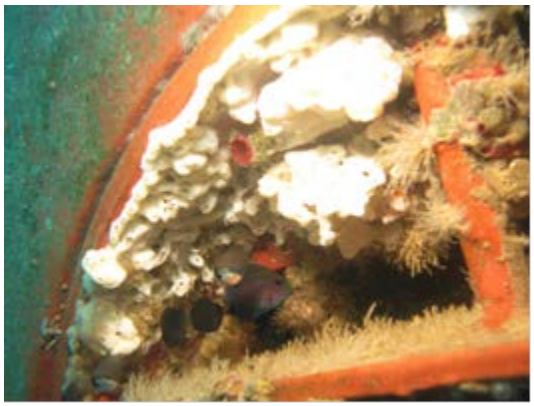
Guam

Marine Biosecurity Action Plan



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Guam Marine Biosecurity Action Plan

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About this Document

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Background

Invasive species and biosecurity

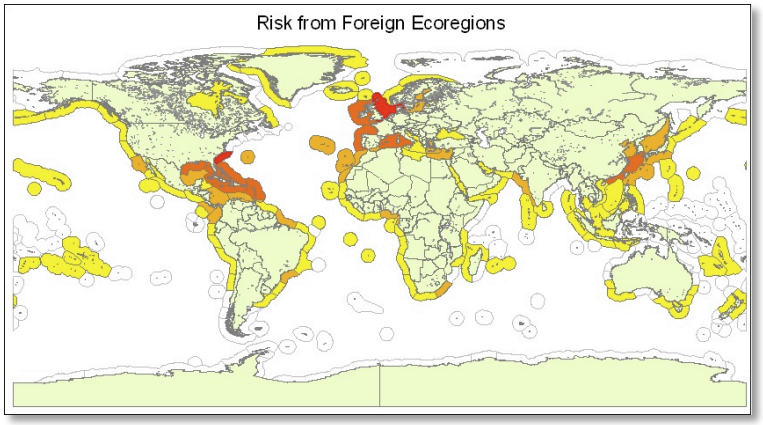
Nonnative species are introduced by humans, whether intentionally or unintentionally, into ecosystems all over the world. Some introductions are nonthreatening to the ecosystem in which they are introduced, and the species is unable to establish a population. However, if the species is able to thrive in the new environment and become established, it may out-compete native species and have significant negative economic, ecological, social, cultural, and human health impacts, thus becoming an invasive species.

An invasive species is defined by Executive Order 13112 as a species not native to the region whose introduction (by humans) causes, or is likely to cause, economic or environmental harm or harm to human health. For an organism to be considered an invasive species, it must meet all of the following criteria:

- non-native
- able to establish in a new location (start an incipient population) (or at least seems likely to be able to do this based on life history traits and/or examples of establishment in similar locations)
- cause harm (to environment and/or directly to humans and/or their endeavors) (or at least seems likely that it would cause harm if permitted to establish based on life history traits and/or examples from other locations)

While there is no list of characteristics which fit all invasive species, a variety of factors contribute to the ability of a species to invade, including:

- the ability to tolerate a variety of habitat conditions
- the ability to grow and reproduce rapidly
- the ability to outcompete natives for resources
- the lack natural enemies or pests in the new ecosystem



This map indicates relative risk from ecoregions outside the northeastern United States, evenly weighting ballast water volume sourced from a region and number of ships from that region. Red represents the highest risk and yellow the lowest risk. Ecoregions in white did not source any ships with a destination in the northeast United States. Figure adapted from Slosberg, 2014.

The widespread occurrence of invasive species along with increasing globalization will only exacerbate the problem of invasive species. As countries are addressing invasive species which are already established, they also realize the need for prevention of new invasive species introductions and the need to prevent the transport of invasive species from their location to other areas. An approach designed to prevent transport of invasive species between regions (countries, islands, states, etc.) is often referred to as biosecurity.

The term biosecurity is used across a variety of disciplines, but was first used in the agricultural and environmental

communities to describe an approach designed to prevent or decrease the transmission of naturally occurring infectious disease and pests in crops and livestock (Koblentz 2010). This definition is concerned primarily with threats to animal and plant health and biodiversity, which may or may not have a direct effect on human health. Some countries, such as New Zealand and Australia, have created biosecurity legislation to comprehensively deal with this issue (Meyerson and Reaser 2002). For Micronesia, the RBP is a great step forward in addressing these concerns throughout the region, and more and more countries are beginning to seriously address biosecurity through the establishment of stricter regulations and management plans.

Invasive species and island ecosystems

Oceanic islands throughout the world are notoriously vulnerable to biological invasions. Islands experience long periods of evolution in isolation from those forces faced routinely by plants and animals on continents. This isolation also contributes to the vulnerability of islands to biological invasion (Loope and Mueller-Dombois 1989). Smaller numbers of native species on isolated islands and the intensity of human impacts on small land areas of islands have clearly made the situation worse by increasing most islands' susceptibility to invasion.[1]

Guam has a diverse marine biota with over 5000 species of major coral reef organisms, including over 1,000 nearshore fish species and over 400 scleractinian coral species (Paulay 2003, Burdick et al. 2008). Guam is also the economic hub for Micronesia with the largest and busiest port in the region, giving it the greatest potential in the region for receiving non-native species; it already possesses a rich biota of non-native marine species which are mostly limited to Apra Harbor. While none of these species have caused massive detrimental effects to native marine organisms, they are dominant components of artificial structures in the harbor (Paulay et al. 2002) and pose a risk for future invasion. Also, with the proposed military build-up and relocation of Marines from Okinawa, Japan to Guam, and the accompanying projected six-fold increase in cargo arriving at ports of entry (Marler & Moore 2011), the potential for movement of more non-native marine species which can become invasive to Guam is a real threat.

Biological diversity and marine invasive species

Biodiversity enhances an ecosystem's resilience and stability against both natural and anthropogenic disturbances. This diversity not only applies to general species diversity, but also to a diversity of species that serve the same function in an ecosystem but respond differently to environmental factors. This provides redundancy in the ecosystem and enhances resiliency by filling niches (Walker 1995). If niches are left unfulfilled, or have only one species fulfilling that role, an introduced species may be able to come in, outcompete natives for resources, and become invasive.

Of marine ecosystems, coral reefs are one of the most biologically diverse ecosystems on the planet. The coral animals that provide the reef structure also provide multiple niches which are filled by the thousands of other marine animals which inhabit the reef. In the United States, and abroad, multiple coral reef areas are being protected from natural and anthropogenic disturbances through the creation of Marine Protected Areas (MPAs). Oftentimes, marine protected areas are considered ecosystems with greater biodiversity, resilience, and stability than unprotected areas. They protect both species and functional diversity, enhancing resilience and stability. This can make it more difficult for invasive species to become established in these ecosystems as most niche areas are already inhabited by native species.

[1] Text for this section taken directly from Loope, LL 1999.

Synopsis of invasive species on Guam

Invasive species are an increasing threat to Guam's fragile island ecosystems. Over the years, Guam has been victim to many species invasions, most notable being the Brown Tree Snake (*Boiga irregularis*). The Brown Tree Snake arrived on Guam after World War II and since then has grown to a population size of up to 10,000 snakes per square mile (Quitugua 2011). This snake has led to power outages, the extirpation of many native bird species, and the loss of domesticated pets. To combat the negative effects of the Brown Tree Snake, approximately $5 million is spent each year for interdiction on Guam (Quitugua 2011). Other terrestrial invasive species are also causing significant damage to Guam's native ecosystems and threatening human health (i.e. Chain of Love *Antigonon leptopus*, Coconut Rhinoceros Beetle *Oryctes rhinoceros*, Little Fire Ant *Wasmannia auropunctata*). Because of these impacts, much time, effort, and monetary resources has been devoted to terrestrial invasive species. Marine invasive species (MIS), however, have received little attention as of yet.

*The Brown Tree Snake on Guam (*Boiga irregularis*). Photo credit: Bjorn Lardner.*

To date, there are approximately 100 known non-native marine faunae on Guam (Appendix A); none of these species, however, has proven invasive. Most of these species are limited to Apra Harbor as it is the main point of entry for marine species that are introduced via shipping traffic. Paulay et al. (1997) found that while many non-indigenous species have invaded the marine waters of Apra Harbor, most have made little impact and remain restricted to artificial substrata while a small percentage were found in natural habitats. Artificial substrata, including mooring and navigational buoys, had a biota comprised of many species not found elsewhere on island, however the species inhabiting these places were mostly considered non-native. Outside of those species considered non-native, Apra Harbor also boasts a diverse native biota that is only found inside the harbor. With both types of species co-existing in the harbor, the negative impact of non-native species on the native biota in the harbor can have a greater impact on the overall marine diversity of Guam.

The status of marine flora on Guam is less clear. As of 2004, there were 270 species of benthic algae described for Guam (Tsuda 2003). While checklists and species inventories have been compiled for algae on Guam, native and non-native status of these species has not been addressed until recently. An effort to assess ecosystem resilience to invasive species focused on macroalgae diversity based on morphospecies distributions (Schils in prep.). This study found that using morphospecies as a basis for risk assessment is inadequate due to high cryptic diversity in macroalgae from the Western Pacific and that the number of potential invasive species would be underestimated if based solely on morphospecies descriptions. Therefore, the risks of invasive marine algae cannot be assessed based on morphospecies and will require more detailed study.

Goal and Objectives

While Guam has a fairly diverse marine flora and fauna, this does not necessarily mean it is immune to marine invasions. We already have approximately 100 documented non-native marine species present in Guam. With the relocation of military troops from Okinawa, Japan to Guam, and the associated in-water construction activities, new pathways for invasive species will be opened. The goal of the Guam Marine Biosecurity Action Plan is to: *minimize the harmful ecological, economic, social, cultural, and health impacts of marine invasive species through the prevention and management of their introduction, expansion, and dispersal into, within, and from Guam*.

To assist in this goal, the following major objectives have been identified:

Objectives:

1. Coordination and collaboration: improve the coordination and collaboration of people, resources, and efforts involved with invasive species
2. Prevention: minimize the introduction and spread of invasive species into and throughout the waters of Guam
3. Monitoring and early detection: ensure effective programs that allow for the early detection of new invasive species and the monitoring of existing invasive species
4. Response, eradication, and control/management: establish effective systems for rapid response, eradication, and control/management; evaluate and provide support to management plans and encourage the development of management techniques
5. Education and outreach: increase education and outreach efforts to ensure awareness throughout the island on marine invasive species threat and solutions
6. Research: increase research efforts on key invasive species, associated issues, and economic impacts to allow for more effective management
7. Funding : coordinate federal and local agency budgets to support marine invasive species priorities, develop partnerships, and seek opportunities to leverage funds within state and local agencies, local governments, industry, as well as other entities including non-governmental organizations
8. Policy: ensure local laws and regulations effectively promote the prevention and control of marine invasive species.

Scope and limitations of this Plan

While this plan is meant to be as comprehensive as possible, there were some limitations realized during the development of this plan, especially given the short amount of time to develop it. Many aspects of the plan may have not been developed to their fullest extent and include (but are not limited to) invasive species studies, climate change effects on species invasions, and the inclusion of RBP findings. The coordination of invasive species studies in Apra Harbor was not feasible in the short amount of time to prepare this plan. Therefore, what is known about MIS on Guam, and what is reported here, may not be complete. Also, the effects of climate change on species invasions to Guam were not developed. It is known that climate change contributes to shifts in the distribution of native species as well as facilitates the establishment and range extension of invasive species (Stachowicz et al. 2002). For that reason, climate change should be incorporated into the marine invasive species conversation. In addition, it was hoped that the Regional Biosecurity Plan for Micronesia and Hawaii (RBP) would have been completed before the creation of this plan in order to help refine the scope of this document. Unfortunately, the RBP has not yet been released; once released, a review of this biosecurity plan may be necessary.

This plan, as stated, will focus on marine species and marine invasives. With that said, there is great concern regarding invasive species in Guam's freshwater ecosystems as well. It has been stated that approximately 75% of known fish and shrimp species in Guam's freshwater ecosystems are non-native (Lindstrom 2014). Those species of most concern are what is being brought in, and what has been brought in, for aquaculture. Also species that are estuarine or brackish pose a threat to both marine and freshwater habitats if introduced as they are able to tolerate variable salinities. If they become established within marine waters that possess naïve prey and open niches, their potential for invasion is great.

It is also recognized that certain native species have the ability to experience population booms which can cause ecological damage similar to an invasive species. These species are considered nuisance species. While this plan does not focus on these species, it is important to understand the nature of these population blooms which can inform strategies to prevent and control invasive species incursions.

Problems and Concerns

Negative impacts of marine invasive species

The main point of entry for most marine invasive species will be Apra Harbor and the accompanying Port Authority of Guam and Inner Apra Harbor. The harbor not only serves personal, commercial, and Naval vessel traffic, but is a tourist attraction as well as it is home to many habitats and species not found elsewhere on Guam. Its coral reefs and fishery resources are major components of Guam's economy. According to the Guam Economic Development Authority, tourism accounted for up to 60% of the government's annual revenues in 2003 (Tourism: Core Components of Guam's Economy). Therefore, Guam's coral reef ecosystems are an integral component to the economy, and the threat of marine invasive species to these ecosystems also threatens Guam's economy.

While not all introduced species will become invasive, those that do will have a negative impact on the surrounding area where they become established. Some of the negative impacts from invasive species include the following:

<u>Environmental Impacts</u>

- Loss of biodiversity
- Loss of ecosystem functions
- Decreased (or change in) water quality

<u>Economic Impacts</u>

- Loss of tourism revenue
- Decreased property values
- Impacts to near-shore fisheries
- Costs associated with clean-up and control (most costs of invasive alien species are borne by society at large)
- Increased cost of doing business by interfering with current systems, processes, or equipment (such as from bio-fouling)

<u>Public Health and Quality of Life</u>

- Human health risks from harmful algal blooms (HABs)
- Impacts to recreational activities
- Perceived annoyance to humans

<u>Cultural/Traditional Impacts</u>

- Competition with culturally important native species, direct impacts to native species
- Impacts to culturally important practices (i.e. traditional fishing)

Examples of these impacts are documented below in the case studies.

Case studies

Guam:

The Brown Treesnake (*Boiga irregularis*) arrived on Guam following World War II. Shortly thereafter, the snake was able to form an incipient population and establish itself in Guam's forests. As there were no natural predators, and its prey source was abundant, the Brown Tree Snake was able to reach unprecedented numbers (Fritts and Leasman-Tanner 2001). Snakes have caused the extirpation of most of the native forest vertebrate species; thousands of power outages affecting private, commercial, and military activities; widespread loss of domestic birds and pets; and fear for envenomation of children (Fritts and Leasman-Tanner 2001). One island-wide power outage caused by the snake cost the power utility more than $6 million and the estimates of snake-related power outages is $1 million per year (Pimentel et al. 2005). The total costs of endangered species recovery efforts, planning for snake containment on Guam, and other programs directly related to the snake's invasion of Guam cost in excess of an additional $1 million per year; in addition, up to $2 million per year is invested in research and control (Pimentel et al. 2005). The budget for the U.S. Department of Agriculture's Wildlife Services Program BTS control activities on Guam was approximately US $1.7 million for fiscal year 2000 (Vice and Pitzler 2000). Since Guam is a major transportation hub in the Pacific, and the main distributor for imported products throughout Micronesia, countless opportunities exist for the brown tree snakes on Guam to be introduced accidentally to other Pacific islands (Fritts and Leasman-Tanner 2001). It is apparent that not only is this invasive species causing extensive biological and environmental damage, it is also costing an exorbitant amount of money to keep it from causing the same damage in other areas of the United States.

The Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) (CRB) is a relatively new introduction to Guam, first arriving in 2007. It was first discovered in Tumon, Guam among construction materials and has spread quickly throughout the island causing irreversible damage to coconut trees. Unfortunately this species was not able to be contained when it was discovered and has established itself on Guam. One of Guam's iconic WWII battle sites in Asan, and part of the War in the Pacific National Historical Park, has recently chosen to remove between 65 and 100 coconut trees to help mitigate the infestation in the park (Guam Ranger).

