

Testimony of Steve Coles  
Before the U.S. House of Representatives Subcommittee on Fisheries Conservation, Wildlife, and Oceans  
Honolulu, Hawaii  
April 15, 2004

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to present testimony on marine alien and invasive species problems in Hawaii. My name is Dr. Steve Coles, and I am substituting for Dr. Lu Eldredge, who was unable to attend this session. Both of us are invertebrate zoologists at the Bishop Museum, here in Honolulu. We are long-term residents and researchers in the Hawaii and Pacific region, and we have been working together for several years studying the occurrence and impact of marine alien species in the Hawaiian Islands.

Alien species, also termed nonindigenous or introduced, are those organisms that have been brought to an area through man-related activities and reproduced and propagated, becoming part of the recipient area's permanent biota and ecosystem. Sometimes these introductions are uncontrolled by predators or other factors that would limit their populations, and the introduced species become over-abundant and dominant, consuming, out-competing, or otherwise overwhelming native organisms. These problematical introduced or alien species are termed invasive, pest or nuisance species. Examples of invasive aquatic introductions that become notorious outside of Hawai'i are the zebra mussel that has overwhelmed freshwater systems throughout the eastern and central United States and Canada, the green *Caulerpa* algae that has monopolized the marine environment of the western Mediterranean, and the European green crab that is a voracious predator of nearshore organisms on both the east and west coasts of the United States.

The Hawaiian Archipelago has been subject to numerous anthropogenic introductions of both terrestrial and aquatic plants and animals. The Hawaiian Islands are known as the extinction capital of the world and perhaps should also be called the introduced species capital of the world. More than 20% of the entire species composition of the Hawaiian biota, is of nonindigenous, or introduced, origin.

The marine environment has not escaped this encroachment of alien invasive species. Most people do not observe them on a regular basis, but substantial numbers of marine introductions have managed to establish themselves in our shallow waters. Hawai'i has an estimated total of approximately 25,600 species for its entire biota, of which about 7000 are marine invertebrates. Of these we presently recognize 201 invertebrate species to be introduced and 86 species to be cryptogenic, or, having some characteristics associated with alien status but insufficient information to designate them as introduced. These cryptogenic species are subject to be reassigned to introduced or native species as additional information on them becomes available

Scientists at the Bishop Museum have conducted intensive biological surveys in all the major harbors and ports in the main Hawaiian Islands, as well as at Kaho'olawe Island, Midway and French Frigate Shoals in the Northwestern Hawaiian Islands, Johnston Atoll, and in Pago Pago Harbor and reef sites on the island of Tutuila, American Samoa. In addition to these intensive surveys where organisms are collected, returned to the laboratory, sorted and identified, rapid assessments utilizing on-site observations by expert observers have been carried out at more than 40 coral reef sites outside of ports and harbors on five of the main Hawaiian Islands. Although our studies focus on marine invertebrates, we also determine the species composition of algae and fishes on our surveys and the occurrence and relative abundance of introduced species for those groups. These efforts began with an initial study in Pearl Harbor in 1996-97 and continue today as we are finishing the sorting and identification of samples collected from neighbor island harbors in 2003.

A clear and consistent pattern has emerged from these studies. In O'ahu's harbors and in areas such as Kaneohe Bay and Waikiki that have undergone a variety of environmental disturbances, introduced and cryptogenic species, collectively termed NIS, are a major portion of the total identified biota. Around 100 NIS were observed or collected in Pearl Harbor, in O'ahu's commercial and small-craft harbors and in Kaneohe Bay, and 50 NIS were identified off Waikiki. These high numbers of NIS account for between 7 and 23% of the total taxa identified on these surveys, and are among the highest values that have been reported for

marine introduced and cryptogenic species anywhere in the world. NIS are so abundant and dominant at many places in Hawaii's harbors and enclosed embayments that little else living is visible on hard surfaces in these environments.

Fortunately, most of these introduced and cryptogenic species appear to have remained primarily in the organic rich and turbid waters that predominate in harbors and enclosed embayments, and most NIS have not spread onto Hawaii's coral reefs or open coastlines. In our recently completed rapid assessment of NIS at 41 coral reef sites on five of the main Hawaiian Islands a total of only 26 NIS, including introduced algae and fish, were recorded, with a maximum of six NIS at any site. Since these rapid assessments were based on visual observations of large, recognizable species, minute organisms that include many of the known introduced species were undoubtedly overlooked. However, the results are entirely consistent with previous intensive surveys on open-ocean coral reefs at Kaho'olawe, Midway, French Frigate Shoals and Johnston Atolls where totals of only two to ten NIS were found among the hundreds of species identified from material collected, sorted and identified for each study.

This pattern of results is encouraging, but it would be misleading or even dangerous to discount the importance of introduced species on the basis that only a few have been found to occur outside of harbors and embayments. Single introduced species that have proliferated to the point that they became invasive have had highly negative environmental or economic impacts at many places in the world, and Hawaii is no exception. The best known examples of this are five species of introduced marine algae that have become a serious invasive problem in Hawaii's nearshore waters, and these will be reported on by our colleagues from the University of Hawaii, Drs. Celia Smith and Cindy Hunter.

