

Actions Towards Reducing the High Impacts of Invasive Species on U.S. and U.S.-Affiliated Islands

Alternate title to consider: Island Resilience is American (US/National) Resilience: Addressing the High Impacts of Invasive Species on U.S. and U.S.-Affiliated Islands

Alternative more verbose: Addressing Invasive Species on U.S. and U.S.-Affiliated Islands: Recommendations for collaborative approaches that significantly advance climate resilience, national security, biodiversity protection, and cultural heritage.

Introduction

Islands Matter for U.S. Food Production, Economies, Biodiversity, Cultural Heritage, and National Security

Second only to the impacts of climate change, invasive species severely damage food security, economies, ecosystems, and cultures in islands worldwide (IPBES, 2023; Brewington et al., 2023; Micronesian Islands Forum, 2024). At the same time, there are synergistic effects between climate change and invasive species that both intensify the impacts of invasive species and reduce resilience to climate change (Invasive Species Advisory Committee, 2023; Brewington et al., 2024). Invasive species are responsible for almost 90% of recorded species extinctions on islands and billions of dollars in damages to agriculture, the environment, public health, and infrastructure (Bellard et al., 2016; IPBES, 2023). According to an analysis from 1989 to 2019, invasive species have cost islands that are part of, or affiliated with, the United States more than \$16 billion in cumulative damages, compared to \$468 billion in the nation (Brewington, unpublished data; Turbelin et al., 2023). When adjusted by land area and population, these costs to islands are more than seven times greater than those to the continent, and more than double the cost per capita. U.S. and U.S.-affiliated islands¹ are also home to many underserved and frontline communities that are uniquely vulnerable to the effects of climate change, which has grave implications for the spread, establishment, and management of invasive species (Lenzner et al., 2020; Kappes et al., 2021).

Islands are ecologically isolated by expanses of ocean, which reduce the numbers and types of plants and animals that are able to colonize their land and the marine environments without the influence of people. Indigenous human communities historically produced all the food and materials needed to sustain island populations, and the ingress of new people, plants, and animals was very low. However, many islands today have much higher populations of residents and visitors and import the vast majority of their food and materials, resulting in exponential increases in opportunities for new species to be transported to islands.

In the United States, one quarter of all species listed on the Endangered Species Act are from islands, with 646 species evaluated and listed in the State of Hawai'i, the Territories of Puerto Rico, Guam, American Sāmoa, and the U.S. Virgin Islands (USVI), and the Commonwealth of the Northern Mariana Islands (CNMI) (FWS, 2024). Invasive species are a primary contributor to these species' endangered status and have caused catastrophic losses to native and endemic species in islands, including to the point of species extinction and ecosystem collapse (Haines et al., in press). Many

¹ Throughout the paper, we use the term "U.S. and U.S.-affiliated islands" to collectively refer to all U.S. States and Territories that are entirely or partly comprised of oceanic islands in the Pacific and Atlantic Oceans, as well as the Freely Associated States of Palau, the Marshall Islands, and the Federated States of Micronesia.

established invaders must also be actively managed in perpetuity, merely one flight or shipment away from continental ports and other island jurisdictions (e.g., the brown tree snake on Guam [*Boiga irregularis*], the small Indian mongoose on Puerto Rico [*Herpestes javanicus*]). On some U.S. and U.S.-affiliated islands, such as Hawai'i and Puerto Rico, established or emerging invasive species pose serious risks to continental agricultural industries and human health (e.g. fruit flies, land snails, mosquitos, giant hornets, and cotton pests). Further, the devastating impacts of many invasive species, such as the destabilization of agricultural systems and economies, as well as the loss of ecosystem function and services, have implications for U.S. national security by heightening the risks of future pandemics, conflict, mass migration, political instability, loss of social cohesion, and economic harm (Schoonover et al., 2021). The U.S.-affiliated Pacific Island countries with their enormous Exclusive Economic Zones (EEZs)² are particularly critical with respect to global diplomacy and relations, as well as U.S. defense capabilities, but are also a highly vulnerable corridor for invasive species introductions to other islands and the continent.

Ultimately, islands are a bellwether for invasive species impacts, both Nationally and globally, and are indicative of what continental communities and ecosystems may experience in the future. Accordingly, science, systems, and solutions developed for islands may be widely applicable across the United States and facilitate more proactive response. Because islands are often gateways for emerging invasive species elsewhere (Seebens et al., 2018; U.S. Department of Agriculture, n.d.), the prevention and management of invasive species on islands should be integrated into policies and actions at all jurisdictional levels to prevent their establishment, address their impacts, and avoid further spread. This paper responds to a request by U.S. Federal agencies and departments for the Invasive Species Advisory Committee (ISAC) to address the unique challenges that invasive species bring to U.S. and U.S.-affiliated islands and offers recommendations for transforming how invasive species are considered within relevant planning, processes, policy, and management decisions for islands.

Geographic Scope and Structure of the Paper

The geographic scope of this paper includes all U.S. States and Territories that are entirely or partly comprised of oceanic islands in the Pacific and Atlantic Oceans, as well as the Freely Associated States of Palau, the Marshall Islands, and the Federated States of Micronesia (Figure 1). It is important to recognize that the Federal agencies' roles on different islands vary according to whether they are States, Territories, or in free association with the United States, and that the regulatory structure, authorities, and conditions differ. These islands reflect a diversity of political statuses, as well as diverse population characteristics, biological resources, historical contexts, and invasive species challenges that are also faced by U.S. continental islands with lower rates of endemism and higher similarity to their adjacent landmasses (e.g., the Channel Islands, the Florida Keys, the Aleutian and Bering Sea Islands). The State of Hawai'i, for example, has an almost equal number of non-native plant taxa as the entire continental United States combined, despite having an area that is less than 0.4% in size (Simpson and Eyler, 2018).

² An EEZ is an area of the ocean, generally extending 200 nautical miles (230 miles) beyond a nation's territorial sea, within which it has jurisdiction over both living and nonliving resources (United Nations General Assembly, 1982).