Hawaii:[2]

At least 19 species of macroalgae have been intentionally or unintentionally introduced into Hawai'i since the mid-1950s, five of which have successfully established and become distributed around the Hawaiian Islands. Each of these five algal species has become the dominant component of a number of reef environments where they appear to be outcompeting native benthic species (Smith et al. 2002). Three of the species, *Gracilaria salicornia*, *Hypnea musciformis*, and *Kappaphycus* spp., form extensive, destructive blooms. *G. salicornia* and *Kappaphycus* spp. have been observed in recent surveys to be overgrowing reef-building corals in Kane'ohe Bay, the south shore of O'ahu including the world famous Waikiki area, and the south shore of Moloka'i, which harbors some of Hawaii's most intact and expansive coral reef ecosystems (Russell 1983, 1992, Hodgson 1994, Rodgers and Cox 1999, Nishimura 2000, Woo 1999, Eldredge and Smith 2001, Smith et al. 2002, Smith et al. in press). These species pose an immediate threat to the health of Hawaii's coral reef ecosystems (Smith et al. 2002, Smith et al. in press). The costs associated with removal of algae from beaches, reduced property values, and reduced occupancy rates for hotels and condominiums in impacted areas is estimated at over $20 million lost in potential revenue. These blooms also reduce property values with a resultant tax loss in one community estimated to be in excess of $1.8 million annually.

[2] Text for this section adapted from Shluker 2003.

Another invasive species getting much attention is *Carijoa riisei. C. riisei* is an octocoral first reported in Hawai'i in 1972 and up until recently it appeared to be a relatively harmless introduction producing no recognized negative impacts on the overall reef community. However, a large-scale survey of the Maui Black Coral Bed in 2001 revealed that *C. riisei* populations exploded at many stations at depths between 75-100m. This depth represents the lower limits of the black corals *Antipathes dichotoma* and *A. grandis,* the two species that make up 100% of the commercial harvest of black coral collected annually from the Maui Bed. This fishery produces over $30 million in annual retail sales of precious coral jewelry (Grigg 2001). The 2001 survey showed that up to 90% of the black coral colonies of both species that occur in this zone are dead, having been overgrown by *C. riisei.* While the black corals that occur in this depth range are too deep to be harvested by traditional methods, this segment of the population is important as a source of larvae for re-seeding the shallower portions of the population which are harvested, and *C. riisei* is now considered the most invasive marine invertebrate on Hawaiian reefs.

Greater Caribbean:
In 2002 the first lionfish specimen was collected off the coast of North Carolina and provided the first solid evidence of lionfish presence in the Atlantic Ocean. This is the first documentation of a West Pacific fish population on the U.S. Atlantic coast and the first documented case of a marine fish posing a major invasive threat (Albins & Hixon 2011). These lionfish are venomous, fast reproducing, voracious predators. They are a major threat to native fish in the Atlantic as native fish are naïve prey for the lionfish. It has been stated that they will most likely cause deleterious changes to Atlantic and Caribbean coral reef ecosystems (Albins & Hixon 2011) as they can wipe out 90% of a reef (Linendoll 2013). Under a worst case scenario, the lionfish will starve from eating all prey, which cascades into a reduction in important herbivorous species causing buildup of seaweeds and algae on reefs (Albins & Hixon 2011).

Vectors and pathways
This section describes some of the proposed methods and pathways for the introduction and dispersal of non-native marine species. While this is not a complete list, it is the first step in addressing invasive species concerns. For marine non-native introductions on Guam, and elsewhere, the mechanism of greatest concern is the international and domestic shipping industry. This industry has been one of the leading sources of non-native species introductions worldwide.

<u>Potential Mechanisms for Introduction:</u>

I. Commercial Shipping – cargo vessels, fishing boats, and towed platforms
   A. Ballast water: "Shipping moves over 80 percent of the world's commodities and transfers approximately 3 to 5 billion tonnes of ballast water internationally each year." (Global Ballast Water Management Programme Website). Ballast water has traditionally been the culprit for marine and freshwater invasions. For Guam, ballast water is not considered the major vector of marine invasives as Guam is a major importer, not exporter, of goods, and Guam's economy is tourist-based (Paulay et al. 2002). With that being said, ballast water as a vector should still be considered, especially as Guam could be a supplier of marine invasive species to other islands in the region through this pathway.
   B. Vessel hulls: Animals attached to the ship's hull (biofouling) that can survive the trip over the open ocean are of main concern and have been known to supply Guam with non-native species in the past (Paualy et al. 2002). Coutts and Taylor (2004) found the greatest biofouling diversity and extent were greatest among niches (Figure 2).

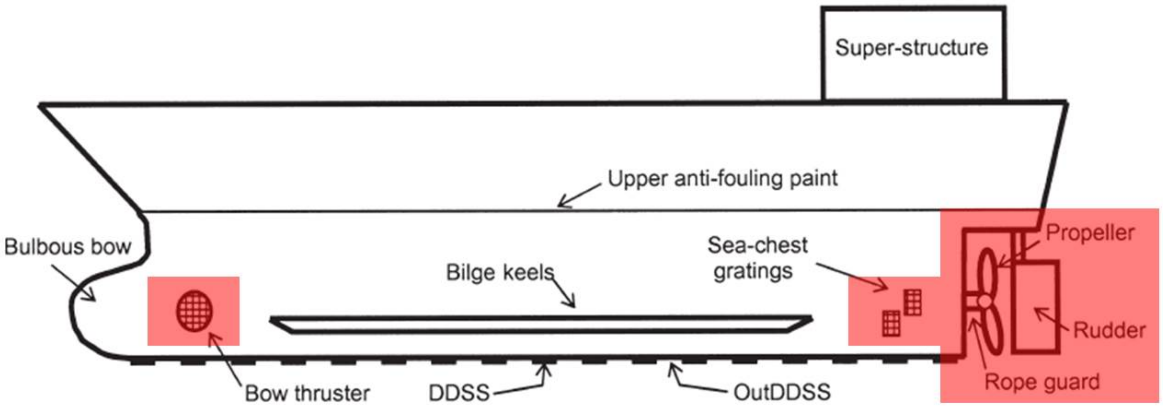


Figure 2. Adapted from Coutts & Taylor, 2004. Areas highlighted in pink demonstrate niche areas on ships which have the greatest biofouling potential.

C. Fisheries gear: This includes nets and floats. If not cleaned properly and being transported from an area with known invasives to a naïve site, there may be invasive species transport.
D. Live holding and bait wells: The release of baitfish, sediments, and associated symbionts and pathogens from these wells is of main concern.
E. Dry docks: In the past dry docks have been known to arrive on Guam severely fouled with organisms from the originating country which were non-native to Guam.

II. Recreational boating
A. Boat Hull: Hull fouling is the major source for non-native marine species introductions via recreational boats.

III. Aquaculture and aquarium trade
A. Accidental and intentional releases: This includes accidental and intentional releases of target and non-target organisms. The Guam Aquaculture Development and Training Center (GADTC) produces pathogen free shrimp post-larvae and brood stock (*Penaeus (Litopenaeus) vannamei*), tilapia fry (*Oreochromis niloticus* hybrids), and Claris catfish fry.

IV. Recreational Activities
A. Dive Gear: When traveling between islands/countries if dive gear is not cleaned appropriately, organisms can "hitch-hike" on gear and be transported between places. It is likely that microscopic organisms (i.e. bacteria, parasites, viruses) would be more common with this pathway.

V. Construction materials
A. In-water construction materials: Barges and other construction materials can harbor non-native species when brought in for projects.

VI. Buoys
A. Fish Aggregating Devices (FADs): There is much known fouling on FADS and other buoy systems which are left out in the open ocean (thus their fish aggregating capabilities).
B. Oceanographic buoys: Same as for FADs
C. Other monitoring buoys: Same as for FADs

VII. Marine debris
A. Fouling: organisms can foul any piece of floating marine debris and "hitch" a ride into a new location.

Many of the mechanisms for introduction are also vectors of spread after an introduction. The introduction into one area itself may not lead to the invasion, but the spread of the species to another location with more favorable conditions may lead to an invasion (i.e. up or down the coast, or to another bay). Also, many non-native marine species can disperse through natural dispersal once introduced to a new area.

Gaps in prevention and detection

Despite the efforts of many agencies and efforts which contributed information to this plan, unwanted non-native species are still entering Guam. The gaps addressed below were compiled from marine invasive species meetings and personal interviews with agencies to discuss the issue of marine invasives.

Gaps in Prevention

1. The subject of marine invasive species is not at the forefront of invasive species conversations among natural resource agencies, government agencies, shipping companies, or the public. If there is no knowledge or conversation about marine invasive species for these groups, it will be hard for these groups to assist in marine invasive species prevention.
2. It is thought that there is still a major issue with inspection and quarantine for aquaculture and aquarium stock shipments. In particular, fish fry used to arrive late at night in bags of hundreds, and inspection involved holding a flashlight to the bags to determine if non-target species were hitchhiking. Once they leave the cargo hold and are introduced to the ponds, they are virtually uncontrollable.
3. Guam has a black list of species which outlines those species which are not allowed for import to Guam (Appendix D). Unfortunately, if these species make it through Guam Customs and Quarantine inspection, it is not illegal to possess these species according to Guam law.
4. The level of illegal importation (i.e. number of shipments and point of origin) for fish and invertebrates is unclear. It is suspected that there is some trade and import in the restaurant and aquarium industry. While it is impossible to know the actual amount, it may be possible to estimate the magnitude of those imports from past successful seizures.
5. Recreational vessels are not routinely checked for hull fouling and ballast water as regulations are non-existent or not as strict as for commercial shippers. Also, fishing vessels that are below a certain size are not included in regulations from the USCG either.
6. Ballast water is very clearly defined for vessels. For other in-water objects, such as drydocks, it is unclear as to what this kind of water and what the holding tanks are called. If there is no "ballast water" defined for these vessels, the intake and expulsion of water may not be regulated as well if it is not defined as ballast water.
7. The exchange and reporting of ballast water exchange is required under federal regulations by the USCG (Ballast Water Management for Control of Nonindigenous Species in Waters of the United States 2012). It is very difficult, however, to know if a ship has exchanged their ballast appropriately as reporting and exchange is done outside port. Also, reporting is not necessarily shared between agencies.
8. Ballast water exchanges and control of hull-fouling are required for military vessels. However, there currently is no program for auditing of these vessels unless there is blatant non-compliance. Also, the military is exempt from biosecurity inspections if such inspections jeopardize national security (e.g., when craft is actively engaged in warfare, cargo is classified).
9. First-class mail is protected against inspection without a warrant under Federal statutes. Other classes of mail can be inspected, but personnel and equipment availability limits the level of examination. The availability of live animals and plants through mail services is expanding which

provides additional unregulated sources for pest introduction. Many of these businesses are unaware of Guam's import requirements and freely mail material to Guam without any notice to potential customers about agricultural quarantine restrictions. Receiving agricultural items through the mail without proper State or Federal permits is a violation of existing regulations.

10. Hull fouling is to be removed from vessel hulls by regulation under U.S. 33 CFR 151.2000-2080 (Ballast Water Management for Control of Nonindigenous Species in Waters of the United States 2012). These regulations are vague and do not provide details with the frequency and thoroughness required. The IMO has also released guidelines for the control and management of ship's biofouling (International Maritime Organization Resolution MEPC.207(62)) however these are just recommendations and are not requirements either and these recommendations are meant to be used to compliment individual state requirements. Unfortunately, Guam does not have specific hull-fouling/biofouling regulations so ships are able to enter Guam with excessive fouling.
11. A clearly defined list of species which pose an invasive threat to Guam is non-existent. The USCG and GCQA inspectors do not have any clear guidance on species to look for when inspecting ships which can limit their ability to prevent marine species from coming in.

Gaps in Detection

1. While there are monitoring programs in place which survey both inner and outer reef areas around Guam, including Apra Harbor, the scale at which a non-native would be able to be detected is most likely not present in these monitoring efforts.
2. The level of expertise needed to identify non-native/invasive species on Guam is high, and may not be readily available for a given group (or groups) of animals at the time identification is needed.
3. A comprehensive list of native vs. non-native marine species (i.e. a baseline) present on Guam does not exist. Therefore, detection of a non-native species will be difficult.
4. The capacity of agencies to detect marine invasive species may lie in the amount of personnel they have to devote to this subject. The fewer personnel, the greater the likelihood of non-detection. Many agencies are understaffed and have multiple vacancies which would may decrease their detection capabilities.

Current known non-native marine species on Guam

Known non-native marine species on Guam are outlined in Appendix B. For many of these species, their potential to become invasive is unclear and the most recent investigation as to their presence around Guam may have been greater than 10 years ago when assessing the marine biodiversity of Guam and the Mariana Islands (Paulay 2003). For those species which have been found on Guam, most have been limited to Apra Harbor (Paulay et al. 1997). However, their distribution beyond the harbor mouth is unclear and leaves a large gap in the marine invasive species baseline.

One species which has had nominal investigation is *Neopomacentrus violescens*. This fish was first described on Guam in the mid-1980s. It was assumed to have come in ballast discharge and first showed up around mooring buoys in Apra Harbor (T. Donaldson pers. comm.). *N. violescens*

Neopomocentrus violescens. *Photo credit: guamreeflife.com (Dave Burdick)*

has spread out within the harbor and water movement due to numerous typhoons has been the hypothesized pathway for spread. Recently, *N. violescens* has been found to have moved from buoys and artificial substrates to natural substrates (D. Burdick pers. comm.). While these qualitative observations are valuable, a quantitative survey would validate these observations and provide valuable information on non-native species for Guam.

Species to look out for

When considering species which may be high risk for invasion, four questions must be asked:

1) What is the probability of the species entry to Guam?
2) What is the probability of the species establishment on Guam?
3) What is the probability of the spread of the species after establishment?
4) What are the potential significant adverse impacts?

These questions should first be addressed to known marine invasive species within the region to determine their likelihood of invasion to Guam. Also, those invasive species in ports of countries which have direct shipping access to Guam should be assessed using these questions. This will help create a target list of species to consider as high risk for invasion.

Species which are considered biofouling high risk species for introductions into the region are listed in Appendix C. These species were chosen based on observations throughout the Pacific, largely from what has been seen in Hawaii. This list was compiled by Steve McKagen (NOAA) and Scott Goodwin (NOAA). These are tropical marine non-native species which have established in Hawaii and are at high risk for biofouling transport. Of this list of 93 species, 23 are present on Guam, and six have sister species present on Guam. While this list is not exhaustive, at the very least it provides a list of species with known life history traits and habitat preferences which may translate into other species which may be high risk for invasion.

One group of organisms which should be of concern is microorganisms. This group includes those organisms which can be implicated as disease agents (bacteria and viruses) and can cause planktonic blooms. The planktonic blooms of concern are those algae which cause red tide and paralytic shellfish poisoning. Also, the animals which may serve as vectors for disease agents should also be considered high risk species regardless of their individual invasion risk.

Plotosus lineatus. *Photo credit: Jean-Claude Baur, http://fishbase.sinica.edu.tw/search.php*

One species of fish which is considered a high risk species for invasion is *Plotosus lineatus*. This fish is native to reefs in Yap and Palau. It has also been found in Saipan as an introduced species from the aquarium trade. In big schools, this fish can be a voracious predator. This fish also has highly venomous serrate spines of the first dorsal and each of the pectoral and can be fatal in rare cases (T. Donaldson pers. comm.). This fish is also associated with brackish waters and may pose a risk to both freshwater and marine systems. It has also been found up to 60m in depth. Given these characteristics, this fish has great potential to negatively impact several aquatic ecosystems on Guam.

