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PREVENT Invasives in the CARIBBEAN

POLICY BRIEF
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PREVENTION AND MANAGEMENT OF MARINE INVASIVE ALIEN SPECIES IN THE CARIBBEAN

Oceans cover more than 70% of the earth's surface, providing a pathway for marine species to disperse, either on their own or facilitated by human activity, to areas where they are non-indigenous. In their new environment, they can become invasive if conditions are favourable and in the absence of natural enemies such as predators, parasites or diseases. These marine Invasive Alien Species (IAS) can have devastating effects on ecosystems, fisheries and aquaculture, human health, tourism and coastal development.

The World Register of Introduced Marine Species estimates that globally there are 1,711 introduced marine species (Rius, et al., 2021); not all of which have become invasive in their new locations. Over 100 exotic marine species have already been introduced into the wider Caribbean region (Smith et al. 2021). It is likely that many of these species will, at some point, enter the subregion of Barbados and the Organization of Eastern Caribbean States (OECS) countries, if they are not already present. If any of these become invasive, the vast and open character of marine systems will make it more difficult to detect, investigate and manage these marine invasions. There will also be greater requirement for technical inputs (Geburzi and McCarthy, 2018).

Prevention is by far the cheapest and most effective form of invasive species management [Lockwood et al. (2013); Lodge et al. (2016)]. However, predicting which species will become invasive is difficult, especially since changing conditions, such as rising seawater temperatures caused by global warming, can cause species to proliferate in habitats that were once inhospitable. Risk assessments can identify non-native species that should be prioritized for monitoring and the implementation of control or eradication programmes.

The project 'Preventing Costs of Invasive Alien Species (IAS) in Barbados and the OECS Countries' commissioned a risk assessment for the marine environment of the project countries. The researchers, Nicola S. Smith, Amanda R. Gray and Isabelle M. Côté, paired stratified random sampling with a semi-quantitative approach. This allowed them to do relatively complex modelling despite the many challenges often faced by analysts in the region, including inadequate quantitative data on many species and transport vectors, restricted access to available data, limited technical expertise and the high cost of conducting risk assessments. The risk analysis consisted of:

1. A retrospective relative risk assessment of vectors in the wider Caribbean region; evaluating risks in relation to other vectors. The results of which were used to forecast vector-relative risks in the short to medium term in the subregion.
2. An assessment of the risks that non-indigenous species currently present in the region that pose a risk to Barbados and the OECS

The retrospective relative-risk analysis of vectors for the region confirmed that the aquarium trade, shipping (specifically, ballast water and biofouling), and fisheries (the capture of fish) and aquaculture (the farming of aquatic animals and plants) were the predominant vectors by which exotic species entered regional waters.

Aquarium releases introduced 41 species in the region, the majority of which were marine fishes associated with the international aquarium trade in Florida. Intentional and unintentional aquarium releases have been identified as a leading cause of freshwater fish invasions in the waters of the United States (Courtenay and Stauffer, 1990).

Unfortunately, the next highest source of introductions (31 species) could not be linked to any specific vector. Following this were biofouling and ballast water, ranked third and fourth, respectively, for the greatest number of species brought in by particular vectors.

Aquaculture was responsible for the introduction of 21 species, while fisheries introduced 15 species, although the latter may contain species that were added by aquaculture. Canals and natural dispersal accounted for nine species while oil rigs only brought four species to the region.

Main transport vectors of marine non-native species into the Caribbean

Aquarium releases
Saltwater species bought for home aquariums are sometimes released, deliberately or accidentally, into the marine environment where they can become invasive.

Ballast water
Seawater stored by large ships to provide stability and aid in manoeuvrability is often pumped into ballast tanks in one location and discharged, when it is no longer needed, at another site. The discharged ballast water carries biological material ranging from phytoplankton to small fish.

Biofouling
Organisms, such as barnacles and algae, can travel to other areas attached to the submerged part of the vessel's hull causing biological fouling or biofouling.

Fisheries
In the live seafood trade, non-native species caught in one location can sometimes be released into another, along with microorganisms, parasites and pests present in the holding waters or in materials used for packaging and transport.

Aquaculture
Non-native species in aquaculture operations may escape confinement into the ocean. Their larvae and non-indigenous live foods may also be released in discharges.

The assessment of the risks that non-indigenous species currently present in the region that pose a risk to Barbados and the OECS identified potential threats. The findings were similar to those of the retrospective regional analysis.

