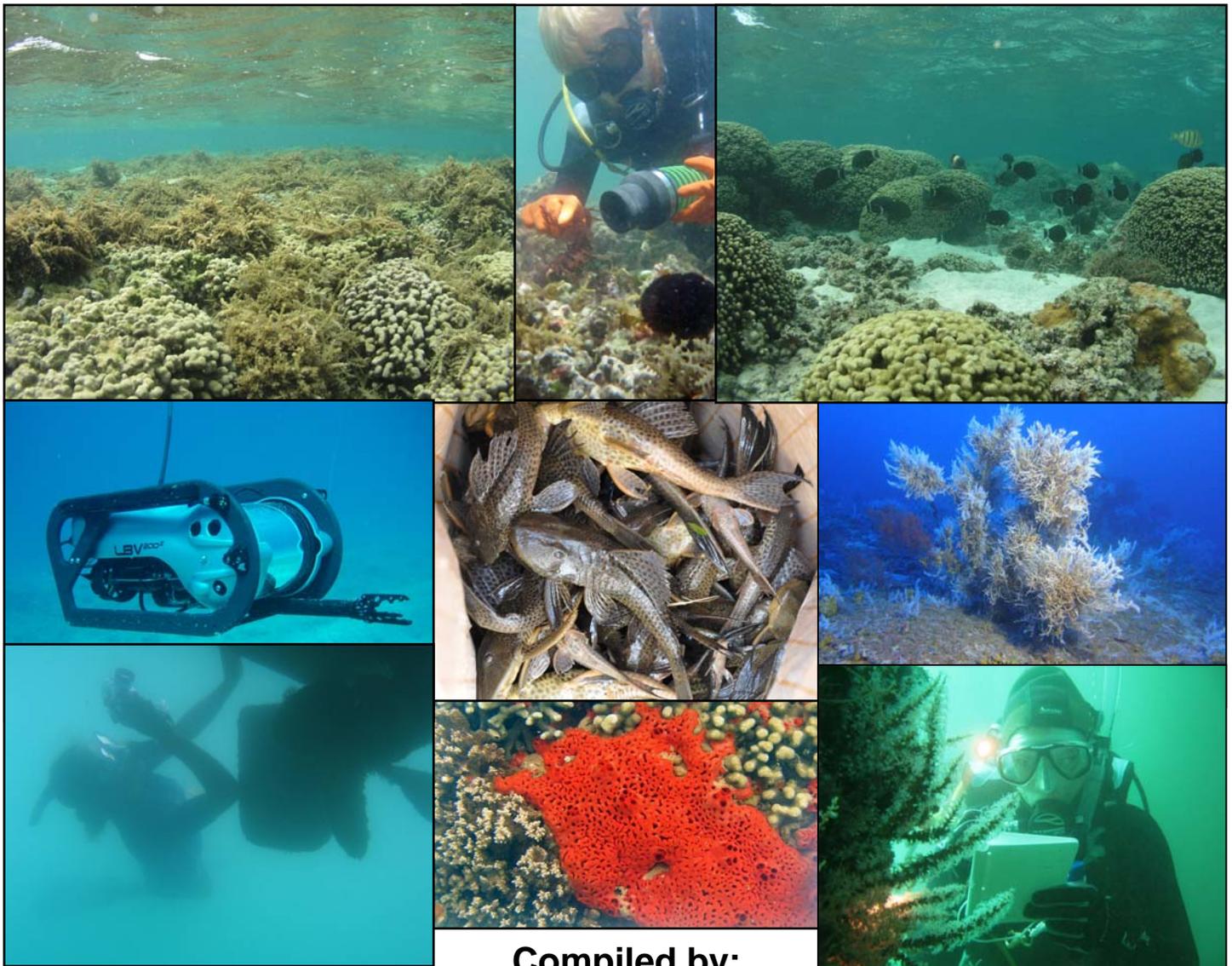


Division of Aquatic Resources Department of Land and Natural Resources



Aquatic Invasive Species Summary Report 2008-2009



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Introduction

During 2008 and 2009, the Division of Aquatic Resources, Department of Land and Natural Resources continued developing a program to broadly address the impacts and threats of aquatic invasive species (AIS) in Hawaii. Many projects focus on alien algae with various approaches but others address more broadly reaching AIS issues. However, previous projects not reported within this summary have addressed issues with many various species. Previous projects have included an attempted eradication of the Snowflake Coral on Kauai, the assessment of impacts from the Keyhole Sponge in Kaneohe Bay (pictured on cover), community efforts to remove Armored Catfish in Manoa Valley, Oahu (pictured on cover), eradication of Mushroom Anenomes on Oahu, eradication of Upside Down Jellyfish in Waipae Tidepools, Hawaii, and a major clean-up of *Salvinia molesta* in Lake Wilson, Oahu. Issues with AIS have similar components to terrestrial based invasive species, but are also very unique in the management and pathways of the threat. Generally, a lack of response and control tools is a major obstacle in addressing the threat of AIS. Hence, a large amount of effort is spent developing tools, approaches, and methods in order to develop sustainable management strategies. The few examples of various projects being addressed are briefly described in this summary.

Mechanical Removal via the “Supersucker” in Kaneohe Bay with Native Sea Urchin Biocontrol



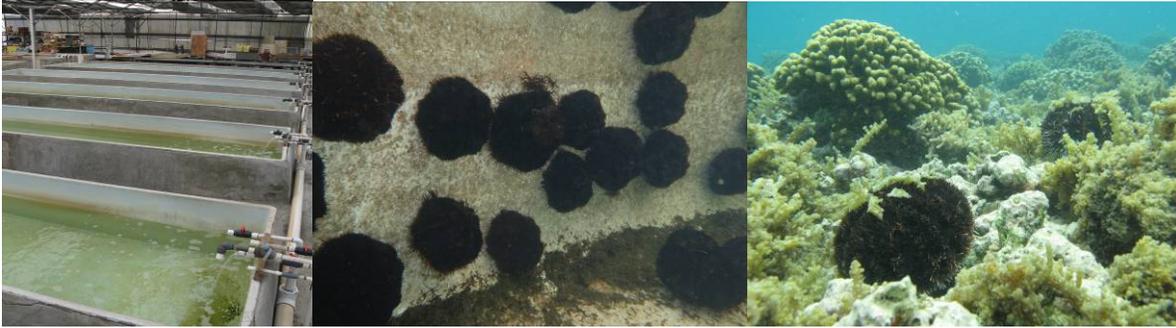