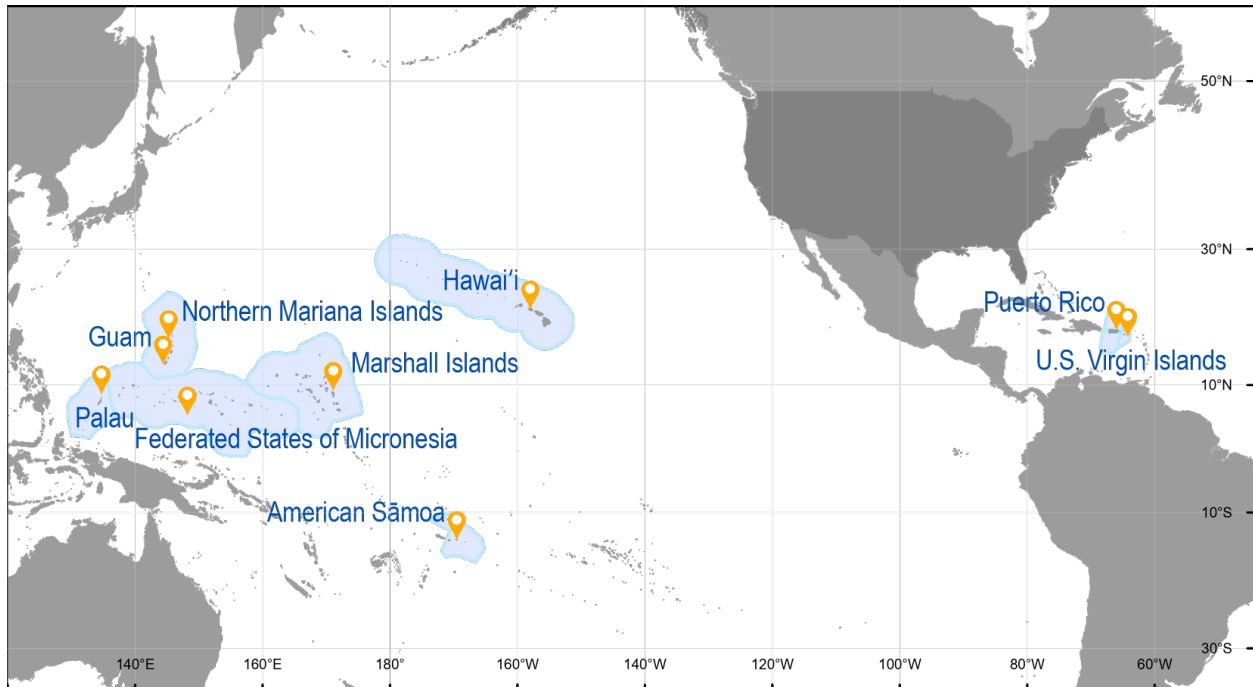


Figure 1. Map of the U.S. and U.S.-affiliated islands that comprise the geographic scope of this paper: the State of Hawai'i; the territories of Puerto Rico, Guam, American Sāmoa, and the USVI; the CNMI; and the Freely Associated States of Palau, the Marshall Islands, and the Federated States of Micronesia. The EEZs are shown in blue and make up 3.8 million square miles in area, slightly larger than the continental United States.

The paper is focused on four priority action areas that highlight top regulatory, policy, and implementation gaps around U.S. Federal engagement on islands: 1) terrestrial biosecurity³, 2) marine biosecurity, 3) control measures and long-term impact reduction, and 4) social and capacity conditions. **These are urgent priorities for islands, are feasible and actionable, and are invasive species issues of general importance to the entire United States.** The paper highlights top regulatory or policy gaps under each of the priority action areas in the context of specific cases. We conclude with a set of best practices and recommendations that can guide agencies in better meeting the needs of U.S. and U.S.-affiliated islands regarding invasive species.

Priority Action Areas

1. Terrestrial Biosecurity

In part because of their isolation and unique ecological characteristics, islands are highly susceptible to and disproportionately affected by invasive species (Vitousek et al., 1997; Bellard et al., 2016; Seebens et al., 2018). In addition, due to limited human and financial capital, many U.S. and U.S.-affiliated islands do not have sufficient capacity, funding, or facilities for rapidly responding to new or emerging biosecurity threats. This section discusses the need for improved prevention efforts and addressing gaps

³ In this paper, the term "biosecurity" encompasses pre-border, at-the-border, and post-border policies and practices intended to prevent the arrival and establishment of invasive species, including weeds, vertebrate and invertebrate pests, and diseases, and protect the environment and society from their potential negative effects. It is distinct from other concepts such as biosafety, laboratory biosecurity, or bioterrorism.

in jurisdictional coordination for more efficient and equitable terrestrial biosecurity on U.S. and U.S.-affiliated islands.

1.1 Prevention Efforts

Island communities increasingly require a constant inflow of goods (commodities, cargo, and their conveyances) to sustain residential populations, visitor volume, and economies. This pattern of extensive inbound trade is one of the primary pathways for the introduction of invasive species; therefore, it should be a top priority for implementing effective preventative policies and actions.

Inbound foreign commerce is regulated by federal agencies to reduce risks to U.S. agricultural and natural resources, with each Agency prioritizing its actions to reflect its mission, jurisdiction, and international obligations. In practice, this generally results in regulatory decisions that focus on protecting the resources that hold the greatest domestic economic importance (e.g., commodities like wheat, soy, beef, and tree species used for commercial timber). This framework for how risks are identified and deemed actionable does not reflect environmental or economic needs for U.S. and U.S.-affiliated islands, which decreases the effectiveness of their respective individual prevention and rapid response frameworks. Invasive species that threaten smaller scale tropical crops, traditional foods, and/or native non-commercial trees are currently underrepresented on federal lists. It is also important to note that organisms that are deemed incapable of establishing into continental climates, or are unlikely to affect high priority continental species or systems, may readily establish in tropical island ecosystems.

Individual governments of the United States, including Hawai'i, do not have the authority to regulate incoming foreign commerce; meanwhile, Federal agencies do not otherwise enforce State or Territory preventative policies and species exclusion lists unless complex agreements are established. There are, however, some existing programs and models that directly address the need for State and Territorial priorities to be formally reflected in Federal action at ports of entry:

- States and Territories can petition the U.S. Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS) to recognize State quarantines excluding individual plant pests at ports of entry through the Federally Recognized State Managed Phytosanitary (FRSMP) program.
- The "Hawai'i Ant Policy," enacted in 2002, directs that all non-established ant species are Federally actionable when they are intercepted in foreign cargo or conveyances bound for or in transit through Hawai'i (Hawaii Ant Group, 2007). It was based on a petition and a Pest Risk Analysis that considered the extreme impacts of ant introductions on islands.
- The territory of Guam has a unique Memorandum of Understanding (MOU) that authorizes Guam Customs and Quarantine and Guam Department of Agriculture-Biosecurity Division to search, identify, and determine the disposition of foreign cargo.

Federal, State, and Territorial agencies understand the importance of working together and sharing information to advance prevention at ports of entry, but significant barriers prevent effective collaborations and timely information sharing. Data collection detailing the importation of commodities, exporters, importers, and producers from foreign sources into the United States and analysis tools by Department of Homeland Security Customs and Border Protection (DHS-CBP) are proprietary and under security restrictions, and the information collected is held back due to the Uniform Trade Secrets Act as well as Homeland Security restrictions. Under MOUs and joint operations, information may be shared on a controlled and regular basis by CBP to its Federal agency partners such as USDA APHIS, Department of

Defense, NOAA, and DOI and the U.S. Fish and Wildlife Service (USFWS); however, these agencies do not have a similar controlled, timely, and regular conduit of sharing information with their State and Territorial government counterparts. Some Federal agencies disclose findings on a quarterly, monthly, or discretionary (at discretion/opinion of Federal entity) schedule to their State or Territorial counterparts. There is no single platform, user interface, nor other digital mechanism to share real-time information between Federal Agencies, or from Federal Agencies to States and Territories. This relates to the movement of cargo and conveyances and interception events for cargo and conveyances entering the U.S. bound for U.S.-affiliated islands. One notable exception to this situation is Guam, whose previously mentioned MOU between DHS-CBP and the territorial government of Guam could serve as a model for other Territories.

To address the broad lack of formal avenues for sharing prevention, interception, and situational awareness related data at ports of entry, some jurisdictions have Pest Risk Assessment Committees (actual committee names vary according to region or locality), where Federal and local regulatory agencies discuss pest interceptions and other issues that may be of interest. However, these committees, when they do exist, do not represent a consistent solution to information sharing challenges, as even within these committees, DHS-CBP and USDA-APHIS do not share interception information in a timely manner with State and Territorial governments, nor do all other relevant federal agencies (including DOD, NOAA, and USFWS) participate regularly.

