

HAWAI‘I

The island of Hawai‘i 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. Hawai‘i 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 Hawai‘i 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 Hawai‘i 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. Hawai‘i 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'ō (*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 Ichneuemonidae 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 'alalā (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 Hawai'i;
- 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): Kahauale'a NAR (1992), Kīpāhoehoe NAR (2002), Laupāhoehoe NAR (1989), Manukā NAR (1992), Pu'o o Umi (1989), and Pu'u Maka'ala (1989);
- DOFAW and State Parks jointly developed a management plan for the ahupua'a of Pu'u Wa'awa'a and the makai lands of Pu'u 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 'Ōla'a-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 Hawai'i 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 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 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 enclosures 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

Hakalau Forest NWR (32,700 acres)

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 ‘ōhi‘a (*Metrosideros polymorpha*).

Kona Forest Unit of Hakalau Forest NWR (5,341 acres)

Species: Forest birds, ‘io (Hawaiian hawk), historically ‘alalā (tract was acquired as ‘alalā 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.

‘Ōla‘a -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, Kūlanī Correctional Facility, Kamehameha Schools)

Species: Forest birds, ‘io, 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 Kūlanī with Mauna Loa Strip of Hawai‘i Volcanoes NP.

Future Needs: Continue existing management. Secure funding to implement identified priority projects (e.g., North Kona fencing, Kūlanī reforestation), effectively implement expansion of partnership boundaries to “Three-Mountains.”

Hawai‘i Volcanoes National Park (323,431 acres), NPS

Species: Bat, forest birds, ‘io (Hawaiian hawk), nēnē (Hawaiian goose), seabirds (including ‘ua‘u (Hawaiian petrel) and ‘akē‘akē (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 ‘ua‘u (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.

Kahaule‘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, ‘io (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*.

Ka‘ū Preserve (3,491 acres), TNC

Species: Forest birds, ‘io (Hawaiian hawk), terrestrial invertebrates, rare plants. Possibly ‘ōpe‘ape‘a.

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, ‘io (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.

Pu‘u Wa‘awa‘a Wildlife Sanctuary (3,806 acres), DOFAW

Species: ‘Ōpe‘ape‘a (Hawaiian hoary bat), forest bird, ‘io (Hawaiian hawk), pueo, nēnē (Hawaiian goose), recovery habitat for ‘alalā, 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 Pu‘u Wa‘awa‘a 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., Ponoheo 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: ‘Ōpe‘ape‘a (Hawaiian hoary bat), ae‘o (Hawaiian stilt), ‘alae ke‘oke‘o (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 ‘Aimakapā (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.

Pu‘uhonua 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.

Pu‘ukoholā 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 Hawai‘i. 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 ‘Ōla‘a-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 Ka‘ū 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.

Ka‘ū Forest Reserve (DOFAW) and adjacent State parcels at Kiolaka‘a, Wai‘ōhinu and Ka‘alāiki

Species: Forest birds include five common (‘amakihi, ‘apapane, ‘elepaio, ‘i‘iwi, ‘ōma‘o) and three endangered (‘akiapōlā‘au, ‘ākepa, Hawai‘i creeper) species, ‘io (Hawaiian hawk), potential habitat for release of ‘alalā. The native arthropod community is known to be diverse in some areas at lower elevations. Hawaiian hoary bat (‘ōpe‘ape‘a) 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 Hawai‘i 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, ‘akiapōlā‘au, nēnē, ‘io, ‘ua‘u, possibly ‘akē‘akē, ‘ōpe‘ape‘a. 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 Ka‘ū Forest Reserve, Mauna Loa Forest Reserve, ‘Ōla‘a -Kīlauea Watershed Partnership and Hawai‘i 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 ‘akiapōlā‘au, 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 Pōhakuoa and Hawai‘i Volcanoes NP (DLNR, U.S. Army, DOFAW)

Species: ‘Ōpe‘ape‘a, ‘ua‘u and ‘akē‘akē, nēnē. Diverse and rare invertebrate communities including *Hylaeus* spp., Lepidoptera, Heteroptera, and Coleoptera species known from adjacent Pu‘u Wa‘awa‘a. Rare *Leptachatina* sp. (snail), *Helicoverpa confusa* (moth), *Rhyncogonus stellarius* (weevil) known from adjacent Pōhakuoa 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 worldwide. 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 ‘ōpe‘ape‘a 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 Kīpahohoe), 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: ‘ākepa, ‘akiapōlā‘au and Hawai‘i creeper in a few locations, ‘io, last known range of ‘alalā. 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 Ka‘alu‘alu (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 Ka‘alu‘alu 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 ‘Ōla‘a-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 ‘Āinahou 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.

Pihā 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; Pihā divides this important habitat and is not currently managed for conservation. Habitat degradation by ungulates and invasive plant species in Pihā 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 ‘ōhi‘a (*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 Pu‘u Wa‘awa‘a (DOFAW), Ka‘ūpūlehu (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, ‘io, 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 Hawai‘i. ‘Umi 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 ‘alalā.

Potential Conservation Actions: Conservation partnerships. Implementation of 2003 Management Plan for the *Ahupua‘a* of Pu‘u Wa‘awa‘a. 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: Waipi‘o and Waimanu Valley, Kīholo Springs Pond and Marsh, Opae‘ula Pond, Kealakekua Bay Pond, Lokoaka Pond, Waiākea Pond, Ke‘anae Pond

Species: Ae‘o (Hawaiian stilt), ‘alae ke‘oke‘o (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. Waipi‘o and Waimanu have extensive wetlands and taro *lo‘i* 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 ae‘o and ‘alae ke‘oke‘o 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, ae‘o (Hawaiian stilt), migratory shorebirds.

Basis for Priority Designation: There are only about 700 anchialine pools worldwide, 80 percent of which are on Hawai‘i. 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: ‘O‘opu, *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’), ‘Umi Manu and Henahena systems (Pu‘u Wa‘awa‘a), Ka‘ū and Kapāpala (tubes are unsurveyed), Emesine Cave (Upper Waiākea FR), Wao Kele O Puna, Kīhōlo Bay, Ka‘ūpūlehu and Pu‘u Wa‘awa‘a ahupua‘a between Mamalahoa and Queen Kaahumanu Highways

Species: Endemic cave-adapted fauna. A unique species is known from coastal tubes at Kīhōlo (*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 Ka‘ūpūlehu and Pu‘u Wa‘awa‘a, 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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