavaiensis*			uhiuhi	X		X
Canavalia	*molokaiensis*				X		

*X=Endangered, Threatened, Candidate, Proposed Endangered
**X=fewer than 50 individuals in the wild
***X=important habitat or dominant plant in community

Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Canavalia	*pubescens*				X		
Canthium	*odoratum*			alahe'e			X
Capparis	*sandwichiana*			maiapilo			X
Carex	*alligata*						X
Carex	*spp.*			sedge			X
Cenchrus	*agrimonioides*	var.	*agrimonioides*		X		
Centaurium	*sebaeoides*				X		
Chamaesyce	*celastroides*	var.	*kaenana*	'akoko	X		X
Chamaesyce	*deppeana*				X		
Chamaesyce	*eleanoriae*					X	
Chamaesyce	*halemanui*				X		
Chamaesyce	*herbstii*				X		
Chamaesyce	*kuwaleana*				X		
Chamaesyce	*olowaluana*			akoko			X
Chamaesyce	*rockii*				X		
Chamaesyce	*skottsbergii*	var.	*skottsbergii*		X		
Charpentiera	*obovata*			papala			X
Charpentiera	*spp.*			papala			X
Cheirodendron	*platyphyllum*			lapalapa			X
Cheirodendron	*trigynum*			'olapa			X
Chenopodium	*oahuense*			'aweoweo			X
Cibotium	*chamissoi*			hapu'u			X
Cibotium	*glaucum*			hapu'u			X
Cibotium	*spp.*			hapu'u			X
Cladium	*jamaicense*			'uki			X
Claoxylon	*sandwicense*			pooloa			X
Clermontia	*clermontioides*			ohawai			X
Clermontia	*drepanomorpha*				X		
Clermontia	*fauriei*			haha'aiakamanu			X
Clermontia	*lindseyana*				X		
Clermontia	*oblongifolia*	subsp.	*brevipes*	'oha wai	X	X	
Clermontia	*oblongifolia*	subsp.	*mauiensis*	'oha wai	X	X	
Clermontia	*peleana*	subsp.	*peleana*	'oha wai	X	X	
Clermontia	*pyrularia*			'oha wai	X	X	
Clermontia	*samuelii*	subsp.	*hanaensis*		X		
Clermontia	*samuelii*	subsp.	*samuelii*		X		
Clermontia	*spp.*			oha, 'oha wai, haha, oha kepau			X
Colubrina	*oppositifolia*				X		

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Coprosma	*elliptica*			pilo			X
Coprosma	*ernodeoides*			kukainene			X
Coprosma	*kauensis*			pilo			X
Coprosma	*menziesii*			pilo			X
Coprosma	*montana*			pilo			X
Coprosma	*ochracea*			pilo			X
Coprosma	*pubens*			pilo			X
Coprosma	*rhynchocarpa*			pilo			X
Coprosma	*spp.*			pilo			X
Cryptocarya	*mannii*			holio			X
Ctenitis	*squamigera*				X		
Cyanea	*acuminata*				X		
Cyanea	*asarifolia*			haha	X	X	
Cyanea	*asplenifolia*				X		
Cyanea	*copelandii*	subsp.	*copelandii*		X		
Cyanea	*copelandii*	subsp.	*haleakalaensis*		X		
Cyanea	*crispa*				X	X	
Cyanea	*dunbariae*			haha	X	X	
Cyanea	*eleeleensis*			haha	X	X	
Cyanea	*gibsonii*			haha	X	X	
Cyanea	*glabra*			haha	X	X	
Cyanea	*grimesiana*	subsp.	*grimesiana*	haha	X	X	
Cyanea	*grimesiana*	subsp.	*obatae*	haha	X	X	
Cyanea	*hamatiflora*	subsp.	*carlsonii*	haha	X	X	
Cyanea	*hamatiflora*	subsp.	*hamatiflora*		X		
Cyanea	*horrida*			haha		X	
Cyanea	*humboldtiana*				X		
Cyanea	*koolauensis*				X		
Cyanea	*kuhihewa*			haha	X	X	
Cyanea	*lobata*	subsp.	*lobata*	haha	X	X	
Cyanea	*longiflora*				X		
Cyanea	*magnicalyx*			haha		X	
Cyanea	*mannii*				X		
Cyanea	*mceldowneyi*				X		
Cyanea	*munroi*			haha		X	
Cyanea	*obtusa*			haha	X	X	
Cyanea	*pinnatifida*			haha	X	X	
Cyanea	*platyphylla*			'aku'aku	X	X	

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Cyanea	*procera*			haha	X	X	
Cyanea	*profuga*			haha		X	
Cyanea	*purpurellifolia*			haha		X	
Cyanea	*recta*				X		
Cyanea	*remyi*				X		
Cyanea	*rivularis*				X		
Cyanea	*sessilifolia*				X		
Cyanea	*shipmanii*			haha	X	X	
Cyanea	*solanacea*			popolo, haha nui		X	
Cyanea	*spp.*						X
Cyanea	*st.-johnii*			haha	X	X	
Cyanea	*stictophylla*			haha	X	X	
Cyanea	*superba*	subsp.	*superba*	haha	X	X	
Cyanea	*superba*	subsp.	*regina*		X		
Cyanea	*tritomantha*			aku			X
Cyanea	*truncata*			haha	X	X	
Cyanea	*undulata*			haha	X	X	
Cyclosorus	*interruptus*			neke fern			X
Cyperus	*fauriei*				X		
Cyperus	*laevigatus*			makaloa			X
Cyperus	*odoratus*					X	
Cyperus	*pennatiformis*	var.	*bryanii*		X		
Cyperus	*pennatiformis*	var.	*pennatiformis*		X		
Cyperus	*trachysanthos*				X		
Cyrtandra	*crenata*				X		
Cyrtandra	*cyaneoides*				X		
Cyrtandra	*dentata*				X		
Cyrtandra	*filipes*				X		
Cyrtandra	*giffardii*				X		
Cyrtandra	*gracilis*			ha'iwale		X	
Cyrtandra	*halawensis*			ha'iwale		X	
Cyrtandra	*hematos*			ha'iwale		X	
Cyrtandra	*kaulantha*			ha'iwale		X	
Cyrtandra	*kealiae*	subsp.	*kealiae*		X		
Cyrtandra	*munroi*				X		
Cyrtandra	*oxybapha*				X		
Cyrtandra	*paliku*			ha'iwale		X	
Cyrtandra	*polyantha*				X		

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Fern, Fern Allies & Flowering Plants

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Cyrtandra	*sessilis*			ha'iwale	X	X	
Cyrtandra	*spp.*						X
Cyrtandra	*subumbellata*				X		
Cyrtandra	*tintinnabula*				X		
Cyrtandra	*viridiflora*				X		
Cyrtandra	*waiolani*			ha'iwale		X	
Delissea	*niihauensis*	subsp.	*kauaiensis*		X	X	
Delissea	*niihauensis*	subsp.	*niihauensis*		X		
Delissea	*rhytidosperma*				X	X	
Delissea	*rivularis*			haha		X	
Delissea	*subcordata*				X	X	
Delissea	*undulata*				X	X	X
Deschampsia	*nubigena*						X
Dianella	*odorata*			uki			X
Dicranopteris	*linearis*			'uluhe			X
Diellia	*erecta*				X		
Diellia	*falcata*				X		
Diellia	*mannii*					X	
Diellia	*pallida*				X	X	
Diellia	*unisora*				X		
Diospyros	*sandwicensis*			lama			X
Diplazium	*molokaiense*				X	X	
Diplazium	*sanwichiananum*			ho'i'o			X
Dodonaea	*viscosa*			'a'ali'I			X
Dracaena	*aurea*			halapepe			X
Dryopteris	*angelica*					X	
Dryopteris	*crinalis*	var.	*podosorus*			X	
Dryopteris	*spp.*						X
Dryopteris	*tetrapinnata*				X		
Dubautia	*arborea*			na'ena'e			X
Dubautia	*herbstobatae*				X		
Dubautia	*kenwoodii*			na'ena'e		X	
Dubautia	*latifolia*				X		
Dubautia	*paleata*			na'ena'e pua kea			X
Dubautia	*pauciflorula*			na'ena'e	X	X	
Dubautia	*plantaginea*	subsp.	*magnifolia*		X		X
Dubautia	*plantaginea*	subsp.	*humilis*		X		
Dubautia	*raillardioides*			na'ena'e 'ula			X

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Dubautia	*spp.*			naenae			X
Elaeocarpus	*bifidus*			kalia			X
Elaphoglossum	*spp.*			ekaha; laukahi nunui			X
Eragrostis	*fosbergii*				X		
Eragrostis	*monticola*						X
Eragrostis	*variabilis*			kawelu			X
Erythrina	*sandwicensis*			wiliwili			X
Eugenia	*koolauensis*				X		
Euphorbia	*haeleeleana*				X		
Euphorbia	*spp.*			koko or akoko			X
Exocarpos	*luteolus*				X		
Flueggea	*neowawraea*				X		
Freycinetia	*arborea*			ieie			X
Gahnia	*lanaiensis*				X	X	
Gardenia	*brighamii*			nanu	X	X	
Gardenia	*mannii*				X		
Geranium	*arboreum*			hinahina	X		X
Geranium	*kauaiense*				X		
Geranium	*multiflorum*				X		
Geranium	*tridens*			hinahina			X
Gossypium	*tomentosa*			ma'o			X
Gouania	*hillebrandii*				X		
Gouania	*meyenii*				X		
Gouania	*vitifolia*				X	X	
Haplostachys	*haplostachya*				X		
Hedyotis	*cookiana*			'awiwi	X	X	
Hedyotis	*coriacea*				X		
Hedyotis	*degeneri*	var.	*coprosmifolia*		X		
Hedyotis	*degeneri*	var.	*degeneri*		X		
Hedyotis	*haupuensis*			pilo		X	
Hedyotis	*mannii*			pilo	X	X	
Hedyotis	*parvula*				X		
Hedyotis	*schlechtendahliana*	var.	*remyi*	kopa	X	X	
Hedyotis	*st.-johnii*				X	X	
Hedyotis	*terminalis*			manono			X
Hedyotis	*terminalis*			manono			X
Heliotropium	*anomalum*			hina hina			X
Heliotropium	*curassavicum*			kipukai			X

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Hesperomannia	*arborescens*				X		
Hesperomannia	*arbuscula*				X	X	
Hesperomannia	*lydgatei*				X		
Heteropogon	*contortus*			pili grass			X
Hibiscadelphus	*distans*			hau kuahiwi	X	X	
Hibiscadelphus	*giffardianus*			hau kuahiwi	X	X	
Hibiscadelphus	*hualalaiensis*			hau kuahiwi	X	X	
Hibiscadelphus	*woodii*			hau kuahiwi	X	X	
Hibiscus	*arnottianus*			hauhele, hau	X		X
Hibiscus	*brackenridgei*	subsp.	*mokuleianus*	ma'o hau hele	X	X	
Hibiscus	*brackenridgei*	subsp.	*brackenridgei*		X		
Hibiscus	*brackenridgei*	subsp.	*molokaiana*	ma'o hau hele		X	
Hibiscus	*clayi*			koki'o 'ula 'ula; aloalo	X	X	
Hibiscus	*kokio*						X
Hibiscus	*tiliaceus*			hau			X
Hibiscus	*waimeae*	subsp.	*hannerae*		X		
Huperzia	*mannii*				X		
Huperzia	*nutans*			wawae'iole	X	X	
Huperzia	*stemmermanniae*			wawae'iole	X	X	
Ilex	*anomala*			kawa'u			X
Ipomoea	*spp.*						X
Isachne	*distichophylla*			ohe			X
Ischaemum	*byrone*				X		
Isodendrion	*hosakae*				X		
Isodendrion	*laurifolium*				X		
Isodendrion	*longifolium*				X		
Isodendrion	*pyrifolium*			aupaka; wahine noho kula	X	X	
Jacquemontia	*ovalifolia*	subsp.	*sandwicensis*				X
Joinvillea	*adscendens*						X
Kanaloa	*kahoolawensis*				X	X	
Kokia	*cookei*			koki'o	X	X	
Kokia	*drynarioides*			hau hele 'ula; koki'o	X	X	
Kokia	*kauaiensis*				X		
Labordia	*cyrtandrae*			kamakahala	X	X	
Labordia	*lydgatei*				X	X	
Labordia	*sp. nov.*					X	
Labordia	*tinifolia*	var.	*wahiawaensis*	kamakahala	X	X	
Labordia	*tinifolia*	var.	*lanaiensis*		X		

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Labordia	*triflora*			kamakahala	X	X	
Labordia	*waialaeale*			kamakahala lau li'I			X
Lepidium	*arbuscula*				X		
Lepturus	*repens*						X
Lipochaeta	*lobata*	subsp.	*leptophylla*		X		
Lipochaeta	*spp.*						X
Lobelia	*gaudichaudii*	subsp.	*koolauensis*		X		
Lobelia	*monostachya*				X	X	
Lobelia	*niihauensis*				X		
Lobelia	*oahuensis*				X		
Lobelia	*spp.*						X
Lysimachia	*filifolia*				X		
Lysimachia	*iniki*					X	
Lysimachia	*lydgatei*				X	X	
Lysimachia	*maxima*				X	X	
Lysimachia	*pendens*					X	
Lysimachia	*scopulensis*					X	
Lysimachia	*spp.*						X
Lysimachia	*venosa*				X		
Machaerina	*angustifolia*			'uki			X
Marsilea	*villosa*			'ihi'ihilauakea	X		X
Melanthera	*fauriei*				X		
Melanthera	*kamolensis*				X		
Melanthera	*micrantha*	subsp.	*exigua*		X		
Melanthera	*micrantha*	subsp.	*micrantha*		X		
Melanthera	*tenuifolia*				X		
Melanthera	*venosa*				X		
Melanthera	*waimeaensis*				X		
Melicope	*adscendens*			alani	X	X	
Melicope	*anisata*			mokihana			X
Melicope	*balloui*			alani	X	X	
Melicope	*clusiifolia*			kukaemoa			X
Melicope	*cruciata*			pilo 'ula		X	
Melicope	*degeneri*			alani	X	X	
Melicope	*haupuensis*			alani	X	X	
Melicope	*hiiakae*			alani	X	X	
Melicope	*knudsenii*			alani	X	X	
Melicope	*lydgatei*			alani	X	X	

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Melicope	*macropus*				X		
Melicope	*makahae*				X		
Melicope	*mucronulata*			alani	X	X	
Melicope	*munroi*				X		
Melicope	*ovalis*				X		
Melicope	*pallida*				X		
Melicope	*paniculata*				X		
Melicope	*quadrangularis*				X		
Melicope	*reflexa*				X		
Melicope	*saint-johnii*				X		
Melicope	*zahlbruckneri*			alani	X	X	
Metrosideros	*polymorpha*			'ohi'a			X
Microlepia	*strigosa*	var.	*mauiensis*		X		
Munroidendron	*racemosum*				X		
Myoporum	*sandwicense*			naio			X
Myrsine	*juddii*				X		
Myrsine	*knudsenii*			kolea		X	
Myrsine	*lessertiana*			kolea			X
Myrsine	*linearifolia*				X		
Myrsine	*mezii*			kolea	X	X	
Myrsine	*sandwichensis*			kolea lauli'I			X
Myrsine	*sp.*			kolea			X
Nama	*sandwicensis*						X
Neowawraea	*phyllanthoides*			mehamehame			X
Neraudia	*angulata*	var.	*dentata*		X		
Neraudia	*angulata*	var.	*angulata*		X		
Neraudia	*ovata*				X	X	
Neraudia	*sericea*				X		
Nestegis	*sandwicensis*			olopua			X
Nothocestrum	*breviflorum*			'aiea	X		X
Nothocestrum	*latifolium*			'aiea			X
Nothocestrum	*longifolium*			'aiea			X
Nothocestrum	*peltatum*			'aiea	X	X	
Nothocestrum	*spp.*						X
Nototrichium	*humile*				X		
Ochrosia	*haleakalae*				X		
Ochrosia	*kilaueaensis*				X		
Oreobolus	*furcatus*						X

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Osmanthus (Olea)	*sandwicensis*						X
Osteomeles	*anthyllidifolia*			uulei			X
Pandanus	*odoratissiumu*			hala; lauhala			X
Pandanus	*tectorius*			hala			X
Panicum	*fauriei*	var.	*carteri*		X		
Panicum	*niihauense*			lau'ehu	X	X	
Panicum	*spp.*						X
Pelea	*spp.*			alani			X
Peperomia	*subpetiolata*			'ala 'ala wai nui	X	X	
Perrottetia	*sandwicensis*			olomea			X
Peucedanum	*sandwicense*				X		
Phyllostegia	*bracteata*				X		
Phyllostegia	*brevidens*					X	
Phyllostegia	*glabra*	var.	*lanaiensis*		X		
Phyllostegia	*haleakalae*				X	X	
Phyllostegia	*helleri*				X		
Phyllostegia	*hirsuta*				X		
Phyllostegia	*hispida*				X	X	
Phyllostegia	*kaalaensis*				X	X	
Phyllostegia	*knudsenii*				X	X	
Phyllostegia	*mannii*				X	X	
Phyllostegia	*mollis*				X		
Phyllostegia	*parviflora*	var.	*parviflora*		X		
Phyllostegia	*parviflora*	var.	*lydgatei*		X	X	
Phyllostegia	*parviflora*	var.	*glabriuscula*			X	
Phyllostegia	*pilosa*				X	X	
Phyllostegia	*racemosa*			kiponapona	X	X	
Phyllostegia	*renovans*					X	
Phyllostegia	*stachyoides*					X	
Phyllostegia	*velutina*				X		
Phyllostegia	*waimeae*				X	X	
Phyllostegia	*warshaueri*				X	X	
Phyllostegia	*wawrana*				X	X	
Pipturus	*spp.*			mamaki			X
Pisonia	*sandwicensis*			aulu			X
Pisonia	*spp.*			papala kepau			X
Pisonia	*umbellifera*			papala kepau			X
Pittosporum	*halophyllum*			ho'awa		X	