The Supersucker barges are a fleet of mechanical tools used to assist in the control of alien invasive algae. They consist of a floating platform equipped with suction pumps and hoses which divers utilize to remove alien algae from the reef. With support from the Hawaii Invasive Species Council, DAR began overseeing operations of the Supersucker Project in 2009. Although DAR is overseeing operations, the project is still managed as a partnership with University of Hawaii and The Nature Conservancy (TNC).

In July 2008 a small patch reef, roughly 3000 m² in Kaneohe Bay, was cleared. Consequently, the algae re-grew to baseline levels in six months without any further intervention. In July 2009 re-clearing began on the reef using Supersucker Sr. along with help from its smaller version, Supersucker Jr. DAR is studying the combined effects of mechanical removal and increased native herbivory using the native collector urchin, *Tripneustes gratilla*, on the biomass re-growth of invasive algae. Experiments are being conducted to determine the urchins' effectiveness in grazing the alien algae and inhibiting its rapid re-growth after mechanical removal on a scale larger than previous studies. Urchins were collected from Z-slab artificial reefs along the West Coast of Oahu and then transported to the State of Hawaii's Anuenue Fisheries Research Center (AFRC) to be quarantined. Upon completion of quarantine, the animals were transported and carefully placed onto newly cleared sections of the reef. The urchins' progress and/or the

possible re-growth of alien algae will be monitored to determine required stocking densities and the efficiency of using collector urchins as a native biocontrol agent.

The artificial Z-slab reefs will be monitored to measure any impacts from urchin removal as well as urchin population recruit and migration in the area.