The researchers, headed by Dr. N. Smith, used an Aquatic Species Invasiveness Screening Kit AS-ISK v2.2 (Copp et al. 2016) to screen 32 species randomly-selected from a pool of over 100 non-native species currently present in the region but not yet identified in the subregion. The species were each assigned risk ratings for invasiveness, which was used to develop watch lists of non-native, marine taxa that may require special regulations and monitoring to prevent future invasions. The watch lists allow managers to efficiently use limited resources by prioritizing groups most likely to cause harm.

Three watch lists were developed for IAS likely to enter the subregion *(see Table 1)*:

1. **Red** (high likelihood of becoming invasive)
2. **Orange** (medium likelihood of becoming invasive)
3. **Green** (low likelihood of becoming invasive)

Table 1: The 32 non-native species likely to be introduced and established in Barbados and the OECS countries

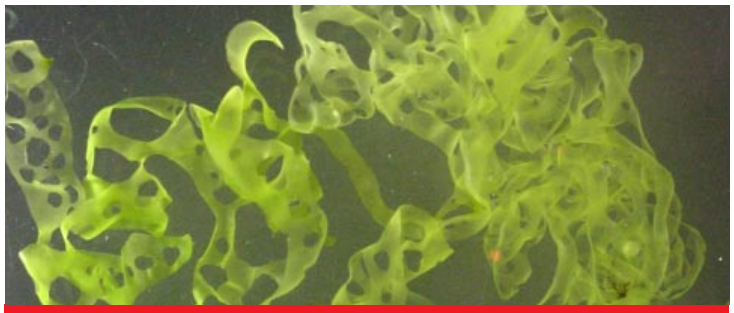
Red list	
Species	**Common name**
Chrysaora quinquecirrha	Atlantic sea nettle
Penaeus monodon	Giant tiger prawn
Scatophagus argus	Spotted scat
Ulva reticulata	Ribbon sea lettuce

Orange list	
Species	**Common name**
Acanthophora spicifera	Erect sea moss[1]
Acanthurus guttatus	Whitespotted surgeonfish
Acanthurus pyroferus	Chocolate surgeonfish
Arcuatula senhousia	Asian date mussel
Chaetodon lunula	Racoon butterflyfish
Crepidula fornicata	Slipper limpet
Dascyllus aruanus	Whitetail damselfish
Gemma gemma	Amethyst gem clam
Heteractis crispa	Leathery sea anemone
Heterodontus zebra	Zebra bullhead shark
Hypnea musciformis	Crozier weed
Litopenaeus vannamei	Whiteleg shrimp
Naso lituratus	Orangespine unicornfish
Ophiothela mirabilis	Brittle star
Perna perna	Brown mussel
Phyllorhiza punctata	Australian spotted jellyfish
Pomacanthus maculosus	Yellowbar angelfish
Pomacanthus semicirculatus	Semicircle angelfish
Protemblemaria punctata	Warthead blenny
Rhinecanthus aculeatus	Lagoon triggerfish
Scylla serrata	Mud crab
Tridemnum solidum	Overgrowing mat tunicate
Zebrasoma scopas	Twotone tange
Zebrasoma veliferum	Sailfin tang

Green list	
Species	**Common name**
Amphiprion ocellaris	Clown anemonefish
Aplysia cervina	Sea hare
Gelagna succincta	Lesser girgled triton
Watersipora subtorquata	Redrust bryozoan

The Giant tiger prawn (*Penaeus monodon*) (*Fabricius, 1798*) - *Photo courtesy CSIRO*

An aggressive predator in its native range (from 30°E to 155°E in longitude and from 35°N to 25°S in latitude), the giant tiger prawn has already been recorded in Mexico, Jamaica, and Trinidad and Tobago. They can grow to a larger size than native crustaceans, outcompeting them for food resources. They also carry several harmful pathogens that can be transmitted to wild crustacean populations.



The Ribbon sea lettuce, *Ulva reticulata* (Forsskål, 1775)
Photo courtesy Invasive Algae Database

Native to the Indo-west Pacific region, the ribbon sea lettuce has been reported in the Venezuelan waters of the Atlantic Ocean. It forms massive algal blooms or 'green tides' in high nutrient waters and the resulting build-up of organic matter and increased activity of microbes involved in the decomposition process can deplete oxygen in the water to dangerous levels. There are also negative consequences for tourism and water sports. At a sailing event for the 29th Olympic Games held in Qingdao, China in 2008 was jeopardized by a green tide that occurred shortly before the competition. More than 10,000 people and 1,400 boats were needed to clean up the massive algal bloom, which covered 13,000 km^2 of ocean (CABI, 2021).