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Pittosporum	*hawaiiense*			hoawa			X
Pittosporum	*hosmeri*			hoawa			X
Pittosporum	*spp.*			hoawa			X
Pittosporum	*terminalioides*			hoawa			X
Plantago	*hawaiensis*				X		
Plantago	*princeps*	var.	*anomala*		X		
Plantago	*princeps*	var.	*laxifolia*		X		
Plantago	*princeps*	var.	*longibracteata*		X		
Plantago	*princeps*	var.	*princeps*		X		
Platanthera	*holochila*				X	X	
Platydesma	*campanulata*			pilo kea			X
Platydesma	*remyi*				X		
Pleomele	*forbesii*				X		
Pleomele	*hawaiiensis*				X		
Poa	*mannii*				X		
Poa	*sandvicensis*				X		
Poa	*siphonoglossa*				X		
Portulaca	*sclerocarpa*				X		
Portulaca	*sp. A*					X	
Pritchardia	*affinis*			loulu	X	X	
Pritchardia	*aylmer-robinsonii*			loulu	X	X	
Pritchardia	*beccarriana*			loulu			X
Pritchardia	*glabrata*			loulu		X	
Pritchardia	*kaalae*				X		
Pritchardia	*munroi*			loulu	X	X	
Pritchardia	*napaliensis*				X		
Pritchardia	*remota*				X		
Pritchardia	*schattaueri*			loulu	X	X	
Pritchardia	*sp. 1*			loulu		X	
Pritchardia	*spp.*						X
Pritchardia	*viscosa*			loulu	X	X	
Pseudomorus	*sandwicensis*			aiai			X
Psychotria	*grandiflora*			kopiko	X	X	
Psychotria	*hexandra*	var.	*oahuensis*	kopiko	X	X	
Psychotria	*hobdyi*				X		
Psychotria	*sp.*			kopiko			X
Psydrax	*odorata*			alahe'e			X
Pteralyxia	*kauaiensis*				X		

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Pteralyxia	*macrocarpa*			kaulu			X
Pteris	*lidgatei*				X		
Pyschotria	*hawaiiensis*			kopiko			X
Racomitrium	*lanuginosum*						X
Ranunculus	*mauiensis*				X		
Raowolfia	*sandwicensis*			hao			X
Remya	*kauaiensis*				X		
Remya	*mauiensis*				X	X	
Remya	*montgomeryi*				X	X	
Reynoldsia	*sandwicensis*			ohe, ohe makai			X
Rhynchospora	*chinensis*	subsp.	*spiciformis*	kuolohia			X
Rubus	*hawaiensis*			'akala			X
Sadleria	*cyatheoides*			amaumau			X
Sanicula	*mariversa*				X		
Sanicula	*purpurea*				X		
Santalum	*ellipticum*			'iliahialo'e			X
Santalum	*freycinetianum*	var.	*lanaiense*		X		
Santalum	*freycinetianum*			'iliahi			X
Sapindus	*oahuensis*			kaulu			X
Sapindus	*saponaria*			a'e			X
Scaevola	*coriacea*				X		
Scaevola	*glabra*			'ohe naupaka			X
Scaevola	*procera*			naupaka kuahiwi			X
Scaevola	*sericea*			naupaka kahakai			X
Scaevola	*sp.*			naupaka			X
Schiedea	*adamantis*				X	X	
Schiedea	*apokremnos*				X		
Schiedea	*attenuata*				X	X	
Schiedea	*haleakalensis*				X		
Schiedea	*hawaiiensis*					X	
Schiedea	*helleri*				X	X	
Schiedea	*hookeri*				X		
Schiedea	*jacobii*					X	
Schiedea	*kaalae*				X	X	
Schiedea	*kauaiensis*				X	X	
Schiedea	*kealiae*				X		
Schiedea	*lauii*					X	
Schiedea	*lychnoides*				X		

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Schiedea	*lydgatei*				X		
Schiedea	*membranacea*				X		
Schiedea	*nuttallii*				X	X	
Schiedea	*obovata*				X	X	
Schiedea	*perlmanii*					X	
Schiedea	*pubescens*				X		
Schiedea	*salicaria*				X		
Schiedea	*sarmentosa*				X		
Schiedea	*spergulina*				X		
Schiedea	*spergulina*	var.	*leiopoda*			X	
Schiedea	*stellarioides*				X		
Schiedea	*trinervis*				X		
Schiedea	*verticillata*				X		
Schiedea	*viscosa*				X	X	
Schoenoplectus	*lacustris*	subsp.	*validus*	'aka'akai			X
Sesbania	*tomentosa*			'ohai	X		X
Sesuvium	*portulacastrum*			'akulikuli			X
Sicyos	*alba*			'anunu	X	X	
Sicyos	*lanceoloidea*			'anunu		X	
Sida	*fallax*			'ilima			X
Sideroxylon	*sandwicense*			aulu, kaulu			X
Silene	*alexandri*				X	X	
Silene	*hawaiiensis*				X		
Silene	*lanceolata*				X		
Silene	*perlmanii*				X		
Smilax	*melastomifolia*			pi'oi			X
Solanum	*americanum*			popolo			X
Solanum	*incompletum*			popolo ku mai	X	X	
Solanum	*sandwicense*			popolo 'aiakeakua	X	X	
Solanum	*nelsonii*			popolo			X
Sophora	*chrysophylla*			mamane			X
Spermolepis	*hawaiiensis*				X		
Sporobolus	*virginicus*			'aki'aki			X
Stenogyne	*angustifolia*				X		
Stenogyne	*bifida*				X	X	
Stenogyne	*campanulata*				X	X	
Stenogyne	*cranwelliae*				X		
Stenogyne	*kaalae*	subsp.	*sherffii*			X	

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Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Stenogyne	*kanehoana*				X	X	
Stenogyne	*kealiae*				X		
Stenogyne	*macrantha*			ma'ohiohi			X
Stenogyne	*purpurea*						X
Stenogyne	*rugosa*			ma'ohiohi			X
Stenogyne	*scrophularioides*			ma'ohiohi			X
Styphelia	*tameiameiae*			pukiawe			X
Syzygium	*sandwicensis*			'ohi'a ha			X
Tetramolopium	*arenarium*	subsp.	*arenarium*		X		
Tetramolopium	*capillare*				X		
Tetramolopium	*diersingii*					X	
Tetramolopium	*filiforme*	var.	*filiforme*		X		
Tetramolopium	*filiforme*	var.	*polyphyllum*		X		
Tetramolopium	*lepidotum*	subsp.	*lepidotum*		X	X	
Tetramolopium	*remyi*				X	X	
Tetramolopium	*rockii*	var.	*calcisabulorum*		X		
Tetramolopium	*rockii*	var.	*rockii*		X		
Tetraplasandra	*bisattenuata*			'ohe mauka		X	
Tetraplasandra	*flynnii*			'ohe'ohe		X	
Tetraplasandra	*gymnocarpa*				X		
Tetraplasandra	*hawaiensis*			ohe'ohe			X
Tetraplasandra	*sp.*			ohe			X
Touchardia	*latifolia*			olona			X
Trematolobelia	*singularis*				X		
Urera	*kaalae*			opuhe	X	X	
Urera	*sandvicensis*			opuhe			X
Vaccinium	*calycinum*			'ohelo; 'ohelo kau la'au			X
Vaccinium	*reticulatum*			'ohelo			X
Vaccinium	*spp.*						X
Vicia	*menziesii*				X	X	
Vigna	*o-wahuensis*				X		
Viola	*chamissoniana*	subsp.	*chamissoniana*		X		
Viola	*helenae*				X	X	
Viola	*kauaensis*	var.	*wahiawaensis*	nani wai'ale'ale	X	X	
Viola	*lanaiensis*				X	X	
Viola	*oahuensis*				X		
Wikstroemia	*monticola*			'akia			X
Wikstroemia	*oahuensis*			'akia			X

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Fern, Fern Allies & Flowering Plants

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Wikstroemia	*oahuensis*			'akia			X
Wikstroemia	*phillyreifolia*			'akia			X
Wikstroemia	*sanwicensis*			'akia			X
Wikstroemia	*skottsbergiana*			'akia		X	
Wilkesia	*gymnoxiphium*			iliau			X
Wilkesia	*hobdyi*				X		
Wilkesia	*spp.*			iliau			X
Xylosma	*crenatum*				X	X	
Xylosma	*hawaiiense*			maua			X
Zanthoxylum	*dipetalum*	var.	*tomentosum*	kawa'u	X	X	
Zanthoxylum	*hawaiiense*				X		
Zanthoxylum	*oahuense*				X		
Zanthoxylum	*spp.*			a'e or hea'e			X
Aquatic Plants							
Halophila	*hawaiiana*			seagrass			X
Ruppia	*maritima*			widgeon grass			X
Endemic Terrestrial Algae							
Bjornbergiella	*hawaiiensis*						X
Diprora	*haenaensis*						X
Navicula	*contenta*						X
Navicula	*hawaiiensis*						X
Navicula	*thurstonensis*						X
Scytonema	*javanicum*	var.	*hawaiiense*				X
Scytonema	*pulvinatum*						X
Endemic Freshwater Algae							
Batrachospermum	*spermatiophorum*						X
Cladophora	*longiarticulata*	var.	*valida*				X
Conferva	*sandvicensis*						X
Cosmarium	*depauperatum*						X
Eunotia	*abbottiae*						X
Eunotia	*smithiae*						X
Frustulia	*creuzburgensis*						X
Haematococcus	*thermalis*						X
Lophopodium	*sandvicense*						X
Lyngbya	*cladophorae*						X
Micrasterias	*adscendens*						X
Navicula	*genustriata*						X
Navicula	*oahuensis*						X
Navicula	*testata*						X

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Endemic Freshwater Algae

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Pithophora	*affinis*						X
Pithophora	*macrospora*						X
Staurastrum	*monticulosum*	var.	*duplex*				X
Staurastrum	*subtile*						X
Stauroneus	*maunakeäensis*						X
Stigonema	*aerugineum*						X
Tolypothrix	*musicola*	var.	*havaiensis*				X
Trentepohlia	*cucculata*	var.	*sandvicensis*				X
Trentepohlia	*diffracta*	var.	*sandvicensis*				X
Xanthidium	*octocorne*	var.	*majus f. havaiensis*				X
Endemic Marine Algae							
Acrochaetium	*dotyi*						X
Alsidium	*cymatophilum*						X
Antithamnion	*erucacladellum*						X
Boodleopsis	*hawaiiensis*						X
Callidictyon	*abyssorum*						X
Callithamniella	*pacifica*						X
Centroceras	*corallophilloides*						X
Ceramium	*cingulum*						X
Ceramium	*dumosertum*						X
Ceramium	*hanaense*						X
Ceramium	*tranquillum*						X
Ceramium	*womersleyi*						X
Chrysymenia	*glebosa*						X
Codium	*cicatrix*						X
Codium	*extricatum*						X
Corallophila	*ptilocladioides*						X
Crouania	*sp.*						X
Dasya	*iridescens*						X
Dasya	*kriseniae*						X
Dasya	*muurayana*						X
Ditria	*reptans*						X
Dotyella	*hawaiiensis*						X
Dotyella	*irregularis*						X
Dotyophycus	*pacificum*						X
Dudresnaya	*littleri*						X
Euptilocladia	*magruderi*						X
Fernandosiphonia	*ecorticata*						X
Gelidiella	*womersleyana*						X

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Endemic Marine Algae

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Gelidium	*pluma*						X
Gelidium	*reediae*						X
Gracilaria	*abbottiana*						X
Gracilaria	*coronopifolia*						X
Gracilaria	*dawsonii*						X
Gracilaria	*dotyi*						X
Gracilaria	*epihippisora*						X
Grateloupia	*hawaiiana*						X
Halymenia	*chiangiana*						X
Halymenia	*cromwellii*						X
Halymenia	*stipitata*						X
Hawaiia	*trichia*						X
Helminthocladia	*rhizoidea*						X
Helminthocladia	*simplex*						X
Herposiphonia	*dubia*						X
Hypoglossum	*wynnei*						X
Janczewskia	*hawaiiana*						X
Laurencia	*crustiformans*						X
Laurencia	*mcdermidae*						X
Liagora	*perennis*						X
Lophocladia	*kipukaia*						X
Micropeuce	*setosus*						X
Naccaria	*hawaiiana*						X
Padina	*melemele*						X
Padina	*thivyae*						X
Peleophycus	*multiprocarpium*						X
Phaeocolax	*kajimurai*						X
Platoma	*ardreanum*						X
Pleonosporium	*intricatum*						X
Plocamium	*sp.*						X
Polyopes	*hakalauensis*						X
Polysiphonia	*profunda*						X
Polysiphonia	*rubrorhiza*						X
Polysiphonia	*tuberosa*						X
Prionitis	*corymbifera*						X
Pseudochlorodesmis	*hawaiiensis*						X
Pterocladiella	*bulbosa*						X
Reticulocaulis	*mucosissimus*						X
Sargassum	*echinocarpum*						X

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Appendix B: Wildlife (Flora) Species of Greatest Conservation Need

Endemic Marine Algae

Genus	Species	var./subsp.	Subspecies	Common/Hawaiian name	Federal status*	GSN?**	Important interaction***
Sargassum	*obtusifolium*						X
Sargassum	*polyphyllum*						X
Scinaia	*furcata*						X
Scinaia	*hormoides*						X
Spirocladia	*hodgsoniae*						X
Sporochnus	*dotyi*						X
Trichogloeopsis	*hawaiiana*						X
Ululania	*stellata*						X
Valonia	*trabeculata*						X
Womersleyella	*pacifica*						X
Wrangelia	*elegantissima*						X

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APPENDIX C: OVERVIEW OF MANAGEMENT PROGRAMS AND EXISTING REGULATIONS

A variety of land and water management programs and existing regulations protect Hawaii's native species and their habitats. This appendix provides an overview of these protections, first outlining the land and water management by Federal, State, county, and private entities, then describing existing regulations in order from international, Federal, State, and local protections.

LAND AND WATER MANAGEMENT PROGRAMS

National Parks

The National Park System, operated by the National Park Service of the U.S. Department of Interior, was established to preserve natural areas (including scenery, natural and historic features, and wildlife) in the United States so that they can be enjoyed by current generations and preserved for future generations. The protection, management, and administration of these areas are to be conducted in light of the high public value and integrity of the National Park System. There are eight national park units in Hawai'i: Haleakalā National Park (Maui); Kalaupapa National Historical Park (Moloka'i); Hawai'i Volcanoes National Park (Hawai'i); Kaloko-Honokōhau National Historical Park (Hawai'i); Pu'uhonua O Hōnaunau National Historical Park (Hawai'i); Ala Kahakai National Historic Trail (Hawai'i); Pu'ukoholā Heiau National Historic Site (Hawai'i), and the U.S.S. Arizona Memorial (O'ahu).

National Wildlife Refuges

Over 500 National Wildlife Refuges (NWRs) across the United States form a system of habitats managed by the U.S. Fish and Wildlife Service of the U.S. Department of Interior. Hawaii's Refuges were established to protect the Islands' unique native plants and animals and their habitats. There are ten wildlife refuges in Hawai'i: Hawaiian Islands NWR (Northwestern Hawaiian Islands, including marine waters), Hanalei NWR (Kaua'i), Hulē'ia NWR (Kaua'i), Kīlauea Point NWR (Kaua'i), O'ahu Forest NWR (O'ahu), James Campbell NWR (O'ahu), Pearl Harbor NWR (O'ahu), Keālia Pond NWR (Maui), Kakahai'a NWR (Moloka'i), and Hakalau Forest NWR (Hawai'i).

