GloFouling
PARTNERSHIPS

Guide to Developing National Status Assessments

of Biofouling Management to Minimize the Introduction of Invasive Aquatic Species

Guide
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GloFouling Partnerships:

Building Partnerships to Assist Developing Countries to Minimize the Impacts from Aquatic Biofouling (GloFouling Partnerships) is a collaboration between the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the International Maritime Organization (IMO). The project aims to develop tools and solutions to help developing countries to reduce the transfer of aquatic invasive species through the implementation of the IMO Guidelines for the control and management of ships' biofouling.
www.glofouling.imo.org

Funding Agency:

GEF - the Global Environment Facility - was established on the eve of the 1992 Rio Earth Summit to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided over USD 21.1 billion in grants and mobilized an additional USD 114 billion in co-financing for more than 5000 projects in 170 countries. Today, the GEF is an international partnership of 184 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues.
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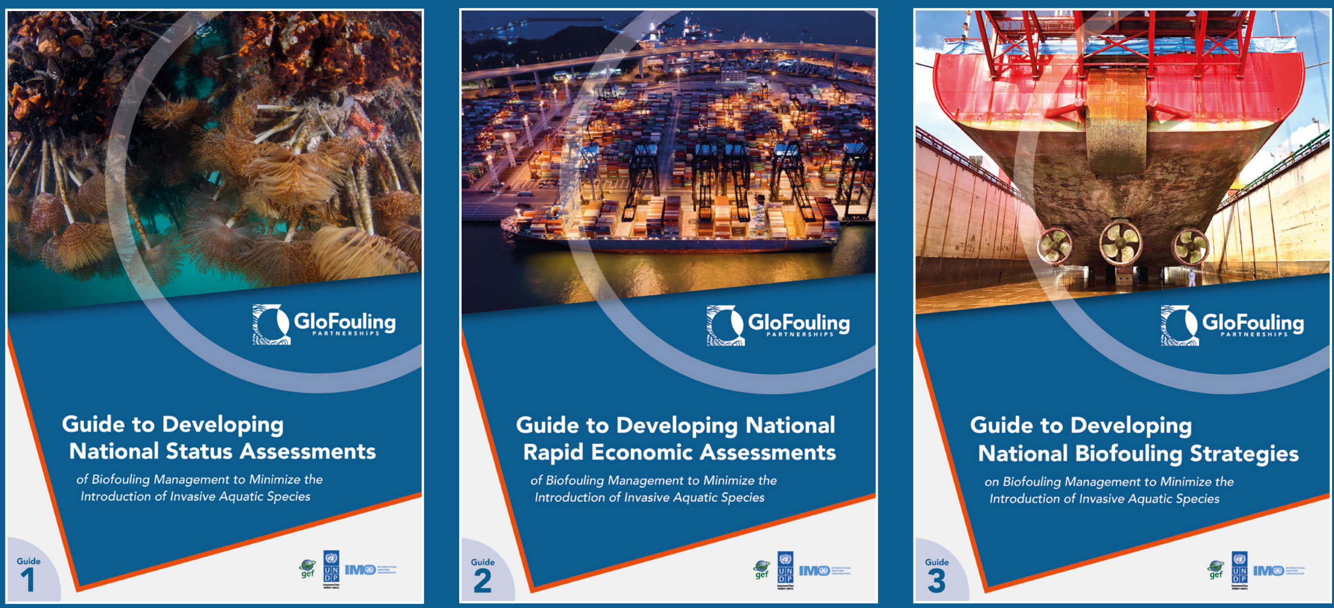
This Guide to Developing National Status Assessments of Biofouling Management to Minimize the Introduction of Invasive Aquatic Species (Guide 1) is the first out of a series of three guides, which were developed under the GEF-UNDP-IMO GloFouling Partnerships project. The three guides aim at assisting governments and interested stakeholders to minimize the risk of Invasive Aquatic Species (IAS) transferred through biofouling, by: conducting national status assessments to identify pathways, gaps and needs (Guide 1); assessing the economic costs and benefits of biofouling management to minimise the introduction of IAS (Guide 2); developing and adopting national biofouling strategies and action plans to minimize the introduction of IAS via biofouling (Guide 3).