[1] *This species might be native to some parts of the Caribbean, but it is not clear if its native range also includes the subregion. (Smith et al. 2021)*

The watch lists are meant to be dynamic and continuously updated as new data and technology become available. This requires an ongoing source of resources that is not always available, particularly in small island states.

The species in the lists have been introduced by one or more of the transport vectors identified in the retrospective analysis. The management of these vectors will help to delay, if not prevent, the arrival of these species into the subregion.

Transport vectors into the subregion

Three known transport vectors emerged from the research done by Dr. Smith and her team, as the most likely means of future introductions of non-native species into the subregion, as illustrated in Figure 1:

1. the aquarium trade,
2. shipping, and
3. fisheries and aquaculture.

The aquarium trade introduced the most species to the wider Caribbean region in the past and is expected to continue this trend in the future based on a previous risk assessment. The available data indicates that the threat from this vector stems almost exclusively from the aquarium trade in Florida, where fish are bought as pets and then accidentally or intentionally released. Stricter regulations and education programmes on invasive species in Florida will help to curtail the threat from this vector in the Caribbean and by extension, in Barbados and the OECS.

Ship hulls, ballast water and biofouling, pose the second greatest known risk to the subregion in the future, introducing Arthropoda, Mollusca, Echinodermata, Cnidaria, Rhodophyta and Bryozoa.

In recognition of this growing threat and in light of the global expansion of trade in goods and services, the International Maritime Organization adopted the Ballast Water Management Convention, which came into force in 2017 (IMO, 2021). The Convention is a treaty that serves to prevent the spread of non-indigenous, aquatic organisms and pathogens through a ship's ballast water. All countries in the subregion are signatories, except Dominica and St Vincent and the Grenadines.

Fisheries and **aquaculture** are both expected to introduce Mollusca while aquaculture is also expected to introduce Arthropoda.

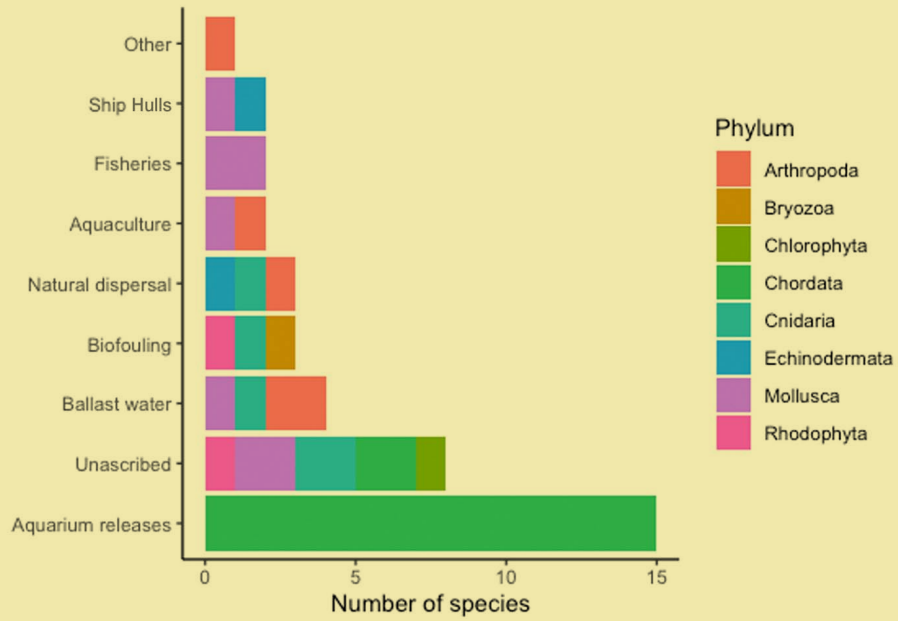


Figure 1: Distribution of number of marine species by phyla that may enter the subregion by various vectors.

The vectors identified in Figure 1 are subject to change over time, since it was not possible to predict those that currently do not exist, or to determine the impacts of recent regulations, policies and developments on existing vectors. Also, the findings are sensitive to biases in data availability.

What is Needed

The management of transport vectors will help to delay, if not prevent, the arrival of non-native species into the subregion. Early detection and rapid response (EDRR) aimed at removing new introductions before they can become established in a marine environment is difficult but not impossible. Since 1999, 14 specimens comprising 9 species have been removed from Florida's marine waters as part of an EDRR programme. Most reports of non-native marine fishes originated from the recreational diving community, emphasizing the importance of outreach and education (Schofield and Akins. 2019).