Biocontrol Development and Sea Urchin Rearing



Further investigation is underway to determine long-term utility of native grazers, such as sea urchins, to assist in the control or elimination of invasive algae. The culture and outplanting of native sea urchins may allow managers to control the growth of invasive algae without endless mechanical removal. Previous research at the University of Hawaii has shown this method to be a highly effective tool on a small scale. Larger scale experiments would allow the tool be monitored and altered to test further success. In order to pursue larger scale experiments, a source of urchins must be developed. Collecting a large number of urchins from the reef may cause harm to the donor area. So, the solution is to raise urchins for the purpose of outplanting. Urchin rearing trials will take place at AFRC utilizing the infrastructure already in place. The rearing of large quantities of sea urchins will be implemented in conjunction with the Supersucker project in order to address invasive algae issues in a comprehensive approach. Once urchins are available in sufficient numbers, outplanting trials will begin to test for effective outplanting densities as well as strategies for density manipulation. All activities will be closely monitored for algal abundance, coral health, and reef improvement.

Herbivory Enhancement Area on Maui



An Herbivory Enhancement Area (HEA) on Maui was proposed and implemented based on previous DAR study that conducted fish and habitat surveys at all of Hawaii’s Marine Life Conservation Districts as well as nearby reefs which were open to fishing. The study found a strong correlation between the biomass of fish and the amount of macroalgae. Specifically, reefs which had large numbers of herbivorous fish had very little or no macroalgae, and reefs that

were closed to fishing tended to have larger stocks of herbivorous fish. This resulted in the development and implementation of an HEA on Maui. After engaging stakeholders for support, this area was officially designated an HEA on July 25, 2009 and provides full protection of herbivorous fishes and sea urchins in the area. The area begins at Kekaa fronting the Sheraton Hotel and extends around Honokowai Point to the southern Edge of Honokowai Beach Park. Data gathered from this project will be used to evaluate the potential of protecting herbivorous species in other areas that have been severely impacted by invasive algae.

DAR Ballast Water and Hull Fouling Program



DAR continued working on minimizing the introduction and spread of AIS into Hawaii from vessels. Ballast water is being managed by Hawaii's Administrative Rules, Chapter 13-76, relating to Non-Indigenous Aquatic Species. Rules have allowed the State to manage ballast water on a local level, by working with the shipping industry to limit the amount and reduce the risk of ballast water discharged in Hawaii's waters. Further verification is in the planning stages with the recently acquired sampling tools including a Ballast Water Assurance Meter which was recently approved by the US Coast Guard as the first tool to accurately check for ballast water exchange.

Hull Fouling, which is responsible for the majority of AIS introductions to Hawaii's waters, is being addressed as a high priority. DAR also continues to work with the Alien Aquatic Organism Task Force (AAOTF) to develop a comprehensive plan for preventing the introduction and dispersal of alien aquatic organisms found on the hulls of vessels. The AAOTF includes representatives from state and federal agencies, shipping industries, the scientific community and non-government organizations. DAR is currently reviewing how others are managing this vector as well as conducting studies, such as an assessment of recreational vessels in Hawaii, to get a better understanding of how to address hull-fouling issues.

The program is conducting AIS inspections using new technologies such as a remotely operated vehicle, a variety of pole cameras, and underwater drop cameras. Inspections are conducted on high-risk events such as unexpected arrivals, vessel groundings or vessels that may carry AIS. DAR is also assisting The Papahānaumokuākea Marine National Monument with inspections of vessels that enter one of the largest protected marine areas in the world. This program requires that 100% of the vessels (excluding US Coast Guard and Military vessels) entering into monument waters undergo a hull inspection and certification. The Monument has very few non-native species and rigorous inspection of vessel hulls, ballast water, ancillary and scientific gear is done to maintain the biosecurity of this potential World Heritage Site.