U.S. Military Installations – Integrated Natural Resources Management Plans

The Sikes Act Improvements Act of 1997 required every military installation containing land and water suitable for the conservation and management of natural resources to complete an Integrated Natural Resources Management Plan (INRMP). The purpose of these INRMPs is to integrate the mission of the military installation with stewardship of the natural resources found there. There are several INRMPs covering military installations in Hawai'i, including:

- Oahu INRMP (covers U.S. Army installations at Dillingham Military Reservation, Kahuku Training Area, Kawailoa Training Area, Mākua Military Reservation, Schofield Barracks East Range, Schofield Barracks Military Reservation);

- Pōhakuloa Training Area INRMP (covers U.S. Army installation at Pōhakuloa Training Area, Hawai‘i);
- Marine Corps Base Hawai‘i INRMP (covers Marine Corps installations on O‘ahu, including Mōkapu Peninsula (Kāne‘ohe Marine Base), Waikāne Valley, and Marine Corps Training Area – Bellows);
- Pearl Harbor Naval Complex INRMP (covers U.S. Navy installations at Pearl Harbor, O‘ahu);
- Naval Magazine Pearl Harbor INRMP (covers U.S. Navy installation at Lualualei, O‘ahu);
- Naval Computer and Telecommunications Area Master Station Pacific INRMP (covers U.S. Navy installation at Wahiawā and Lualualei, O‘ahu); and
- Pacific Missile Range Facility INRMP (covers U.S. Navy installation at Barking Sands, Kaua‘i).

National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) is responsible for managing fisheries in Federal waters and protecting species under the Endangered Species Act, the Marine Mammal Protection Act, and other Federal legislation.

Western Pacific Fisheries Management Council

The Western Pacific Fisheries Management Council (WPFMC) is responsible for recommending fisheries management actions in Federal waters in the region including Hawai‘i, and works in concert with the National Marine Fisheries Service. WPFMC develops Fisheries Management Plans (FMPs) under the Magnuson-Stevens Fishery Conservation and Management Act for commercially harvested species. These plans must identify Essential Fish Habitat (EFH) that is necessary for “spawning, breeding, feeding, or growth to maturity” and enact actions to minimize threats to and conserve EFH. These plans also identify more limited Habitat Areas of Particular Concern that are key habitats for managed species. FMPs are developed for bottomfishes, coral reef ecosystems, crustaceans, pelagic fishes, and precious corals.

Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve

The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve was established in 2000 by Executive Order. The Reserve protects the species in the marine waters and submerged lands of the Northwestern Hawaiian Islands, as well as the Hawaiian Islands NWR outside of State waters. It is managed by the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA-NOS). Only limited fishing that occurred before the Executive Order is allowed, and then only in areas not designated for complete protection from fishing and other consumptive uses. The Reserve is currently undergoing the public process to become a National Marine Sanctuary.

Hawaiian Islands Humpback Whale National Marine Sanctuary

Jointly managed by NOAA-NOS and Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources (DAR) to protect humpback whales in Federal and State waters. The sanctuary's goal is to promote comprehensive and coordinated management, research, education, and long-term monitoring for the endangered humpback whale and its habitat. The Sanctuary includes waters around portions of all the Main Hawaiian Islands, centering on the key habitat of Maui County. Protections for the whales include increased fines for violations of the Endangered Species Act and Marine Mammal Protection Act and 100 yard approach rule to limit harassment of whales in the water. Funding and personnel for research, education, and enforcement also increase these actions in the State.

State Natural Area Reserves
The State Natural Area Reserve system (NARS) was established to preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawai‘i (Hawai‘i Revised Statutes (HRS) Chapter 195). The NARS are managed by the State Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW). Each Natural Area Reserve was established based on the concept of protecting ecosystems rather than individual species, with the goal of preserving and protecting representative samples of Hawaiian biological ecosystems and geological formations. There are 19 NARS in Hawai‘i covering more than 109,000 acres. Hono o Na Pali (Kaua‘i), Ku‘ia (Kaua‘i), Ka‘ena Point (O‘ahu), Pahole (O‘ahu), Mt. Ka‘ala (O‘ahu), West Maui (Maui), Hanawī (Maui), ‘Āhihi-Kīna‘u (Maui) (contains both terrestrial and marine acreage), Kanaio (Maui), Oloku‘i (Moloka‘i), Pu‘u Ali‘i (Moloka‘i), Manukā (Hawai‘i), Kīpāhoehoe (Hawai‘i), Mauna Kea Ice Age (Hawai‘i), Waiākea 1942 Flow (Hawai‘i), Kahauale‘a (Hawai‘i), Pu‘u Maka‘ala (Hawai‘i), Laupāhoehoe (Hawai‘i), Pu‘u o ‘Umi (Hawai‘i).

State Forest Reserves
The State Forest Reserves were first established in Hawai‘i over a century ago to protect the water supply that was being threatened due to the destruction of the forest by cattle (HRS Chapter 183). The Forest Reserves are managed by DOFAW. Limited collecting for personal use (e.g., *ti* leaves and bamboo) and limited (no more than $3,000 value per year) commercial harvesting of timber, seedlings, greenery, and tree ferns is allowed by permit. There are 49 forest reserves on the five major islands (Kaua‘i, O‘ahu, Maui, Moloka‘i, and Hawai‘i), totaling over 640,000 acres; most of the State land in the Conservation District is within a forest reserve.

State Restricted Watersheds
The purpose of a State Restricted Watershed is to regulate human use in areas where water supplies are vulnerable to contamination by public access (Hawai‘i Administrative Rules (HAR) §§ 13-105-1 et seq.). Six restricted watersheds on O‘ahu (3) and Hawai‘i (3) have been established and are managed by DOFAW.

State Wilderness Preserves
The purpose of a State Wilderness Preserve is to preserve and protect “all manner of flora and fauna” (HAR §§ 13-3-1 et seq.). The only wilderness preserve in the State is the Alaka‘i Wilderness Preserve on Kaua‘i, covering just over 9,000 acres on the summit plateau of Mt. Wai‘ale‘ale, and is managed by DOFAW.

State Wildlife Sanctuaries
Wildlife Sanctuaries are established by the State to conserve, manage, and protect indigenous wildlife (HAR §§ 13-125-1 et seq.). The Wildlife Sanctuaries are managed by DOFAW. There are four wildlife sanctuaries in the State: Paikō Lagoon Wildlife Sanctuary (Oʻahu), Kanahā Pond Wildlife Sanctuary (Maui), Kīpuka ʻĀinahou Nēnē Sanctuary (Hawaiʻi), and the Hawaiʻi State Seabird Sanctuary (multiple islands offshore of the Main Hawaiian Islands and two islands of Kure Atoll in the Northwestern Hawaiian Islands).

State Parks
There are 52 state parks encompassing nearly 25,000 acres on all the Main Hawaiian Islands. These parks are managed for outdoor recreation and heritage opportunities and range from landscaped grounds with developed facilities to wildland areas with trails and primitive facilities (HRS Chapter 183).

Leased and Unencumbered Lands
The State Department of Land and Natural Resources, Division of Land Management manages State lands not set aside to agencies or otherwise encumbered or designated for a specific land use. Some of these lands are leased by auction to private landowners, while lands that are not under lease are called "unencumbered lands." Unencumbered lands are often beach or coastal areas in the Conservation District (see below – State Land Use Districting) but do not include parks, harbors, or forest reserves.

Hawaiian Home Lands
The Department of Hawaiian Home Lands manages approximately 200,000 acres in trust for Native Hawaiians. The mission of the Department of Hawaiian Home Lands is to manage the Hawaiian Home Lands trust effectively and to develop and deliver land to Native Hawaiians. The Department will partner with others towards developing self-sufficient and healthy communities.

Commission on Water Resources Management
The Commission on Water Resources Management within the Department of Land and Natural Resources is mandated by Chapter 174C of the Hawaiʻi Revised Statutes to set policies, protect resources, defines uses, establish priorities while assuring rights and uses, and establish regulatory procedures for inland surface water and ground water resources. The Commission designates and manages water management areas and is responsible for protecting instream uses of water, including maintaining the biological integrity of aquatic wildlife.

State Marine Waters
DAR manages marine and freshwater areas throughout the State under general management authority from Hawaiʻi Revised Statutes Chapters 188 and 190. These areas include 11 Marine Life Conservation Districts (MLCD), 19 Fish Management Areas (FMA), three Public Fishing Areas (PFA), two Wildlife Sanctuaries, and the South Kona ʻōpelu Fishing Area.

Eight MLCDs include areas that are set aside as No Take Marine Protected Areas to protect sensitive species and habitats and other areas that allow a variety of forms of take but were set up to manage user conflicts or address other management issues. Some limitations on access (e.g., boats) also occur. FMAs were mostly set up to manage user conflicts. They have restrictions on gear, size of fish, access, season, etc., that differ from general fishing regulations. Only the Waikiki Shoreline FMA is completely No Take. Many FMAs are in harbors, bays, or canals. PFAs are managed areas with regulations to protect introduced freshwater gamefish and other fishes. Access, take, size, gear, and season limits are used. The Sanctuaries are limited access and take areas set up for conducting scientific research (Coconut Island) and conservation (Paikō Lagoon).

Bottomfish Restricted Areas

Bottomfish Restricted Areas (BRAs) are managed by DAR and were established in 1998 after encouragement by the Western Pacific Fisheries Management Council and consultation with an ad hoc committee and extensive public comment. Their goal is to protect stocks of bottomfish in the Main Hawaiian Islands. No fishing for state-defined bottomfish species is allowed in these areas. There are 18 BRAs.

Fish Replenishment Areas

Fish Replenishment Areas (FRAs) are managed by DAR and were established in 2000 in order to protect the stocks of marine aquarium fishes on the island of Hawai‘i and to mange conflicts among commercial aquarium fishers and other resource users. No commercial or recreational aquarium fish collecting or fish feeding is allowed. There are nine FRAs in West Hawai‘i.

Kaho‘olawe Island Reserve

In late 1990, the U.S. Department of Defense stopped using Kaho‘olawe for bombing and target practice and shortly thereafter began a Congressionally-funded clean-up of the island. In 1993, the Hawai‘i State Legislature established the Kaho‘olawe Island Reserve to protect the entire island and surrounding coastal waters extending two miles seaward and established the Kaho‘olawe Island Reserve Commission (KIRC) to manage the island. The U.S. Navy clean-up resulted in approximately ten percent subsurface clearance of the island and 69 percent surface clearance of unexploded ordnance from the island. In 2003, management and ownership of the island was officially transferred from the U.S. Navy to KIRC, a state agency administratively attached to DLNR. Kaho‘olawe Island Reserve is to be used solely and exclusively, in perpetuity, for: (1) the preservation and practice of all rights customarily and traditionally exercised by Native Hawaiians for cultural, spiritual, and subsistence purposes; (2) the preservation and protection of the Reserve’s archaeological, historical, and environmental resources; (3) rehabilitation, revegetation, habitat restoration, and preservation; and (4) education. Commercial uses are strictly prohibited in the Reserve (HRS Chapter 6K). Marine take is restricted to non-commercial catch for Kaho‘olawe visitors and open trolling for the general public in restricted areas and dates.

Division of Boating and Ocean Recreation

The aim of the Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DOBOR) is to preserve Hawaii's natural and cultural resources while ensuring public access to State waters and enhancing the ocean experience. DOBOR manages 30 boat harbors and boat launching facilities as well as designated offshore mooring areas. DOBOR regulates commercial operations, events, placement of sinking vessels, pollution, anchoring, and user conflicts, all of which can affect wildlife conservation efforts.

Office of Conservation and Coastal Lands

The Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) has a mission to protect and conserve Conservation District lands and beaches within the State of Hawai'i (including submerged lands) for the benefit of present and future generations, pursuant to Article XI, Section 1, of the Hawai'i State Constitution. OCCL plays an important role in determining shoreline boundaries for public access, shoreline encroachments, administers application for ocean aquaculture, and enacts beach restoration projects.

State Department of Agriculture

The State Department of Agriculture, Agricultural Resource Management Division operates the State's Agricultural Park program. This program makes land available to small farmers at reasonable cost with long-term tenure and provides irrigation water. There are ten agricultural parks: four on Hawai'i, four on O'ahu, one on Kaua'i, and one on Moloka'i. The lessees are all engaged in diversified agricultural crops or aquaculture and are small farming enterprises (under 20 acres). The Division also manages five irrigation systems, two on O'ahu, two on Hawai'i, and one on Moloka'i.

Board of Water Supply

The Boards of Water Supply in each county own and manage land in their island watersheds, typically in mountainous areas, in order to protect the county's supply of water.

Cooperative Efforts

Invasive Species Committees

Over the past decade, partnerships and groups have organized to address gaps in Hawaii's biosecurity system. These include the Hawai'i Invasive Species Council (HISC), to provide cabinet-level leadership, the Coordinating Group on Alien Pest Species (CGAPS), for interagency and non-governmental organization communications and collaborative projects, and the Invasive Species Committees (ISCs) for island-based rapid response.

HISC was created in 2003 to advise the Governor on issues regarding invasive species, create and implement an invasive species plan, review State agency mandates and commercial interests, and suggest appropriate legislation to improve the State's administration of invasive species programs and policies. HISC, under the co-leadership of the State Department of Agriculture and the Department of Land and Natural Resources, is comprised of the leaders of the

University of Hawai‘i, the State Department of Business, Economic Development and Tourism, State Department of Health, and State Department of Transportation, with an invitation to participate issued to the county mayors, State Department of Defense, State Department of Commerce and Consumer Affairs, State Department of Hawaiian Home Lands, Federal agency representatives and non-profit agency representatives. Hawai‘i is the sixth state in the nation to create this type of council.

CGAPS was formed in 1995 and is comprised of primarily management-level participants from every major agency and organization involved in invasive species work including Federal, State, county, and private entities. Members meet quarterly to discuss how to influence policy and funding decisions, improve communications, increase collaborations, and promote public awareness.

The first ISC was formed on Maui in 1997 in response to the need for an early detection and rapid on-the-ground response to an array of incipient invasive species, and one is now on every major Hawaiian island (Kaua‘i, O‘ahu, Maui, Moloka‘i, and Hawai‘i). The ISCs are voluntary partnerships of private, government, non-profit organizations, and individuals working together to address invasive species issues particular to the island. The overall goal of the ISCs is to prevent, eradicate, or control priority incipient plant and animal species that threaten Hawaii’s most intact Federal, State, and private conservation lands.

In addition, there are working groups specific to high-priority potential invasive species. Two examples include the West Nile Virus Prevention Group and the Brown Tree Snake Rapid Response Team. The West Nile Virus Prevention Group is composed of a broad coalition of government agencies and non-governmental organizations, including the State Department of Agriculture, Department of Land and Natural Resources, and Department of Health, the Federal Department of Agriculture, and the Department of Interior's Fish and Wildlife Service and U.S. Geological Survey Biological Resources Division, the U.S. Postal Service; the University of Hawai‘i, the Hawaiian Humane Society, the Honolulu Zoo, Ducks Unlimited, and the Nature Conservancy of Hawai‘i. The West Nile Virus Prevention Group has developed a plan to respond to, track, and limit the spread of West Nile virus in Hawai‘i. A multi-agency Brown Tree Snake Rapid Response Team has been formed to address potential brown tree snake sightings in Hawai‘i. Members travel to Guam for regular training in how to search for and capture brown tree snakes, as one method to prevent the establishment of this animal.

Watershed Partnerships

The first Watershed Partnership was established in East Maui in 1991 by the State Department of Land and Natural Resources, the National Park Service, the county of Maui, the East Maui Irrigation Company, the Nature Conservancy, Keola Hana Maui, and Haleakalā Ranch Company in recognition that active management was needed to sustain a healthy forested watershed and that effective management is best achieved through coordinated actions of all major landowners in the watershed. Since that time, Watershed Partnerships have now been established on six islands: Kaua‘i Watershed Alliance (Kaua‘i, 2003), Ko‘olau Mountains Watershed Partnership (O‘ahu, 1999), West Maui Mountains Watershed Partnership (Maui, 1998), Leeward Haleakalā Watershed Restoration Partnership (Maui, 2003), East Moloka‘i Watershed Partnership (Moloka‘i, 1999), Lāna‘i Forest and Watershed Partnership (Lāna‘i, 2001), ‘Ōla‘a-Kīlauea Partnership (Hawai‘i, 1994), and the Kohala Mountains Watershed Partnership (Hawai‘i, 2004). Overall, these partnerships cover over 344,000 hectares (850,000 acres) of forested watershed, involving more than 50 public and private partners. The amount of land under active management varies between partnerships. In 2003, the individual watershed partnerships jointly formed the Hawai‘i Association of Watershed Partnerships, to support the statewide needs of watershed partnerships.

Endangered Forest Bird Conservation

The State has established a partnership of non-profit conservation organizations, private landowners, and government agencies including DLNR and the U.S. Fish and Wildlife Service to work cooperatively for the conservation of endangered birds. The Maui Forest Bird Recovery Project and the Kaua‘i Endangered Bird Recovery Team are two ongoing efforts. The goal of these cooperative efforts is to recover native Hawaiian ecosystems at the landscape level and to establish self-sustaining bird populations in the wild, using management programs that include captive propagation and reintroduction. Their efforts employ an integrated conservation strategy of research, habitat management, and public education, with a focus on ecosystem health and protection as a prerequisite to reintroduction. On Maui, the focus of the program is on conservation efforts in Hanawī NAR for the endangered po‘ouli, while on Kaua‘i, the focus of the program is on conservation efforts in the Alaka'i Swamp for the endangered puaiohi.