Cargo and conveyances entering U.S. and U.S.-affiliated islands from domestic origins also present a high risk to islands, yet are not subject to the same regulatory, inspection, and risk mitigation practices as international trade. Agencies with prevention, inspection, and response authorities in Hawai'i and the U.S. Territories have taken on much of this responsibility and the Freely Associated States have this sovereign authority; however, all lack sufficient capacity to do it thoroughly. This greatly increases the opportunities for invasive species from the U.S. continent to be introduced into island communities.

These gaps in capacity are significantly amplified in the U.S. Territories such as the USVI. On average, the USVI welcomes over 2 million visitors per year, with more than half of those visitors coming from the U.S. continent (USVI Bureau of Economic Research, 2024). As both international and U.S. continental visitations increase to the Caribbean islands and USVI, the probability of invasive species introduction is increased, yet the islands are chronically under-resourced at both the local and Federal levels. In addition, some islands receive a number of non-commercial vessels that are significantly less regulated in terms of cargo and conveyances, a gap that must be addressed. State, Federal, and international permits may be required for the movement of plant materials listed under the Lacey Act, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), or USDA. Without the capacity to inspect small charters and vessels, however, the illegal transport of invasive species is unregulated and potentially increases the movement of invasive species between the USVI, Puerto Rico, and nearby Caribbean Islands (e.g. British Virgin Islands).

U.S. and U.S.-affiliated islands have added invasive species risk potential from two specific pathways: tourism and the U.S. military. These pathways represent high numbers per capita, are transient in nature, and associated individuals may not be aware of invasive species risks or impacts. In the Caribbean, people moving between islands have been ranked as a "high risk" for the spread of invasive species, transporting them on themselves, their clothing, or objects brought to an area (e.g., handicrafts made from plant parts), or by intentionally collecting and moving them to a different location (PERAL, 2009; USDA-APHIS, 2019). High visitor volume of people, goods, and transport also

increases the probability of invasive species introductions in unregulated, or prohibited yet infrequently inspected, foods or goods brought by passenger travel. Hawai'i recorded 9.2 million visitors in 2022 (DBEDT, 2022) and has the highest per-capita military and civilian defense personnel residents of any state (5.2%). That is nearly 10 times that of the state with the largest absolute number (California, 0.7%), while the territory of Guam is an even higher percentage of the island's total population (5.9%) (Defense Manpower Data Center Report, 2024). High military population flux due to changes of station and household moves creates added risk of accidental invasive species introductions. While notable improvements are being made on Department of Defense (DOD) operations, including the drafting of Base-specific biosecurity plans, prevention activities in these spaces are currently inconsistent. Biosecurity protocols (including for contractors, enlisted individuals, and dependents), and the mirroring of local invasive species laws for DOD properties developed at the Base level, along with more general requirements and educational materials for military and civilian households (and shipping companies) moving to islands should be drafted and implemented. To effectively reduce invasive species movement by passenger traffic, significant improvement in consistent and high-quality passenger education, including pre- and post- arrival signage in airports and cruise terminals, is needed for all civilian and military-related individuals entering U.S. and U.S. affiliated islands.

Failing to prevent invasive species establishment or address infestations on U.S. and U.S.-affiliated islands also sets the stage for secondary invasions of other islands or continental areas (e.g., Bertelsmeier and Keller, 2018). This invasion dynamic can be vividly seen in the coconut rhinoceros beetle (CRB; *Oryctes rhinoceros*), a well-known pest of coconut and oil palms. CRB was not found in the Hawaiian Islands until confirmed on the Island of O'ahu in 2013 and subsequently, from that single new point of infestation, the beetle spread to the neighboring islands of Kaua'i, Hawai'i, and Maui by 2023 (Paudel et al. 2021; Coconut Rhinoceros Beetle Response, 2024). It is also believed to have spread from O'ahu to the island of Rota in the CNMI in 2017 (Tay, unpublished data). Now only one domestic flight or ship away from the U.S. continent, CRB is an example of how failures of primary prevention, eradication, and active management within a single island can rapidly cascade into region-wide impacts. On the other hand, the brown tree snake program on Guam demonstrates how investments in strong interdiction efforts can prevent secondary invasions (Invasive Species Advisory Committee, 2023).

1.2 Prevention Authorities

Federal agencies have specific authorities that allow some Agencies to regulate certain invasive species and taxonomic groups. However, there are many examples of species and entire taxa that are not clearly under any agency's authority and thus represent prevention gaps, both on U.S. and U.S.-affiliated islands and the continent. USDA is the lead agency that regulates foreign imports of agricultural and forestry commodities that pose a risk of becoming invasive, or that may carry a pest that can cause significant harm to agriculture or natural resources. They accomplish this through a joint strategic plan with DHS-CBP, which conducts the majority of inspections and enforces USDA regulations. The Department of the Interior (DOI), through the Secretary of the Interior with the Secretary of the Treasury, has limited authority to regulate the importation and interstate movement of listed species of vertebrates, crustaceans, and mollusks as "injurious wildlife." Using the authority of the DOI via USFWS to list species has been arduous and economic considerations have, at times, outweighed the potential risk of some proposed listings. In addition, these combined Agency authorities do not extend to other taxa that fall outside the boundaries of the defined authorities listed above, including taxa such as spiders, soft corals, earthworms, and diseases specific to wildlife (Congressional Research Service, 2017).

USDA has a robust early detection and rapid response (EDRR) framework and designated funding for incursions of high-priority pests of agriculture and forestry that are not already established in the United States, but there is no parallel framework and funding for regionally important nor non-agricultural priority pests and weeds that fall outside of USDA's purview, such as soft coral. Ultimately, without a coordinated effort between the Federal agencies and U.S. and U.S.-affiliated islands that prioritizes a shared and comprehensive list of invasive species, produces an organized risk assessment of potential threats, creates a real-time reporting and notification system between the responsible agencies, and addresses the gaps in jurisdictional regulatory authority, islands are left vulnerable to additional invasive species introductions.

2. Marine Biosecurity

U.S. and U.S.-affiliated islands contain a combined 3.8 million square miles of EEZ area, which includes fisheries and strategic military waters, as well as 84% of the coral reefs in the United States. Healthy coral reefs provide goods and services including food, coastal protection, tourism, recreation, and biocultural uses valued at more than US\$3.24 billion per year to Hawai'i, American Sāmoa, Guam, the CNMI, Puerto Rico, and the USVI (Brander and Beukering, 2013). Threats to coral reefs include coral bleaching, ocean acidification, and pollution, and each of these threats can have synergistic effects when combined with invasive species (Environmental Protection Agency, 2024a). While mangrove forests and seagrass beds also form crucial marine natural infrastructure on U.S. and U.S.-affiliated islands, the following two examples from coral reefs illustrate the grave and urgent need for improved marine biosecurity.

2.1 Example: Stony Coral Tissue Loss Disease

In 2014 there were reports of an unknown coral disease killing multiple species of coral with a 90% mortality rate in some areas of the Caribbean (Aeby et al., 2019; Alvarez-Filip et al., 2022). Although the causal pathogen (or pathogens) of "stony coral tissue loss disease" (SCTLD) has yet to be isolated and identified, experts agree that SCTLD is the most lethal coral disease on record, spreading to 28 Caribbean countries and territories and affecting or killing more than 30 species of coral (NOAA, 2020). Affected reefs are irrevocably changed, shifting in some areas from coral-dominated to algal-dominated reefs (Alvarez-Filip et al., 2019; Alvarez-Filip et al., 2022), negatively impacting fish habitat, resource value, and ecosystem services (Swaminathan et al., 2024). SCTLD is highly contagious and can be transmitted short distances via direct contact between infected corals and through water circulation from nearby infected corals. The SCTLD pathogen can also persist in sediments and reemerge to infect newly settled corals (Studivan et al., 2022).