Another group of organisms which should be discussed for their invasion potential is genetically distinct populations of the same species. While species may be shared between islands in the region, the genetic identities of these populations are most likely different. One example from Guam is the snail, *Lymnaea viridis* (A. Kerr pers. comm). This snail in Southeast Asia harbors a trematode known to cause fascioliasis; however, on Guam, *L. viridis* is free from the trematode as far as is known. Therefore, if Guam were to incur a more recent introduction of *L. viridis*, but from an infected Asian population, it would be hard to determine that this species was the cause, and our well established population could facilitate/accelerate the spread of the disease.

Existing Regulations and Programs

Federal

There are a variety of U.S. Federal laws and regulations which address invasive species; however there is no specific biosecurity department or agency within the federal government. The following federal regulations address invasive species (all types, not just marine) and the effects they can have on native wildlife:

- Animal Damage and Control Act
- Animal Health Protection Act (AHPA)
- Alien Species Prevention Enforcement Act of 1992
- Animal Welfare Act (AWA)
- Endangered Species Act (ESA) of 1973
- Executive Order (EO) 12114 – Environmental effects abroad of major Federal actions
- Executive Order 13112 and the creation of the National Invasive Species Council (NISC)
- Section 15 of the Federal Noxious Weed Act of 1974
- Implementing recommendations of the 9/11 commission act of 2007
- Lacey Act of 1900
- National Defense Authorization Act, public law 110-181, section 314
- National Environmental Policy Act (NEPA) [as amended 42 U.S.C. 4321 et seq.]
- the National Invasive Species Act
- Plant Protection Act (PPA)
- USCG Regulations 33 CFR Part 151 and 46 CFR Part 162
- USDA-APHIS plant health regulations
- USDA-APHIS animal health regulations
- Wild Bird Conservation Act (WBCA)
- USDA animal product manual USDA combined animal and plant health risk ratings for countries
- USDA-APHIS manual for agricultural clearance
- USDA-APHIS PPQ manuals

Guam has its own regulations regarding live organism imports. As a U.S. jurisdiction, Guam must abide by U.S. Federal regulations and requirements. Enforcement of U.S. live import regulations is carried out by state and federal quarantine inspectors at airports and seaports. On Guam, imports of wildlife are monitored by U.S. Fish and Wildlife Service (USFWS), U.S. Customs and Border Patrol, Guam Customs and Quarantine Authority (GCQA) and the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR), with some assistance from NOAA when illegal imports of marine life are suspected.

Local

The following regulations pertain to invasive species specifically for Guam.

- Guam Administrative Rules and Regulations (GARR) Titles 8, 9, and 10
- Title 5 Guam Code Annotated (GCA) §60108
- Guam public law 31-43 Bill No. 111-31 (Cor) "An Act to Add a New Chapter 70 to Division 6 of Title 5, Guam Code Annotated, Relative to Establishing the Guam Invasive Species Council; to Establishing the Guam Invasive Species Inspection Fee and Fund; and to Authorizing the Department Of Agriculture To Establish A Biosecurity Division"
- Importation and sale of aquatic plants is limited to a white list (Appendix E), however, this list is not codified in rule or statute.

Bill No. 111-31 was a major step forward for invasive species and biosecurity efforts for Guam. While this Bill was passed in 2011, the Guam Invasive Species Inspection Fee and Fund was not approved by the Guam legislature until 2014. Once the fee begins to be collected, it is to be used to "(1) recruit and hire a Territorial Invasive Species Coordinator; (2) establish and provide staffing for a Biosecurity Division within the Department of Agriculture to provide inspection, quarantine and eradication of invasive species contained in any freight brought to Guam; (3) suppress and eradicate invasive species present in Guam; and (4) develop the Guam Invasive Species Management Plan and its updates" (Guam Invasive Species Council Act of 2011). The fee approved is $0.75 per 1000 pounds and is estimated to generate $2 million per year.

Objectives and Proposed Actions

Goal of the Guam Marine Biosecurity Action Plan

To minimize the harmful ecological, economic, social, cultural, and health impacts of marine invasive species through the prevention and management of their introduction, expansion, and dispersal into, within, and from Guam.

To assist in this goal, the following major objectives have been identified:

Objectives:

1. **Coordination and collaboration**: improve the coordination and collaboration of people, resources, and efforts involved with invasive species
2. **Prevention**: minimize the introduction and spread of invasive species into and throughout the waters of Guam
3. **Monitoring and early detection**: ensure effective programs that allow for the early detection of new invasive species and the monitoring of existing invasive species
4. **Response, eradication, and control/management**: establish effective systems for rapid response, eradication, and control/management; evaluate and provide support to management plans and encourage the development of management techniques
5. **Education and outreach**: increase education and outreach efforts to ensure awareness throughout the island on marine invasive species threat and solutions
6. **Research**: increase research efforts on key invasive species, associated issues, and economic impacts to allow for more effective management
7. **Funding**: coordinate federal and local agency budgets to support marine invasive species priorities, develop partnerships, and seek opportunities to leverage funds within state and local agencies, local governments, industry, as well as other entities including non-governmental organizations
8. **Policy**: ensure local laws and regulations effectively promote the prevention and control of marine invasive species.

Associated strategies and recommended actions pertaining to each of the above objectives are presented in this section. Some specific tasks may fall under more than one objective and have been noted. Also, these recommendations were compiled from input received at marine invasive species meetings, personal communication with natural resource partners, and personal recommendations of the author.

Objective 1: Coordination and Collaboration

Improve the coordination and collaboration of people, resources, and efforts involved with marine invasive species

- Improve communication regarding marine invasive species within local and federal programs and initiatives on Guam
- Hire a full-time marine invasive species coordinator
- Increase coordination to address marine invasive species between GDOA, GEPA, UOGML, NOAA, USFWS, and others. Where appropriate, create MOUs or MOAs to ensure the ability of agencies to work together in the event of an invasion.
- Increase collaboration between local and federal agencies working on marine invasive species
- Determine where the responsibility of marine invasive species, and the marine invasive species coordinator, will fall, whether under a specific agency or a newly formed entity
- Coordinate with agencies responsible for the Pacific Marine Monuments to address MIS prevention efforts

Objective 2: Prevention

Minimize the introduction and spread of invasive species into and throughout the marine waters of Guam

- Develop the capacity to prescreen vessels arriving at the seaport
- Implement a clean container program like in Australia and New Zealand (Sea Container Cleaning Standards)
- Ensure all vessels and equipment, including barges, dry docks, and dredging equipment, are free from fouling organisms before entering Guam's coastal waters
- Ensure all aquaculture facilities of non-native species are secure, including from natural disasters
- Require all aquaculture shipments entering Guam have an import permit, certificate of origin, and health certificate [also part of Objective 8: Policy]
- Implement hull fouling measures which apply to vessels under 25m in length. Australia has already implemented hull fouling measures which are in the process of becoming mandatory. These measures include: (1) Cleaning the vessel's hull within one month prior to arrival; or (2) Applying antifouling paint within one year prior to arrival; or (3) Booking the vessel to be hauled out and cleaned within one week after arrival (Ballast Water and Hull Fouling: Two Vectors for Aquatic Invasive Species to Invade California) [also part of Objective 8: Policy]
- Coast Guard 100% inspection to enforce ballast release laws (not allowing ships ballast water to remain on ships before entering Guam waters)
- Military to provide inspection and cleaning of Navy and contracted hulls before leaving Asian ports and coming to Guam
- Consider conducting Hazard Analysis and Critical Control Points (HACCP) training for marine systems
- Require a biofouling management plan for all vessels entering Guam waters* [also part of Objective 8: Policy]
- Establish criteria for in-water cleaning methods for hull fouling that do not pose a risk of spreading or releasing non-native organisms in surrounding waters

Objective 3: Monitoring and Early Detection

Ensure effective programs that allow for the early detection of new invasive species and the monitoring of existing invasive species

- Any and all monitoring work to be carried out in relation to marine invasive species should be initiated in Apra Harbor and radiate out from there
- Conduct baseline surveys of marine biodiversity within Apra Harbor, Agat Marina, Agana Boat Basin, Merizo Pier, and any other embayment or harbor which may receive vessel traffic
- Need to assess the extent to which the nonindigenous species have spread out of the recipient habitat into surrounding habitats and how the nonindigenous species have impacted native species
- Need to develop standardized, quantitative, and repetitive field-based surveys of non-native marine species in harbors, bays, and ports
- Conduct surveys of sunken vessels, dry docks, and other artificial substrates in Apra Harbor which may be more likely contain non-native species
- Develop a biofouling survey form for commercial and personal vessels. Use Hawaii's biofouling data forms as a template (Appendix F).* [also part of Objective 5: Education and Outreach]
- Develop a method to inspect niche areas of ships during customs inspections
- Develop a method for inspectors (GCQA and port) to inspect hulls from top side. If further inspection is warranted, then the vessel pays for divers to inspect and prepare a report. If determined to be dirty, then the craft must either be cleaned, or leave port and jurisdictional waters. Self-clean outside of jurisdictional waters could be an option. Hull needs to be clean of all organisms, as the ability to identify all marine organisms is not available
- Support current monitoring efforts for marine invasive species
- Combine information from various surveys conducted inside Apra Harbor to determine gaps in detection areas
- Contact the USCG to assist with buoy cleanings. Scrapings from the buoys could help in biodiversity surveys and baseline knowledge for marine species. Buoys can also serve as the first point of invasion and catching the non-native at the buoy could help in an early response.

Objective 4: Response, Eradication, and Control

Establish effective systems for rapid response, eradication, and control/management

- Create a marine biosecurity response team to address any invasions and be present at GISC and GISAC meetings
- Identify available resources from agencies to be utilized in an emergency response

Evaluate and provide support to management plans and encourage the development of **management techniques**

- Update the Guam General Emergency Response Plan for Invasive Species Incursions
- Update the Guam Marine Biosecurity Action Plan once the MBP and Strategic Implementation Plan (SIP) are released

Objective 5: Education and Outreach

Increase education and outreach efforts to ensure awareness throughout the island on marine invasive species threats and solutions

- Raise awareness of potential threats from marine invasive species, with particular attention first to local and federal decision makers and resource agencies, then to the general public
- Create an avenue (an email address or hotline) for the reporting of marine invasive species
- Increase the promotion of marine invasive species issues on an island-wide level

- Develop a biofouling survey form for commercial and personal vessels. Use Hawaii's biofouling data forms as a template (Appendix F).* [also part of Objective 3: Monitoring and Early Detection]

Objective 6: Research

Increase research efforts on key invasive species, associated issues, and economic impacts to allow for more effective management

- Conduct a thorough risk assessment of algae for the region
- Conduct a pathways analysis to model the risk of introductions and spread of non-indigenous species on Guam and throughout the region.

Objective 7: Funding

Coordinate federal and local agency budgets to support marine invasive species priorities, develop partnerships, and seek opportunities to leverage funds within local agencies, local governments, industry, as well as other entities including non-governmental organizations

- Seek funding for marine invasive species prevention and response
- Determine the amount of funding needed to perform an emergency response to a marine invasion

Objective 8: Policy

Ensure local laws and regulations effectively promote the prevention and control of marine invasive species

- Once black list species are present on Guam, they are not illegal to possess. In order to address this gap appropriate legislation will need to be enacted.
- Establish standards and regulations regarding biofouling, including inspection and certification for all vessels. Make it a requirement that the hull needs to be clean of all organisms, as the ability to identify all marine organisms is not available.
- Develop stronger importation laws for Guam
- Consider an informed embargo of non-local populations of species, certainly those known to elsewhere vector/harbor disease, even if that species is known from Guam/CNMI
- Require a biofouling management plan for all vessels entering Guam waters* [also part of Objective 2: Prevention]
- Require all aquaculture shipments entering Guam have an import permit, certificate of origin, and health certificate [also part of Objective 2: Prevention]
- Implement hull fouling measures which apply to vessels under 25m in length. Australia has already implemented hull fouling measures which are in the process of becoming mandatory. These measures include: (1) Cleaning the vessel's hull within one month prior to arrival; or (2) Applying antifouling paint within one year prior to arrival; or (3) Booking the vessel to be hauled out and cleaned within one week after arrival (Ballast Water and Hull Fouling: Two Vectors for Aquatic Invasive Species to Invade California) [also part of Objective 2: Prevention]

Emergency Response

Once a non-native species has been identified as being present, a response should be initiated as soon as possible. This response should fall in line with that outlined in the Guam General Emergency Response Plan for Invasive Species Incursions (DOA 2005; Appendix A). The response will be initiated by a marine biosecurity rapid response team (to be created), comprised of those individuals on Guam who have been involved in the creation of this plan (recommended). There will be a designated contact for the rapid response that will receive all information and reports of non-native species and disseminate to the group (to be determined). The basic information collected initially should be:

1. species ID
2. delineation of the area where the species is located
3. method of introduction (may need to be a best guess)

Once this information is collected, the emergency response group then needs to determine the threat level of this species to Guam's marine ecosystems. On a very basic level, the threats can be evaluated as no threat, low, medium, and high. These designations can be defined as:

- No threat – the species poses no threat to Guam's marine ecosystems; once introduced this species will not survive or be able to establish a population
- Low threat – the species poses a low threat to Guam's marine ecosystems; once introduced this species may survive, but may be limited to artificial substrates; among the native species there is an identifiable predator for this species which may keep any population bloom in check
- Medium threat – the species poses a medium threat to Guam's marine ecosystems; once introduced this species will be able to survive and establish a population both on artificial and natural substrates, however it may be limited to ecosystems in Apra Harbor; native predators may not be identifiable
- High threat – the species poses a high threat to Guam's marine ecosystems; this species will survive and thrive in Guam's marine ecosystems, establishing a population, and will not be limited by substrate type or reef habitat; no native predators are identifiable

The threat level designation will then inform what type of response is needed. This response will be determined by the marine biosecurity rapid response team on a case by case basis. For example, if the species is determined as having no threat or a low threat, all that may be required is quarterly monitoring of the area of introduction as well as surrounding areas to determine the species fate as it may not survive. For medium and high threat species, a much larger survey effort will be needed as well as possible mitigation.

Methods

In the past, surveys of marine species have been carried out by taxonomists dedicated to specific groups of organisms, compiling checklists for several major groups. Most surveys consisted of timed swims in which as many different taxa as were able to be identified in the field were recorded. If not identifiable in the field, specimens were collected and identified (as best) either by local scientists or by specialists abroad. This kind of survey is best utilized for determining baseline knowledge of Guam species. If these surveys are conducted along permanent transects and surveyed long-term, non-native species may be recorded and identified. Several survey methods which can detect marine invasive species are: traps, pile quadrat scrapings, plankton nets, diver transects, beach seine nets, and benthic grabs (Table A). A very useful resource for marine invasive species surveys is available from New Zealand's Marine Biosecurity Porthole at http://www.marinebiosecurity.org.nz/.