Offshore Island Restoration Committee

The Offshore Island Restoration Committee (OIRC) is a cooperative effort made up of the U.S. Fish and Wildlife Service, State Division of Forestry and Wildlife, Bishop Museum, the University of Hawai‘i at Mānoa, The Nature Conservancy, and the National Park Service to inventory and restore high priority offshore islands and islets throughout the Main Hawaiian Islands. OIRC is currently in the process of inventorying, identifying, and prioritizing offshore islands and islets for restoration, management, and conservation activities.

Hawai‘i and Pacific Plants Recovery Coordinating Committee

The Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) was established by the U.S. Fish and Wildlife Service in 1993 to provide the Service with information and advice on the biology, current status, and management needs to recover the many listed endangered or threatened Hawaiian plant taxa. Current members of the HPPRCC include representatives from the U.S. Fish and Wildlife Service, DOFAW, The Nature Conservancy, U.S. Geological Survey, U.S. Army, Hawai‘i Biodiversity and Mapping program, University of Hawai‘i, and the Hawai‘i Silversword Foundation. HPPRCC is currently developing a strategy for rare plant conservation and has identified “Genetic Safety Net” plants – plants for which there are less than 50 known individuals in the wild. The goal of the developing strategy is to coordinate and integrate existing plant conservation efforts.

Natural Area Partnership Preserves

Under the Natural Area Partnership (NAP) program, the State provides two-thirds of the management costs for private landowners who agree to permanently protect intact native ecosystems, essential habitat for threatened and endangered species, or areas with other significant biological resources (HRS Chapter 195). The NAP program can support a full range of management activities to protect, restore, or enhance significant native resources or geological features. There are seven NAP-funded preserves in Hawai‘i: Pu‘u Kukui (Maui), Kapunakea (Maui), Waikamoi (Maui), Mo‘omomi (Moloka‘i), Kamakou (Moloka‘i), Pelekunu (Moloka‘i), and Kanepu‘u (Lāna‘i). In addition, there is an application pending for an eighth NAP preserve in Ka‘ū (Hawai‘i).

The Nature Conservancy Preserves

The Nature Conservancy of Hawai‘i (TNC) is a private, non-profit affiliate of the national organization, with a mission to protect eight remaining, large native-dominated landscapes from further fragmentation and to sustain these areas as natural systems through coordinated, multi-partner conservation strategies. In addition to managing six of the seven NAP preserves, TNC also manages other protected areas: Honouliuli Preserve (O‘ahu), ‘Ihi‘ihilauakea Preserve (O‘ahu), Kona Hema Preserve (Hawai‘i), and Ka‘u Preserve (Hawai‘i). Additional conservation management is conducted through cooperation with private landowners on Kaua‘i.

National Tropical Botanical Gardens

The National Tropical Botanical Garden (NTBG) is dedicated to the conservation of tropical plant diversity, particularly rare and endangered species. The NTBG, which is supported by private contributions, operates three gardens on Kaua‘i: Limahuli Garden and Preserve (1,000+ acres), McBryde Garden (252 acres), and Allerton Garden (100+ acres).

Land Trusts

The State has several private non-profit organizations whose mission is to acquire lands for long-term protection and preservation for the enjoyment of current and future generations. Examples include the Trust for Public Land, the Maui Coastal Land Trust, and the Kaua‘i Public Land Trust. The Maui Coastal Land Trust is currently managing the Waihe‘e Coastal Dunes and Wetlands Reserve on Maui.

General Conservation Management on Private Land

Unlike the continental United States, most of the private land in Hawai‘i is owned by a few major landowners. Though nearly half of Hawaii’s lands are owned by either State or Federal agencies, the participation and involvement of private landowners, many of whose lands are adjacent to government managed areas, is critical for the conservation of native species and habitats. Hawai‘i has several programs that provide financial and technical support for assisting private landowners interested in conservation on their lands. Examples include Federal programs offered through the U.S. Fish and Wildlife Service and the Natural Resources Conservation Service (within the U.S. Department of Agriculture), State programs through DOFAW (e.g., Landowner Incentive Program, Forest Stewardship program), and county tax incentives (e.g., island of Hawai‘i native forest tax exemption).

EXISTING REGULATIONS

Convention on International Trade in Endangered Species

The Convention on International Trade in Endangered Species (CITES) establishes import and export restrictions and regulations to protect living and dead animals and plants and their parts from excessive extractive use and international trade.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act is the domestic law that implements the United States' commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of migratory birds. Each of the conventions protect selected species of birds that are common to the U.S. and the other country (i.e., they occur in both countries at some point during their annual life cycle).

Federal Endangered Species Act

The Endangered Species Act was passed in 1973, to prevent the extinction of species. The current purpose of the Endangered Species Act (ESA) is to conserve the ecosystems on which threatened and endangered species depend and to conserve and recover listed species. A species may be listed as threatened if it is likely to become endangered within the foreseeable future, and a species may be listed as endangered if it is in danger of extinction throughout all or a significant portion of its range. In addition, listed species receive regulatory protection, as taking (which includes injuring or killing) a listed species is prohibited under the ESA. In addition, the ESA requires Federal agencies to consult with the U.S. Fish and Wildlife Service or National Marine Fisheries Service in order to ensure that activities they fund, authorize, permit, or carry out are not likely to jeopardize the continued existence of the species or result in destruction or adverse modification of critical habitat. The ESA allows the U.S. Fish and Wildlife Service (terrestrial and some aquatic species) or the National Marine Fisheries Service (marine species) to allow takes that would otherwise be prohibited, provided that such taking is incidental to, and not the purpose of, carrying out an otherwise lawful activity (“incidental take”), by permit and an accompanying habitat conservation plan (USFWS only). In addition to the protection offered by listing, many species in Hawai‘i have designated critical habitat, including most of the listed plants, the Blackburn’s sphinx moth, the Kaua‘i cave wolf spider, the Kaua‘i cave amphipod, the palila, Hawaiian monk seal, and the O‘ahu ‘elepaio. Subspecies and other populations may be listed separately if they are sufficiently distinct from their conspecific relatives. In Hawai‘i, such protections extend to bats, some birds, and many plants. Candidate species are those species which are under consideration for listing as threatened or endangered by the

USFWS. NMFS calls these "species of concern" when there is not enough information available to decide on a listing or they are not actively being considered. A number of species are candidates or species of concern in Hawai'i. The ESA also authorizes U. S. implementation of CITES.

Marine Mammal Protection Act

The Marine Mammal Protection Act of 1972 protects marine mammals by prohibiting the take, harassment, and importation of marine mammals in the United States and by prohibiting the take of marine mammals by U. S. citizens anywhere in the world. Exceptions can be granted for scientific research, education, native subsistence, and take incidental to commercial fisheries. The Act also requires establishing stock assessments and research. Species which fall below their "optimal sustainable population" size are listed as "depleted". Depleted populations must have a conservation plan to guide research and management actions to restore the health of the species.

The Clean Water Act

The Clean Water Act of 1977 established the basic structure for regulating discharges of pollutants into the waters of the United States. Its goal is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The Clean Water Act gives the Environmental Protection Agency the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also contains requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants and recognized the need for planning to address the critical problems posed by non-point source pollution.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). The Environmental Protection Agency reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

State Species Protection

The State has established various laws and administrative rules to protect indigenous wildlife and plants. Hawai'i Revised Statutes § 195-1 recognize that "[a]ll indigenous species of aquatic life, wildlife, and land plants are integral parts of Hawaii's native ecosystems and comprise the living heritage of Hawaii, for they represent a natural resource of scientific, cultural, educational, environmental, and economic value to future generations of Hawaii's people" and that "it is necessary that the State take positive actions to enhance their prospects for survival." Administrative rules designed to conserve, manage, protect and enhance indigenous wildlife, endangered and threatened wildlife, and introduced wild birds contain a long list of prohibited activities, with additional protections afforded threatened and endangered species (HAR Chapter 13-124). Similarly, administrative rules designed to conserve, manage, protect and enhance native threatened and endangered plants contain a list of prohibited activities, including a ban on the take of threatened or endangered plants (HAR Chapter 13-107). The State list of threatened and endangered species includes by reference species on the Federal list, as well as a few additional species, such as the ‘i‘iwi on O‘ahu. “Incidental takes” of threatened or endangered species (plant and animals) are allowed subject to approved habitat conservation plans and Safe Harbor Agreements (HRS Chapter 195D).

State Protection for Caves

In 2002, special laws were enacted to protect the irreplaceable resources of cultural, spiritual, aesthetic, and scientific value contained in Hawaii’s network of underground caves (HRS Chapter 6D). A cave is defined as any naturally occurring void, cavity, recess, or system of interconnected passages large enough for human entry beneath the surface of the earth. Hawai‘i State law prohibits destruction of a cave or any part of the interior of a cave without the owner’s written consent, prohibits removing, killing, or harming any native organisms within a cave, prohibits burning any material within a cave that may produce smoke that is harmful to naturally occurring organisms, and prohibits storage or disposal of garbage, dead animals, sewage, litter, or other toxic substances in any cave. However, State law does not prohibit these activities if they occur during permitted construction activities, provided that cave protection mitigation measures disclosed through the environmental review process and land-use permitting processes are adhered to. In addition, State law does not prohibit or constrain surface activities on the land above a cave.

State Land Use Districting

All lands in Hawai‘i are allocated by the State into one of four districts: Conservation, Agricultural, Urban, or Rural. The State, through its Department of Land and Natural Resources (DLNR) and its Board of Land and Natural Resources (the Board), has primary land-management responsibility for activities and development in the Conservation District, while the counties have primary responsibility in the Urban, Rural, and Agricultural Districts. The purpose of the Conservation District is to conserve, protect, and preserve the State’s important natural resources through appropriate management in order to promote the long-term sustainability of these natural resources, and to promote public health, safety, and welfare (HRS Chapter 183C). To this end, only limited development is allowed in the Conservation District. “Important natural resources” include the watersheds that supply potable water and water for agriculture; natural ecosystems and sanctuaries of native flora and fauna, particularly those which are endangered; forest areas; scenic areas; significant historical, cultural, archaeological, geological, mineral, and volcanological features and sites; and other designated unique areas. Permits are required for most activities in the Conservation District (HAR § 13-5-1 et seq.). As an additional measure of protection, all land in the Conservation District has been assigned to one of five subzones that reflect a hierarchy of uses from the most restrictive to the most permissive. These subzones are the Protective Subzone (the most restrictive), Limited, Resource, General, and Special. Except for the Special Subzone, all uses and activities allowed in a more restrictive subzone in the hierarchy are allowed in the less restrictive subzones.

Introduction of Non-native Species

The Hawai‘i Department of Agriculture is primarily responsible for regulating the introduction of non-native species. The Department's Plant Industry Division is responsible for protecting Hawaii's agricultural industries, natural resources, and the public from the entry and establishment of detrimental plants, animals, insects, weeds, and other pests and to assure the safe and efficient use of pesticides in Hawai‘i (HRS Chapters 150A, 152, and 149A; HAR Title 4, Subtitle 6). The Department's Division of Animal Industry is responsible for controlling and preventing the entry and spread of pests and disease that may affect the poultry and livestock industries, operating the rabies quarantine program and the airport holding facility, conducting investigations into violations of animal quarantine/importations statutes, and providing veterinary laboratory support for diagnosing animal diseases (HRS Chapter 142).

State Water Quality

The State Department of Health is responsible for administering the Clean Water Act in Hawai‘i. The Department administers the National Pollutant Discharge Elimination System (NPDES) permit program, issues Clean Water Act Section 401 Water Quality Certifications for federal permits for construction in nearshore and inland waters, and partners to develop best management practices for non-point source pollution control. The Department promotes community-based watershed management through education and voluntary compliance with environmental management standards.

State Environmental Review Requirements

Hawai‘i State law establishes a system of environmental review to ensure that environmental concerns are given appropriate consideration in decision-making (HRS Chapter 343). Similar to the Federal National Environmental Policy Act (NEPA), Hawai‘i law requires environmental assessments or environmental impact statements (depending on the impacts of the project) to be prepared for any project occurring in the Conservation District, as well as any project using State or county lands or funds. There are six other triggers for environmental review that more rarely operate to benefit native species (e.g., construction within the Waikīkī Special District).

Enforcement of Conservation Regulations

The Department of Land and Natural Resources Division of Conservation and Resource Enforcement (DOCARE), the U. S. Coast Guard, the NOAA Office of Law Enforcement, the U. S. Navy, the U.S. Marine Corps Base Hawai‘i, and the county police departments all play a role in enforcing the conservation regulations of the State.

Coastal Zone Management

The Federal Coastal Zone Management (CZM) Program was created through passage of the Coastal Zone Management Act of 1972. The program for Hawai‘i was approved in 1977 (HRS Chapter 205A), and is administered through the Department of Business, Economic Development and Tourism Coastal Zone Management Program (CZM

Hawai‘i). Within a framework of cooperation among Federal, State, and local levels, CZM Hawai‘i employs a wide variety of regulatory and non-regulatory techniques to address coastal issues and uphold environmental law. Among them are stewardship, planning, permitting, education and outreach, technical assistance to local governments and permit applicants, policy development and implementation, and identification of emerging issues and exploration of solutions. CZM Hawai‘i is leading the preparation of a framework for updating the Ocean Resources Management Plan. CZM Hawai‘i is mandated to develop and implement a Coastal Nonpoint Pollution Control Program which is to be approved by NOAA and the Environmental Protection Agency.

Special Management Areas

As mandated by the Hawai‘i Coastal Zone Management program, counties are responsible for administering permits for development in Special Management Areas (SMAs) located along the shoreline. The intent of this permitting process is to avoid the permanent loss of valuable resources and to ensure adequate access to beaches, recreation areas and natural reserves (HRS Chapter 205A). Although SMAs are defined to include all lands extending not fewer than 100 yards inland from the shoreline, counties can amend their boundaries to achieve certain Costal Zone Management objectives. Amendments removing areas from an SMA are subject to State review for compliance with the coastal law.

County Zoning

Counties are responsible for reviewing development in the Agricultural, Rural, and Urban Districts. The Agricultural District includes both “good” farm land and “junk” land that is unsuitable for farming or ranching. “Junk” land includes gulches, steep hillsides, rocky land, and on Maui and the Big Island, even relatively recent lava flows having little or no topsoil. Crops, livestock, and grazing are permitted in the Agricultural District, as are accessory structures and farmhouses. Although land in the Agricultural District is not meant to be urbanized, it has, in practice, been used for large-lot subdivisions. These subdivisions can be designed for “residential” development (i.e., housing units targeted at Hawai‘i residents) or high-end “resort/residential” development (i.e., housing units targeted at non-Hawai‘i residents and associated with resorts). The Urban and Rural Districts in each county are subject to county land use and development (commercial, industrial, residential, etc.) regulations, including county community plans, zoning, and building code regulations.

APPENDIX D: SUMMARY OF PUBLIC COMMENTS RECEIVED

This appendix summarizes the public comments received during development of Hawaii's Comprehensive Wildlife Conservation Strategy (CWCS). It does not include specific biological information (such as new data on a species' distribution or abundance). Further, the public comments have been summarized and aggregated for better understanding and explanation on the incorporation of major themes provided.