The disease has spread long distances and counter-current to Puerto Rico, USVI, and neighboring Caribbean countries in patterns that can only be explained by vessel traffic (Dahlgren et al., 2021; Rosenau et al., 2021). A study using simulated ballast water confirmed the potential for spread by vessels, and that UV ballast water treatment systems are only 50% effective at mitigating the SCTLD pathogen(s) in water (Studivan et al., 2022). Research into the possibility of spread via biofilm, the initial bacterial slime layer that can carry other diseases and supports larger biofouling communities, is underway (Evans et al., 2022). This deadly coral disease is currently only found in the Caribbean (AGRRA, 2024) but there are concerns for global spread given the evidence for vessels as a pathway.

2.2 Vessel Ballast Water and Biofouling

Vessels pose a substantial risk of transporting invasive species to islands in ballast tanks (Carlton, 1985; International Maritime Organization, 2024a) or as vessel biofouling growing attached to the hull or in protected niche areas (Davidson and Ruiz, 2014; International Maritime Organization, 2024b). A recent study projected that global maritime traffic will increase by as much as 1,209%, resulting in a 20-fold increase in global marine species invasion risk by 2050 (Sardain et al., 2019). A review of primary detections of non-native aquatic species in marine, estuarine, and freshwater systems globally from 1965 to 2015 found that vessel ballast water and biofouling were the pathways responsible for most species movements (Bailey et al., 2020).

In the 1990s, global understanding and concern about invasive aquatic species movements with vessel ballast water led to concerted effort by the International Maritime Organization and individual countries, including the United States, to mitigate the risks with binding discharge standards, management practices, and new technologies to treat ballast water (Carlton, 1996; International Maritime Organization, 2024a). There are no parallel binding international mechanisms or agreements that compel the use of and maximum discharge standards for marine pollution control devices to maintain hulls and niche areas at a low biofilm or biofouling risk. However, the passage of the Federal Vessel Incidental Discharge Act (VIDA) in 2018 created a subsection of the Clean Water Act that required the Environmental Protection Agency (EPA) to develop uniform national discharge standards (Environmental Protection Agency, 2024b) and the U.S. Coast Guard to develop within two years thereafter, a new regulatory framework for incidental discharges. When the Coast Guard regulations are finalized, States and Territories will be preempted from keeping or passing different or more stringent regulations, including any ballast management, hull cleanliness, or no-discharge regulations, even if the final regulations do not provide protection against invasive species such as SCTL. While VIDA includes three types of petition mechanisms for greater protections for individual states and territories to petition for a no-discharge zone, the only feasible mechanism is a petition for an emergency order requiring a “best management practice.” In addition, VIDA also specifies that EPA must submit the request to the U.S. Coast Guard and receive a written agreement before granting or denying the emergency request within 180 days of receiving the request, a process and timeline that is not consistent with the emergency that SCTL poses to U.S. and U.S.-affiliated islands in the Pacific (Not sure how to cite this Bill, Title IX, 2018).

VIDA includes a requirement for review and updating every five years, which is an opportunity for the United States to set high but achievable standards and a regulatory framework that compels technology development and use to proactively manage vessel biofilm and prevent biofouling. The framework should mirror the framework for testing, approving, and use of U.S. ballast water management systems.

2.3 Example: Soft Corals from Marine Aquarium Releases & “Outplanting”

A pathway analysis conducted by Bailey et al. (2020) showed that marine aquarium releases, mariculture escapes, and the purposeful “outplanting” of marine aquarium species as a cottage industry were a documented pathway for fewer introduction events, yet the magnitude of harm from such events was no less serious (AGRRA, 2024). Current retail sales of marine aquarium fish and invertebrates are valued at US\$2.15 billion for approximately 55 million fish and invertebrates, numbers that are projected to increase and overshadow major fisheries such as tuna (Watson et al., 2023). The United States receives the highest volume of foreign imports of marine aquarium species (Rhyne et al., 2017) which is largely unregulated internationally and nationally except for those species under CITES.

The invasion of a soft corals popular in the marine aquarium trade provides an example of the issue and need for addressing the marine aquarium pathway and infestations in marine environments. In the early 2000's an aquarium keeper illegally outplanted a popular marine aquarium soft coral known as pulse coral (*Unomia stolonifera*) onto a Venezuela reef for future harvest as a cottage industry (Ruiz Allais et al. 2014). The infestation has since spread across 60 miles of coastline at up to 80% coverage – killing hard corals, displacing other reef dwelling species, and preventing the local regeneration of reef and seagrass ecosystems. This same species, despite its status as a State of Hawai'i regulated species that is illegal to possess, was found across nearly 80 acres during initial delimiting surveys in 2023. This infestation is highly likely to have been the result of intentional aquarium dumping or releasing. In October 2023, a similar and popular marine aquarium species of soft coral called *Xenia umbellata* was discovered on shallow reefs off southwest Puerto Rico (Toledo-Rodriguez et al., 2024). The options for control of these infestations have been limited to smothering with tarps and manual removal. While effective, these control tools are arduous and temporary when infestations are large. Soft corals can easily fragment and drift to new areas and can quickly re-attach to new areas and form new infestations (Ruiz-Allais et al., 2021). Without control tools that can be applied quickly and at appropriate scales, eradication efforts in Puerto Rico and Hawai'i will fail.

2.4 Detection and Control Tools for use in the Marine Environment

Programs, capacity, and tools for early detection and rapid response to marine invasive species are critically lacking (Department of Interior, 2016; Environmental Protection Agency, 2024c). The U.S. Naval Research Laboratory conducts testing of ballast water management systems and the same approach should be applied for testing in-water cleaning systems that capture and remove pollutants, including invasive species prior to discharging effluent. Detection methods will also require investments and focus. Available techniques for environmental monitoring and detection methods include settling plates, benthic and plankton collection and identification, and visual or diver surveys, photo or video surveys where access is not restricted and water clarity allows. The two highest incidence pathways are associated with vessels and it is reasonable to expect that any regulations and mitigations applied will not be 100% effective. Therefore, monitoring and early detection programs such as eDNA in and around harbors should be a high priority.

Also urgently needed are tools and strategies for the eradication or control of various types of marine invasive species. Historically, a significant amount of the funding and capacity for developing control tools and methods for terrestrial invasive species control originated from agricultural and forestry sector investment, which then benefits natural resource protection. However, the same constituencies funding and supporting federal investment in research and development capacity are not present for marine invasive species. In addition, while the Clean Water Act is vital for many environmental reasons, it has also been a barrier to testing, registration, and use of control tools for marine environments. Federal agencies are best suited to test and register control tools for marine environments and the new DOI Early Detection and Rapid Response (EDRR) Framework and funding are a good start in developing a national EDRR framework that can include marine and other species. It is also important to recognize that no Federal agency currently has the authority to restrict the importation of certain types of marine taxa, including the soft coral species described in this paper, making EDRR, control tools, and outreach vitally important.