Invertebrates that are invasive or potentially invasive also occur outside of harbors in Hawaii, although they are not as widespread as invasive marine algae. The most prominent invasive invertebrates species known to date are the Caribbean barnacle *Chthamalus proteus*, the Caribbean snowflake coral *Carijoa riisei*, and the orange keyhole sponge *Mycale armata*. These are all relative newcomers to Hawaiian waters compared to many of the introduced species that dominate the harbor biota and are known to have been here for up to 100 years. The Caribbean barnacle occurs in the high intertidal in quiescent waters, so it is not strictly a coral reef organism, but it does illustrate the rapidity by which an introduced invasive organism can come to dominate in its area of introduction. It did not occur in Hawaii and was not reported elsewhere in the Pacific in the early 1970s. It was first reported in Hawaii in 1996, by which it had become the dominant intertidal organism occurring in bays and harbors throughout Hawaii and occurring as far west as Midway and Guam. The lesson to be learned from this introduction is just how rapid such an organism can propagate and spread throughout a wide geographic area, in this case unnoticed until it comes to the attention of researchers and taxonomic specialists.

The Caribbean snowflake coral was first noted in Hawaii in Pearl Harbor in 1972, and it also has continued to spread throughout the main Hawaiian Islands. It also represents a serious economic threat to an established industry, the sustained harvest of black coral, which has a market value of around thirty million dollars per year. Until recently, introduced snowflake coral was believed to occur only in harbors, under ledges and in caves down to about 100 feet depth where low light and moderate currents appear to favor its growth. However, in 2001 snowflake coral was found abundantly overgrowing black coral off the coast of Maui at depths greater than 250 feet, where over 90% of the black coral trees were dead and completely covered by the invasive snowflake coral. Since black coral trees at this depth are not normally harvested, it is believed that they are important in providing larval recruits to sustain the population subject to harvest, and the overgrowth of black coral trees in the deeper zone represents a threat to the sustainability of the industry and long-term survival of black coral in Hawaii. This species and its impacts have become a priority focus for the Hawaii Department of Land and Natural Resources, which will be described further by Ms Athline Clark.

The final invertebrate, which we have only recently assigned invasive status, is the orange keyhole sponge, unreported in Hawaii until we found it on our initial Pearl Harbor surveys in 1996-97. We now know that this species is common in harbors throughout the main Hawaiian Islands. and it is infrequently found in low abundance on some coral reefs. However, it is in Kane'ohe Bay that it shows invasive characteristics that impact major reef-forming organisms. There it proliferates on and around the dominant reef-forming corals of the bay, competing for living space and sometimes overgrowing corals where the sponge has become established. It is therefore another serious competitor threatening the continued growth and survival of reef corals in Kane'ohe Bay, along with the highly invasive alien algae that will be described by my botanist colleagues.

These three examples illustrate some basic facts that apply quite universally to marine introductions. 1)

Unless they are intentional introductions they usually arrive undetected and remain so until trained experts find them as part of a focused research effort. 2) They come from all over the world and their rate of arrival may be increasing due to increased shipping activity in the last 30 years. 3) They may lie relatively dormant in their arrival area for decades until a combination of environmental and/or biological conditions favor their proliferation to invasive levels. 4) By the time of their detection they usually have become too widespread and abundant for effective control or eradication, unless they still remain in an area that can be confined.

In regard to the later point, it is important to stress the profound difficulty of control or removal of an invasive marine alien species after it has become established. To our knowledge, this has been successful for an invasive marine invertebrate in only one circumstance: and that was the eradication of a marine mussel, closely related to the notorious freshwater zebra mussel, which became established in small boat harbors near Darwin, Australia. This effort was successful because trained researchers conducting a routine monitoring survey for marine introduced species detected the mussel early, the harbors have openings that could be isolated from surrounding waters while all biota in the harbors were killed by heavy doses of sodium hypochlorite and copper sulfate, and a massive, coordinated effort was rapidly mobilized by various government agencies, at a total cost of over 1.6 million dollars.

Given this difficulty of control after establishment of introduced species, it is apparent that major focuses of marine alien species prevention efforts should be on early detection and on stopping their introduction in the first place. All nonindigenous species in Hawai'i have been either intentionally or accidentally introduced to the islands. Intentionally introduced marine species have usually been for food sources, stock enhancement, or aquaculture. In Hawaii several species of marine fishes were released to expand the local fishery; most notably the ta'ape or blue striped snapper, introduced from French Polynesia in 1955. Additional intentional introductions of ornamental fishes have occurred from aquarium releases. These intentional introductions are clearly preventable and can be controlled by maintaining strict import permit restrictions that prohibit direct open water contact from marine or freshwater aquaculture organisms, and by educating the general public about the potentially negative results of releasing their aquarium fishes. The recent movie "Finding Nemo", although presenting a charming and entertaining story, has unfortunately been followed by a reported increase in releases of aquarium fishes by owners wanting to grant their pets their freedom.

Accidental introduction pathways are numerous and more intractable to control. Transport and release of ballast water is considered to be the major pathway for spreading of marine alien species throughout most of the world, but research conducted at Bishop Museum indicates that ballast water is not the major source of marine introductions for Hawai'i. Research findings indicate that hull fouling, or the community of animals and plants growing on artificial substrates, accounts for about 80% of the recognized marine introductions to Hawai'i or movement of introduced marine species among the islands. Other possible pathways, just beginning to receive attention, include nonindigenous species attached to floating debris, organisms that may be inadvertently transported on diving, scientific and collection gear, and parasites and pathogens arriving with other animals and plants

These few examples point out that there are several avenues and preventative measures required to prevent more marine invasives from entering Hawaii's waters and becoming established in our marine communities. Lacking evidence to the contrary, all introduced marine organisms should be considered potentially invasive, and comprehensive measures should be implemented for their detection and control. To do so we must develop a vigilant program that utilizes trained and observant individuals. This will require financial support to extend and enhance activities that have been developed at Bishop Museum, the University of Hawaii and the Hawaii Department of Land and Natural Resources/Department of Aquatic Resources.

In conclusion I would like to thank the subcommittee for the opportunity to testify and for their interest and focus on this issue.