Survey	Description	Appropriate Taxa
Traps	A trap is placed and secured at the desired location. The trap may be affixed to the substrate or floating midwater (dependent upon species desired). The length of time the trap is deployed is dependent on the species targeted and durability of the trap in the elements.	fish, mobile fauna
Pile Quadrat Scrapings	A fixed area of hard substrata is scraped free of organisms. Generally a quadrat is used at certain depths along a transect from the waterline to the seafloor. Before the inside of the quadrat is scraped, sill images are captured for each quadrat. then all scrapings from inside the quadrat are collected in a mesh bag and processed in the laboratory.	sessile benthic encrusting fauna, algae
Plankton Nets		
Zooplankton Drop Net	A net is dropped vertically from the water surface to approximately 1 meter from the seafloor. Once retrieved the net is carefully washed down to collect planktonic organisms into a container at the bottom.	zooplankton
Phytoplankton Net Tow	A net is towed slowly just below the water surface behind a research vessel for 1 minute before being retrieved. The contents are then carefully washe down to collect planktonic organisms into a container at the bottom.	phytoplankton
Diver Transects		
Timed Swims	Diver swims for a fixed time in a straight line along a single depth gradient. All incidence of the invasive species is noted within a desired width of the line swam.	sessile benthic fauna, algae
Circular Areas	Invasives species are counted within a given circular area. A stake pounded into substrate is used to define the pivotal center of the circle. A predetermined length of transect tape is held by a diver as he/she swims around the stake keeping the tape taut.	sessile and mobile benthic fauna, algae
Video Transects	A transect is filmed in its entirety. at a given distance from the seafloor. Generally only one side of the transect is filmed. The film is then analyzed in the lab by the pre-determined frame capture.	encrusting organisms, mobile benthic fauna
Belt Transects	All incidence of invasive species within a predetermined area recorded	sessile and mobile benthic fauna, algae, encrusting organisms
Beach Seine Nets	A beach seine net is dragged from a suitable starting position onto the beach. The catch may be assessed on site for those species readily identifiable. For those needing further ID, the catch is bagged, labelled and placed on ice for freezing for later ID.	fish
Benthic Grabs	A benthic grab attached to a rope is lowered to the seafloor from a boat or a platform. When it reaches the seafloor a trigger system is activated and the grab sampling compartment encloses a sample of seafloor. The sample is then recovered on the vessel in an undisturbed unwashed state. The sediment sample is then passed through a sieve to extraxt the animals and plants.	benthic infauna

Table A. This table outlines survey methods which may be utilized to determine invasive species presence and also to monitor population levels. New Zealand's Marine Biosecurity Porthole was used to help compile this table (Marine Biosecurity Porthole).

Once a non-native species is identified, however, different survey methods should be employed to determine the extent of the invasion and will depend on what kind of information is desired (presence/absence, abundance, diversity, etc.). For instance, a diver transect may consist of a belt transect to determine density of non-native species or a timed swim to determine the extent of the area the species has inhabited. The individual survey types required for a response will also vary between species. The marine biosecurity rapid response team will decide on appropriate methods once the species has been identified. Also, as most new non-native species will enter through Apra Harbor, it should be considered "ground zero" and be the first area to be surveyed, unless reports of non-natives are coming in from elsewhere.

A good initial response survey may include a resurvey of transects from previous species diversity/invasive species studies. Some of these studies include Paulay et al. 1997 Amesbury et al. 1977, and Paulay et al. 2011. The Guam Long-term Monitoring Program and the University of Guam also have permanent monitoring stations in Apra Harbor and have been collecting data at these sites for several years. These sights may be appropriate initial survey points as well. Since these sites have been surveyed in the past they provide a species baseline. If these sites are deemed appropriate to utilize, there will most likely be a need to add in new survey points to gather a more complete picture of the invasion.

Agencies and volunteers

The following agencies have expressed their willingness to participate in marine invasive surveys and emergency response:

University of Guam
NOAA
Guam Environmental Protection Agency
Guam Department of Agriculture – Division of Aquatic and Wildlife Resources
Guam Community Coral Reef Monitoring Program

In the past, these entities have worked together to assess coral bleaching events, ship groundings, and Crown-of-Thorns Starfish outbreaks, among others. Other agencies and groups which can be reached out to for help may be volunteer recreational divers, USCG volunteers, and USCG Auxiliary (these groups may require a certain amount of training) and also natural resource agency partners from the CNMI.

One large aspect of an emergency response is positively identifying the invading species. For many taxa, species ID is difficult and taxa experts will need to be reached out to in order to correctly identify the species. A list of taxa identification experts for Guam and the Marianas has been compiled in Appendix I to assist with species ID in the event of a response and also during baseline species surveys.

Funding

It is hoped that funding for a marine invasive species emergency response will come from the Guam Invasive Species Inspection Fee and Fund as monies that go into the fund are to be utilized for all invasive species emergency response efforts.

Recommendations

On Guam there is much work to be done to address marine invasive species incursions. Through discussions with various stakeholder groups and research into other state, region, and country responses to marine invasive species management, the following recommendations for Guam can be given.

Before addressing specific recommendations, a hierarchical approach to managing invasives was laid out in a joint report from the Secretariat of the Pacific Community (SPC) and Secretariat of the Pacific Regional Environmental Programme (SPREP) (Tye 2009). The approach is as follows and is suggested to be adopted in the following order of priority:

1. Prevention is more effective and cheaper than management of established invasives, so exclusion of invasives by border control is the first line of defense.

2. Eradication is more effective and cheaper in the long run than permanent control of a pest population, so eradication should be considered where feasible.

3. Species that cannot feasibly be eradicated should be considered candidates for biological control.

4. Species that cannot feasibly be eradicated or controlled biologically, especially species whose value to people prevents the use of biocontrol, should be contained within delimited areas where feasible.

5. Permanent control of an established pest population by chemical and/or physical methods should normally be considered the last resort approach, where eradication, biological control and containment are all deemed not feasible with current or achievable resources.

As some aspects of this approach may not be completely feasible for marine ecosystems, especially as containment of marine species is difficult given the continuity of ecosystem, it best outlines that prevention is of utmost importance. Many times prevention and policy go hand-in-hand as ways to combat MIS introductions, and often the only way to bolster prevention is to create regulations. If prevention is tied to regulations there may be a greater potential to keep invasions from occurring. Also, the costs of prevention are less than the costs to try to eradicate or contain invasive species populations and the cost-benefits of improved biosecurity should figure heavily into ensuring a more rigorous prevention network.

As there may be no way to prevent 100% of introductions, the other objectives which may have the greatest impact after prevention are education and outreach, and monitoring and early detection. The subject of MIS has been on the backburner of invasive species conversations for Guam given the lack of an invasion; however, this is precisely the right time to bring MIS to the conversation as there is greater potential for prevention. Thus, having a MIS representative at GISC and GISAC meetings, and also educating local businesses and importers of the risk, is a priority. This representative should be the marine invasive species coordinator. This position is crucial if there is going to be any movement in MIS. Without the devotion of a position solely to MIS it will be very difficult to prevent MIS from occurring or create awareness of MIS.

Education and outreach are such powerful tools, not only for use with the public, but also for government and non-government organizations. Education and outreach applies not only to education about MIS and their impacts, but also to education about the native species that occur on Guam. If it is unknown what the native species are, one cannot differentiate a native species from a non-native species and be expected to be able to report the sighting of a non-native. This is also why baseline surveys of biodiversity for Guam are a recommended task for completion under this plan.

Monitoring and early detection are also paramount to invasive species interdiction. To intercept MIS, the environment in which they will potentially invade needs to be well-known. Regular monitoring of areas with a high likelihood to be invaded is needed. The Guam Long-term Coral Reef Monitoring Program and other projects from the University of Guam Marine Laboratory conduct monitoring activities within Apra Harbor. The information gathered from these projects should be combined to determine which areas have sufficient monitoring, and which areas need to be surveyed. The appropriate amount of survey points and transects needed to be able to detect an invasive species also needs to be determined.

Conclusions

This plan should serve as a starting point for marine biosecurity on Guam. Once the RBP is released this plan should be revised to incorporate the recommendations from the RBP. Also, the agencies which will be utilizing this plan should meet to revise it and address the recommendations within. As no invasive species have been discovered in Guam's marine ecosystems yet, Guam is at an advantage in regards to prevention of MIS. Hopefully this document will facilitate the discussion of MIS on Guam and lead to the prevention of any future marine invasive species occurrence.

DRAFT

Guam General Emergency Response Plan for Invasive Species Incursions

Department of Agriculture
163 Dairy Rd.
Mangilao, Guam
July 2005

Table of Contents

1.0 INTRODUCTION

Guam, being a small, isolated, oceanic island, is susceptible to pest invasions. Guam is the transportation hub for Micronesia with direct shipping links to Asia, Hawaii, North America and Australia. In addition, there are frequent air and ocean freight movements associated with US military bases on Guam. The following emergency response plan (ERP) was developed to provide guidance when invasive species are detected in order to protect Guam's biodiversity, agriculture, tourism, public health, and social and cultural way of life. The goal of this plan is to have a set of procedures in place to be activated immediately whenever an invasive species is first detected.

This draft ERP was initiated by members of the Guam Invasive Species Advisory Committee during an Emergency Response Planning Workshop sponsored by the Secretariat of the Pacific Community (SPC) and held on Guam from May 31 to June 2, 2005. Representatives from other jurisdictions in the region also participated in the workshop; participants came from Palau, Pohnpei, Yap, Chuuk, Kosrae and the Marshall Islands with facilitating experts from SPC and New Zealand.

It is recommended that this ERP plan be reviewed periodically by the Guam Invasive Species Advisory Committee. This plan shall also be reviewed after any exotic pest invasion.

This plan derives legislative powers from relevant national and territorial laws and regulations.

2.0 DEVELOPMENT AND MAINTENANCE OF THE CAPABILITY TO RESPOND TO INVASIVE SPECIES INCURSIONS

2.1 Management Structure

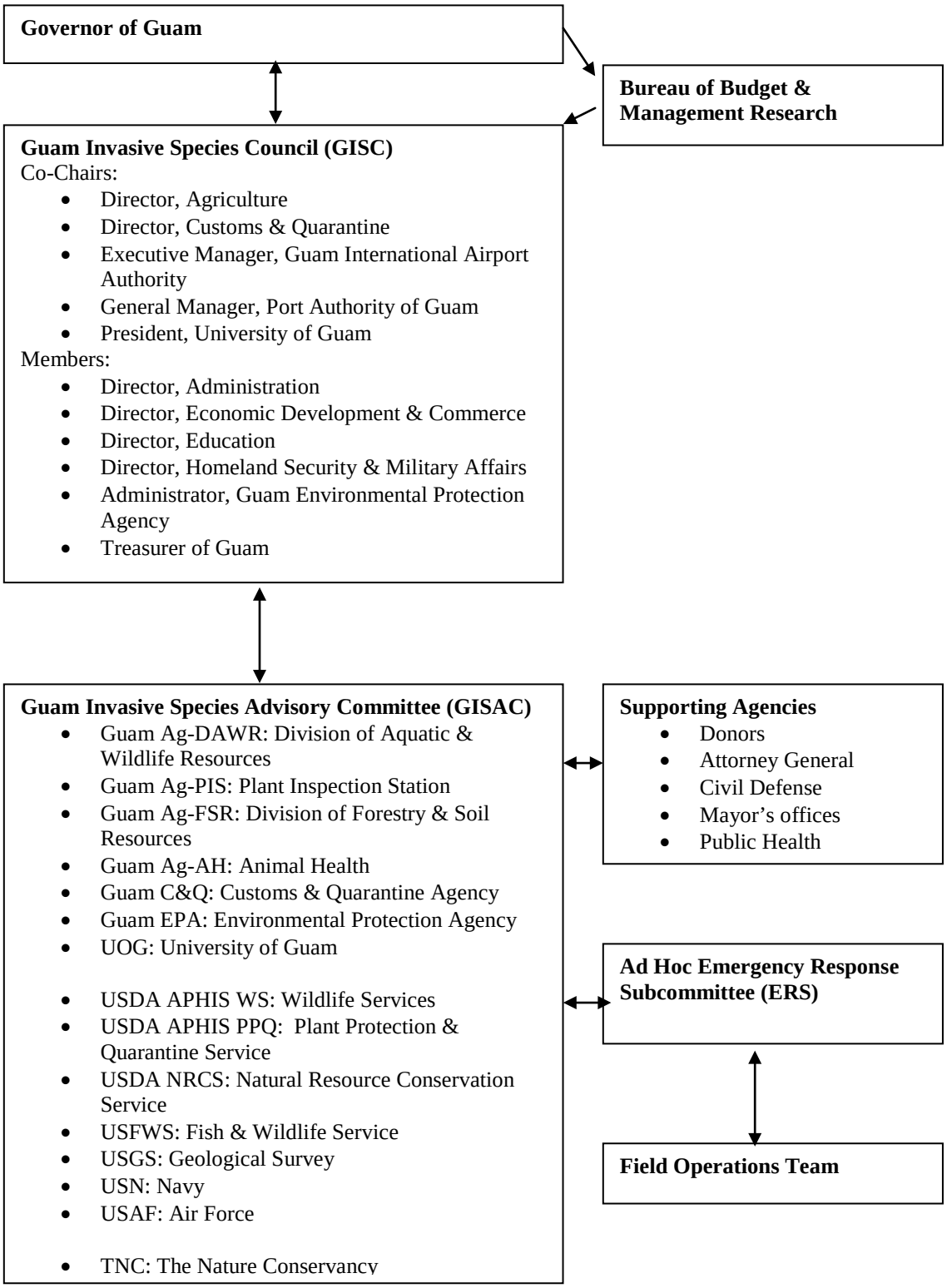
The Governor, on advice from the Guam Invasive Species Council (GISC), plays a leading role in the implementation of the Guam General Emergency Response Plan for Invasive Species.

An Emergency Response Subcommittee (ERS) under the Guam Invasive Species Advisory Committee (GISAC) is formed at the declaration of a response. Membership of this committee is derived from the technical committee members of GISAC based upon the type of invasive species threat.

To facilitate the rapid deployment of field operations, GISAC will identify appropriate persons who could fill the role of Ad hoc Emergency Response Subcommittee and other field team management positions.

At the declaration of an invasive species emergency, Director of Agriculture then appoints the Operations Manager / HQ Controller to implement the Emergency Response Plan (ERP).

Figure 1. Management Structure



2.2 Table 1: Role specifications and appointment criteria

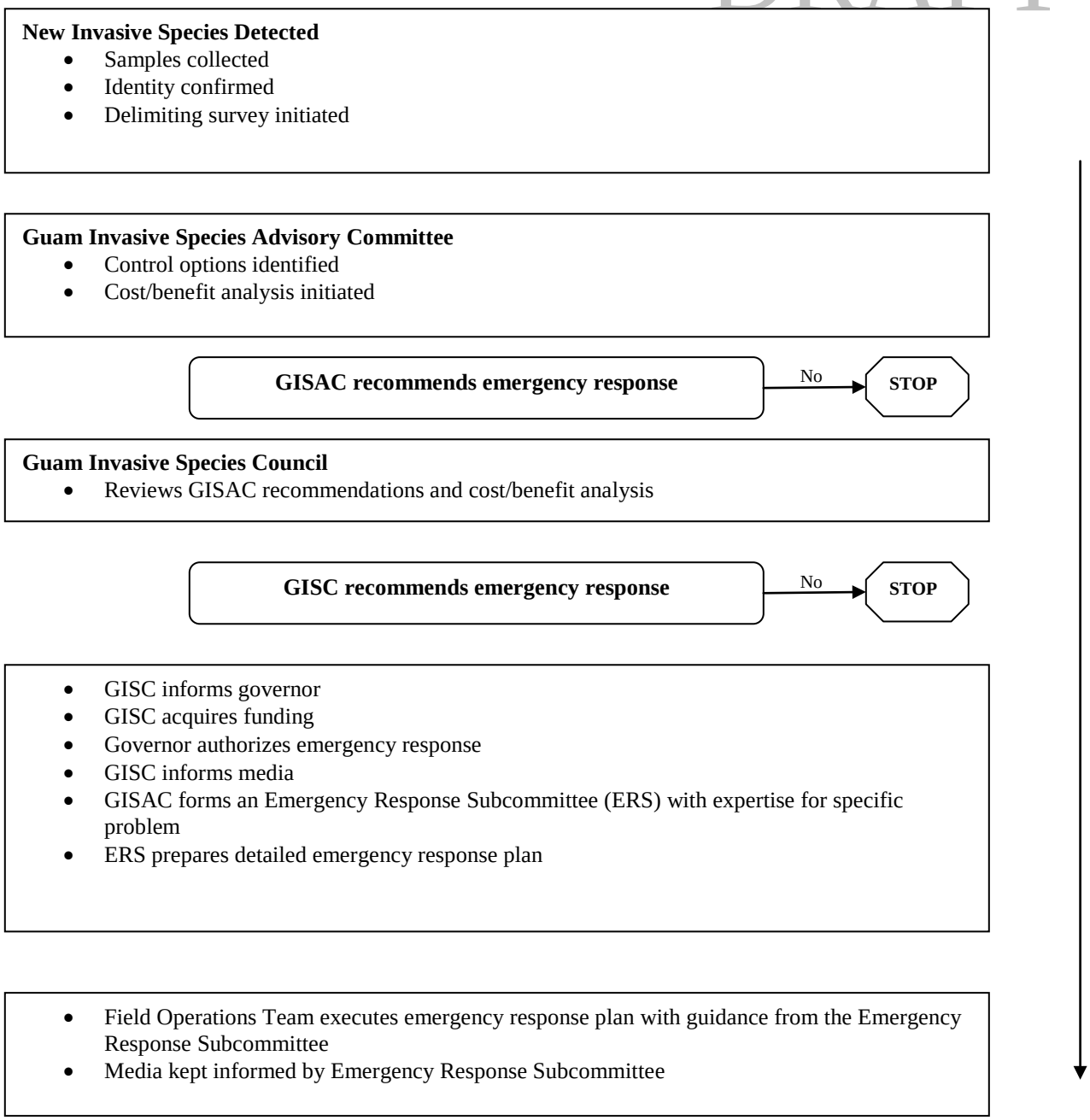
POSITION	FUNCTIONS & RESPONSIBILITIES
Governor	• Declares emergency response • Approves funding and use of territorial resources
Chair, Guam Invasive Species Council	• Provides liaison and coordination among Gov Guam agencies • Requests emergency funding
Chair, Guam Invasive Species Advisory Committee	• Represents technical community • Provides specialists to identify invasive species and delimit its distribution • Identifies mitigation options • Prepares cost/benefit analysis for mitigation options • Recommends emergency response action to GISC
Chair, Ad Hoc Emergency Response Committee	• Plans, coordinates, and manages emergency response project • Coordinates media releases
Manager, Field Operations Team	• Logistics • Day-to-day control of field operations • Reports to Emergency Response Committee

2.3 Stores/Finance.

In an event of outbreak, financial resources must be made available from central government funding. Longer term assistance could be requested from regional organizations and international donor agencies. This financial assistance could include stores and essential consumables.