3. Control Measures and Long-term Impact Reduction

Many U.S. and U.S.-affiliated islands already bear a heavy burden of invasive species due to their biogeography, historical legacies, and global trade. These islands will experience additional native and endemic species losses, along with impacts to ecosystems, food production, economies, and human health if regulatory, policy, and implementation gaps are not addressed. In addition to the clear need for improved prevention capacity and authority described above, biologically based control technology and post-disturbance restoration efforts are urgently needed, as well as chemical control and direct restoration of affected species. These interventions can also reduce the ongoing and ever-growing ecological and economic damage caused by invasive species while building resilience to other risk factors, such as climate change.

3.1 Biologically based Control Technologies

Biologically based control technologies (including classical biological control, various genetic techniques like RNA interference and gene drives, bacterial mechanisms such as *Wolbachia*, sterile or incompatible insect techniques, and others) can greatly reduce the economic and environmental impacts of invasive species. These biological systems for long-term population or transmission (vectoring) control can be crucial tools for reducing harm from established invasive species. Strong scientific research programs and regulatory safeguards have been shown to support targeted approaches that are highly species specific and effective (Secretariat of the Convention on Biological Diversity, 2020). In some cases, biological controls (e.g., parasites, viruses, natural enemies that are commonly termed “classical biological control”) can also become self-sustaining, greatly reducing the environmental and financial costs over time when compared to intensive direct mechanical or chemical control.

On islands already experiencing a heavy burden from invasive species, the development of new or locally appropriate biologically based control technologies and the necessary infrastructure to support those technologies is particularly needed. This is further necessitated by the prohibitively high cost of mechanical or chemical controls that otherwise might be viable alternatives, as these usually have to be imported over long distances and island communities may lack the capacity or labeling to utilize them. A major impediment to the release of more controls in more island locations is the lack of specialized facilities and expertise needed to test the safety and efficacy of controls for new release locations, as well as associated need for locally specific facilities to breed, cultivate, or synthesize the controls prior to release. Proactive research towards preparing for new invasion scenarios and their respective biological tools, such as host-pest-control systems found in the continental United States but not yet found on islands, would also be well served by increased availability of specialized on-island infrastructure.

The rapid development of biologically based control techniques specific to island concerns is critically important for the protection of island ecosystems, agricultural commodities, and cultural resources. The success of this approach is well illustrated by the exploration for and testing of a classical biological control for the erythrina gall wasp (*Quadrastichus erythrinae*). This invasive species was detected in Hawai'i in 2005 and threatened the extinction of the native wiliwili tree (*Erythrina sandwicensis*). In response, *Eurytoma erythrinae*, a parasitoid wasp that preys upon the eggs of the erythrina gall wasp, was sourced from East Africa, brought into containment for testing, and approved in 2008 for release. Post-release evaluations indicate that biological control of erythrina gall wasp has been successful in reducing pest densities and tree mortality, thereby contributing to the long-term conservation of this endemic island species (Kaufman et al., 2020).

Sterile insect technique (SIT) is also a proven management strategy for some widespread, harmful pests. Hawai'i has limited existing insect rearing facilities and few options for sterile insect production. The only SIT production facility in the state is the California Department of Food and

Agriculture's Hawai'i Fruit Fly Rearing Facility on O'ahu; this produces Mediterranean fruit fly males (*Ceratitidis capitata*) that are sterilized by USDA-APHIS and shipped to California for the preventative release program in the Los Angeles Basin and potentially for emergency programs elsewhere in California. The USDA Agricultural Research Service maintains multiple insect colonies, including biological control agents for a few tropical pests, on Hawai'i Island, but these are not production facilities; the colonies are maintained at a scale suitable for research. The University of Hawai'i campuses at Hilo and Mānoa similarly have insect colonies for research. Finally, the Hawai'i Department of Agriculture maintains some insect rearing on O'ahu, but it is of a limited scale at this time and facilities need to be refurbished or upgraded. The limited capacity and facilities on the Hawaiian Islands mean that collaboration, support, and access can be inadequate to address existing or emerging invasive species control needs as they arise, and the lack of facilities on other U.S. and U.S.-affiliated Islands is even more severe. Additionally, while some facilities in the continental United States and other nations (e.g., Mexico, Guatemala, and Fiji) can be used to support island needs, these are important complements, not replacements, of the needed island-specific infrastructure and capacity.

Whether for threatened and endangered endemic species, to maintain the viability of agricultural production, or protect culturally or economically important species, additional facilities to support local research, development, and large-scale rearing and production are needed to achieve success with many forms of biologically-based control technologies (e.g., traditional biological control, sterile insect technique, genetic technologies) at the scale required for ecological and/or economic restoration. Where feasible, these should be sited on the islands. Cultivation of an experienced and strong local workforce through training and capacity building should also be prioritized, as the long-term viability of facilities depends on local knowledge, community support, and inter-agency cooperation.

3.2 Chemical Control Technologies

The use of pesticides and other chemical controls plays a significant role in invasive species management programs on islands. Chemical controls often provide the most effective mechanism for a swift and targeted response, especially related to early detections of newly established plants and invertebrates. In many situations, chemical controls are the most effective tools due to their rapid availability, scalable costs, and immediate impacts. A global review of invasive plant management in ecological restoration found over 42% of the restoration projects relied on herbicides to accomplish their goals including restoration efforts in vulnerable areas such as endangered species habitat (Weidlich et al., 2020).

Using pesticides in island ecological systems can present issues from both methodology and regulatory perspectives. In general, most pesticides are researched and labeled for the use in agricultural production; there is limited research and labeling available for products to be used in non-agricultural island ecosystems. Additionally, the labeled application methods typically don't consider island topography, climate, and vegetative cover. For all new application types – whether on U.S. and U.S.-affiliated islands or emerging needs in continental ecosystems – researching and labeling new products for use on emerging pests or weeds is costly and there is little incentive for a chemical company to register or assist with registering a product for small markets. This high barrier to entry can limit industry's interest in pursuing new products or expanding the use (labeling) of existing ones to new target species or conditions, all of which may be necessary to effectively address invasive species in the island context. Additionally, the EPA's re-registration process for established active ingredients can impede the continued use of existing necessary and effective pesticides. For example, during the re-registration of Rotenone, the primary piscicide used for invasive fish management, the EPA required

additional studies that would cost the registrant an estimated \$3 million, a cost not easily absorbed by the registrant for an active ingredient with a small market.

Future re-registrations of existing pesticides will also be impacted by the EPA's Endangered Species workplan for non-target species (Environmental Protection Agency, 2022). Historically, the EPA has been able to use a "cost-benefit" analysis when registering and re-registering active ingredients. Their new strategy will require a more thorough Section 7 consultation with the USFWS and the National Oceanic and Atmospheric Administration (NOAA) that will emphasize possible toxicity and non-target impacts to endangered species and the destruction of critical habitat, without an evaluation on how the active ingredients can protect vulnerable species from the negative effects of habitat degradation, predation, competition, and spread of disease caused by invasive species.