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Acronyms and Abbreviations

AFS Convention	International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001
BFMP	Biofouling Management Plan
BFRB	Biofouling Record Book
CBD	Convention on Biological Diversity
GEF	Global Environment Facility
GFP	Building Partnerships to Assist Developing Countries to Minimize the Impacts from Aquatic Biofouling (GloFouling Partnerships) referred to as GEF-UNDP-IMO GloFouling Partnerships Project'
GISP	Global Invasive Species Program
IAS	Invasive Aquatic Species
IMO	International Maritime Organization
km	Kilometres
MoU	Memorandum of Understanding
MEPC	Marine Environment Protection Committee (IMO)
MW	Megawatt
PSC	Port State Control
TBT	Tributyltin
UNCLOS	1982 United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

Glossary of Terms

Anti-fouling system	A coating, paint, surface treatment, surface, or device that is used on a ship to control or prevent attachment of unwanted organisms.
Aquatic	Freshwater, brackish or marine.
Benthic	Anything associated with or occurring on the bottom of a body of water. The organisms that live on or in the bottom are known as "benthos".
Biofouling	The accumulation of aquatic organisms such as micro-organisms, plants, and animals on surfaces and structures immersed in or exposed to the aquatic environment. May include microfouling and macrofouling.
Biofouling Guidelines	*The Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species* (resolution MEPC.207(62)), 15 July 2011.
Crevice	A narrow opening.
Guide	Refers to this document throughout.
Guidance for Recreational Craft	*Guidance for Minimizing the Transfer of Invasive Aquatic Species as Biofouling (Hull Fouling) for Recreational Craft* (MEPC.1/Circ.792), 12 November 2012.
In-water cleaning	The physical removal of biofouling from a ship or other submerged structure while in the water.
Invasive aquatic species (IAS)	A non-indigenous species which may pose threats to human, animal and plant life, economic and cultural activities and the aquatic environment.
Macrofouling	Large, distinct multicellular organisms visible to the human eye such as barnacles, tubeworms, or fronds of algae.
Microfouling	Microscopic organisms including bacteria and diatoms and the slimy substances that they produce. Biofouling comprised of only microfouling is commonly referred to as a slime layer.
Niche areas	Areas on a ship that may be more susceptible to biofouling due to different hydrodynamic forces, susceptibility to coating system wear or damage, or being inadequately, or not, painted, e.g. sea chests, bow thrusters, propeller shafts, inlet gratings, dry-dock support strips, etc.
Non-indigenous species/organisms	Species introduced outside their natural past or present range, which might survive and subsequently reproduce.
Oil and gas	Naturally occurring hydrocarbon deposits including crude oil, natural gas and condensates (or a mixture of some/all of these) extracted in either gaseous or liquid form
Pelagic	Relating to the water column of the ocean
Ship	A vessel of any type whatsoever operating in the aquatic environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, fixed or floating platforms, floating storage units (FSUs) and floating production storage and off-loading units (FPSOs)
Spawning	To produce or deposit (eggs).
Transfer pathway	The process or mechanism by which an organism is moved from its native area into a new area
Vector	The specific mode via which a pathway transfers a non-indigenous species. In the case of shipping, both ballast water and biofouling are recognized vectors of non-indigenous species

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Preface

The introduction of invasive species to new environments has been identified as a major and growing threat to marine biodiversity.[1] The development of maritime activities, in particular, has provided new and enhanced pathways for the global spread of Invasive Aquatic Species (IAS). As a result, IAS have now been documented in the majority of the world's marine ecoregions.

The International Maritime Organization (IMO) has been at the forefront of international efforts to tackle IAS by taking the lead in addressing the transfer of non-indigenous organisms through shipping. This role was clearly recognized by the global community in 2012, which committed to support the IMO to adopt and implement appropriate measures to prevent the introduction of and manage the adverse environmental impacts of IAS.[2]

For many years, it was believed that ships' ballast water was primarily responsible for the transport and introduction of IAS. To this end, significant progress has been achieved by IMO and its partners towards managing this transfer pathway, through the *GEF-UNDP-IMO GloBallast Partnerships Project*[3] *and the entry into force on 8 September 2017 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments* (BWM Convention).

Despite these new measures, recent research suggests that the attachment of fouling organisms on the hulls of vessels and other mobile marine structures is also a potential vector for the transfer of IAS. For example, in Port Phillip Bay, Australia, up to 55% of non-indigenous marine species may have been introduced from ships' hulls compared with less than 30% from ballast water. Similarly, in New Zealand close to 60% of non-indigenous marine species are thought to have been introduced through fouling, compared with less than 25% through ballast water. Overall, it is estimated that up to 55% of recognized non-indigenous marine species detected around the world could have been introduced by biofouling on mobile structures.[4]

In response to global concerns about the risks associated with ship-borne biofouling, in 2011 the IMO, through its Marine Environmental Protection Committee (MEPC), adopted *The Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species* (Biofouling Guidelines). These were subsequently complemented by the IMO's *Guidance for Minimizing the Transfer of Invasive Aquatic Species as Biofouling (Hull Fouling) for Recreational Craft* (MEPC.1/Circ.79).