PUBLIC COMMENT RECEIVED THROUGHOUT THE PROCESS – FROM SCOPING THROUGH THE SECOND REVISED DRAFT CWCS

Terrestrial

- Species of Greatest Conservation Need
    - Include IUCN ranking as status reference
    - Helpful to link threatened habitats with species as well as high priority areas on each island for recovery
    - Question on whether to include possible extinct species on the list
    - Question as to why the Canadian goose is not listed
    - Recommended additions of the Bristle-thighed Curlew and Short-tailed Albatross
    - Question on why the green-winged teal is listed
- Habitat
    - Offshore islands should be linked with each island section
    - Recognize Lāʻau Point on Molokaʻi as a critical area for monk seals
    - A wildlife area should not be judged solely on the native species composition
- Threats
    - Recognize game animals and game birds as threats to native wildlife and habitats and that hunting opportunities need to be provided, but with minimal impact to native species. Currently, hunting does not produce this result
    - Disagree that collection is a large pressure on Blackburn's sphinx moth
    - Strengthen avian malaria as a threat
    - Add wildfires as threat to native habitat
    - Add Axis deer on Maui
    - Add alien dominated vegetation as single largest impediment to restoring native ecosystems
    - Add introduced coqui or veiled chameleons as threats since they not only prey on native invertebrates, but also provide food for other introduced species (e.g., lizards, centipedes, etc.) thereby increasing their populations
    - Mongooses are just as big a threat to terrestrial animals as rats and feral cats
    - Feral pigs are known to destroy nēnē nests and take goslings
    - To loss and degradation of habitats, add pesticide and herbicide use, electrical towers, and possibly wind farms

  - There is as of yet no firm evidence that introduced birds are effective carriers and spreaders for avian diseases to native birds
  - IACUC as an impediment to effective invasive species control
- Conservation Actions
  - Consider captive propagation of koloa maoli to enhance wild populations
  - Actions need to be considered at the landscape level
  - Need to recognize the importance of enhanced and secure sources of management funding for State and public private partnership activities
  - Support Cats Indoors Programs statewide
  - Early detection and response key to managing threats to native wildlife
  - In addition to building fencing, emphasis needs to be placed on maintaining fences as well
  - Increase awareness of endangered species and preservation on Moloka‘i
  - To protect the pueo on Moloka‘i, feral animals must be controlled
  - Priority habitats on Kaua‘i should include wetlands for nēnē
- General Comments
  - Concern that the Strategy will lead to increased taxes as more funds will be required to hire staff and carry out the Strategy
  - Concern over using showcase or umbrella species to protect other species and habitats. An alternative recommendation is to use a suite of different species associated with a habitat to monitor both species and habitats
  - Not all introduced species are detrimental to native species as some are used by native species as food and habitat
  - The Strategy should also protect introduced endangered species
  - Native Hawaiian access rights as they relate to conservation-based restrictions should be recognized
  - Add that a West Nile Virus working group has been established to address WNV issues
  - Strategy should include maps of important landscape areas on each of the islands which encompass areas important for conservation of SGCN
  - The Strategy should list specific goals such as the following: urgent need for ungulate free areas on islands where there are currently none; long term goal to represent all ecosystem types of sufficient size in ungulate free status; stepped up and better coordinated effort at keeping the worst habitat modifying weeds out of pristine areas; establish a resilient network of marine managed areas which should include a minimum of 20% no take
  - Need to further prioritize objectives and actions to increase efficacy of the Strategy
  - Clarification on how the Strategy will be implemented post October 1st should be made as well as timeline for all the actions
  - The Strategy could provide more specifics on how the objectives will be achieved (e.g., setting goals and outlining specific actions)
- Fact Sheets
  - Most comments received were corrections and additions to species information concerning habitat use, biology, threats, distribution, conservation actions

Aquatic

- Species of Greatest Conservation Need
  - Include marine algae
  - Include only anchialine species and Newcomb's snail
  - Game fish – should include because are already managed
  - Game fish – should not include because should not allow fishing of them if truly of conservation need
  - Game fish – should include because if listed as overfished, might have to stop fishing, so should take proactive steps to ensure continued fishing opportunities
  - Game fish – if plan to exclude, need a standardized and scientific approach on which will be excluded
  - Game fish – difficult to say if actually being overfished, or what the cause for low numbers is
- Habitat
  - Include discussion of impact on stream habitat (and on other wildlife, such as native birds) by Army Corps of Engineer manipulations
- Threats
  - Include discussion of harvesting of rare shells for sale on Ebay or other Internet auctions
  - Include discussion of extractions for research purposes – currently does not require a permit, and is an area of potential abuse
  - Include discussion of bio-prospecting
  - Impact of two additional cruise ships – trickle-down impact of additional 'spin-off' recreational activities, resulting in increased impacts to marine environment
  - Inefficient use of funding
  - Concern over rechannelization of streams for native stream species
  - Manta ray populations in other parts of the world are threatened by their fishing. Potential threat of fishing to manta rays in Hawai'i
  - Take of rare species supposedly for cultural purpose, but in reality for commercial sale (e.g., polished nerite or kūpe'e)
- Conservation Actions
  - Amending import/export regulations to be more conservative – switch from a ban on identified species to a ban of all except for identified species
  - Establish collection limits on any indigenous species (at a genus or higher taxonomic level – not species specific) to prevent future commercial or recreational take expansion from decimating populations before effective response can be made
  - Require permits for research if involve extraction of organisms
- General Comments
  - Concern about public distribution of sensitive information (e.g., habitat location), especially for species not currently under protection
  - How can species be added over time?

    - Incorporate the *ahupua‘a* concept into the CWCS
    - Try to use knowledge from *kupuna* (elders) about species and habitats

Comments specific to CWCS Drafts

- Similar to the republic of Fiji, airport arrivals to Hawai‘i should be treated to a video explaining the dangers of invasive species to Hawai‘i and how they can be transported in recreational gear; and increase posters at airports that relate to invasive species as well as endangered species export/import regulations and restrictions, including required permits
- Programmatic Safe Harbor Agreements for Hawaiian waterbirds should be included as a management tool
- Broaden handbook recommendation from just post-wildfire treatment to other subjects
- Greater emphasis on traditional Hawaiian resource management systems, such as the *ahupua‘a* system, should be made
- Newell's shearwaters utilize primarily inaccessible nest sites on sheer cliffs or uluhe covered habitats, white-tailed tropicbirds nest primarily in MHI
- Statewide Chapters
    - Habitats - add lakes and anchialine pond descriptions
    - Threats - for ‘alalā, habitat degradation and fragmentation are critical challenges for ‘alalā recovery
    - Threats - under invasive species, add a category called "genetic pollution" which would include GMOs and the problem of hybridization between introduced and native species
    - Threats - avian botulism, most prevalent disease threat for native waterbirds, should be added
    - Threats - feral mallards are a statewide problem for koloa maoli, not a local one. They are a threat not only to the koloa maoli, but to other native waterbirds and eventual relocation of Laysan Duck
    - Threats - add to climate change, increased drought periods which impact wildlife and habitat
    - Threats - add relationship between feral pigs spreading mosquito borne avian disease
    - Threats - for coastal dune ecosystems, off-road vehicles are a major threat
    - Threats - add rats as seed predators on native plant species
    - Objectives - summary of action should be outlined to specifically address how to eradicate feral goats, sheep, and mouflon from palila critical habitat, particularly on Mauna Kea. This should include an assessment of progress and outline of future actions
    - Objectives - add a bullet for need to increase research on management tools for controlling introduced vertebrates
    - Objectives - add a recommendation to increasing outreach and developing partnerships with the agricultural industries and research facilities
    - Objectives - add a recommendation of organizing an interagency and stakeholder task force to examine and conduct pilot studies on how to

make endangered species on private lands economically viable for landowners
    - Objectives - add recommendation identifying the need to promote emergency priority biological control development and release
    - Objectives - identify most serious alien threats to assist interdiction prioritization
    - Objectives - identify specific steps to prevent inter-island spread of invasives
- Island-sections
    - Kauaʻi: add Limahuli preserve as managed by National Tropical Botanical Garden as well as an area that requires enhanced management
    - Kauaʻi: add Haʻena Sate Park wetlands and *loʻi* systems for native wetland birds; Limahuli stream, one of the state's top five pristine streams and utilized by koloa maoli
    - Niʻihau: include language about the significance of ephemeral playa lakes and removal of feral mallards
    - Maui: major streams should include Honokōhau stream, which is impacted by diversions by Honolua ditch; Kanahā pond should be accurately described to reflect current state of water resources to the pond (artificially pumped); instead add 57 diverted streams, USGS maps show 70 diverted streams in east Maui, while west Maui has over one dozen; intact freshwater systems are also found in undiverted streams of Kīpahulu and Kaupō areas (Alelele, Kālepa streams) and Makamakaʻole streams
    - Maui: Kanahā pond is threatened by airport expansion; add threats through importation of invasive plant, seeds, and pathogens as a result of insufficient inspection at airports and harbors; stream restoration language should outline a timeframe
    - Maui: promote funding to support preservation of East Maui wiliwili forest, including actions to treat forest for *Erythrina* gall wasp and seed collection and storage; expand marine protect areas or marine management areas
    - Maui: Fleming Arboretum has a new electronic database with 170 native dryland forest species on its 17 acre site
    - Maui: add to potential areas for enhanced conservation management wiliwili forests, particularly in areas of leeward Haleakalā volcano; dryland forests of southern Maui (Auwahi, Kahikinui, Kaupō, Manawainui); south eastern Maui coastline (Keoneʻoʻio Bay to Kanaloa point) which have anchialine ponds
    - Kahoʻolawe: separate plants and animals for reintroductions and highlight Laysan Duck as one species specifically planned for reintroduction per the recovery plan
    - Hawaiʻi: mouflon sheep should be highlighted as a threat for the entire Mauna Kea area; axis deer
    - Hawaiʻi: draft a Safe Harbor Agreement for endangered waterbirds; secure stable funding for sea turtle work and understanding of adjacent nearshore

marine habitats to better evaluate NPS impacts; suggestions on adding specific inventories for specific taxa which have already been conducted

- Appendices
  - Comments made included edits to distribution information

PUBLIC COMMENT RECEIVED ON DRAFT CWCS AT TECHNICAL WORKSHOPS JUNE-JULY 2005

Species of Greatest Conservation Need

- Include plants on the list of species of greatest conservation need; do not omit them from the CWCS. Recommendations include: including all threatened and endangered plants; including all identified genetic safety net plants (those species with less than 50 individuals); including species with documented animal interactions (food, host, habitat); including species identified as a dominant or co-dominant species in a natural community by Wagner's *Manual of the Flowering Plants of Hawai'i*; including all native plant species; and no plant species should be added at this time but identifying the need to comprehensively plan for the conservation of native plants
- Instead of trying to identify a subset of species found on a particular island (e.g., those endemic to Kaua'i or those for which Kaua'i is important habitat), take a broader approach – either include all known from the island or focus on key species that typify a habitat. Otherwise, lists between islands appear inconsistent (especially where limited by information gaps). Alternatively, take a broad approach so as to be an information source and provide protection to a larger range of native species
- Clarify that SGCN includes non-threatened and non-endangered species – the prevalence of listed species leads to confusion about other species
- Recommend tiering SGCN (e.g., vulnerable, endangered) to reflect that certain species require special, species-specific management. Others disagreed, stating that critically endangered species already receive attention and tiering could detract attention from species that are historically ignored
- Support the inclusion of all native invertebrates – because while a few are listed, there are hundreds with the potential for listing, but there just is not enough information available yet (e.g., drosophila). In addition, new species are collected on nearly every survey

Threats

- Highlight threat of smallmouth bass to native freshwater species; other non-native stream species as threat to terrestrial invertebrates
- Development as a threat – particularly the increase of formerly open lands being fenced/gated and of former agricultural land being converted to residential development
- Fire, especially due to arson and especially in low elevation dry areas, needs to be emphasized as a threat
- Existing regulations are sufficient; the real problem is a lack of enforcement
- Poaching, particularly of marine species, is perceived as a major problem

- Sedimentation of streams and run-off to nearshore reefs is a threat to all islands, as is stream diversions
- Add or highlight threat of ants, feral cats and dogs, rodents, rabbits on Saddle Road, feral chickens, rats, parasitoid wasps and flies, avian disease, feral ungulates (cattle, pigs, goats, mouflon), loss of seed dispersal and changes in habitat, real estate development, light pollution, barn owls, introduction of snakes on island of Hawai‘i
- Highlight threat of pigs, goats, kāhili ginger, strawberry guava as additional threats on Kaua‘i
- Highlight threat of ungulates in general (not just axis deer), feral dogs, feral cats and cat colonies, parrots, *Euglandia rosea* (carnivorous snail), hybridization of koloa maoli, competition from alien species as additional threats on Maui
- Information gaps are a serious threat for invertebrates – surveys are needed as is compilation of unpublished information. Other invertebrate threats include alien invasions, habitat loss, loss of native plants, parasitism, biocontrol, and coqui frogs (and other predators)
- Stress the threat posed by invasive species – key threat facing species in Hawai‘i today. Threat of disease to important dominant plants – especially ‘ōhi‘a and koa – is particularly of concern and would be devastating to a full range of native wildlife in the State
- Add global climate change as a threat
- Add ballast water and hull fouling as potential vectors for invasive species
- Major threat relating to invasive species is that there is no funding for prevention, just eradication, but the best money is spent on prevention

Conservation Actions

- Highlight that restoration is part of conservation
- Need for post-fire restoration needs to be included
- Need to state more clearly that restoration for biological integrity is needed
- Suggest a conservation goal of no net loss of streams
- Suggest adding stream corridors to the Conservation District as a means of increasing protection
- Suggest streamlining Conservation District rules for beneficial conservation projects (such as fencing)
- With invasive species, need a strong statement about the need to control established plants (or animals) and preventing their establishment in still-pristine areas
- Clarify that implementation of existing management plans or continuing existing management programs is a priority
- Existing management needs consistent dedicated funding; current funding is not adequate
- Develop a strategy for post-fire response, as well as for improved interagency fire prevention and fighting
- CWCS should reflect that game hunting and conservation are compatible
- CWCS should reflect that game hunting and conservation are incompatible

- Add eradication of cats from Kaho‘olawe
- Highlight need to continue proactive prevention of invasive species introduction
- Add need to develop standardized information gathering protocols for project types – so information can be compared across years and funding agencies
- Need partnerships to keep light-free areas dark, and to reduce light pollution in areas where light exists
- Actions to respond to invasive species should emphasize the need to erect and maintain ungulate-proof fences, the need for control of established invasives, and the need for early action and rapid response
- CWCS should recognize need to increase inspections of cargo with known potential pests (such as Guam) and monitoring around airports, emphasize the need to establish inter-island quarantine, and identify proactive measures to combat invasive species introduction (such as concrete fences around airports, other ports of entry)
- Emphasize Safe Harbor Agreements and habitat conservation plans and the need to provide technical assistance or funding to support their preparation
- Improve collaboration at the field level (e.g., multi-disciplinary surveys) to increase understanding of interactions between species (plants, invertebrates, and birds)
- Emphasize need to develop information collection and information sharing protocols – require information distribution to an identified repository as condition of funding. Consider incentives to encourage release of survey information on private lands
- Include recommendation to explore ways to mitigate the effects of channelization
- Emphasize need for better communication between agencies with regulatory responsibilities so that actions can be more coordinated and impacts of regulatory action in the larger context are recognized
- Community involvement and community-based management needs to be emphasized
- Include incentives for water diverters/water users to take actions to mitigate impacts of diversions on stream life
- Encourage interagency collaboration – especially between terrestrial and aquatic managers/regulators
- Recognize the important role the military plays (and can play) as partners in native wildlife protection – from active management of areas for conservation, to creation of de facto refuges by secure zones, to ability to partner regarding enforcement
- Explore the importance of demonstration projects as a way for increased community involvement
- Recognize that some non-native species provide good habitat or food for native wildlife (especially in wetland and coastal environments) – e.g., not all non-natives are invasive or ‘bad.’ Also, recognize the difficulty of restoring native communities and the need to *transition* from non-native to native to prevent negative impacts to native wildlife (e.g., avoid clear-cutting non-natives and replanting, because native plants may not survive the first planting)

- Recognize the importance of community action – including the community effort to get Kawai Nui recognized as a Ramsar Wetland of Importance
- Support research to determine where 'excess' birds go when protected areas have reached capacity – to identify appropriate actions to prevent protected areas from becoming a source for a sink
- Increase actions regarding land use changes and opportunities these present
- Recognize the island of Hawai'i is big – especially in comparison to the other islands and so conservation needs to occur at a landscape level
- Incorporate cultural aspects of wildlife conservation, an example is seabirds (petrels were cultivated and harvested)
- Include more specificity in the document – make it easier to implement and to monitor
- Review the current State list of injurious wildlife for additions
- Support Hawaii's participation in a national initiative by the National Science Foundation called National Ecological Observatory Network (NEON) that will have a 30 year time frame and deploy sensors to monitor different habitats and their interactions
- Support mechanisms to allow interagency pooling of funding (e.g., PCSU, CESU)
- Clearly recognize need for more funding as a major constraint on current management and current invasive species response
- Encourage habitat conservation, rather than species-specific actions
- Build on existing plans
- Think creatively in using existing sources of funding or finding new partners
- Explicitly include the need to conduct hands-on actions like captive propagation for critically rare species
- Work with DOE to develop curriculum for local schools to teach about Hawaii's natural resources and conservation; develop internship programs with local universities to better connect students with agencies/organizations needing assistance
- Streamline permitting process for conservation actions
- Update the list of noxious weeds; better yet, change policy so the default is nothing gets in unless on the 'approved list' rather than letting in anything not on the 'bad list'
- Expand invasive species control beyond the ISCs; need better coordination and discussion of priority species and how to control. Replicate Maui 'drive-by weed assessment' on other islands to better understand what is present and what the appropriate response is
- Recognize that some hunting units should not be managed for recreational opportunities but for conservation (game removal)

Priority Areas

- Expand draft priority areas for potential conservation management: too limited in scope. Should reflect areas identified as recovery habitat, areas identified as critical habitat, areas that are facing immediate threats, areas that are actually in use by species of greatest conservation need

- Clarify how priority areas were selected – maps may unintentionally omit areas
- Maps do not illustrate well important areas such as offshore islets, coastal areas, anchialine ponds, wetlands, lava tube systems, riparian corridors
- Priority areas miss some areas that would provide important habitat if there were restoration actions or more active management
- Identify priority areas using a watershed/*ahupua'a* perspective – recognize the difficulty of protecting wetlands and bays without protecting the areas above (mountains and stream corridors)
- Suggest noting which areas are highly managed, which areas are managed but underfunded for management needs, and which areas are not managed at all
- Existing managed areas should be priority areas, must continue to stay managed in the future
- Suggestion that once HI-GAP analysis complete, revisit the issue of priority areas to ensure no areas missed or use to help identify priorities
- Priority areas should include both freshwater streams that are relatively pristine (so that they can be protected) and areas (particularly in middle reaches) that are less pristine but are threatened and still of biological importance. Existing water quality maps could be used to begin process to designate priority streams

Marine systems

- Integrate the marine with the terrestrial to reflect the *ahupua'a* model and the impact of shoreline actions on marine environment (development, coastal alterations, sedimentation)
- Emphasize information on the issues specifically facing aquatic systems
- Include discussion of Marine Managed Areas in each individual island discussion
- Include areas for black coral habitat as priority areas
- Include ship groundings as well as ship strikes as a threat
- Include discussion on light pollution
- Highlight potential harm caused by oil spills and existence of oil response team
- Emphasize threat of water quality
- Consider reinstating *kapu* system rather than creating new managed areas
- Include reference to development of new Marine Managed Areas
- Include reference to marine invasive species plan
- Include threat of recreational use, encouraged by guidebooks promoting sensitive habitats for recreation
- Recommend that State impose a license for all fishing. Others opposed imposition of a fishing license
- Identify need to research areas used by seabirds at sea to evaluate possible protections or management actions
- Fisheries bycatch should also mention dolphins as well
- Additional marine threats to highlight include bleaching and disease, hull fouling and ballast, ship grounding should be added to ship strike, lighting on coasts, recreational overuse should be supplemented with "commercial" overuse, e.g. fish trade for aquarium, what about whale watching industry?