Rapid Response to Grounded Vessels



In June 2009 DAR responded to a sailing vessel which ran aground in shallow waters East of Kapapa Island in Kaneohe Bay, Oahu. The vessel had traveled from Washington State to Mexico, the Marquesas, and finally to Hawaii. DAR worked with experts to identify hull fouling organisms attached to the hull. Three different taxa of algae were collected from the bottom of the hull. It was determined that two out of the three were new alien species to Hawaii and represent a new introduction. Among a number of invertebrates collected that are currently established in Hawaii, two types of barnacles were also found to be alien species. The grounded vessel left two scars in the reef. The grounding and resulting scars represent a good example of a potential pathway for alien species' introduction to Hawaii. These scars and surrounding reefs will be further monitored in future months to determine if any of these alien species were able to colonize the reef. If these introductions are detected in the environment, a rapid response eradication will be attempted.

Rapid Response to *Gracilaria sp.* in Kona



In 2008, DAR was notified by a pond foreman at one of Kailua Kona's resorts. The gentleman expressed concern about an algal species overtaking the substrate of one of the ponds at the resort, and inquired about removal techniques. DAR investigated the concern in August 2008. It was observed that a *Gracilaria sp.* population was restricted to a single man-made, lined, self-contained brackish water pond. In order to properly identify this *Gracilaria* species, preserved samples were sent to the University of Hawaii Botany department for genetic identification. The alga was positively identified as *Gracilaria salicornia*. The source was traced back to an aquaculture facility in Kona at the Natural Energy Laboratory of Hawaii Authority (NELHA). DAR worked with the resort to eradicate the population through a variety of techniques. The resort was able to lower the salinity in the pond by altering its well source and the population has subsequently been eliminated. DAR will continue to communicate with the resort to ensure the

eradication remains successful from the area. This project was a positive example of government and private sector maintaining good communication and collaboration when dealing with the impacts of invasive species.

Molokai Community-Based Invasive Species Control



DAR initiated a Molokai community-based invasive species control project with funding from The National Fish and Wildlife Foundation. DAR will conduct a year-long project consisting of mechanical algae removal, community clean-up events, educational workshops, and outreach activities. *Gracilaria salicornia* is the primary species targeted for removal efforts. A bio-secure protocol for the processing and recycling of the alien algae is being developed; insuring that there will be no reintroductions and that algae biomass is utilized in a beneficial manner. Algae re-growth monitoring will measure the success of the algae removals. This project will serve as a model for community-based invasive species control across Hawaii and will take place at four locations: Kaunakakai Harbor, Keawanui Fishpond, Ualapue Fishpond & Kaloko eli Fishpond. This project has demonstrated a positive collaboration between government and community groups and individuals in accomplishing a invasive species control.

Molokai Upside Down Jellyfish (*Cassiopeia* sp.) Removal Project



In June 2009, DAR collaborated with the Molokai Invasive Species Committee (MoMISC) to remove approximately two hundred upside down jellyfish (*Cassiopeia* sp.) from Kaunakakai's recreational swimming area. Both organizations decided to remove the invasive jellies from the area due to the mild sting that these species cause when disturbed. The site will be monitored over the next year to determine removal success. Previous efforts in Hawaii have shown the manual removal of this species may be effective in its long-term control or eradication.

Maunalua Bay Alien Algae Removal and Seagrass Habitat Restoration



A study currently underway by DAR assisted by the University of Hawaii monitors the succession of native macroalgae/seagrass cover after the removal of *Avrainvillea amadelpha* in a plot site containing a mosaic of *A. amadelpha*, *Halophila hawaiiiana*, and other native and nonnative algal species. The restoration area is a 40-m diameter (1256 m²) circle plot located approximately 225 meters offshore Paiko Lagoon, Oahu. An estimated 235 human hours were required to remove an estimated 3000 kgs of *Avrainvillea amadelpha* from the plot. DAR has also assisted in community cleanup events organized by TNC & Malama Maunalua to scale up the alien algae removal effort in Maunalua Bay. These efforts and studies have help support TNC and Malama Maunalua's acquisition of economic stimulus funds from NOAA's Restoration Center.