3.0 THE TECHNICAL PROCESS

Figure 2. Flow chart showing the technical process.



3.1 Initial Response

Once an invasive species is detected at a site, it should be reported to GISAC. A locally based Technical Specialist visits the site and makes a preliminary diagnosis of the problem, taking appropriate precautionary measures, and collects samples if necessary. If the detection is positive (or not negative), the chair of GISAC is informed immediately. A confirmation of the specialist's identification may require overseas identification. Funds may be requested for the identification of the specimen overseas.

A delimiting survey, to establish the extent of spread of the pest, as well as some initial controls, may be advised by the Technical Specialist. These controls may include restriction of the movement of risk or host material and the application of chemicals or other treatments to prevent further spread of the problem. Tracing may be required to establish the entry pathway of the pest and to establish whether any further spread has occurred.

The Chair of GISAC convenes an emergency meeting of GISAC to review the situation. If an emergency response is warranted, a chair for an Emergency Response Subcommittee (ERS) is appointed. The situation will be reported to GISC indicating that a response operation is required.

Other departments and stakeholders would be notified accordingly once the ERS has been formed.

3.2 Response

The ERS will develop a strategy and present the situation including a cost/benefit analysis to GISC. The response will be activated by the Governor. The Director of Agriculture appoints a field operations team manager according to set procedures. Operations will be conducted according to the advice of the ERS. Field response operations can be divided into the following areas of activity:

- Operations / HQ management
- Logistics / Administration
- Diagnostic / laboratory
- Mapping
- Surveillance / trapping / ground surveys
- Movement control
- Tracing
- Organism management / control / eradication

The results of these operations will indicate whether the exotic pest can be eradicated or not.

Stand-down procedures shall be implemented based on the ERS recommendations.

4.0

MANAGEMENT PROCEDURES –(See Figure 1. Management Structure, generic to both animal and plant outbreaks.)

4.1 Overview of the management system

The Management structure should be broad based with personnel holding key responsible areas from all authorities and agencies involved in the emergency or outbreak or who can contribute to its resolution. Representatives need to be of sufficient authority to be able to make decisions on behalf of their organization. This team shall be called the Emergency Response Subcommittee (ERS).
The ERS will make decisions on what actions to take according to reports received on the outbreak.

4.2 Director of Agriculture (Table 1)

Will be responsible for the entire operation.

4.3 Chair of Emergency Response Committee

Manage and oversee the program and entire operation (including expenditure).

- Notify other government agencies, non-governmental organizations and other stakeholders on implications of actions taken, such as environmental impacts (chemical usage, slaughter of animals, dumping and burning), human health, social and economic issues.
- Responsible to administer restrictions on the movement of people, machinery, plants or plant products, animals or animal products and the sale of such products according to appropriate legislation. Should liaise with the Attorney General's office, Police and other government agencies if required.

4.4 Field Operations Team Manager

The field operations team manager is required to report to the Chair of ERS and provide information to the ERS on the progress of the program.

4.4 Mapping Group and GIS

The Department of Agriculture, with the assistance of other relevant agencies, will provide the maps required for the emergency response program. Geographical information system (GIS) software, available in the Department would be a useful tool for mapping boundaries and estimating sizes of both the infested areas and of the endangered area. GIS could also be used for enhancing prompt containment of the outbreak.

4.5 Logistics and Administration Group

The Department of Agriculture, with the assistance of other appropriate agencies, shall be responsible for the supply of resources and the provision of the budget, which will include the following:

- Human resources
- Salaries and wages
- Overtime payments
- Accommodation for off-island experts
- Hiring of temporary labor
- Transport, including the hire of transport or other equipment to mobilize staff, plant and plant material, animal and animal material
- Fuel and spare parts
- Specialized equipment as required for the response type
- Safety equipment and first aid kits
- Stationary and other consumables
- Compensation - appropriate compensation payments for destroyed crops and animals or any materials affected by the outbreak

All Occupational Safety and Health regulations must be adhered to.

4.4 Media and Community Liaison

The Director of Agriculture, as chairperson of GISC, is responsible for releasing official information relating to the Emergency response.

4.5 Information Management

The ERS Chair is responsible for compilation and storage of all records, data and information on the outbreak for further reference.

4.6 Monitoring and surveillance

In the event of a stand-down, ERS will direct the appropriate agency to continue to operate a monitoring and surveillance program.

5.0 FIELD TEAM ROLES

5.1 Overview of the field operations systems

After a response is declared, the ERS subcommittee shall inform the Field Team Operations Manager to implement the appropriate action. This area of responsibility will involve day to day implementation of the operation. The operation will manage the containment and eradication activities within the response zone.

5.2 Field Team Operations Manager responsibilities

This person shall report to the ERS Chair. Duties will include:

- Deliver field response operations as specified by ERS
- ensure appropriate procedures are followed
- ensure infested products are disposed of or treated in the most appropriate way
- ensure treatments are applied correctly and safely.
- Assess personnel requirements and establish the support team
- Carry out contingency plans for the specified outbreak
- If necessary, requests recruitment of temporary labor, keep records of all field staff employed in the operation, submit pay sheets to the administration group.
- Suggest improvements to the ERS Chair.
- Compile reports as required

5.3 Field Team Members responsibilities

These persons shall report to the Field Team Operations Manager and:

- forward resource requirements to the Field Team Operations Manager
- Report on suggested improvements to the operation to Field Team Operations Manager
- Traces, checks, treats and, if necessary, destroys host material, removes from the infested areas, following the procedures outlined in the containment plan.
- Issues inspection, treatment, and compensation forms
- Keep records of inspected, treated, destroyed or released plants, plant materials, animal product and equipment.

6.0 STAND-DOWN PROCEDURES

6.1 Actions

The stand-down is implemented under either of the following conditions:

- The eradication is successfully completed
- Eradication or containment is unsuccessful and the program is stopped.

6.2 Report

The Field Operations Team Manager will submit a report to the ERS Chair, which will provide a basis on decisions made for a stand down. The report will include:

- Overview
- Operational procedures
- Decisions made
- Results
- Costs
- Problems encountered
- Recommendations

The Chairperson informs stakeholders and funding agencies about the winding up of the operation. Chairperson ERS briefs the media about:

- objective of the operations
- costs and benefits
- further action

6.3 Notification

The Chairperson ERS shall inform stakeholders on the stand down, including Field Operations Team, all stakeholders, funding agencies and aid donors.

6.4 Disbandment of Response Team(s)

The Operations Manager arranges for detailed officers and volunteers to return to their respective institutions and all outstanding entitlements to be settled. The Field Team Operations Manager convenes a meeting with all staff, to debrief, review their work and thank them.

The Field Team Operations Manager, in consultation with the Chairperson ERS, may make arrangements to return hazardous chemicals and dispose of specifically acquired equipment during the time of operation. The Operations Manager returns all field records sheets to the Director for filing and future reference. After the operations, the Director reviews the operation work with the ERS and updates certain sections of the ERP based on the experience gained from the last operation.

7.0 AVOIDING THE SAME PROBLEM IN THE FUTURE

After the winding up of the operation, GISC will determine the long-term strategy for surveillance and monitoring.

8.0 APPENDICES

Appendix 1. Active Invasive Species Mitigation Programs in Guam

Asian cycad scale (*Aulacaspis yasumatsui*)	Biocontrol introductions initiated Emergency insecticide treatments
Betelnut bud rot (*Phytophthora palmivora*)	Containment program in place. Removal of infected trees, preventive fungicide treatments (trunk injections)
Scarlet gourd (*Coccinia grandis*)	Biological control initiated
Brown treesnake (*Boiga irregularis*)	Containment program in place to prevent shipment of snakes off-island.
Coqui frog (*Eleutherodactylus coqui*)	First introduction believed eradicated; quarantine strengthened; public awareness campaign and surveillance on-going.

Appendix 2
List of Important Exotic Pests and Diseases and Their Status in the Region
(x indicates presence)

A. Insects

Insect Pests	Guam	CNMI	Pohnpei	Chuuk	Kosrae	Yap	Marshalls	Palau
Asian Longhorned Beetle								
Melon Fruit Fly, *Bactrocera cucurbitae*	x	x						
B. philippinensis								x
B. occipitalis								x
Mango F.F, *B. frauenfeldi*			x	x	x	x	x	x
Breadfruit F.F, *B. umbrosa*								x
Other exotic fruit flies								
Taro Beetle, *Papuana*								
Rhinoceros Beetle, *Oryctes rhinoceros*								x
Glassy Winged Sharpshooter *Homalodisca coagulata*								
Red Imported Fire Ant *Solenopsis invicta*								
Little Fire Ant *Wasmannia auropunctata*								
Other exotic ant species								
Exotic Whitefly species								
Asian Cycad Scale *Aulacaspis yasumatsui*	x							
Exotic Scales species								
Papaya Mealybug *Paracoccus marginatus*	x							x
Exotic Mealybug species								
Exotic Leafhoppers sp.								
Exotic Aphids species								
Brown Scale *Coccus hesperidum*								
Citrus Psyllid *Diaphorina citri*								
Orchid Weevil *Orchidophilesus aterrimus*								
Cottony Cushion Scale								

B. Plant Pathogens

Plant Pathogens	Guam	CNMI	Pohnpei	Chuuk	Kosrae	Yap	Marshalls	Palau
Banana Blood disease								
Betelnut bud rot, *Phytophthora palmivora*	x	x						
Sweet Potato Little leaf								
Panama wilt								
Moko disease								
Exotic Nematodes								
Red Ring Disease of coconut								
Black pod of Cocoa								
Bacterial disease of Papaya								

Bacterial Black spot of Mango								
Phytophthora heart rot of pineapples								
Bacterial wilt on tomato								
Mealybug wilt								
Melon rust								
Watermelon fruit blotch								
Powdery mildew on papaya								
Phytophthora heveae on coconut								
Phellinus noxius (Flame tree)								
Cassava Bacterial blight								
Bacterial canker on avocado								
Phytophthora root rot on avocado								

C. Vertebrates, Mollusks and Marine Organisms

Vertebrates, Mollusks, etc	**Guam**	**CNMI**	**Pohnpei**	**Chuuk**	**Kosrae**	**Yap**	**Marshalls**	**Palau**
Brown Treesnake, *Boiga irregularis*	x	?						
Coqui, *Eleutherodactylus coqui*	Erad ?							
Greenhouse frog, *E. planirostris*	x							
Barking frog, *Rana sp.*	x							
Exotic snakes and other reptiles and amphibians								
Exotic Rodent species								
Giant African Snail, *Achatina fullica*	x		x	x	new		x	x
Monkeys								x
Exotic Birds								
Exotic Marine pests								

D. Viruses of Plants

Virus Diseases	**Guam**	**CNMI**	**Pohnpei**	**Chuuk**	**Kosrae**	**Yap**	**Marshalls**	**Palau**
Banana Bunchy Top disease	x							
Papaya Ring Spot virus	x							
Tinangaja disease	x							
Cadang cadang								
Banana mosaic virus								
Banana infectious chlorosis virus								
Banana bract mosaic virus								
Banana streak disease								
Alomae & bobonae disease								
Coconut lethal yellowing								
Tomato spotted wilt virus								
Squash mosaic virus								
Kava dieback								
Coconut disease per Vanuatu								
Swollen shoot of Cocoa virus								
Papaya Droopy Necrosis								
Papaya Apical Necrosis								
Avocado sunblotch viroid								
Cassava Green mottle								

E. Weeds

Weeds	Guam	CNMI	Pohnpei	Chuuk	Kosrae	Yap	Marshalls	Palau
Miconia calvescens								
Mile-A-Minute, *Mikania micrantha*	x		x		x	x		x
Koster's Curse, *Clidemia hirta*								x
False Kava, *Piper auritum*			x					
Giant Sensitive Plant, *Mimosa diplotricha*	x		x		?	x		x
Cogon Grass, *Imperata cylindrica*						x		x
Giant Bramble, *Rubus moluccanus*					x			
Chain of Love, *Antigonon leptopus*	x		x			x	x	x
Ivy gourd, *Coccinia grandis*	x	x	x			x		
Octopus tree								Erad
Navua sedge, *Kyllinga polyphylla*								
Water hyacinth, *Eichhornia crassipes*	x		x					
African tulip-tree, *Spathodae campanulata*	x		x	x		x		x
Foeted cassia *Cassia tora*,								
Paddy's Lucerne, *Sida rhombifolia*								
Trumpet tree, *Cecropia peltata*								
Balloon vine, *Cardiospermum grandiflorum*								
Parthenium weed, *Parthenium hysterophorus*								

F. Animal Diseases

Animal Diseases	Guam	CNMI	Pohnpei	Chuuk	Kosrae	Yap	Marshalls	Palau
Bird flu, Highly pathogenic avian influenza								
Rabies								
Newcastle disease								
Hog Cholera								
Foot and Mouth Disease								
Fowl Pox								
Infectious Bursal Disease								
Rinderpest								
Peste des petitis ruminants								
Contagious bovine pleuropneumonia								
Bluetongue								
Sheep pox and goat pox								
Aujeszky's disease								
West Nile Virus								

Appendix B: Known Non-native Species

		Species	Status	Apra	Out	Artificial only	Persistence
Porifera		*Callyspongia* aff. *fibrosa*	C	Y	N	Y	Established
		Gelliodes fibrosa	?	?	?	?	?
		Haliclona (Sigmadocia) caerulea	?	?	?	?	?
		Ianthella basta	C	Y	N	N	Established
		Mycale (Crambia) sp. 1	C	Y	N	Y	Established
		Niphates sp. 1	C	Y	N	Y	Established
		Tedania c.f. ignis	I	Y	N	Y	Established
Cnidaria	Anthozoa	*Actinaria* sp. 1	C	Y	N	Y	Established
		Actinaria sp. 2	C	Y	N	Y	Established
		Actinaria sp. 3	C	Y	N	Y	Established
		Litophyton sp. 1	I	Y	?	Y	?
	Hydrozoa	*Clytia hemisphaerica*	C	Y	N	Y	?
		Clytia latitheca	C	Y	Y	N	?
		Clytia linearis	C	Y	Y	N	Established
		Clytia noliformis	I	Y	N	Y	?
		Corydendrium parasiticum	C	Y	Y	N	Established
		Ectopleura pacifica	I	Y	N	Y	Established
		Obelia dichotoma	I	Y	N	Y	?
		Pennaria disticha	C	Y	Y	N	Established
		Thyroscyphus fruticosus	C	Y	Y	N	Established
		Turritopsis nutricula	C	Y	N	Y	Established
Annelida	Polychaeta	*Oenone fulgida*	I	Y	N	Y	?
		Sabellastarte sp.	I	Y	N	Y	?
		Salmacina dysteri	C	Y	N	Y	Established
		Thelepus setosus	I	Y	N	Y	?
		Timarete caribous	I	Y	N	Y	?
Mollusca	Gastropoda	*Cellana mazatlandica*	I	N	N	N	Extirpated
		Crepidula aculeata	I	Y	N	Y	Extirpated
		Crucibulum spinosum	I	Y	N	Y	Extirpated?
		Tathrella iredalei	I	N	N	N	Extirpated?
		Trochus niloticus	I	Y	Y	N	Established
	Bivalvia	*Anomia nobilis*	I	Y	N	Y	?
		Chama fibula	I	Y	N	Y	?
		Chama macerophylla	I	Y	N	Y	?
		Crassostrea echinata	I	Y	N	N	Extirpated?
		Crassostrea gigas	I	?	N	N	Extirpated?
		Isognomon ephippium	C	Y	N	N	Established
		Trapezium sublaevigatum	C	Y	N	N	Established
		Tridacna derasa	I	Y	N	N	No repr.?
		Tridacna gigas	I	N	N	N	Extirpated
Bryozoa		*Amathia distans*	I	Y	Y	Y	Established
		Bryozoan sp. 1 (metallic)	C	Y	?	Y	Established
		Bugula neritina	I	Y	?	N	?
		Celleporaria sp. 1	C	Y	Y	N	Established
		Schizoporella serialis	I	Y	?	Y	?