- Include consideration of overharvesting of non-fish species and include policies to address this threat

General Comments

- Aquatic systems (i.e., freshwater streams) need to be better integrated with the terrestrial elements of the CWCS as they are linked and affect one another. Focusing on stream corridors might be a useful way to link upland to the coast and to better protect the whole resource
- Incorporate success stories into the CWCS (e.g., nēnē)
- Encourage taking an *ahupua'a* approach to conservation
- Emphasize habitat and protection at a habitat level more
- How will the CWCS actually be implemented and what does the CWCS really mean for partners and for the public? Will it determine future funding priorities?
- How will the SGCN list be maintained?
- How will information collected through implementation of the CWCS be maintained? Concerns were expressed regarding disclosure of sensitive information to the public (e.g., concerns that collectors may trespass onto private lands if a particular species is present)
- How will activities be prioritized? Suggestion to prioritize based on protecting areas falling outside of currently managed areas. Suggestion to not prioritize, because conservation success will depend on factors beyond biological need (community support, landowner interest, funding availability, etc.)
- How can the State DLNR, with perceived conflicting mandates, lead a CWCS without addressing and resolving some of their internal conflicts – such as the incompatibility of game hunting and conservation? Encouraged better internal communication and a need to update internal policies
- How strongly will the State DLNR be acting to implement the CWCS, now that important actions are identified as needed on State lands? How will implementation fit in relation to other management mandates?
- Will the review process occur more often than ten years? How will there be accountability of the implementation?

PUBLIC COMMENT RECEIVED ON DRAFT CWCS AT PUBLIC MEETINGS JUNE-JULY 2005

Kaua'i

- Plants should be included in the CWCS if it truly is to be a comprehensive document, in light of the huge number of endangered plants and the important role of many natives (specifically koa, 'ōhi'a, hala, and lama) in the ecosystem
- The CWCS should include discussion/acknowledgement of GMOs (genetically modified organisms) - the impact of GMOs on wildlife is not fully researched but is possible considering documentation (by this member of the public) of nēnē eating GMO corn. The CWCS should explore the need to review use of State lands for GMO research
- Development is a significant threat - to native wildlife and to open space. Specific comments included: need to hurry and protect areas such as the Salt Pond

Area (considered by the speaker as a priority area for both wildlife and for cultural significance) before the landowner tries to develop it fully

- Urbanization is a problem – there needs to be more restrictions to ensure development does not result in sedimentation/runoff (non-point source pollution) to adjacent properties and the ocean
- Additional threats important to Kaua‘i include: feral pigs and goats - impacting landscape all over the island, creating wallows for breeding mosquitoes, causing siltation and sedimentation of freshwater and marine resources - impacting the ‘o‘opu and hihiwai as well as the fish in the coastal flats
- Need to clearly recognize that there should be areas for conservation where the goal is removal of all ungulates and other areas for hunting
- Feral chickens - what is their impact on threatened or endangered species, and if the Department doesn't know, it should consider this research and not treat chickens any more favorably than other introduced animals
- Support for the protection of threatened and endangered species
- It is likely that all the north shore reefs are of quality to warrant protection
- Marine threats are comprehensive, and the CWCS should develop objectives to parallel every identified threat
- Encourage collaboration with regional watershed councils as much as possible
- Is there a connection between military/Navy testing and whale beaching? CWCS should address this issue

Moloka‘i

- CWCS should address residential development (off-islanders cutting off traditional access as develop and build fences around homes)
- CWCS should address the need to conduct enforcement of existing rules (mentioned repeatedly)
- ‘Ilio Point to Kalaupapa is important seabird habitat where there is a need to control cats and pigeons
- There is a need for more surveys on bat distribution on Moloka‘i
- Plants should be included in the CWCS, especially island endemics
- The East Moloka‘i watershed area east of Kapualei is a priority area
- Streams on the north coast of Moloka‘i - Waikolu, Wailau and Pelekunu - are of high importance with full array of native wildlife
- CWCS should consider the re-introduction of historic birds
- Marine debris a huge problem - disturbing limu production along some shorelines
- Sewage issues of east end homes along ocean may contribute to algal growth
- Utilize *ahupua‘a* concept as a framework in planning; native rights must be preserved
- Additional 'no fishing' zones should be identified to improve seed stock
- There needs to be a policy developed to address expanding "eco-tourism" activities before they become a problem to the resources

Maui

- Emphasize prevention of introduction of new invasive species and the need to improve both prevention capacity and detection/response capacity for those that are introduced
- Recognize the connection between the land and the reefs (including the direct harm from runoff/pollution)
- Planning has been done. Instead, what is needed is to take action and address issues. Put actual resources into doing something
- Recognize the importance of water - and clean water - to Maui and Maui's species and the problem of politics relating to water use and policy
- Encourage reforestation
- Include opportunities for local communities to have a say in planning
- Expand enforcement capacity
- Consider an airport tax on visitors to help pay for invasive species prevention
- Incorporate accountability in the CWCS
- Expand MPAs (marine protected areas) to protect all the marine eco-types
- Consider closures of areas to all type of activities, not just a few (e.g., if close to fishing should also close to tourists snorkeling)
- Provide ways to educate both residents and tourists about natural resources and conservation actions

Lānaʻi

- Recognize need to prevent invasive species introduction from Maui, especially at Mānele Bay with the ferry from Maui
- Implement erosion control on windward side
- Ensure Lānai's natural resources receive attention and are not forgotten
- Conduct bird surveys to determine which native birds are still present on the island
- Recognize need for coastal protection – especially on the northeastern portion of island
- Include restoration as well as protection as needed conservation actions
- Recognize need to increase funding for enforcement

Hawaiʻi

- For data collection, consider talking with old-timers to gather information
- Existing surveys are woefully inadequate to determine status of species
- Overview of permitted animal rehabilitators is inadequate
- Hawaiʻi is the endangered species capital of the world, yet the agricultural inspection happens as people leave, not when they enter. There should be twice as stringent inspections for entry
- Commercial shipping, nursery plants, and Christmas trees should undergo thorough inspections or treatments. Unfortunately, feel little is being done currently. Also, there is no reason to import plants – should require nurseries to sell local stock only. Should focus on known problem importers (e.g., places that have sold or continue to sell invasive species)

- Consider instituting a tax on plant imports – regressive, so that the more is imported, the higher the tax. Would provide a disincentive to import and promote local supply
- Need a bigger emergency fund to deal with detected invasives – so early response can be effective
- Mosquitoes are a major vector – so CWCS should aim to eliminate mosquitoes since the technological capacity now exists
- Turtles are a threat to marine fish by eating all the algae, leaving nothing for the fish, and attracting sharks. Turtle season should be open again
- Most of the conservation problems stem from a lack of funding to address problems when they were small – is there any commitment for more money?
- What will the CWCS mean for private landowners? How can they be encouraged to participate? Many want to, but see hurdles – permitting problems, concern over later liability if species thrive, lack of information on options that would benefit the landowner and native species
- Cattle do not harm the dryland forest; it is the goats and sheep. Cattle can help reduce fountain grass through grazing and it is cheaper and more effective than herbicides
- Federal government has a history of regulating – State should avoid too much regulation
- Kepa Maly has a CD available summarizing the history of fishing in Hawai‘i – a great resource on the cultural background of this activity
- Hawai‘i is the only State without a recreational fishing license – this needs to change. The license would be a revenue source and a way to gather needed information
- Regarding gill nets, instead of a flat ban, manage, like the West Hawai‘i Fisheries model
- The State should encourage local management wherever possible, using the West Hawai‘i Fisheries Council as a model. WHFC has local support for needed actions – reducing enforcement problems
- How does the CWCS fit in with all the other planning initiatives ongoing – coastal zone management, ocean sustainability, etc.
- Aquarium fish collection is another area where the State loses money by not taxing or at least monitoring the collection
- Manta rays should be considered vulnerable species
- Marine protected areas are a great idea that the CWCS should explore
- Pollution in Hawai‘i is mainly too many nutrients – which can kill the coral reef
- Actions need to be proactive – it is harder to address problems late
- Hopefully the CWCS will spill over to encourage land use policies positively impacting the environment
- State laws should limit the importation of birds
- How much money is there to implement the CWCS?
- Who will set the priorities regarding implementation of the CWCS?

- Though update every ten years, there are things that will likely happen in the interim (e.g., a potential new invasive species) – how will the CWCS account for this possibility?
- All agree that early detection and rapid response is needed – this is not new. The problem is in doing
- How will the CWCS deal with overlapping authorities/inconsistent involvement? (e.g., government, academics, research, citizens all with their own reasons for being involved and different level of resources)
- Concerned about ‘opae‘ula and anchialine ponds – there are three primary threats: mosquitofish introduced by Department of Health, introduced mollies, and introduced Tahitian prawns. Government took the lead in taking the steps backwards, but now wants to be in control of conservation? Need to explore the idea of task forces for specific species – made up of government, academics, private sector – to improve communications and develop the best plan of action for that species
- Genetically modified organisms (GMOs) are of concern – just approved in Kona and likely to impact native species
- CWCS discusses threatened and endangered species – and clearly loss of habitat is important. For birds, there is government and private cooperation. What about anchialine ponds? Approximately 95 percent of the habitat has been lost. Need to encourage actions on private lands
- Feral ducks may be disease carriers that threaten the native duck
- Cattle have played a huge role in harming habitat. State Land division does not monitor the number of cattle on leased land – need to recognize the need to have a management plan/policy
- Feral dogs, cats, and now chickens are a problem
- Do not institute licensing for recreational fishing; will create more enforcement difficulties. Instead, encourage more education and voluntary catch reporting.
- CWCS should address cruise ship impacts, such as sewage and dropping anchor, and think proactively about addressing their impacts
- What’s the status of gill nets, and will a final policy address Native Hawaiian issues?
- What is the practicality of enforcing anything in the Northwestern Hawaiian Islands, especially foreign vessels illegally poaching? How big a problem is this?
- Shoreline encroachments are a serious problem – people illegally irrigating to get more vegetation (and thus more land) when getting their shoreline certifications – harming wildlife by reducing available habitat for turtles, monk seals, seabirds. The law needs to be clarified
- Does the CWCS address the need for monitoring emerging open ocean aquaculture?
- CWCS should identify the need to increase resources for enforcement – to increase enforcement capacity. Not just additional bodies, but also tools – like satellite monitoring of the Northwestern Hawaiian Islands or air patrols
- Recognize that enforcement officers are doing education and outreach too – often the first contact for the public

- CWCS is a huge task, and there is very little money for implementation (in comparison to the State's needs). Support the effort and support the State not relinquishing any authority to the Federal government
- Turtle protection is a conservation success – ban on eating has resulted in greater populations. Education has been effective
- Aquarium fish collecting policy is another success – setting aside certain areas for replenishment areas (with no take). Both collectors and locals are not happy – so likely the policy is a good one
- State has a mandate to run a sustained yield hunting program, but also has a mandate to protect endangered species and outplant native plants. There can be co-existence between these two programs
- Are there areas where game birds are a problem? Do they predate on native species or compete with them?
- Is there a year or timeframe when the evolutionary process is determined to stop? (e.g., what about birds that find their way here naturally and begin to evolve)
- CWCS needs to recognize half of life is reality and other half is perception. Need to work on the perception side so that people voluntarily participate in conservation. When talk about enforcement, rules, many perceive as a negative. Instead need to transition discussion to positive. Example is the island's exceptional tree law – recognizing exceptional trees creates an incentive for people to value it and not want to cut it. Might want to create similar programs for native species. There are many examples of great stewardship in the private sector already, so a recognition program could be easy to establish. This would involve the community in conservation
- CWCS needs to focus on commonalities and not a 'divide and conquer' strategy. Aim for the middle, and then build on that support with education, propaganda, and recognition for good work
- CWCS should also include stiffening penalties on habitat degradation (such as discharge of untreated waste in Forest Reserves) – current law treats this as a petty misdemeanor and violators receive a slap on wrist. Not a large deterrent, especially if the profit outweighs the costs of getting caught
- Ecotourism facilitates greater public access into areas. Need to keep an eye on this trend so that resources are not damaged before anyone notices

O'ahu

- Include plants as species of greatest conservation need – plants are important component of ecosystem in which animals live and have value of their own as well (high levels of endemism)
- Plants were here first before animals
- Plants have unexplored medicinal uses – so CWCS should ensure their long-term protection too – for our future benefit
- Fire is a huge threat, particularly due to arson
- Aquatic threats include pollution, drought, and flooding, waste management policies (illegal dumping), uncontrolled development
- Direct take is a threat, particularly of many marine species

- Strategy should be proactive and positive, with a vision of where we see Hawai‘i in the future
- How will the CWCS really make a difference – general conservation objectives are great but not really new. How is this process and plan different from past efforts?
- Many invertebrates (e.g., *Drosophila* flies) are highly host-specific and this may assist in identifying specific plants to be covered in the CWCS
- Invasive species strategy should follow the New Zealand model, should include landing fees to fund needed improvements at airports
- Draft CWCS does a great job pulling together a lot of information, but determining actual/highest priorities from the array of strategies is difficult
- CWCS should identify need to connect folks currently working in isolation – encourage more collaboration and communication
- Real need in Hawai‘i is more money – without more funding, the CWCS will be like any other plan
- CWCS omits discussion of fishponds, which do host bird populations. Though many are privately owned, they are important for restoration of marine fish and birdlife
- Regarding the use of gill nets in the strategies section, the current wording supports the continued use of gill nets. Rather, the strategy should be to examine banning the use of gill nets altogether
- There are many resources available in Hawai‘i – the need is connecting different resources together
- Recognize the importance of proper management of the coastal dune ecosystem
- Emphasize the importance of preventing the introduction of new invasive species
- Nearshore nutrification is a threat; could be impacting nearshore fisheries and the nearshore limu (algae) community
- Recognize the concept of community-based management and their role in enhancing enforcement capacity
- Oil spills are a marine threat – and not limited to tankers but pertains to research vessels too
- The need to protect Ni‘ihau’s marine resources both for the species and for the local indigenous community should be recognized
- Commercial use continues to expand and can see initial negative impacts to species (reduced ‘ōpihi) – maybe should explore self-regulation of tourist activities (e.g., boat tours, hiking tours)

Incorporation of Feedback from Public Open Houses and Technical Workshops for Hawaii’s Comprehensive Wildlife Conservation Strategy

Ten major themes emerged during this series of public outreach and participation events held on the six islands. They were addressed and incorporated in the following ways:

The need to increase invasive species preventative measures

The concern over increased entry of invasive species into the State was heard on every island. People identified the need to increase preventative measures and improve the capabilities of rapid response to the arrival of new invasives. Strategies on how to support this were added in Chapter 4 as well as specific strategies on each island as identified during public open houses and workshops (Chapter 6, Island Conservation Needs).

The need to emphasize ongoing actions in currently managed areas
Currently managed areas for conservation such as National Parks, National Wildlife Refuges, National Marine Sanctuary, Natural Area Reserves, Wildlife Sanctuaries, Watershed Partnerships, Private Reserves, and others were always recognized in the CWCS as important areas for conservation of native wildlife and habitats. However, language in each of the island sections (Chapter 6) as well as in the statewide section (Chapter 4) was added to clarify this importance and further emphasize these areas as priority for continued management. Additionally, these chapters outline the future support needed for conservation actions that require additional funding to achieve goals and objectives.

The need to include plants as listed Species of Greatest Conservation Need
Native plants were always recognized in Hawaii's CWCS through its approach in emphasizing the need for habitat-level management and by recognizing plants as important hosts for native invertebrates, as food sources for native birds, and generally as habitat for native wildlife. However, as a result of the feedback garnered through public open houses and technical workshops, flora are now also listed specifically as Species of Greatest Conservation Need (SGCN). For terrestrial plants, specific species listed as SGCN include threatened and endangered plants, genetic safety net plants (plants with less than 50 individuals left), plants with identified animal interactions, and dominant and co-dominant plants in one of the recognized natural communities in the *Manual of Flowering Plants of Hawai'i*. In addition, endemic terrestrial algae were included. These species were selected based on recommendations made by the Hawaiian botanical community. For aquatic flora, all endemic plants and algae were included.