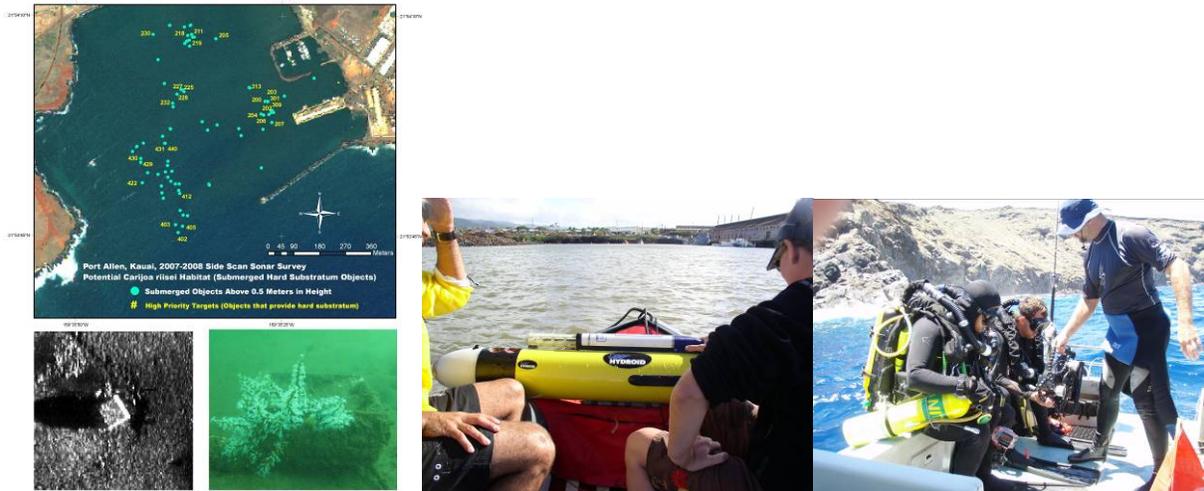
AIS Surveys and Distribution Mapping for 5 Alien Algae Species



DAR has been conducting visual surveys for five major invasive marine macroalgae species (*Gracilaria salicornia*, *Kappaphycus/Euchuma* spp. complex, *Acanthophora spicifera*, *Avrainvillea amadelpha*, *Hypnea musciformis*) around the state since 2005. Since that time, over 40,000 data points have been collected from Oahu, Molokai, Hawaii, and Kahoolawe. Surveys typically extend from shore to the barrier reefs of potential habitats and are conducted on snorkel, making straight line swims from beach to reef. Portable global positioning system devices are used to record spatial data along with relative algal abundances. Data points are imported into ArcGIS software allowing the generation of accurate maps that project algal abundance and distribution. These maps are essential for determining further algal management strategies and are being used to develop and implement a comprehensive approach to remove

and control the spread of non-native algae by utilizing mechanical removal, native grazers and the reintroduction of native species.

Snowflake Coral (*Carijoa riisei*) Surveys



DAR has conducted surveys for the Snowflake Coral, *Carijoa riisei*, around the known boundaries of Kauai County. Surveys with partnership of the University of Hawaii used an autonomous underwater vehicle to map the seafloor of Hanapepe Bay (Port Allen) on Kauai to determine potential substrate in which the soft coral could inhabit. This project continued our control project beneath the Port Allen Commercial Pier. In addition, divers surveyed remote areas around Kauai County using both open and closed circuit diving equipment. Surveys were conducted around parts of Kauai, Niihau, Kaula Rock and Five Fathom Pinnacle. These surveys will help support the development of an Integrated Assessment for NOAA's National Ocean Service to determine future management needs and strategies.