Table A1. The known non-native marine species inhabiting Guam. This list is compiled from Paulay et al. (2002) and Pauley et al. (2011). Status: C = cryptogenic, I = introduced, ? = unknown. Apra: occur in Apra Harbor, Y = yes, N = no. Out: occur outside Apra Harbor in natural habitats, Y = yes, N = no. Artificial only: encountered only on artificial substrata, Y = yes, N = no. Persistence: current occurrence on Guam.

		Species	Status	Apra	Out	Artificial only	Persistence
Arthropoda	Cirripedia	*Balanus eburneus*	I	N	Y	N	Established
		Chthamalus proteus	I	Y	Y	N	Established
	Malacostraca	*Charybdis helleri*	C	Y	Y	Y	Established
		Metopograpsus oceanicus	C	Y	N	N	Established
		Penaeus monodon	I	N	N	N	?
		Penaeus stylirostris	I	N	N	N	In maricuture
		Penaeus vannamei	I	N	N	N	In maricuture
Echinodermata		*Ophiactis savignyi*	C	Y	Y	N	Established
Chordata	Ascideacea	Ascidiacea sp. A	C	Y	?	Y	Established
		Ascidia sp. B	C	Y	?	Y	Established
		Ascidia sydneiensis	I	Y	Y	Y	Established
		Botryllus cf. *simodensis*	C	Y	N	Y	Established
		Botryllus niger	C	Y	Y	N	Established
		Botryllus sp. A	C	Y	?	Y	Established
		Botryllus sp. B	C	Y	?	Y	Established
		Cnemidocarpa irene	C	Y	Y	N	Established
		Didemnun perlucidum	I	Y	Y	Y	Established
		Didemnum psammathodes	C	N	Y	N	Established
		Diplosoma listerianum	I	Y	Y	Y	Established
		Diplosoma sp. A	C	Y	?	Y	Established
		Herdmania insolita	C	Y	N	Y	Established
		Hermania pallida	C	Y	Y	N	Established
		Lissoclinum fragile	I	Y	Y	Y	Established
		Microcosmus exasperaturs	I	Y	Y	Y	Established
		Microcosmus helleri	C	Y	Y	N	Established
		Microcosmus pupa	C	Y	N	Y	Established
		Perophora muticlathrata	C	Y	Y	N	Established
		Perophora sagamiensis	C	Y	N	N	Established
		Phallusia nigra	I	Y	Y	Y	Established
		Polyandrocarpa sagamiensis	C	Y	N	Y	Established
		Plycarpa aurita	C	Y	N	Y	Established
		Polyclinum constellatum	I	Y	N	Y	Established
		Pyura cf. *robusta*	C	Y	Y	N	Established
		Pyura confragosa	C	Y	N	Y	Established
		Pyura curvigona	C	Y	Y	N	Established
		Pyura honu	C	Y	N	N	Established
		Rhodosoma turcicum	I	Y	?	N	?
		Styela canopus	I	Y	N	Y	Established
		Symplegma brakenhielmi	I	Y	N	Y	Established
		Symplegma sp. A	C	Y	N	Y	Established
	Osteichthyes	*Gambusia affinis*	I	N	Y	N	Established
		Mugil cephalus	I	N	N	N	?
		Neopomacentrus violascens	I	Y	N	N	?
		Omobranchus elongatus	I	Y	N	N	?
		Oreochromus mosambicus	I	N	Y	N	Established
		Parioglossus philippinus	I	Y	N	N	?
		Rhabdamia gracilis	I	Y	?	?	?

Table A1. (cont'd.)

Appendix C: Potential Marine Invasive Species

The following species are considered biofouling high risk species in general based on observations throughout the Pacific, largely from what has been seen in Hawaii. This list was compiled by Steve McKagen (NOAA) and Scott Goodwin (NOAA). These are tropical marine non-native species which have established in Hawaii and are at high risk for biofouling transport. Those species with an "X" are already present in Guam, and those with and "(X)" have species within the same genus which are already present in Guam.

Species	Guam
Porifera	
Callyspongia sp.	(X)
Chelonaplysilla violacea	
Cladocroce burrapha	
Crella spinulata	
Darwinella australiensis	
Dictyodendrilla dendyi	
Dysidea sp.	
Dysidea arenaria	
Echinodictyum asperum	
Gelloides fibrosa	X
Halichondria sp.	
Heteropia glomerosa	
Lissodendoryx similis	
Monanchora sp.	
Monanchora quadrangulata	
Mycale grandis	(X)
Phorbas arborescens	
Sigmadocia cf. *caerulae*	
Strongylamma wilsoni	
Suberites zeteki	
Tedania strongylostyla	(X)
Tethya deformis	
Cnidaria	
Bouganvillia ramosa	
Carijoa riisei	
Diadumene leucolena	
Diadumene lineata	
Dynamena crisioides	
Annelida	
Branchiomma nigromaculata	
Circeus cf. *amoricana*	
Eulaeospira orientalis	
Hydroides crucigerus	
Hydroides dirampha	
Hydroides elegans	

Species	Guam
Annelida (cont'd)	
Janua pagenstecheri	
Neodexiospira foraminosa	
Neodexiospira preacuta	
Rhamphostomella argentea	
Scrupocellaria cf. *sinuosa*	
Watersipora edmondsii	
Pileolaria militaris	
Pomatoceros cf. *minutus*	
Pomatoleios kraussii	
Sabellastarte spectabilis	(X)
Salmacina tribranchiata	(X)
Serpula cf. *watsoni*	
Serpula verimcularis	
Simplicaria pseudomilitaris	
Mollusca	
Chama fibula	X
Chama macerophylla	X
Crucibulum spinosum	X
Hipponix australis	
Vermetus alii	
Crustacea	
Balanus amphitrite	
Balanus eburneus	X
Balanus trigonus	
Caprella acutifrons	
Ericthonius brasiliensis	
Glabropilmnus seminudus	
Gonodactylaceusus mutatus	
Jassa falcata	
Megabalanus californicus	
Megabalanus peninsularis	
Megabalanus tanagrae	
Metopograpsus oceanicus	X
Nanosesarma minutum	
Pachygrapsus gakaravensis	

Species	Guam
Pycnogonida	
Anoplodactylus sp.	
Echinodermata	
Ophiactis savignyi	X
Bryozoa	
Bugula neritina	X
Bugula robusta	
Hippoppdina feegeensis	
Holoporella pilaefera	
Rhamphostomella argentea	
Scrupocellaria cf. *sinuosa*	
Watersipora edmondsii	
Urochordata	
Ascidia archaia	
Ascidia sydneiensis	X
Botrylloides simodensis	X
Botrylloides sp.	(X)
Cnemidocarpa irene	X
Didemnum cf. *perlucidum*	X
Diplosoma listerianum	X
Eusynstyela hartmeyeri	
Herdmania momus	
Herdmania pallida	X
Lissoclinum fragile	X
Microcosmus exasperatus	X
Phallusia nigra	X
Polyandrocarpa sagamiensis	X
Polycarpa aurita	X
Polyclinum constellatum	X
Styela canopus	X
Styela clava	
Styela plicata	
Symplegma brakenhielmi	X
Symplegma sp.	X

Appendix D: Black List of Species Not Allowed for Import to Guam

The following list of fish species was compiled by Guam DOA. It contains those species which are not allowed for import to Guam.

Acanthorutilis handlirschi, Cicek
Acipenser spp., Sturgeon
Agosia chrysogaster, Longfin Dace
Alabama cavefish, *Speoplatyrhinus poulsoni*
Algae eater, *Hypostomus* spp., *Plecostomus* spp.
Ambloplites cavifrons, Roanoke Bass
Amblyopsis rosae, Cavefish
Amblyopsis spelea, Northern Cavefish
Ammocrypta spp., Darters
Arapaima gigas, Arapaima
Arapaima, *Arapaima gigas*
Archoplites interruptus, Sacramento Perch
Arkansas River Speckled Chub*, Macrhybopsis aestivalis tetranemus*
Australian lungfish, *Neoceratodus forsteri*
Ayumodoki, *Hymenophysa curta*
Beautiful shiner, *Cyprinella formosa*
Barrens Topminnow*, Fundulus julisia*
Big Spring spinedace, *Lepidomeda mollispinis pratensis*
Blackside dace, *Phoxinus cumberlandensis*
Blue shiner, *Cyprinella formosa*
Blue Sucker*, Cycleptus elongatus*
Caecobarbus geertsi, Cavefish
Campostoma ornatum, Mexican Stoneroller
Catostomus microps, Modoc sucker
Catostomus spp., Wall Canyon Sucker
Catostomus warnerensis, Warner sucker
Cavefish, *Amblyopsis rosae, Caecobarbus geersti*,
Channa spp., Snakeheads
Chasmistes spp., Suckers
Chihuahua Catfish, *Ictalurus* sp.
Chubs, *Gila* spp.
Cicek, *Acanthorutilus handlirschi*
Ciscos, *Coregonus* spp.
Coelacanth, *Latemeria chalumnae*
Colorado Squawfish, *Ptycocheilus lucius*
Colossoma oculus, Red Pacu
Coregonus spp., Ciscos
Coreobagrus ichikawai, Nekogi
Cottus pygmaeus, Pygmy sculpin
Cottus spp., Sculpins
Crenichthys baileyi, White River springfish
Crenichthys nevadae, Railroad Valley springfish
Crenicichla spp., Pike cichlids
Cui-cui, *Chasmistes* spp.
Cycleptus elongatus, Blue Sucker
Cynoscion macdonaldi, Totoaba
Cyprinella caerulea, Blue shiner
Cyprinella formosa, Beautiful shiner
Cyprinella monacha, Spotfin chub
Cyprinodon spp., Pupfish
Daces, *Rhinichthys* spp.
Darters, *Etheostoma* spp.,*Percina* spp.,*Ammocrypta* spp.
Delta smelt, *Hypomesus transpacificus*
Deltistes luxatus, Lost River sucker
Desert dace, *Erimichthys acros*
Elassoma spp*.,* Pygmy Sunfish
Empretrichthys latos, Pahrump pupfish
Erimichthys acros, Desert dace
Erimystax cahni, Slender chub
Etheostoma spp., Darters
Eucyclogobius newberryi, Tidewater goby
Flame Chub, *Hemitremia flammea*
Flathead Chub, *Platygobio gracilis*
Fundulus julisia, Barrens Topminnow
Fundulus sciadicus, Plains Topminnow
Fundulus waccamensis, Waccamaw Killifish
Gambusia spp., Mosquito fish
Gasterosteus aculeatus santaeannae, Santa Anna Stickleback
Gasterosteus aculeatus williamsoni, Unarmored Threespined stickleback
Gila spp., Chubs
Gila Topminnow, *Poeciliopsis occidentalis*
Gombessa, *Latimeria chalumnae*
Greater Redhorse*, Moxostoma valenciennesi*
Guadelupe Bass*, Micropterus treculi*
Headwater Catfish*, Ictalurus lupus*
Hemitremia flammea, Flame Chub
Huso spp., Sturgeon

Hybognathus amarus, Rio Grande minnow
Hybognathus argyritis, Western Silvery Minnow
Hybognathus placitus, Plains Minnow
Hymenophysa curta, Ayumodoki
Hypomesus transpacificus, Delta Smelt
Hypostomus spp., Algae Eater
Hysterocarpus traski pomo, Russian River Tule Perch
Ictalurus pricei, Yaqui catfish
Ictalurus sp., Chihuahua Catfish
Ictalurus lupus, Headwater Catfish
Ikan Temolah, *Probarbus jullieni*
June sucker, *Chasmistes* spp.
Kanawha Minnow, *Phenacobius teretulus*
Key Silverside*, Menidia conchorum*
Lampreys, *Lampetra* spp.
Lampetra spp., Lampreys
Latimeria chalumnae, Coelacanth
Lavinia spp., Roaches
Leafy Sea Dragon, *Phycodurus eques*
Lepidomeda albivallis, White River spinedace
Lepidomeda mollispinis pratensis, Big Spring spinedace
Lepidomeda vittatta, Little River spinedace
Little Colorado spinedace, *Lepidomeda vittata*
Longfin Dace*, Agosia chrysogaster*
Longfin Smelt, *Spirinchus thaleichthys*
Lost River Sucker*, Deltistes luxatus*
Lythrurus snelsoni, Ouachita Mountain Shiner
Macrhybopsis aestavalis tetranemus, Arkansas River Speckled Chub
Madtoms, *Noturus* spp.
Meda fulgida, Spikedace
Menidia conchorum, Key Silverside
Menidia extensa, Waccamaw silverside
Mexican Blindcat, *Prietella phreatophilia*
Mexican Stoneroller*, Campostoma ornatum*
Micropterus sp., Shoal Bass
Micropterus treculi, Guadelupe Bass
Miyako Tango, *Tanakia tanago*
Moapa coriacea, Moapa dace
Moapa dace, *Moapa coriacea*
Modoc Sucker, *Catostomus microps*
Mosquito fish, *Gambusia* spp.
Moxostoma robustum, Robust Redhorse
Moxostoma spp., Suckers
Moxostoma valenciennesi, Greater Redhorse
Nekogigi, *Coreobagrus ichikawai*
Neoceratodus forsteri, Australian lungfish
Northern cavefish, *Amblyopsis spelea*
Notropis spp. Shiners
Noturus spp. Madtoms
Novumbra hubbsi, Olympic Mudminnow
Olympic Mudminnow, *Novumbra hubbsi*
Onchorhynchus spp., Salmon
Oregon chub, *Oregonichthys crameri*
Oregonichthys crameri, Oregon chub
Oregonichthys kalawatseti, Umpqua River Chub
Osmerus spectrum, Pygmy Smelt
Ouachita Mountain Shiner, *Lythrurus snelsoni*
Paddlefish, *Polyodon spathula*
Pahrump pupfish, *Empetrichthys latos*
Pangasianodon gigas, Thailand Giant catfish
Pangasius sanitswongsei, Sailfin catfish
Percina spp., Darters
Phenacobius teretulus, Kanawha Minnow
Phoxinus cumberlanensis, Blackside dace
Phoxinus tennesseensis, Tennessee Dace
Phractocephalus hemiliopterus, Red Tail catfish
Phycodurus eques, Leafy Sea Dragon
Pike cichlids, *Crenicichla* spp.
Piranha, *Serrasalmus* spp., *Pygocentrus* spp.,*Taddyella* spp.
Plagopterus argentissimus, Woundfin
Plains Minnow, *Hybognathus placitus*
Plains Topminnow*, Fundulus sciadicus*
Platygobio gracilis, Flathead Chub
Plecostomus spp., Algae eater, Plecostomus
Plecostomus, *Plecostomus* spp.
Poeciliopsis occidentalis, Gila Topminnow
Polyodon spathula, Paddlefish
Prietella phreatophilia, Mexican blindcat
Probarbus jullieni, Ikan temolah
Pseudoscaphirhyncus spp., Sturgeon
Ptycocheilus lucius, Colorado squawfish
Pupfish, *Cyprinodon* spp.
Pygmy Smelt, *Osmerus spectrum*
Pygmy Sunfish, *Elassoma* spp.