The need for increased compliance with existing conservation rules and regulations and increase enforcement
Many comments were raised on how Hawai'i was not in need of new rules or regulations for conservation, but in need of better compliance with enforcement of already existing rules and regulations. The issue of compliance was separated out as its own major threat and strategies were developed to increase enforcement and compliance in Chapter 4.

The need for more funding to support on-the-ground conservation actions
The lack of both consistent and long-term funding was identified as a major conservation challenge by many. Without funding to conduct research, implement conservation actions, hire staff, enforce laws, carry out monitoring, and conduct other priority conservation measures, protecting native wildlife and habitats is impossible. The lack of funding has been pulled out as its own identified major threat. Additionally, instead of being a strategy, enhancing funding has been added as a brand new objective with its own

strategies identifying potential new funding mechanisms and ways of leveraging existing funds in new ways (Chapter 4).

The need to continue to support involvement of communities in conservation efforts
The role of communities and involvement of citizens in conservation projects and activities is one of the reasons why Hawaiʻi has several conservation success stories. To continue to support these initiatives, the important role of communities and community involvement in conservation is highlighted as strategies in both the statewide and island conservation needs sections (Chapters 4 and 6 respectively).

The need to highlight freshwater resources and better integrate them with terrestrial and marine sections
In Hawaiʻi, the connection between issues affecting both land and sea are important. For example, habitat loss and degradation in the watersheds affect freshwater streams and water quality, which in turn affects marine habitats through sedimentation and pollution. To further emphasize these connections and integration of habitats and threats, additional information was provided for freshwater habitats and the threats facing these areas in the statewide overview (Chapters 3 and 4). Similarly, objectives and threats to freshwater habitats identified in the statewide and marine chapters were better integrated and repeated or added to in the island sections on freshwater resources (Chapter 6).

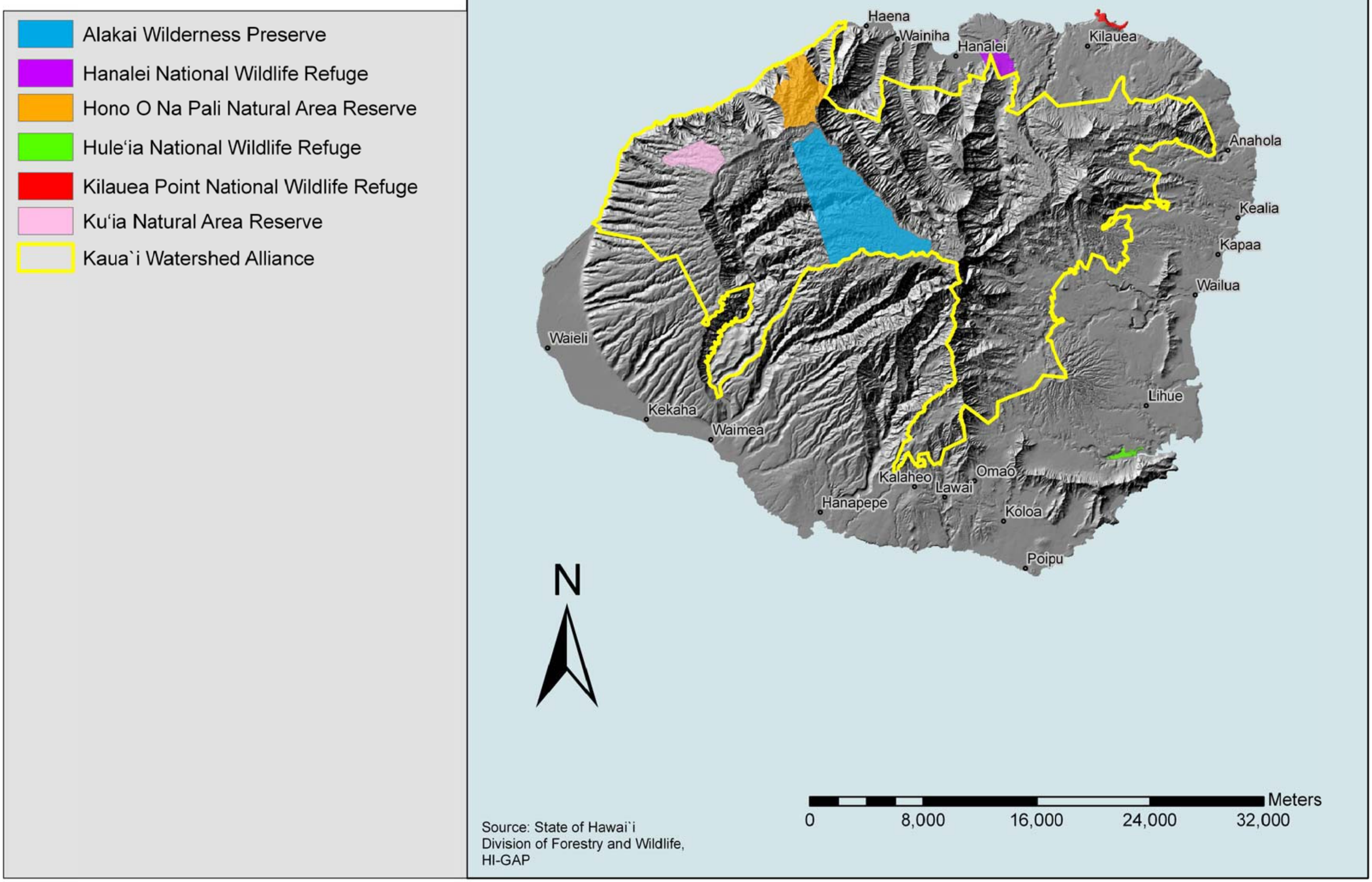
The need to highlight conservation threats such as development
The Strategy is required to identify and describe threats to Species of Greatest Conservation Need. Major threats are identified at the statewide level (Chapter 4) as well as at the marine (Chapter 5) and island levels (Chapter 6). However, one consistent threat heard at the public open houses and technical workshops was the concern over development, particularly of open spaces and along streams and shorelines. To address this, development and shoreline alterations have been pulled out as threats under "Loss and Degradation of Habitat." Fire as well as sedimentation has also been similarly added. Other threats identified at the island level have been added in the island overviews (Chapter 6).

The need to prioritize actions
Given the great conservation needs and limited funding available to address these needs, people felt that further prioritization of actions was necessary in the Strategy than had already been done. As a result of this feedback, in Chapter 4 Statewide Conservation Needs, highest priority strategies were identified under each of the seven conservation objectives listed. These strategies were selected based on the degree to which they would contribute to conservation over the next ten years, strategies that need to occur first before other strategies can be implemented, and feedback during the technical workshops and public open houses held during the months of June and July.

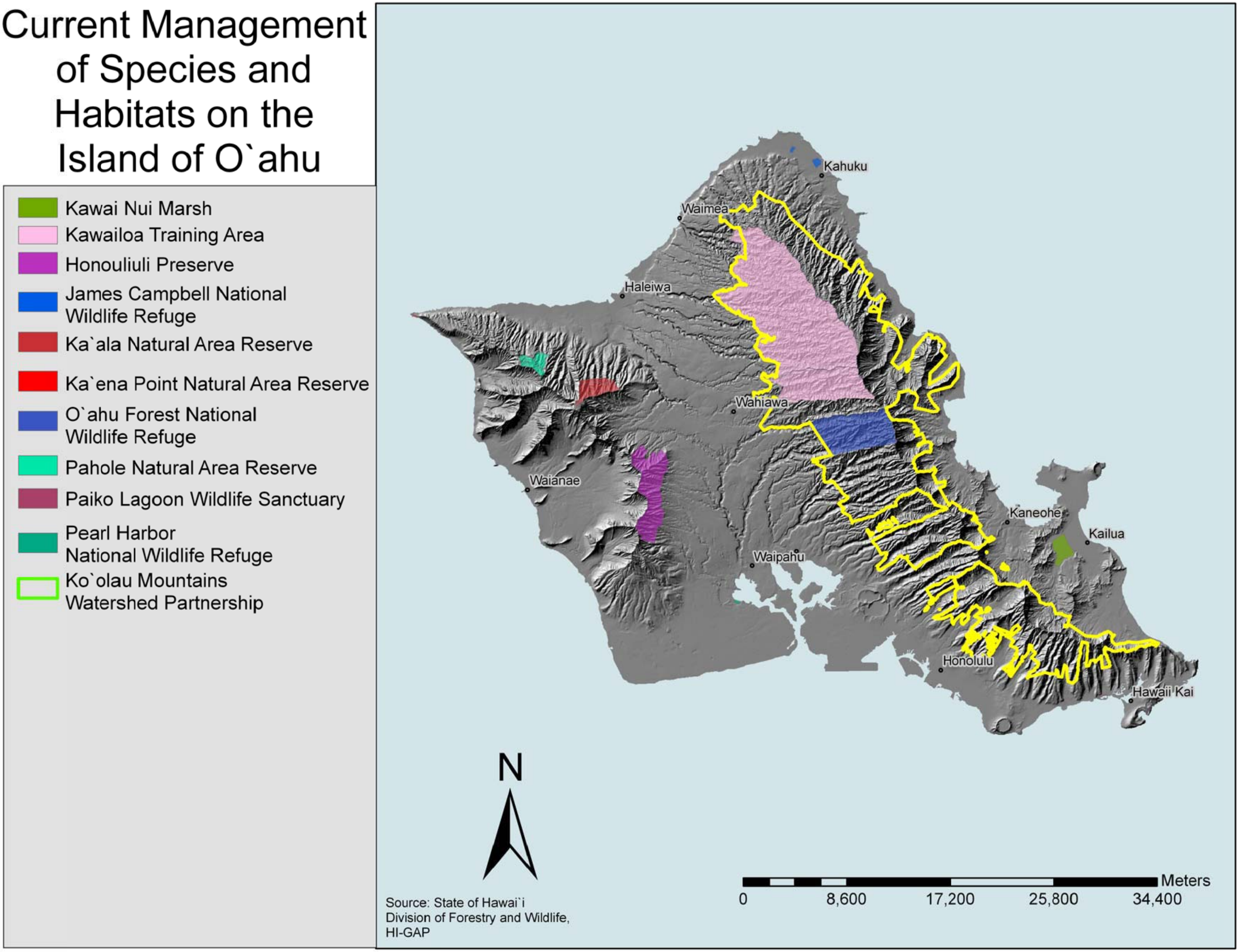
The need to highlight additional areas that would benefit from future conservation management.
The public scoping draft recognized areas that could benefit from increased conservation management. Many individuals or groups highlighted additional areas for this section.

These additional areas were considered for addition, evaluation for future additions, or additions to include in on-going processes (e.g. marine managed areas re-evaluation).

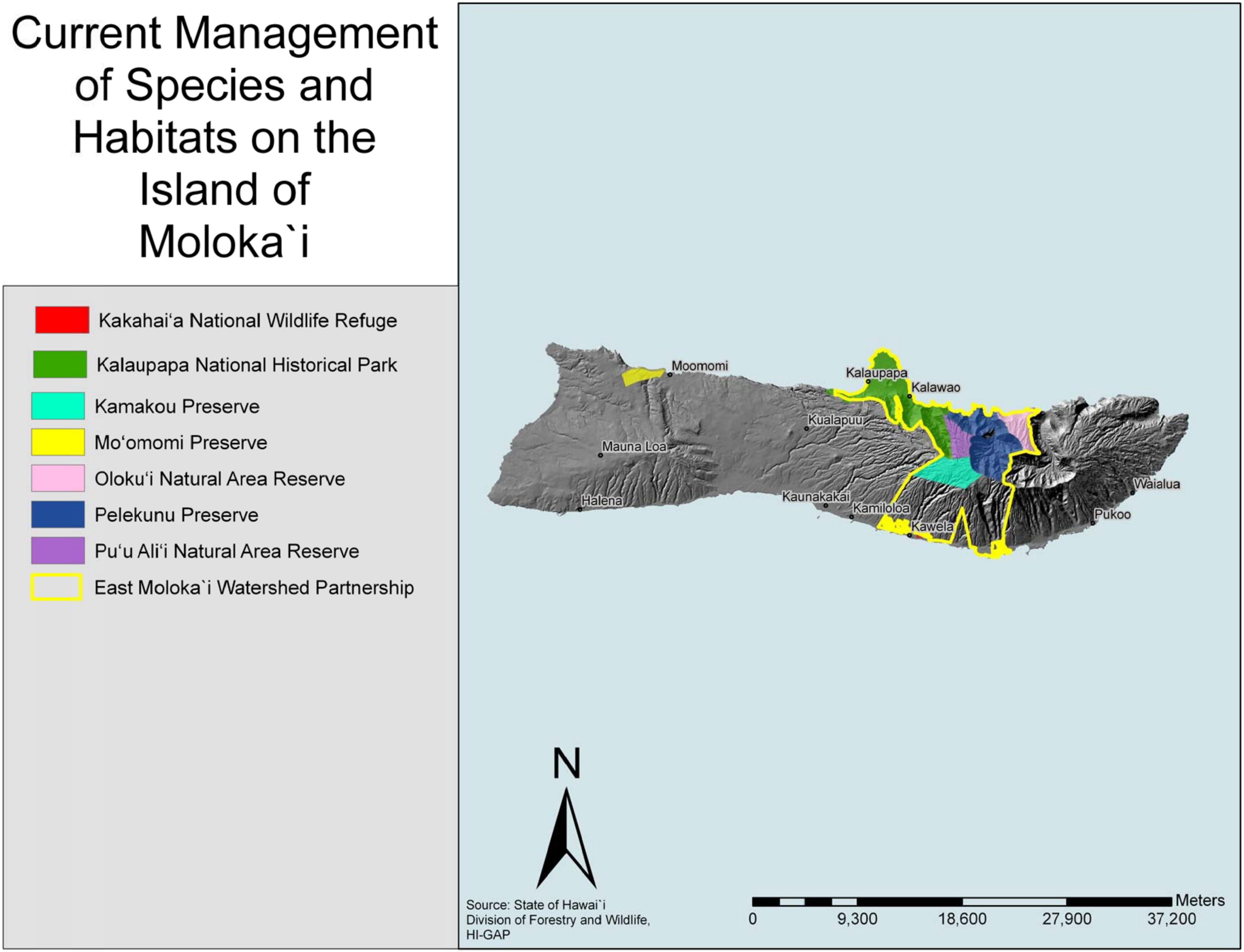
Current Management of Species and Habitats on the Island of Kaua`i



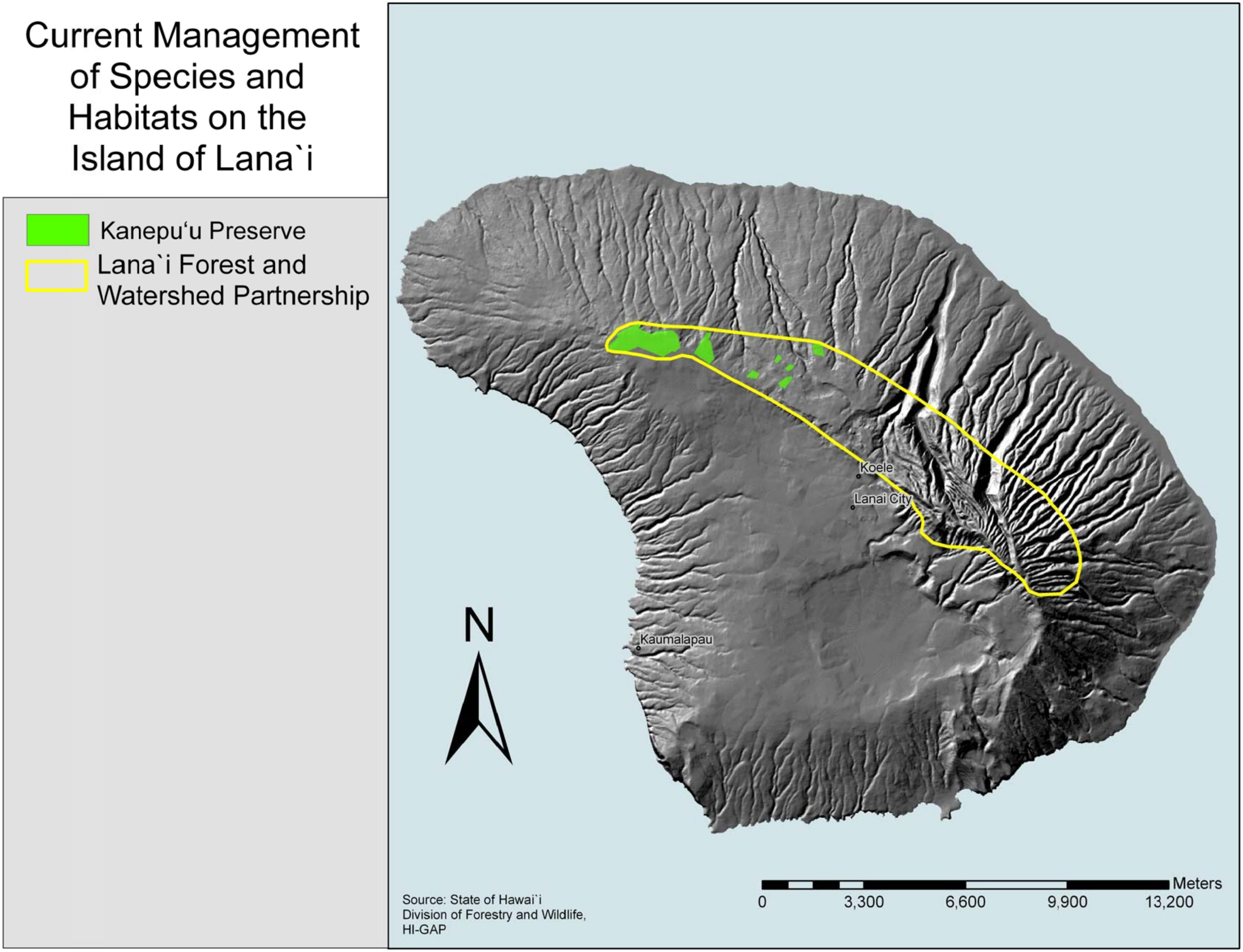
Current Management of Species and Habitats on the Island of O`ahu