The management and prevention of IAS incursions requires ongoing surveillance activities by experienced marine biologists along with general awareness campaigns to engage the public to recognise and report local occurrences.

Aquarium

In Barbados alone, more than 5,000 kg of live fishes are imported each year, although this statistic includes both marine and freshwater species (https://www.tilasto.com/en/country/barbados/handel/ornamental-fish-live-import- weight). Two key management actions have been proposed to reduce the overall risk of invasion via the aquarium trade:

1. Implement programmes to increase awareness of invasive species among sellers, especially in managerial positions, and hobbyists.
2. Improve labelling practices to include accurate identification of marine species for sale, as well as information on life-history and behavioural traits (maximum size, growth rate, aggressiveness, etc.). This would inform consumers about the potential risks of their purchases and reduce the risk of release of unwanted pets into the wild.

Shipping

A key management strategy to minimise the risk of shipping as a vector of marine introductions is to treat ballast water. Dominica and St Vincent and the Grenadines, need to join the other Caribbean countries and become signatories of the Ballast Water Management Convention.

Aquaculture

Mitigating the risk of introductions from aquaculture is difficult because many species translocated through this vector arrive as cryptic hitchhikers on species targeted for farming. Management would involve:

1. Placement of aquaculture facilities away from any water bodies, protected areas or otherwise ecologically valuable or vulnerable areas.
2. Strict controls and monitoring of aquaculture transfers and practices. This should include the use of risk assessments prior to transfers as well as quarantines. In addition, farm infrastructure should be maintained and cleaned, and measures taken to limit the dispersal from detached farm materials, such as ropes and buoys.
3. Establish rearing facilities in-country. This will stop the need for imports and associated risks. Environment risk assessments that include the threat of releases of invasive species into the wild should be conducted as a precondition for aquaculture start-ups.
4. Limit imports to stock for breeding facilities.

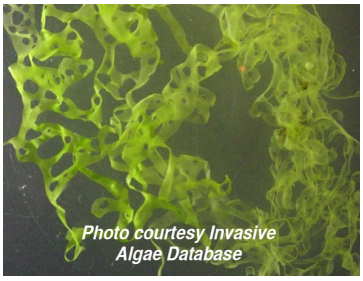


Photo courtesy Invasive Algae Database


Photo courtesy J. E. Randall, FishBase


Photo courtesy Ranjith Chemmad


Photo courtesy Jarek Tuszyński

POLICY BRIEF

No. 4 SEPT 2021

Key Messages

Prevention is the key to managing the incursion of invasive marine species. This requires the enactment and enforcement of laws and regulations aimed at preventing the introduction and spread of non-native invasive species, including regulations for vessel operations, mandatory labelling of species in the aquarium trade and even banning the importation of high-risk species.

The establishment of an early detection and rapid response programme will prompt pre-emptive action.

Awareness campaigns will engage the public to recognise and report local occurrences.

The risks associated with the aquarium trade is high and requires:

- Better laws and enforcement;
- Labelling practices that include accurate identification of marine species for sale, thorough information about the species, and a warning to consumers about the potential risks of releasing unwanted pets into the wild; and
- Increased prices for non-native species, supported by training and education programmes for both sellers and hobbyists to increase the awareness of invasiveness risks.

Dominica and St Vincent and the Grenadines, need to join the other countries of the Caribbean in signing onto the Ballast Water Management Convention of the International Maritime Organization.

Support for the development of technical expertise, the production of data and improved access to available data are necessary for the effective management of marine invasive alien species.

This Policy Brief is based on a Risk Assessment for the Marine Environment conducted by Nicola S. Smith, Amanda R. Gray and Isabelle M. Côté under the project Preventing Costs of Invasive Alien Species (IAS) in Barbados and the OECS Countries. The full report is available at: https://caribbeaninvasives.org

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This policy brief is the forth in a series providing information to decision makers on the actions needed to address the problem of invasive alien species. The briefs are produced by the Project, **'Preventing the Costs of IAS in Barbados and the OECS'**, which started in September 2018 and has now been extended to December 2022.

The Global Environment Facility (GEF) funded project is being implemented by the United Nations Environment Programme (UNEP) and executed by the Centre for Agriculture and Biosciences International (CABI) with support from the participating countries (Antigua and Barbuda, Barbados, Dominica, Grenada, St Kitts and Nevis, St Lucia, and St Vincent and The Grenadines).

The project results will support the conservation of biodiversity in the Caribbean region and so contribute to the global efforts to safeguard biodiversity.

For more information on the Project contact the Regional Project Coordinator,

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Project : Caribbean Invasives