3.3 Post-Disturbance Restoration

When prevention efforts have failed and invasive species are widespread on islands, serious long-term investments and novel approaches may be needed to facilitate restoration and recovery after disturbances, and to prevent reinvasion (Reaser et al. 2007). Passive ecosystem restoration methods, such as the removal or exclusion of herbivores, may not be sufficient if the damage is severe (Chazdon et al., 2021; Luna-Mendoza et al., 2017) or a rapid response is needed (Zahawi et al., 2014). U.S. and U.S.-affiliated islands are also disproportionately impacted by climate change and are projected to experience increases in both the severity and frequency of extreme storms, droughts, wildfires, and other hazards (Frazier et al., 2023; Mendez-Lazaro et al., 2023). With these impacts, there is a greater likelihood of newly facilitated or transported invasions or the rapid establishment of invasive species after a disaster. Active and timely restoration planting and management, on the other hand, has improved recovery outcomes post-wildfire on islands like the Hawaiian archipelago, which is challenging due to the rapid spread of established invasive grasses (Trauernicht et al., 2018).

Many U.S. and U.S.-affiliated islands lack the capacity, infrastructure, and tools for rapid restoration efforts. Effective restoration efforts require access to facilities that are specific to the ecosystem, cultural, workforce, and/or research needs. Existing examples of this necessary infrastructure include reforestation stock nurseries like the Cambalache Tree Nursery in Puerto Rico, food and cultural plant public and private nurseries, and threatened animal breeding facilities like the Maui Bird Conservation Center. Tools such as seed collection and storage capacity, seedling production, workforce development, and optimized pre-and post-planting protocols are also required (for estimates of needs related to continental U.S. forest restoration, see Fargione et al., 2021). In some cases, the impacts of invasive species may also necessitate the development of resistant host populations, as is the case in Hawai'i with the endemic 'ōhi'a (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees and their respective invasive fungal pathogens, the "rapid 'ōhi'a death" fungus (*Ceratocystis lukuohia*) and koa fusarium fungus (*Fusarium oxysporum*). These endemic island species require long-term support for their respective research and development programs, specific to their endemic ranges, if they are to persist.

Because the tools and models developed for restoration at scale in the continental United States are often not feasible or applicable to smaller scale, specialized restoration on islands with unique ecological conditions (e.g., terrain, microclimates, soils), ranges of microclimates, species, and cultural values are needed. Increasing and developing capacity for post-disturbance restoration, particularly locally adapted strategies developed with climate-informed decision frameworks, such as "Resist-Adapt-Direct" (Lynch et al., 2021) and "Resistance, Resilience, Transition" (Nagel et al., 2017), can increase the resilience of native landscapes to invasive species, climate change, and future disasters.

Detailed maps, geospatial and climate data, and coordinated risk assessments on priority species and high-risk pathways tailored to islands are needed to ensure these restoration efforts are effectively planned, sited, and implemented for current and future conditions. For example, the National Land Cover Database offers nationwide land cover data for the continental United States, but only limited products are generated and updated for U.S. and U.S.-affiliated islands. These information sources are already provided in-kind to States, with up-to-date information at relevant scales, but this same information sources are often absent, outdated, not relevant to local conditions, or only partially available to U.S. and U.S.-affiliated Islands local government and research communities.

4. Island-Specific Social and Capacity Conditions

4.1. Social and Historical Concerns Surrounding Invasive Species

Communities on U.S. and U.S.-affiliated islands have a history of being used as laboratories and testing grounds, and have been systematically denied opportunities otherwise considered entitlements for the continental U.S. states. Historical introductions of invasive species for purposes like agriculture, erosion control, and biological control have demonstrably worsened invasive species burdens on nearly all U.S. and U.S.-affiliated islands. In many cases, this legacy has created distrust by island communities towards actions and proposals put forward by outside entities, including federal agencies. The lack of social license for many invasive species actions, whether or not they are supported by science or management best practices, can create negative impacts on islands. Advancing all elements of the Priority Action Areas in this paper requires serious investments in federal-to-local discourse, layperson and professional education, and collaborative approaches that respect island cultural and social concerns.

4.2. Supporting Sufficient Capacity on Islands

Supporting sufficient capacity for research, implementation, and long-term management is chronically challenging for all U.S. and U.S.-affiliated islands. Even when federal assistance or cooperative agreements are available to island communities, local agencies and entities may be unable to access this critical federal financial support to manage invasive species due to a lack of staff capacity for grants applications and reporting, limited English fluency, and/or an inability to procure the matching funds that may be required. There are a variety of programs that have tackled these issues successfully in other instances, including the NFWF and ATB Tribal Assistance program, California Technical Assistance Program, U.S. Forest Service Community Navigators, and others. These model programs should be emulated and/or extended to assist in more direct capacity support for federal grants and agreements applications, reporting, and related administrative processes to increase access of U.S. and U.S.-affiliated islands to federal funding sources that can add local capacity.

Recommendations

Based on the above findings and summaries of the unique challenges that invasive species bring to islands in the United States, the Invasive Species Advisory Committee offers the following recommendations.

Table 1. Reference table for identifying what recommendations correspond to the priority action areas in the paper.

Recommendation	Terrestrial	Marine Biosecurity	Long-term	Social & Capacity Conditions
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	Biosecurity		Mitigation	
1. Expand Federal Support of Island-based Invasive Species Coordination				
a) Support integrated Federal-State-local invasive species councils	X	X	X	
b) Identify and track island-based staff, funding, and capacity	X	X	X	
c) Implement regional compacts, strategies, and communiques	X	X	X	
d) Identify cross-agency collaborative opportunities for interdiction	X	X	X	
e) Expand notification networks and real-time communications	X	X	X	
f) Become an active member in regional Plant Protection Organizations	X		X	
g) Conduct island-specific risk assessments and filling resource and data gaps	X	X	X	X
h) Establish and maintain a non-competitive rapid response fund	X	X		
2. Enhance Programs, Partnerships, Tools, and Place-Based Efforts for Prevention				
a) Implement mandatory inspection of inbound/outbound goods	X	X		
b) Enhance policies, services, and actions	X	X		
c) Codify data access and communications plans	X	X		
d) Ensure the existence of Pest Risk/Port Security Committees	X			
e) Implement and enforce island-specific prevention priorities	X	X		
f) Implement marine mitigation grant program		X		
3. Meet Island-Specific Research and Infrastructure Needs				
a) Create and co-design new infrastructure and capacity			X	
4. Develop Control Tools for Impact Reduction				
a) Lead research and registration of control tools for marine invasive species		X		
b) Identify and address shared challenges and opportunities for biological control			X	
c) Assess the barriers and needs for using biological control			X	
d) Incorporate the benefits of pesticides for endangered species into Section 7 consultation process	X		X	X
5. Improve Education, Outreach, and Communication				
a) Improve and expand preventative programs	X	X		
b) Evaluate and update information provided to moving and shipping companies	X	X		
c) Improve awareness and outreach through “table-top” exercises	X	X		

6. Address Gaps in Federal Prevention and EDRR				
a) Work with the Aquatic Nuisance Species Task Force to clarify jurisdictional authorities	X	X		
b) Continue developing the National EDRR framework	X	X		
7. Respect and Support Island Community Needs				
a) Support social science for local awareness and to address cultural concerns			X	X
b) Improve access to federal programs and funding	X	X	X	X

1. Expand Federal Support of Island-based Invasive Species Coordination

Invasive species concerns, concepts, and actions must be fully integrated into efforts to address climate resilience, food security, economies, cultural concerns, and biodiversity, as well as international assistance and geopolitical strategies around U.S. and U.S.-affiliated islands. The existing strengths of Federal, State, and local partnerships should be formalized and amplified through agreements with a greater attention to island specific biology, culture, jurisdiction, capacity, and cross-coordinating bodies.