The Biofouling Guidelines are premised on the recognition that implementing practices to control and manage biofouling can greatly assist in reducing the risk of IAS transfer. They also acknowledge that such management practices can improve a ship's hydrodynamic performance and can therefore, be an effective tool in enhancing energy efficiency and reducing greenhouse gas emissions and air pollution from shipping.

The Biofouling Guidelines establish a globally consistent approach to the management of biofouling by listing management measures and operational practices that should be undertaken by ship operators to manage biofouling. Among other things, the Biofouling Guidelines present best practice for choosing, applying and maintaining anti-fouling systems for ships and include recommendations for regular in-water inspection, cleaning of problem areas, crew training and record keeping. Through the Biofouling Guidelines, IMO Member States are requested:

"to take urgent action in applying these Guidelines, including the dissemination thereof to the shipping industry and other interested parties, taking these Guidelines into account when adopting measures to minimize the risk of introducing invasive aquatic species via biofouling, and reporting to the MEPC on any experience gained in their implementation."

1 UNGA (2016).

2 Noted in paragraph 164 of The Future we Want: Outcome document of the United Nations Conference on Sustainable Development Rio de Janeiro, Brazil, 20–22 June 2012.

3 http://archive.iwlearn.net/globallast.imo.org/

4 Hewitt and Campbell (2010).

5 IMO resolution MEPC.207(62), 15 July 2011.

To support the implementation of the Biofouling Guidelines, the *GEF-UNDP-IMO GloFouling Partnerships Project (GFP)* was launched in December 2018, to build capacity in developing countries for implementing the IMO Biofouling Guidelines, as well as other relevant guidelines relating to biofouling management, to catalyse overall reductions in the transboundary introduction of biofouling-mediated IAS.

While the primary focus of the GFP is on ship-borne biofouling, through actions to implement the IMO's Biofouling Guidelines, the project also aims to catalyse the development of best practices and standards for improved biofouling management in other ocean industries, such as offshore oil and gas, aquaculture, and marine renewable energy.

The GFP is designed to assist the participating countries and regions to develop, implement and enforce a broad range of legal, policy and institutional reforms, in order to improve biofouling management practices and thereby mitigate the risk of transferring IAS. At the conclusion of the GFP it is expected that the participating countries will have reviewed their current legal, policy and institutional arrangements, defined biofouling management strategies and drafted appropriate national biofouling management measures at both national and regional scales.

To achieve this, the GFP is supporting the preparation of a number of national-level assessments to determine the current status of biofouling management in each country, as a first step in reviewing the legal, policy and institutional arrangements in each country, to provide sufficient information to establish a suitable national framework for managing biofouling. These rapid National Status Assessments are aimed at providing the appropriate understanding and knowledge baseline, from which to determine the essential needs for developing a future national biofouling strategy and related initiatives.

1 Purpose and Organisation of this Guidance Document

1.1 Purpose of a National Status Assessment on Biofouling Management

One of the key outputs for the countries participating in the GFP is the development of country-specific "National Biofouling Management Strategies and Action Plans", to define how countries establish and implement national biofouling management frameworks, consistent with the IMO's Biofouling Guidelines. The development of such strategies and action plans requires a detailed appreciation of the existing arrangements for addressing biofouling risks in each country.[6] Such a "National Status Assessment" is critical to determine whether the *status quo* is acceptable, appropriate and adequate to each country's needs, in the context of the costs and benefits of taking action to prevent future IAS introductions.

Recognizing that completing such an assessment may place significant demands on some countries, the GFP has developed this *Guide to Developing National Status Assessments of Biofouling Management to Minimize the Introduction of Invasive Aquatic Species* (hereafter referred to as "the Guide") to assist the beneficiary countries to undertake their National Status Assessments.