Implementation Plan for Tilapia Eradication for Kawaiele Bird Sanctuary



The Kawaiele Bird Sanctuary is an important feeding and nesting area for endemic and endangered water bird species (e.g. *Himantopus mexicanus knudseni*, *Gallinula chloropus sanvicensis*, *Anas wyvilliana*). These bird populations depend directly and indirectly on the

abundance of aquatic vegetation such as *Ruppia* sp. The presence of invasive fish, specifically tilapia, is hindering the growth of aquatic vegetation. The objective of this project was to identify methods that could be used to control invasive fish in the sanctuary. Six fish control methods were reviewed including: dewatering, netting/ trapping, electrofishing, blasting/ explosives, biocontrol and piscicides. The review process was done through analysis of technical literature, consultation with experts and evaluation of case studies. The results have been presented in two reports: “Invasive Fish Control and Eradication: A Preliminary Plan for the Kawaiele Bird Sanctuary, Mana Plain Conservation Area, Kauai, Hawaii” and “Implementation Plan for Tilapia Control in the Kawaiele Site”. Chemical treatment with rotenone (CFT Legumine™) has been identified as the most suitable method to eradicate tilapia in the sanctuary. This method can kill all invasive fish with no significant undesirable effects, provided that risks are mitigated by neutralization with potassium permanganate followed by monitoring. According to consultations with US Fish and Wildlife Service rotenone experts, the implementation of a rotenone treatment in the sanctuary would be safe and relatively easy because the site characteristics are very appropriate for this type of treatment. Nevertheless, the application of chemicals to water bodies requires a series of permits, licenses and multi-agency approval. In addition, a project of this nature may face public opposition. Thus, sufficient time and resources would have to be set aside for public outreach, multi-agency consultation and processing of permits. Dewatering and fish collection with nets have been identified as next best alternative; however, there are a number of issues that would need to be resolved with this treatment. This project is a multi-agency collaboration, but DAR is working on the initial steps to obtain the appropriate authorization to use rotenone in the sanctuary.

Chemical Toolbox for Control and Eradication of AIS in Hawaii

One of the specific strategies for managing AIS in the 2003 State of Hawaii AIS Management Plan is "to research management efforts and effective measures in Hawaii and elsewhere regarding specific species, and use this knowledge when developing strategies and plans to address these species". The Chemical Toolbox Project was created to address this provision. The project's overall objective is to offer DAR and other resource managers options that can be used for effective management of AIS in Hawaii. A comprehensive assessment scrutinized more than 70 active ingredients that have been tested or that show potential against AIS. The assessment was done through a review of technical literature and direct contact with other AIS managers, scientists and representatives from the chemical industry. Chemical properties evaluated included active ingredients' mode of action and selectivity, effectiveness against target species of interest, toxicity to humans and to other non-target species, degradation and fate in the environment, and registration status. The findings from this assessment are presented in a report that includes a list of chemical products with potential for the purpose of combating new AIS introductions (i.e. rapid response actions) and controlling established AIS populations in Hawaiian waters. Associated application, containment and neutralization methods are also presented in the report. In addition, legal and regulatory issues related to the application of chemical substances to aquatic systems have been investigated, and dialogue with other State departments that hold authority over this matter initiated. A framework for the utilization of chemical control and eradication of AIS tools is under development.

Aquaculture as a Vector for the Spread of AIS in Hawaii

Recently, the Division of Aquatics Resources has reviewed its authorities and permits for aquaculture of regulated species. During this review, it was determined that DAR policy would be to discourage the culture of non-native species that are under regulation in the State of Hawaii. Specifically, this policy targets the culture and sale of non-native *Gracilaria* spp. This determination was largely based on the rapid response event from the transfer of *Gracilaria salicornia* from an aquaculture company at NELHA to an uninfected area. Originally, this species was transferred from Oahu to NELHA for commercial aquaculture. There has been an increasing demand for this non-native species as a food item while the State of Hawaii spends a tremendous amount of resources controlling this species. Aquaculture activities have been the primary vector in which *Gracilaria salicornia* has spread across the state.

In addition, DAR has begun working even closer with the Department of Agriculture (DOA) in reviewing requests to import non-native aquatic species. In particular, DAR has taken a position that we would like to see a zero risk determination for any import of non-native algae before the species is imported into the State of Hawaii. DAR will continue dialogue and cooperation with DOA on this issue.

Funding Sources:

Hawaii Invasive Species Council
Department of Land and Natural Resources
National Oceanic and Atmospheric Administration
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National Fish and Wildlife Foundation
Department of Defense