- a. Each island’s relevant agencies and departments should have a body coordinating invasive species efforts across its shared geographies and jurisdictions. In some cases, this body may be an island-specific invasive species council; in others, another mechanism or body may be appropriate. The creation and/or increased support of integrated councils (such as the Hawai’i Invasive Species Council) will better leverage existing expertise, funding, data management, and authorities, as well as elevate the profile of these councils' importance. **We recommend supporting and participating in integrated Federal-State-local councils or similar bodies that will be able to address invasive species concerns with more self determination and autonomy,** to ensure Federal investments are efficient and cost-effective for island-specific needs. **We recommend that Federal agencies formalize their participation in these coordinating bodies with MOUs (or similar) and seek opportunities to fund interventions that are identified.** The existing Regional Response Teams for environmental incident response that are co-chaired by the EPA and the U.S. Coast Guard could serve as further precedent for a national standard on coordination.
- b. The variable jurisdictional status of each island (State, Territory, Freely Associated State) creates inequities in capabilities and adds complexity to invasive species prevention and management and recovery. The Office of Insular Affairs Pacific Island regional biosecurity training program is a successful example of Federal assistance across complex jurisdictions to achieve coordination around specific invasive species. **Federal agencies should support invasive species councils and networks in identifying and forming professional networks linking staff, funding, and capacity in U.S. and U.S.-affiliated islands.** Such support would improve border protection, interagency communications, and information sharing across State, Territorial, regional, and Federal boundaries.
- c. **We recommend that Federal agencies actively engage with the relevant entities as laid out in existing international and regional compacts, strategies, and communiques to advance shared priorities.** These include Strategic Action Plans from the 2022 Pacific Ecological Security Conference, the Regional Biosecurity Plan for Micronesia and Hawai’i (RBP), and the Greater Caribbean Safeguarding Initiative (GCSI), which call on agencies (USDA, DOI, DOD, Department of Commerce, the United States Agency for International Development, and DHS) to support and

advance invasive species prevention and management efforts to protect U.S. and U.S.-affiliated islands (U.S. Department of the Navy, 2015; PESC, 2022a, 2022b, 2022c; Micronesian Islands Forum, 2023; Micronesian Islands Forum, 2024; U.S. Department of Agriculture, 2024).

- d. **Cross-agency collaborative opportunities should be identified, and appropriate mechanisms established (e.g., MOUs or similar agreements), to maximize efficiency, efficacy, and capacity.** On Guam, for example, this could include an interagency agreement enabling the cross-training of detector dogs for inspections covering their respective regulated taxa. The National Island Restoration MOU between 10 Federal and non-Federal signatories to promote an integrated and coordinated approach to protecting, managing, and restoring islands provides an example of such cooperation around shared objectives (U.S. Fish and Wildlife Service, 2024).
- e. Formally required, accurate, and functionally real-time data-sharing, reporting and notification systems between the responsible agencies representing Federal, State and Territorial governments should be built into communications plans at all levels of invasive species response. **We recommend the development and improvement of data sharing platforms, notification networks, and real-time mechanisms of information dissemination between agencies and governments, enabling more effective prevention, early detection, and rapid response to all invasive species taxa.** The current barriers to sharing information, including ineffective and irregular systems, could be improved if Federal, State, and Territorial governments collectively prioritized finding mutually workable solutions.
- f. Communication and cross-coordination through the two Regional Plant Protection Organizations that are relevant to the U.S. and U.S.-affiliated islands, the Caribbean Agricultural Health and Food Safety Agency (CAHFSA) and the Pacific Plant Protection Organization (PPPO) should be formalized through United States membership in these forums. The interests of Hawai'i, Florida, and the Gulf states would be best served not just by State and Territorial participation, but also Federal participation and membership. **We recommend that USDA acts to enable the United States to become an active nation and/or official member, in CAHFSA and PPPO.** The existing strengths of U.S. Federally led GCSI should be advanced via engagement within the CAHFSA, as a member organization of GCSI, and the needs within and between Caribbean islands and nations would be more thoroughly met with this multilevel approach.
- g. **We recommend empowering invasive species councils to co-create island specific risk assessments for pathways, invasive species of concern, or inbound commodities,** wherein both current situational analysis and future climate modeling is integrated. In addition, **we recommend a gap analysis of what resources are available for invasive species management for continental agencies and researchers are not being disseminated to island States and Territories**—and we recommend timely action to fill those resource gaps.
- h. Eradication or active management of invasive species on a single island should be considered prevention for other islands and the continental United States due to secondary infestations. **We recommend that a non-competitive rapid response fund for Federal and State entities to engage in island-based response be established and maintained.** For any invasive species established on an island where the tools and capacity for eradication or active management are feasible elsewhere, **we further recommend that a full effort at parallel eradication or parallel management on the affected island be supported by a strong Federal response.** This recommendation benefits both the islands themselves, and the most likely (due to climatic matching) continental regions to be affected by primary establishments on islands, such as California, the Gulf states, and the southeastern Atlantic states.

2. Enhance Programs, Partnerships, Tools, and Place-based Efforts for Prevention

Islands should be empowered to implement better protections from invasive species arriving via passenger travel, cargo and conveyances, military affiliated actions, and household moves, regardless of international or domestic points of origin. Prevention efforts should match the scope and scale for the unique island context: economies and systems that are often highly dependent on external inputs such as tourism, food imports, and military installations.

- a. The USDA-APHIS inspection program for pre-departure from Hawai'i to the U.S. continent is an example of the support that is needed by the Federal Government for goods and visitors arriving to the territories and Hawai'i. **We recommend mandatory inspection of inbound and outbound goods and traveler possessions through interagency collaboration, MOUs, facilities sharing, and other mechanisms.**
- b. On some U.S. and U.S.-affiliated islands where Federal agencies have jurisdiction over inbound and transshipped foreign goods, there are few or no locally based Federal agency staff to conduct inspections or take regulatory actions. **We recommend Federal agencies enhance policies, services, and actions for preventing the entry of new invasive species from foreign sources where they are the lead, or provide collaborative, meaningful support on islands that retain jurisdiction over foreign imports.**
- c. Existing port of entry information systems, such as Emergency Action Notifications generated by DHS-CBP, would be highly useful to island governments and agencies in real time. Information sharing among and between Federal inspection agencies and State and Territorial agency program managers and inspectors will improve the ability of all parties to respond to a pest of local concern as early and effectively as possible. **We recommend the creation of a codified data access system (protected informational portal), data use agreements, and communications plan for Federal Agencies to exchange information with State and Territory-based agencies.** These should be integrated into the National Early Detection and Rapid Response Information Network (SIREN) to respect the needs of legal issues (such as Protected Trade Information) while allowing a channel of clear and timely communication.
- d. Pest Risk Assessment Committees that incorporate state priorities into Federal agency priorities for mutual situational awareness should be created and supported by all relevant Federal agencies to represent each island port or grouping of ports. **We recommend these committees be expected to exist, have a standing Federal agency representative membership inclusive of DHS, DOD, NOAA, USDA, USFWS, and have a regular meeting schedule** as part of all major port of entry standard operating procedures.
- e. Few mechanisms exist to allow Federal port of entry agencies the ability to implement and enforce island-specific prevention priorities. **We recommend that the mechanisms that do exist (e.g., FRMMP) should be updated and streamlined to allow for greater responsiveness to island specific needs.** For those jurisdictional spaces where no such program exists, **the Federal entity of record should scope and implement new programs that would allow for the Federal recognition of state- and island- managed programs for that taxa or spatial environment.** Thirdly, **we recommend that the Hawai'i Ant Policy be used as an exemplar of a policy allowing Federal inspection agencies to stop foreign imports containing a broad suite of potentially harmful species.**
- f. **We recommend the funding of the invasive species marine mitigation grant program authorized by the Vessel Incidental Discharge Act, to assist all jurisdictions with inspection, monitoring, and enforcement programs.** There is a significant lack of Federal, State, and Territorial capacity available to co-enforce once VIDA is enacted.