The Guide forms one of a series of three GFP outputs, which also include:

- *Guide to Developing National Rapid Economic Assessments of Biofouling Management to Minimize the Introduction of Invasive Aquatic Species;* and
- *Guide to Developing National Biofouling Strategies on Biofouling Management to Minimize the Introduction of Invasive Aquatic Species.*

The purpose of a National Status Assessment is to:

1) Identify and characterise the various biofouling transmission pathways that may lead to the introduction and secondary spread of IAS;
2) Identify the status of IAS in the country and how IAS might be dispersed from an initial point of entry point;
3) Identify and document the natural resources and activities of socio-economic importance that are vulnerable to the introduction of IAS;
4) Document how existing governance processes inform management practices, and the efficacy of those practices in relation to biofouling management;
5) Identify the broad measures employed in each country to manage the risks posed by IAS; and
6) Identify knowledge and capacity gaps, institutional needs and technical skills and tools required to ensure an adequate and effective national biofouling management framework.

Completed National Status Assessment will provide a country-specific measure of the gaps in knowledge and capacity to enable implementation of a comprehensive biofouling management framework, as outlined in this Guide. This in turn will help with devising a strategy to move towards the establishment of a comprehensive national biofouling management framework.

1.2 Organisation of this Guidance Document

To assist countries in the completion of their National Status Assessments, this Guide sets out a five-step assessment approach (Figure 1-1), with each of the substantive chapters of the Guide corresponding to each of the five steps.

Following this overview **(Chapter 1), Chapter 2** of this Guide presents a brief summary of the risks associated with biofouling including the various mechanisms by which IAS can be transported and spread, including:

- the different pathways that can introduce IAS;
- the potential for IAS to establish and spread; and
- the consequences that may result from the establishment of IAS, in terms of environmental and socio-economic impacts.

[6] Initially, the following 12 countries are participating in the project and will develop National Biofouling Status Assessments: Brazil, Ecuador, Indonesia, Fiji, Jordan, Madagascar, Mauritius, Mexico, Peru, Philippines, Sri Lanka, and Tonga.

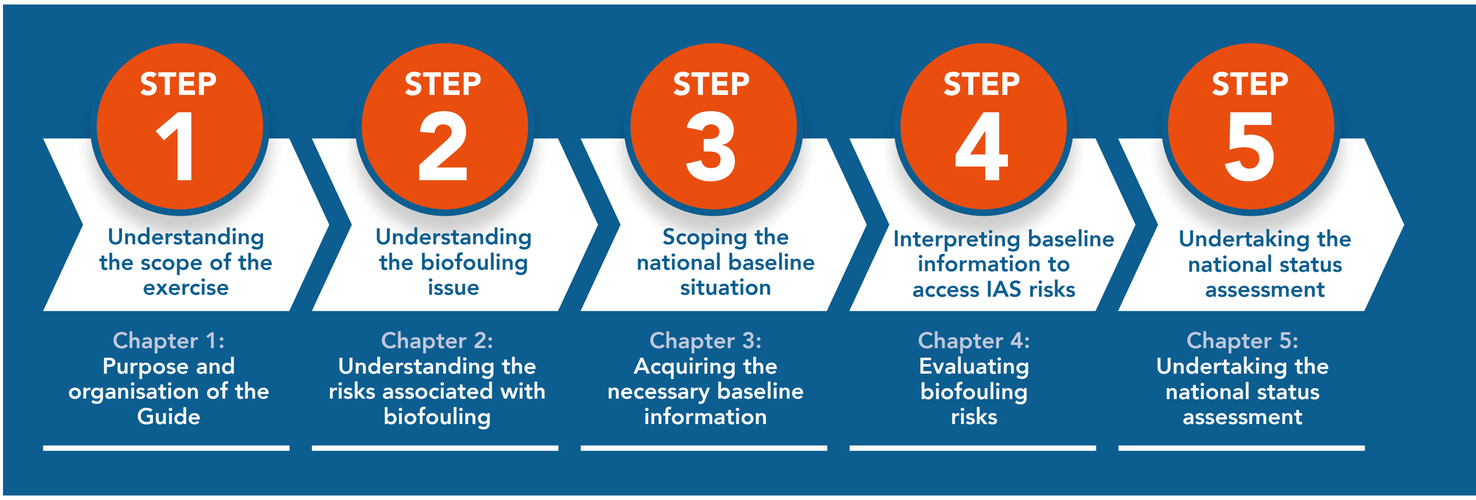


Figure 1-1: Steps to undertake the National Status Assessment on biofouling management

To support the preparation of National Status Assessments, **Chapter 3** provides an overview of the various types of baseline information needed to build a comprehensive national picture of the current status of biofouling management arrangements in each country. In this regard, **Chapter 3** provides a series of tables which includes illustrative lists of information sources that will be useful in completing the National Status Assessments.

To assist in interpreting this baseline information, **Chapter 4** provides a brief overview of how to interpret the information collected to develop a broad understanding of the risks associated with biofouling-related IAS in each country.