Current Management of Species and Habitats on the Island of Moloka`i

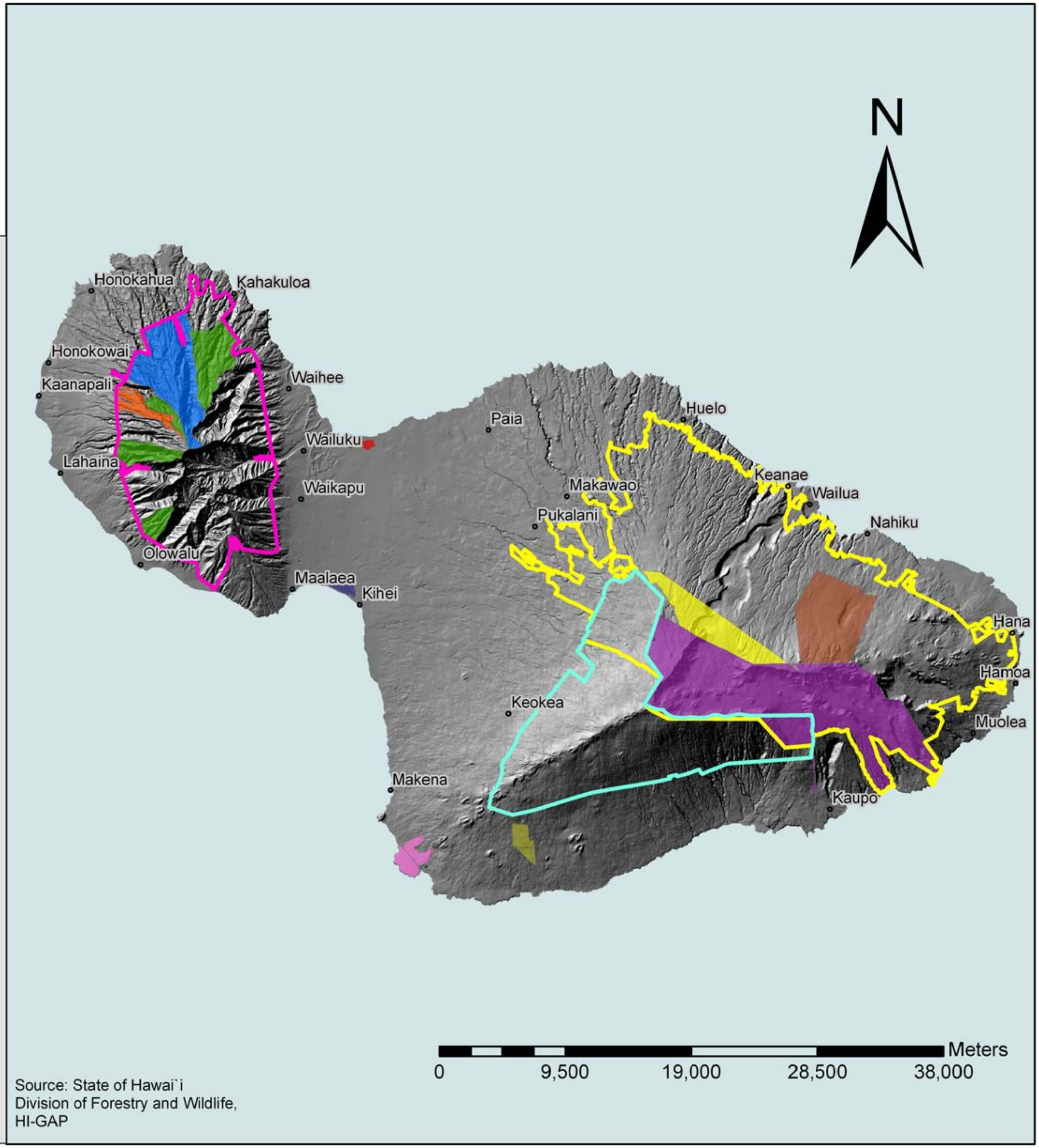


Current Management of Species and Habitats on the Island of Lana`i



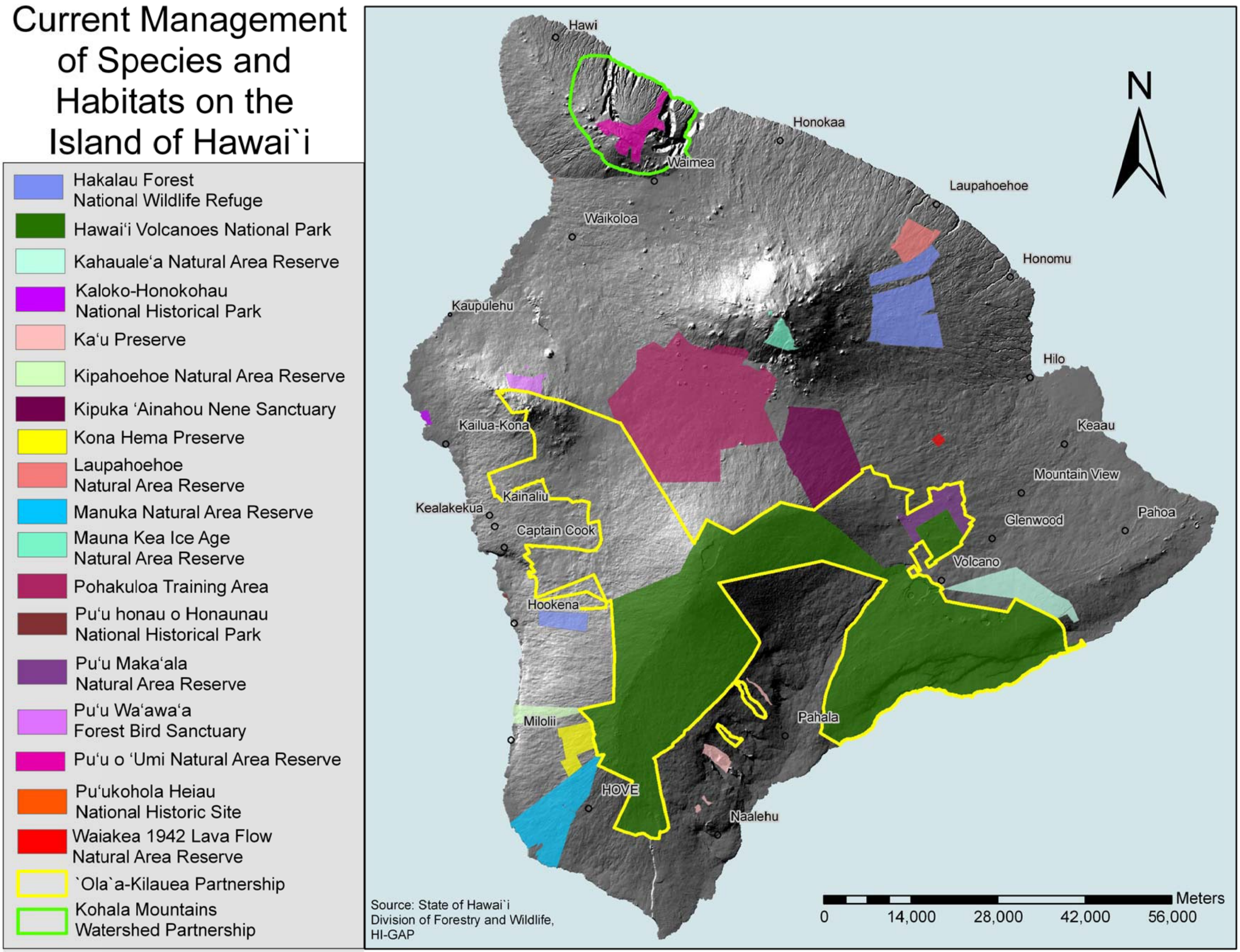
Current Management of Species and Habitats on the Island of Maui

- Haleakala National Park
- Hanawi Natural Area Reserve
- Kanaha Pond Wildlife Sanctuary
- Kanaio Natural Area Reserve
- Kapunakea Preserve
- Kealia Pond National Wildlife Refuge
- Pu‘u Kukui Preserve
- Waiakamoi Preserve
- West Maui Natural Area Reserve
- ‘Ahihi Kina‘u Natural Area Reserve
- East Maui Watershed Partnership
- Leeward Haleakala Watershed Restoration Partnership
- West Maui Mountains Watershed Partnership



Current Management of Species and Habitats on the Island of Kaho`olawe

Kaho‘olawe Island Reserve


Current Management of Species and Habitats on the Island of Hawai`i
Hakalau Forest National Wildlife Refuge
Hawai‘i Volcanoes National Park
Kahauale‘a Natural Area Reserve
Kaloko-Honokohau National Historical Park
Ka‘u Preserve
Kipahoehoe Natural Area Reserve
Kipuka ‘Ainahou Nene Sanctuary
Kona Hema Preserve
Laupahoehoe Natural Area Reserve
Manuka Natural Area Reserve
Mauna Kea Ice Age Natural Area Reserve
Pohakuloa Training Area
Pu‘u honau o Honaunau National Historical Park
Pu‘u Maka‘ala Natural Area Reserve
Pu‘u Wa‘awa‘a Forest Bird Sanctuary
Pu‘u o ‘Umi Natural Area Reserve
Pu‘ukohola Heiau National Historic Site
Waiakea 1942 Lava Flow Natural Area Reserve
`Ola`a-Kilauea Partnership
Kohala Mountains Watershed Partnership
Hawi
Honokaa
Waimea
Laupahoehoe
Waikoloa
Honomu
Kaupulehu
Hilo
Kailua-Kona
Keaau
Mountain View
Kainaliu
Kealakekua
Captain Cook
Glenwood
Pahoa
Volcano
Hookena
Milolii
Pahala
HOVE
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Source: State of Hawai`i Division of Forestry and Wildlife, HI-GAP
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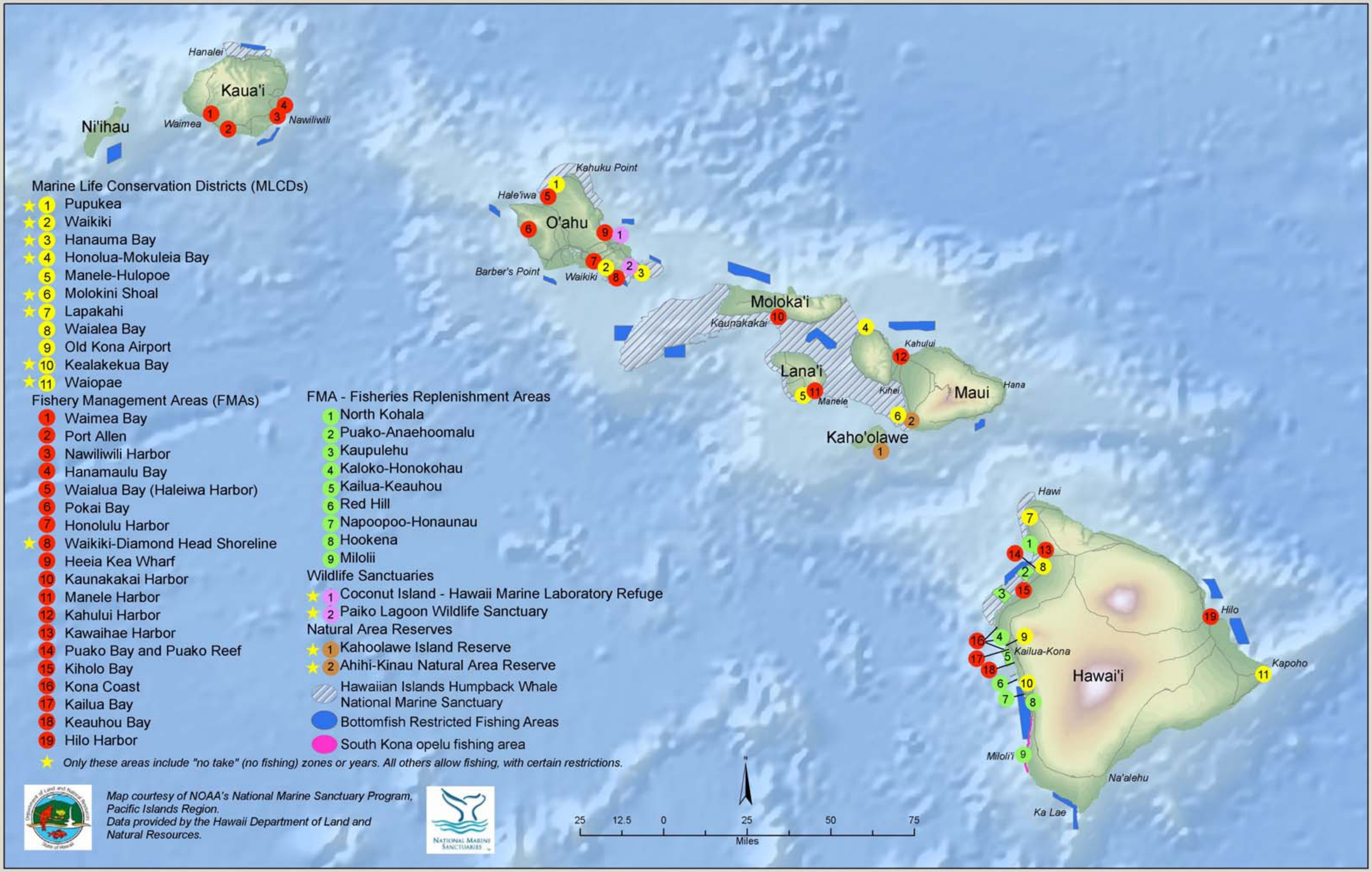
Hanalei
Kaua'i
Ni'ihau
Waimea
Nawiliwili
Kahuku Point
Hale'iwa
O'ahu
Barber's Point
Waikiki
Moloka'i
Kaunakakai
Kahului
Lana'i
Manele
Kihei
Maui
Hana
Kaho'olawe
Hawi
Hilo
Kailua-Kona
Hawai'i
Kapoho
Miloli'i
Na'alehu
Ka Lae
Marine Life Conservation Districts (MLCDs)
★ 1 Pupukea
★ 2 Waikiki
★ 3 Hanauma Bay
★ 4 Honolua-Mokuleia Bay
5 Manele-Hulopoe
★ 6 Molokini Shoal
★ 7 Lapakahi
8 Waialea Bay
9 Old Kona Airport
★ 10 Kealakekua Bay
★ 11 Waiopae
Fishery Management Areas (FMAs)
1 Waimea Bay
2 Port Allen
3 Nawiliwili Harbor
4 Hanamaulu Bay
5 Waialua Bay (Haleiwa Harbor)
6 Pokai Bay
7 Honolulu Harbor
★ 8 Waikiki-Diamond Head Shoreline
9 Heeia Kea Wharf
10 Kaunakakai Harbor
11 Manele Harbor
12 Kahului Harbor
13 Kawaihae Harbor
14 Puako Bay and Puako Reef
15 Kiholo Bay
16 Kona Coast
17 Kailua Bay
18 Keauhou Bay
19 Hilo Harbor
FMA - Fisheries Replenishment Areas
1 North Kohala
2 Puako-Anaehoomalu
3 Kaupulehu
4 Kaloko-Honokohau
5 Kailua-Keauhou
6 Red Hill
7 Napoopoo-Honaunau
8 Hookena
9 Milolii
Wildlife Sanctuaries
★ 1 Coconut Island - Hawaii Marine Laboratory Refuge
★ 2 Paiko Lagoon Wildlife Sanctuary
Natural Area Reserves
★ 1 Kahoolawe Island Reserve
★ 2 Ahihi-Kinau Natural Area Reserve
Hawaiian Islands Humpback Whale National Marine Sanctuary
Bottomfish Restricted Fishing Areas
South Kona opelu fishing area
★ Only these areas include "no take" (no fishing) zones or years. All others allow fishing, with certain restrictions.
Map courtesy of NOAA's National Marine Sanctuary Program, Pacific Islands Region.
Data provided by the Hawaii Department of Land and Natural Resources.
25 12.5 0 25 50 75
Miles
National Marine Sanctuaries