3. Meet Island-Specific Needs for Research and Infrastructure

Well-funded research and the infrastructure to implement are core components of being able to reduce and manage invasive species impacts on islands. Aviaries, tree nurseries, and other long-term infrastructure supporting native species recovery and restoration are necessary to respond to species displacement and ecosystem-level alterations caused by invasive species. These facilities and skilled capacity are key ecosystem restoration necessities to protect island cultural and natural heritage. They should have ample and flexible use of space, be modernized to meet current best practices, and should not be centralized, as actual local conditions are part of the required natural infrastructure. In the case of laboratories and rearing facilities, they should be viewed as an interagency asset in disaster preparedness and funded in part by One Health rapid response related concepts, as local response to disease vectors is a key tenet of invasive species control on many islands.

- a. **We recommend new and upgraded infrastructure and long-term staff capacity be created and co-designed according to the needs of island communities and governments.** Facilities should take local ecological conditions into account, be integrated into the local communities to create long-lasting workforce opportunities, create ecological and disaster resilience redundancy for threatened and endangered species

4. Develop Control Tools for Reducing the Impacts of Established Invasive Species

Control tools for invasive species that are established on U.S. and U.S.-affiliated islands must support the needs of those islands. This may require research and development of new biologically based control mechanisms, new safety and efficacy testing for pesticides and herbicides, increased chemical control registration flexibility, or different implementation and regulatory mechanisms.

- a. While development, testing, and registration of terrestrial chemical and mechanical control tools are largely borne or subsidized by agriculture and forestry industries or public health agencies, there is little to no parallel research and development pathway for control tools for use in the marine environment. **We recommend Federal agencies take the lead in the research and registration of chemical, mechanical, and other control tools for the prevention (e.g., to proactively manage biofilm) and control of marine invasive species (e.g., soft corals).**
- b. Federal leadership, research, and infrastructure to expand the use of biological control technology is urgently needed to adequately address the impacts of invasive species specific to tropical ecosystems on U.S. and U.S.-affiliated islands. **We recommend that Federal agencies continue to identify and address shared challenges and opportunities for biological control,** including implementing the Pacific Biological Control Strategic Action Plan (PESC, 2022a) and taking parallel actions to address biological control needs for Puerto Rico and the USVI. Islands will also benefit from Federal engagement on the development and use of advanced biotechnologies (Executive Office of the President, 2022) and other novel control technologies aimed at reducing the impacts of widespread harmful invasive species, such as malaria-vectoring mosquitoes, CRB, ants, rodents, and reptiles. **Federal agencies should deepen their commitments to collaborating on the science and implementation of biological controls, including advanced biotechnologies,** addressing these problematic groups of invasive species.
- c. **We encourage the NISC to assess and address barriers and needs for increasing the use and availability of biological controls as tools, with particular attention to islands that are heavily invaded.** This may include a new biological control white paper (e.g., Invasive Species Advisory Committee, 2015, 2016).

- d. **We recommend that the EPA and USFWS incorporate the beneficial impacts of pesticides for protecting endangered species and associated habitats into the Section 7 consultation process for the registration and re-registration of pesticides.** Because the testing of pesticides for continental systems does not factor in local island conditions or varying jurisdictional authorities, **we recommend increases in local technical capacity to ensure sound science and regulatory expertise in these situations.** Unintended consequences could occur if there is not flexibility in procedures, especially in local use areas where invasive and endangered species intersect.

5. Improve Education, Outreach, and Communication

There is inconsistent usage of Federally backed programs such as “Don’t Pack a Pest” across all U.S. and U.S.-affiliated jurisdictions, both on islands as well as continental areas. Ongoing research and data would better inform what programs are being utilized or should be expanded, or to identify voluntary programs that are *not* being utilized and thus other investments would be more effective.

- a. **We recommend that preventative programs like “Don’t Pack a Pest” and “Hungry Pests” be institutionally supported, expanded, improved with the use of ongoing social science research, and made consistent** in terms of their presence at all island-relevant and continental ports of entry for air and sea travelers. **We also recommend expanded Federal focus on the “Don’t Let it Loose” message and programs, including greater attention to marine aquarium and pet trade audiences.**
- b. Household moves (civilian and military-associated relocations) present a high-risk pathway for the movement of invasive species, yet passenger-based education (see Recommendation 5a) does not suit this pathway’s needs. **We recommend a consistent outreach program covering all taxa associated with this pathway be created and directly integrated into the requirements and self-certifications processes for household moving and shipping companies, inclusive of all U.S. military contractors and Department of Defense documentation.** Current USDA and State-led programs oriented to household moves, such as those directed at specific continental pests (e.g. spongy moth, spotted lanternfly), should be evaluated and harmonized, or potentially consolidated, into this broader and more consistent approach.
- c. Invasive species management staff and scientists need ongoing professional training and support. **We recommend that Federal agencies improve invasive species awareness and outreach through U.S. and U.S.-affiliated Island community tailored “table-top” exercises with the relevant response groups** (e.g., regulatory authorities, non-profits, academic institutions, Federal agencies outside of their typical professional space).

6. Address Gaps in Federal Prevention Authorities and EDRR Programs

There are regulatory gaps where one jurisdiction ends and another begins. This problem is especially acute with regard to a lack of authority to regulate the importation of marine invertebrates (Jewell, 2020), as well as some non-agricultural terrestrial pests (such as invasive earthworms) and freshwater species.

- a. **We recommend that the NISC work with the Aquatic Nuisance Species Task Force to clarify jurisdictional authorities within the EDRR framework** and assess and clearly articulate regulatory authority gaps for prevention and to clearly articulate ways to fill gaps. Further, we encourage NISC and member agencies to identify species and pathways, and to apply restrictions on particularly high-risk species.

- b. **We recommend that NISC and member agencies continue with the development of the National EDRR Framework**, including securing permanent annual funding for EDRR to protect wildlife and habitats. **Further, the USFWS, DHS-CBP, DOD, and other relevant Federal agencies should support islands' law enforcement efforts by sharing information and working together to enforce local invasive species and wildlife offenses**, similar to the 2019 MOU signed by the Great Lakes St. Lawrence Governors & Premiers (Great Lakes St. Lawrence Governors & Premiers, 2019).

7. Respect and Support Island Community Needs

- a. **We recommend that agencies support social science research and direct outreach to increase local awareness of invasive species impacts, address cultural concerns about the removal or eradication of invasive species, and educate local communities on the efficacy and current safeguards on control mechanisms.** This will encourage co-creation, mutual understanding, and collaboration around management efforts and to ensure environmentally just outcomes pursuant to Executive Order 14096 (Executive Office of the President, 2023).
- b. **Federal agencies should enable local capacity by making available professional translation assistance, community embedded grants and agreements direct assistance programs, and match waivers** in jurisdictions where these barriers are an impediment to accessing federal programs and funding (Invasive Species Advisory Committee, 2023).

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