Pygocentrus spp., Piranha
Pygmy sculpin, *Cottus pygmaeus*
Railroad Valley springfish, *Crenichthys nevadae*
Razorback Sucker, *Xyrauchen texanus*
Red Pacu, *Colossoma oculus*
Red-Tailed catfish, *Phractocephalus hemiolopterus*
Relict Dace, *Relictus solitarius*
Relictus solitarius, Relict Dace
Rhinichthys spp., Daces
Rio Grande minnow, *Hybognathus amarus*
Rivulus, *Rivulus marmoratus*
Rivulus marmoratus, Rivulus
Roaches, *Lavinia spp.*
Roanoke Bass, *Ambloplites cavifrons*
Robust Redhorse, *Moxostoma robustum*
Russian River Tule Perch, *Hysterocarpus traski pomo*
Sacramento Perch, *Archoplites interruptus*
Sailfin Catfish, *Pangasius sanitwongsei*
Salmo spp., Salmon
Salmon, *Onchorhychus* spp.,*Salmo* spp.,*Salvelinus* spp.
Salvelinus spp., Salmon
Sandhills Chub, *Semotilus lumbee*
Santa Anna Stickleback, *Gasterosteus aculeatus santaeanna*
Satan eurystomus, Widemouth Blindcat
Scaphirhynchus spp. Sturgeon
Sculpins, *Cottus* spp.
Semolitus lumbee, Sandhills Chub
Serrasalmus spp., Piranha
Shiners, *Notropis* spp.
Shoal Bass, *Micropterus* sp.
Shortnose sucker, *Chasmistes* spp.
Slender dace, *Erimystax cahni*
Snakeheads, *Channa* spp.
Speoplatyrhinus poulsoni, Alabama cavefish
Spikedace, *Meda fulgida*
Spirinchus thaleichthys, Longfin Smelt
Spotfin chub, *Cyprinella monacha*
Sturgeon, *Acipenser* spp.,*Scaphirhynchus* spp.,*Huso* spp.,*Pseudoscaphirhyncus* spp.
Suckers, *Moxostoma* spp.
Taddyella spp., Piranha
Tanakia tanago, Miyako tango
Tennessee Dace, *Phoxinus tennesseensis*
Thailand Giant catfish, *Pangasianodon gigas*
Tidewater goby, *Eucyclogobius newberryi*
Toothless Blindcat, *Trogloglanis pattersoni*
Totoaba, *Cynoscion macdonaldi*
Trogloglanis pattersoni, Toothless Blindcat
Umpqua River Chub, *Oregonichthys kalawatseti*
Unarmored threespined stickleback, *Gasterosteus aculeatus williamsoni*
Waccamaw Killifish, *Fundulus waccamensis*
Waccamaw silverside, *Menidia extensa*
Walking catfish, *Clarias* spp.
Wall Canyon Sucker, *Catostomus* spp.
Warner sucker, *Catostomus warnerensis*
Western Silvery Minnow, *Hybognathus argyritis*
White River spinedace, *Lepidomeda albivallis*
White River springfish, *Crenichthys baileyi*
Widemouth Blindcat, *Satan eurystomus*
Woundfin, *Plagopterus argentissimus*
Xyrauchen texanus, Razorback sucker
Yaqui catfish, *Ictalurus pricei*

Any species not on this list that is on CITES, ESA, or USFWS injurious species list are also not allowed to be imported to Guam.

Appendix E: White List of Species Allowed for Import to Guam

The following list of species was compiled by Guam DOA. It contains those species which are allowed for import to Guam.

Aborichthys spp.
Abramites spp. (all)
Acanthocephala limabat
Acanthocobitis botia
Acanthophthalmus kuhlii
Acanthopsis choirorhynchus
Acanthurus achilles
Acanthurus lineatus
Acanthurus nigrofuscus
Acanthurus olivaceous
Acanthurus pyroferus
Acanthurus triostegus
Acarichthys heckelli
Achirus errans
Aequidens spp. (all)
Agamyxis pectifrons
Altolamprologus spp. (all)
Amblyeleotris fasciata
Amblyeleotris guttata
Amblyeleotris steinitzi
Amphilophus citrinellum
Amphilophus citrinellum X *Cichlasoma synspilum*
Amphiprion chrysopterus
Amphiprion clarckii
Amphiprion melanopus
Amphiprion peredarion
Anamolops katopteron
Anampses meleagrides
Anostomus spp. (all)
Antenarius picta
Antennarius commersonii
Antennarius hispidus
Antennarius striatus
Anubias spp. (all)
Aphyocharax spp. (all)
Aphyosemion spp. (all)
Apistogramma spp. (all)
Aplocheilichthys spp. (all)
Apogon cyanosoma
Apolemichthys trimaculatus
Apteronotus albifrons
Archocentrus nigrofasciatus
Archocentrus sajica
Arenigobius bifrenatus
Aristichthys nobilis
Aristochromis christyi
Arnoldichthys spilopterus
Asterophysus batrachus
Astronotus ocellatus
Astyanax mexicanus
Aulanocara spp. (all)
Aurelia aurita
Awaous grammepomus
Badis badis
Bagre bagre
Balantiocheilus melanopterus
Balistoides conspicillum
Barbodes spp. (all)
Barbonymus altus
Barbus spp. (all)
Bathyaethiops caudomaculatus
Beaufortia levertii
Bedotia geayi
Betta spp. (all)
Boehlkea fredcochui
Boraras spp. (all)
Bothus mancus
Botia spp. (all)
Boulongerella maculata
Brachydanio spp. (all)
Brachygobius spp. (all)
Bryconaethiops microstoma
Calappa lophos
Calloplesiops altivelis
Camposia retusa
Capoeta spp. (all)
Carcinoscorpius rotundicauda UWW only
Carinatetraodon travancoricus
Carnegiella spp. (all)
Carrasius auratus
Cassiopea frondosa
Centropyge bicolor
Centropyge bispinosa
Centropyge colini
Centropyge flavicauda

Centropyge flavissima
Centropyge heraldi
Centropyge loricula
Centropyge multicolor
Centropyge nigriocella
Centropyge shepardi
Centropyge vrolickii
Cephalopholis miniatus
Cephalopholis sexmaculata
Cephalopholis urodeta
Cerianthus ceriantharia
Cerianthus filiformis
Certonardoa semiregularis
Cetoscarus bicolor
Chaca chaca
Chaetodon auriga
Chaetodon benneti
Chaetodon ephippium
Chaetodon lunula
Chaetodon melannotus
Chaetodon meyeri
Chaetodon punctatofasciatus
Chaetodon reticulatus
Chaetodon rostratus
Chaetodon trifascialis
Chaetodon unimaculatus
Chaetodon vagabundus
Chalceus spp. (all)
Chalinochromis spp. (all)
Chanda spp. (all)
Chandamaranda chandamaranda
Cheirodon spp. (all)
Chela spp. (all)
Chelmon rostratus UWW only
Chelonodon patoca
Chilodus punctatus
Chitala spp. (all)
Chrysiptera biocellata
Chrysiptera brownriggii
Chrysiptera caeruleolineata
Chrysiptera glauca
Chrysiptera traceyi
Cichlasoma spp. (all)
Cirrhitichthys falco
Cirrhitichthys oxycephalus
Cleithracara maronii
Clypeaster humilis
Cobitis taenia
Coelurichthys microlepis
Coius spp. (all)
Colisa spp. (all)
Colomesus spp. (all)
Copadichromis spp. (all)
Copella spp. (all)
Coris aygula
Coris gaimard
Corydoras spp. (all)
Corynopoma riisei
Crenuchus spilurus
Cribinopsis crassa
Cromileptes altivelis
Crossocheilus siamensis
Cryptocentrus cyanotaenia
Cryptocoryne spp. (all)
Cryptodendrum adhesivum
Ctenobrycon spilurus
Ctenochaetus hawaiiensis
Ctenochaetus marginatus
Ctenochaetus strigosus
Cyathopharynx furcifer
Cynolebius spp. (all)
Cyphotilapia frontosa
Cyprinus carpio
Cyprochromis leptosoma
Cyrtocara moori
Danio spp. (all)
Dario spp. (all)
Datnoides microlepis
Dermogenys pusillus
Dicrossus spp. (all)
Dimidochromis spp. (all)
Diodon holocanthus
Diodon hystrix
Distichodus affinis
Distichodus lussoso
Distichodus noboli
Distichodus sexfasciatus
Echenius naucrates
Echidna nebulosa
Echinodorus spp. (except for *E. cordifolius*)
Ecsenius bicolor
Eigenmannia virescens
Eirmotus octozona
Entacmea quadricolor
Epalzeorhynchus spp. (all)
Epinephalis lanceolatus

Erpetoichthys calabaricus
Esomus danricus
Etroplus spp. (all)
Filogranella elatensis
Forcipiger flavissimus
Forcipiger longirostris
Fronia monilis
Gagata cenia
Gasteropelecus spp. (all)
Gastromyzon spp. (all)
Genicanthus bellus
Genicanthus melanospilos
Genicanthus watanabei
Geophagus spp. (all)
Glossolepsis spp. (all)
Gnathanodon speciosus
Gnathonemus petersi
Gobiodes broussonnettii
Gobiodon atrangulatus
Gobiodon histrix
Gomphosus varius
Gorgasia preclara
Grammistes sexlineatus
Gymnarchus niloticus
Gymnochanda filamentosa
Gymnocorymbus ternetzi
Gymnogeophagus balzanii
Gyrinocheilus aymonieri
Halaelurus buergeri UWW only
Halichoeres biocellatus
Halichoeres chrysus
Haplochromis spp. (all)
Hara jordani
Hasemania nana
Helostoma temminki
Hemichromis bimaculatus
Hemichromis lifalli
Hemigrammopetersius caudalis
*Hemigrammus s*pp. (all)
Hemiodopsis spp. (all)
Hemipteronotus taeniourus
Heniochus acuminatus
Herichthys carpinte
Herichthys cyanoguttatus
Herichthys dovii
Herichthys maculicauda
Heros appendiculatus
Heros severus
Heteractis aurora
Heteractis magnifica
Heteroconger hassi
Heterodactyla hemprichii
Hexabranchus sanguinensis
Hexanematichthys leptospis
Hippocampus abdominalis UWW only-captive bred only
Hippocampus kuda UWW only- captive bred only
Hippolysmata grabhami
Histrio histrio
Homaloptera spp. (all)
Hoplolatilus starcki
Hymenocera elegans
Hymenocera picta
Hyphessobrycon spp. (all)
Hypselacara temporalis
Iguanodectes spilurus
Indostomus paradoxus
Inpaichthys kerri
Iodotropheus sprengerae
Iratherina werneri
Jordanella floridae
Julidochromis spp. (all)
Kryptopterus spp. (all)
Labeo spp. (all)
Labeotropheus spp. (all)
Labidochromis caeruleus
Labiobarbus festivum
Labroides dimidiatus
Labropsis micronesica
Labropsis xanthonota
Lactoria cornuta
Ladigesia roloffi
Laetacara spp. (all)
Lamprichthys tanganicanus
Lamprologus spp. (all)
Leiocassis siamensis
Lepidarchus adonis
Lepidocephalus guntea
Leporinus spp. (all)
Leptobarbus hoeveni
Leptobotia micronoemocheilus
Limulus polyhemus
Linkia laevigata
Liosomadoras spp. (all)
Luciosoma setigerum

Lutjanus kasmira
Lybia tessellata
Lysmata amboinensis
Lysmata debelius
Macolor macularis
Macrochir kaempferi UWW only
Macrognathus spp. (all)
Macropharyngodon meleagris
Macropodus spp. (all)
Malacanthus latovittatus
Mastacembelus spp. (all)
Mastigias papua
Megalamphodus spp. (all)
Meiacanthus atrodorsalis
Meiacanthus grammistes
Melanochromis spp. (all)
Melanotaenia spp. (all)
Mesonauta festivum
Mesonauta salvini
Metynnis hypsauchen
Metynnis schreitmuelleri
Microgeophagus spp. (all)
Microrasbora spp. (all)
Microsorium pteropus
Microsynodontis batesii
Mimagoniates barberi
Mirolabrichthys imeldae
Misgurnus fossilis
Moenkhausia spp. (all)
Mogurnda adspersa
Monocentrus japonicus
Monocirrhus polyacanthus
Monodactylus argenteus
Monotretus travancoricus
Moringua raitaborua
Mormyrus kannume
Morulius chrysophekadion
Muraena pardalis
Myleus rubripinnis
Mylossoma aureum
Myrichthys colubrinus
Myrichthys maculosus
Mystus tengara
Mystus vittatus
Myxocyprinus asiaticus
Nandopsis managuense
Nandopsis salvini
Nannacara spp. (all)
Nannaethiops unitaeniatus
Nannobrycon spp. (all)
Nannochromis spp. (all)
Nannostomus spp. (all)
Nemateleotris decora
Nemateleotris magnifica
Nematobrycon spp. (all)
Neocirrhites armatus
Neoglyphidodon melas
Neolamprologus spp. (all)
Neolebias spp. (all)
Neopetrolisthes maculatus
Neopetrolisthes oshimmai
Nimbochromis livingstonii
Nimbochromis venustus
No amphibians may be imported
No reptiles may be imported
Noemacheilus bhimachar
Noemacheilus corica
Nothobranchius spp. (all)
Notopterus spp. (all)
Novaculichthys taeniourus
Olindias formosa UWW only
Ompok sabanus
Oncinopus decapoda
Ophthalmotilapia spp. (all)
Osphronemus goramy
Osteoglossum bicirrhosum
Osteoglossum ferrerai
Ostracion cubicus
Ostracion meleagris
Otopharynx spp. (all)
Oxycirrhites typus
Pangasius larnaudi
Pangasius polyuranodon
Pangasius sutchi
Pangio spp. (all)
Pantodon buchholtzi
Papiliochromis spp. (all)
Papyrocranus afer
Papyrocranus congoensis
Paracanthurus hepatus
Paracheirodon spp. (all)
Paracirrhites arcatus
Paracirrhites forsteri
Paracyprochromis nigripinnis
Parailla longifilis
Parambassis ranga

Parapeneus barberinoides
Parapeneus cyclostomus
Pelteobagrus ornatus
Pelvicachromis pulcher
Pentaster obtusatus
Petitella georgia
Phenacogrammus interruptus
Phyllidia varicosa
Phyllopteryx taeniolatus UWW only-captive bred only
Phyllorhiza punctata
Pimelodas pictus
Pimelodella imitator
Placidochromis spp. (all)
Platax orbicularis
Platax tiera
Platydoras costatus
Platyropius siamensis
Plectorhinchus albovittatus
Plectorhinchus gibbosus
Plectorhinchus lessoni
Plectorhinchus lineatus
Plectorhinchus picus
Plectorhinchus unicolor
Plectorhinchus vittatus
Poecilia latipinna
Poecilia reticulata
Poecilia sphenops
Poecilia velifera
Poecilocharax weitzmani
Pogonoculius zebra
Pogonoperca punctata
Pollimyrus spp. (all)
Polypterus spp. (all)
Pomacanthus imperator
Pomacentrus amboinensis
Pomacentrus pavo
Pomacentrus vaiuli
Poppendetta conniae
Prionobrama filigera
Pristella maxilaris
Protomelas spp. (all)
Protoreaster dodosus
Pseudanthias bicolor
Pseudanthias cooperi
Pseudanthias flavicauda
Pseudanthias hutomoi
Pseudanthias pascalus
Pseudanthias pleurotaenia
Pseudanthias ventralis
Pseudechidna brummeri
Pseudobalistes fusca
Pseudocheilinus hexataenia
Pseudocrenilabrus spp. (all)
Pseudogastromyzon spp. (all)
Pseudomugil furcatus
Pseudotropheus spp. (all)
Pterapogon kauderni UWW only-captive bred only
Ptereleotris coeruleus
Ptereleotris evides
Ptereleotris heteropterus
Ptereleotris zebra
Pterois radiata
Pterois volitans
Pterophyllum spp. (all)
Puntius spp. (all)
Pygoplites diacanthus
Pyrrhulina spp. (all)
Rachoviscus spp. (all)
Rasbora spp. (all)
Rasboroides vaterfifloris
Rhinecanthus aculeatus
Rhinomuraena quaesita
Rhinopias spp. UWW only
Rhynchocinetes durbanensis
Rhynchocinetes uritai
Rita rita
Roeboides descalvadensis
Sabillastarte indica
Salarias fasciatus
Salarias irroratus
Sargocentron spiniferum
Saron marmoratus
Saron rectirostris
Satanoperca spp. (all)
Sawbwa resplendens
Scatophagus argus
Schistura spilota
Sciades pictus
Scianochromis spp. (all)
Selenotoca multifasciata
Semaprochilodus spp. (all)
Serranocirrhitus latus
Sillaganopsis panijus
Sillago domina

Simpsonichthys constanciae
Sinogastromyzon wui
Solenostomus paradoxus
Spathiphyllum tasson
Sphaerichthys osphremenoides
Spilotichthys pictus
Stenopus hispidus
Stichodactyla mertensii
Stigmatogobius sadanundio
Stoichactis haddoni
Sundanio spp. (all)
Symphysodon aquefasciatus
Symphysodon discus
Synodontis spp. (all)
Tanichthys albonubes
Tateurundina ocellicauda
Taxiphyllum barbieri
Telmatherina ladigesi
Tetragonopterus argenteus
Tetraodon biocellatus
Tetraodon fahaka
Tetraodon fluviatilis
Tetraodon miurus
Tetraodon nigroviridis
Tetraodon palembangensis
Thalassoma lunare
Thalassoma lutescens
Thayeria spp. (all)
Theraps nicaraguense
Theraps synspilus
Thor amboinensis
Thoracocharax stellatus
Thorichthys meeki
Thorichthys meeki X *Amphylophus citrinellum* X *Theraps synspilus*
Toxotes jaculator
Trichogaster spp. (all)
Trichopsis spp. (all)
Trinectes maculatus
Tropheus spp. (all)
Uaru amphiacanthoides
Urticina felina
Vesicatrus tegatus
Vesicularia dubyana
Xenomystus nigri
Xiphophorus helleri
Xiphophorus maculatus
Xiphophorus variatus
Xyrichthys pavo
Zebrasoma flavescens
Zebrasoma veliferum

Appendix F: Hawaii's Biofouling Survey Data Forms for Personal and Commercial Vessels

Hawaii Biofouling Questionnaire for boats

Vessel Information & Particulars	
Today's date (MM/DD/YYYY)	
Your boat's name:	
Type of boat (check the appropriate box):	Sailboat/Yacht ☐ Motorboat ☐ Other ☐ Specify _____
Boat length (feet)	
Where is the boat's home harbor? Check **not applicable** if stored on land when not in use.	Home harbor marina name: Home harbor town/city: Home harbor State/Country: Not applicable ☐

Maintenance & Anti-Fouling Paint	
When was the most recent occasion that the boat was hauled out for anti-fouling paint application?	Date (**Month/Year**): Don't know ☐
What antifouling paint is currently coating the hull of the boat? If you don't know the brand of paint, **check don't know** and provide a more generic description if possible (e.g. copper ablative, foul-release etc) If the boat has no anti-fouling paint at present, check the appropriate box.	Manufacturer/Company: Product Name:
	Don't know ☐ Generic Description (if possible):
	This boat does not have anti-fouling paint ☐
Since the last application of anti-fouling paint, has the boat been manually cleaned (scrubbed or brushed)?	Yes ☐ Date of most recent cleaning(**M/Y**): No ☐ Don't know ☐
If it has been manually cleaned, what method was used? And where did this cleaning occur? (check all that apply)	In-water by a diver at my home marina ☐ In-water by a diver at another marina ☐ Location (city/country): Out-of-water / On land ☐ Other ☐ (specify)_____
During a typical year, how often do you clean your boat?	Number of summer cleanings: Number of winter cleanings:

Storage / stationary periods	
Since the last cleaning or antifouling paint application (whichever is most recent), what is the longest time	Duration (in days or months): End Date (Month/Year):

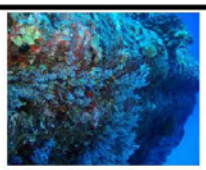
that the boat has been **in-water at a single location**? Where was this location? (Check home port if this was the location)	Harbor Name: City: State/Country: or Home Port ☐

Recent Voyage Information	
Have you arrived to the state of Hawaii by boat from **overseas or the mainland** during the last month?	Yes ☐ No ☐ If yes, go to section "overseas/mainland arrivals" If no, please continue to the next question
Since the boat was last removed from the water (for paint application or storage), how many trips has it been on? A rough estimate is fine.	Number of trips:_____
Have you travelled by boat to harbors in Hawaii other than your home marina during the last 12 months?	Yes ☐ No ☐
If yes, please list the name of the marina, approximate date and duration. If you need space for more than three marinas, please use the blank side of the cover page.	Marina name: Date (MM/YY): Duration of stay:
	Marina name: Date (MM/YY): Duration of stay:
	Marina name: Date (MM/YY): Duration of stay:

Overseas/mainland arrivals

Overseas/mainland arrivals	
When and where did you arrive by boat into Hawaii?	Date (M/D/Y): Arrival harbor in Hawaii:
If you are a returning resident, please just check that box. If you are a visitor, how long do you plan to stay in Hawaii? Your best estimation is fine.	I am a returning resident ☐ Duration ____
If you are a returning resident, please continue to the next question. If you are a visitor, which island(s) do you intend to visit? (check all that apply).	Islands you intend to visit: Kauai ☐ Ni'ihau☐ Oahu ☐ Maui ☐ Molokai ☐ Lanai ☐ Hawaii Island (Big Island) ☐
What was your last port-of-call prior to arrival in Hawaii? If you have arrived directly from your home port, just check that box.	Harbor Name: City: State/Country: Arrived from home harbor ☐
List the previous ports visited since the most recent cleaning or anti-fouling paint application. If possible, list them in reverse order from your last-port-of-call prior to departure for Hawaii.	Harbor Name: City: State/Country: Date (D/M/Y):
	Harbor Name:

If you need more space, please use the blank side of the cover page to add more locations visited *en route* to Hawaii.	City: State/Country: Date (D/M/Y):
	Harbor Name: City: State/Country: Date (D/M/Y):
	Harbor Name: City: State/Country: Date (D/M/Y):
	Harbor Name: City: State/Country: Date (D/M/Y):


On behalf of DLNR, The University of Hawai`i is conducting a study:

Biofouling Management Practices of Shippers and Boaters

Do you own or operate a ship or boat in Hawaii?

If the answer is **YES**...

We would like to invite you to participate in a research study.

Fouling species are a nuisance to boat owner, harbors and the environment! **The purpose** of this research is to learn more about boat movements and hull maintenance. We are interested in the marine biology of animals and seaweeds that can attach to and live on the bottoms of boats (biofouling).

During 2013 you might see us visiting marinas and harbors throughout Hawaii collecting questionnaire data. You can also contact the researcher to participate electronically. Study volunteers can request a summary of the data analysis.

To learn more about the study please email or call

Sonia Gorgula 808.587.2275 or Sonia.gorgula@hawaii.gov

UH IRB Approval Date 03-XX-13

Hawaii Biofouling Questionnaire for commercial vessels

Vessel Information & Particulars	
Vessel Name	
Official / IMO Number	
Vessel type (containership, barge etc)	
Responsible Officer's Name and Title (Person filling this form)	
Vessel/Company/Agent **Email** address	
Date of Submission (**Day/Month/Year**)	
Vessel Age (years)	
Vessel typical speed (laden speed in knots over the last four months)	
Vessel typical port residence time (hours or days)	_____hours **OR** _____days

Previous Dry Docking	
Since delivery, has the vessel been removed from water for maintenance?	Yes ☐ No ☐
If **YES**, enter the date and location of the <u>most recent</u> out-of-water maintenance:	Date (Day/Month/Year): City/Port: Country:
If **NO**, enter the delivery date and location where the vessel was built:	Delivery Date (Day/Month/Year): City/Port: Country:

Anti-Fouling Paint (A/F Paint)	
Were the vessel's **<u>submerged portions</u>** coated with an anti-fouling paint (includes foul-release paint) during the out-of-water period listed above?	Yes ☐ No ☐
If <u>not</u>, when was the last anti-fouling coating applied to the vessel?	Date of A/F paint application (**Day/Month/Year**):
For the most recent anti-fouling coating, what product (top coat A/F paint) was used for **hull surfaces**? Please list more than one if necessary and indicate what parts of the hull each product was used on?	For the **<u>hull bottom</u>** Manufacturer/Company: Product Name: For the **<u>hull sides</u>** Manufacturer/Company: Product Name:
Were additional anti-fouling coatings used for other submerged surfaces (e.g. rudder, thrusters, sea-chests)?	No ☐ Don't know ☐ Yes ☐ If yes, what products were used Manufacturer/Company: Product Name: Manufacturer/Company: Product Name:

Do you know when the next out-of-water maintenance is scheduled?	Yes ☐ Month & Year _____ Don't know ☐
Sea chests	
Were the sea-chests inspected and/or cleaned during the most recent out-of-water maintenance listed above? If there has been no out-of-water maintenance since delivery, select Not Applicable. **Check all that apply.**	Yes, sea chests were inspected ☐ Yes, sea chests were cleaned ☐ No, sea chests were **not** inspected or cleaned ☐ Not applicable ☐
Are **Marine Growth Protection Systems (MGPS)** installed in the sea-chests and/or sea strainers? (Note, these are not just cathodic protection against corrosion, but anti-fouling systems to prevent marine growth)	Yes ☐ If yes, MGPS installed in (please check one option) Sea chest ☐ Sea strainer ☐ Both ☐ If yes, provide the name of the Manufacturer_____ Model _____ No ☐
Are the MGPS operational?	Yes ☐ No ☐
In-water cleaning	
Has the vessel undergone in-water cleaning of the submerged portions of the vessel since the last out-of-water period?	Yes ☐ No ☐
If yes, when and where did the most recent in-water cleaning occur? Do not include out-of-water cleaning.	Date (Day/Month/Year): City/Port: Country: Vendor providing cleaning service:
If yes, what underwater portions of the vessel were cleaned in-water? **Check all that apply.**	Propeller ☐ Hull surfaces ☐ Intake Gratings ☐ Bilge keels ☐ Rudder ☐ Thrusters ☐ Unknown ☐
If yes, what method was used for in-water cleaning?	Divers ☐ Robotic ☐ Both ☐
If yes, were any steps taken to capture the removed material (debris) during cleaning?	Yes ☐ Which method?: Net ☐ Suction ☐ No ☐ Don't know ☐
Are other areas treated (rinsed, cleaned etc) to prevent or limit biofouling accumulation? Check all that apply.	Anchors ☐ Anchor chains ☐ Chain locker ☐ Tow lines ☐ Other ☐ Specify: _____
Recent Voyage History	
Since the hull was last cleaned, has the vessel visited the **Panama Canal**?	Yes ☐ How many times? _____ No ☐
Since the hull was last cleaned, has the vessel visited tropical ports (between 23.5°S and 23.5°N latitude) **outside** of Hawaii?	Yes, ☐ How many times? _____ No ☐
Since the hull was last cleaned, has the vessel visited	Yes ☐ How many times? _____

freshwater ports?	No ☐
List the **previous 10 ports** visited by this vessel prior to arrival in Hawaii. Start with the most recent port (your last port prior to Hawaii) and list them in the reverse order they were visited. Check this box if the vessel visits the same ports on a regular route - ■ - and only list the route once even if it is fewer than 10 ports.	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port & Country: Date (Day/Month/Year):
	Port: Date (Day/Month/Year):
Periods of Inactivity (Lay-Ups)	
Since the most recent hull cleaning (in- or out-of--water) or delivery, has the vessel spent **10 or more consecutive days** in any single location? Do not include time spent out-of-water or during in-water cleaning.	Yes ☐ No ☐
If **NO**, provide the date, location and duration of the longest amount of time spent in a single location:	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____hours **OR** ____days
If **YES**, list all of the occurrences whereby the vessel spent 10 or more consecutive <u>days</u> in any single location since the last hull cleaning. Begin with the most recent and list in reverse order. Include the instance of maximum duration at one location since the last hull cleaning.	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
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	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
	Date of arrival(D/M/Y): City/Port: Country: Duration of Stay: ____days
Biofouling Management Plan and Record Book	
Are you familiar with the International Maritime Organizations' *"2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species"*?	Yes ☐ No ☐ If yes, do you keep a copy of the IMO biofouling guidelines on board? Yes ☐ No ☐
Do you have a biofouling management plan and record book for your vessel?	Yes ☐ No ☐ If yes, when was this implemented? Month & Year _____

Appendix G: Definitions

Alien species – with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem (Executive Order 13112 of February 3, 1999)

Ballast water – any water and associated sediments used to manipulate the trim and stability of a vessel

Cryptogenic species – a species that is not clearly native or introduced to a region

Introduced species – a nonnative species which has intentionally or unintentionally escaped, been released, disseminated, or placed in an ecosystem as a result of human activity

Invasion – the incoming or spread of something usually hurtful

Invasive species – an introduced species, including animal and plant disease agents and pests, that adversely affects the habitat and bioregion it invades economically, environmentally, socially, culturally, and or ecologically

Native species – with respect to a particular organism, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem (Executive Order 12113 of February 3, 1999); *Synonyms:* indigenous

Non-native species – a species transported or established outside of its natural range whether intentionally or unintentionally; can become invasive. *Synonyms:* introduced, foreign, nonindigenous, exotic, alien

Nuisance species – native or nonnative species that threaten the diversity or abundance of native species, the ecological stability of infested areas, or commercial, agricultural, or recreational activities dependent on such areas

Appendix H: Acronyms

DOA	Guam Department of Agriculture
DAWR	DOA's Division of Aquatic and Wildlife Resources
GCQA	Guam Customs and Quarantine Authority
GISC	Guam Invasive Species Council
GISAC	Guam Invasive Species Advisory Committee
HAACP	Hazard Analysis and Critical Control Points
IMO	International Maritime Organization
MIS	Marine Invasive Species
NOAA	National Oceanographic and Atmospheric Administration
RBP	Regional Biosecurity Plan for Micronesia and Hawaii
SIP	Strategic Implementation Plan
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environmental Programme
USCG	United States Coast Guard
USFWS	Unites States Fish and Wildlife Service
UWW	Underwater World

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