To conclude the Guide, **Chapter 5** presents a basic methodological approach that countries can follow in order to complete their own National Status Assessment.

To support this Guide, **Chapter 6** provides details of reference material and information sources that might be useful in preparing the baseline analysis. In addition, a number of **Annexes** are also provided, which include background information to assist users of this Guide with interpretation and application of some of the concepts used throughout the Guide.

Annex A provides the reader with a brief overview of the existing international policy arrangements that apply to IAS and the management of marine biofouling specifically, as well as highlighting examples of how some countries have approached the problem of implementing these arrangements in national and regional legal frameworks.

Annex B presents an overview of the various legal, policy and institutional elements that are considered necessary for countries to implement a comprehensive national biofouling management framework. This framework provides the basic framework against which the assessment team can assess the country's level of preparedness to manage biofouling as outlined in **Chapter 3**.

To assist with undertaking the National Status Assessment, **Annex C** of this Guide presents a standardized self-assessment template that will guide assessment teams through the process of identifying, collecting and analysing the relevant information needed to complete the National Status Assessment.

A critical output from the self-assessment process is the preparation of a *National Biofouling Status Report*. To assist in the preparation of this report, in conclusion, **Annex D** of this Guide presents a suggested Table of Contents and outline format for such a report.

2

Understanding the Risks Associated with Biofouling

From a biosecurity perspective, the risks associated with biofouling can be described in terms of the **likelihood** that an invasive organism is introduced and successfully colonises a new area, as a result of biofouling, and the **impacts** that such an organism may cause.

After briefly describing the biological processes that lead to the transfer of IAS through biofouling, this chapter therefore, provides an overview of the various pathways by which IAS can be transported, introduced and spread. It also provides an overview of the potential impacts that may occur once an IAS is established in a new region.

2.1 Invasive Aquatic Species (IAS)

Non-indigenous species (also known as non-native, exotic, or alien species), are species that have been introduced to areas beyond their natural geographic range. Non-indigenous species are not necessarily "invasive" but if the environmental conditions in the recipient area are suitable, a non-indigenous species may become established, reproduce and spread, with the potential to cause harm to the local environment, economic activities, and human health. In the context of marine and freshwater environments, such organisms are generally called Invasive Aquatic Species (IAS)[7]. It is important to note, however, that indigenous species may also become invasive in their native environment, usually as a result of altered environmental conditions. Similarly, not all non-indigenous species will become invasive.

The majority of marine IAS are shallow water benthic species from inshore waters that generally (but not always) flourish in conditions similar to their native environment. Successful IAS frequently share a set of life history and ecological traits that facilitate their establishment, such as broad environmental tolerance, rapid growth rates, the production of large numbers of offspring, the ability to reproduce both sexually and asexually, opportunism, early maturity and the ability of an organism to change in response to stimuli or inputs from the environment. When combined with a large number of organisms released from a specific source and the frequency by which organisms can be released, the chances of survival in a new environment can be considerably enhanced.

2.2 Biofouling as a Vector for the Introduction of IAS

Biofouling is the accumulation and growth of organisms on submerged natural and artificial surfaces. When a new surface – be it a ship's hull, a jetty, or a mariculture cage - is placed in the marine environment, it is rapidly colonized by a variety of marine species. Colonization starts as soon as an unprotected surface is immersed in water, first with a layer of bacteria and microalgae (microfouling). This microfouling creates a 'biofilm' that stimulates the settlement and attachment of progressively larger organisms, such as macroalgae and invertebrates (macrofouling), to establish on the surface during subsequent days and weeks. The process is illustrated in Figure 2-1 (see next page).

Most marine organisms, whether they are 'pelagic' (living in the water column, e.g. comb jellies and jellyfish), 'benthic' (associated with the seabed, e.g. sea-squirts and polychaete worms), mobile or immobile, have larvae that actively disperse in the water column. Any given volume of water is therefore, likely to contain potential fouling organisms seeking a suitable substrate on which to settle. The type of surface material (including chemical composition and orientation) has a strong influence on whether larvae settle - for example algae prefer surfaces exposed to light, whereas many invertebrate species prefer dark areas that are protected from hydrodynamic forces.

Well established biofouling communities may also include loosely attached and mobile organisms, such as mobile marine worms and small crustaceans, that live

[7] The term 'invasive marine species' (IMS) is also correctly used to define non-indigenous marine species that become invasive. However, the term IAS is used in the IMO Biofouling Guidelines and will, therefore, be used throughout this Guide.

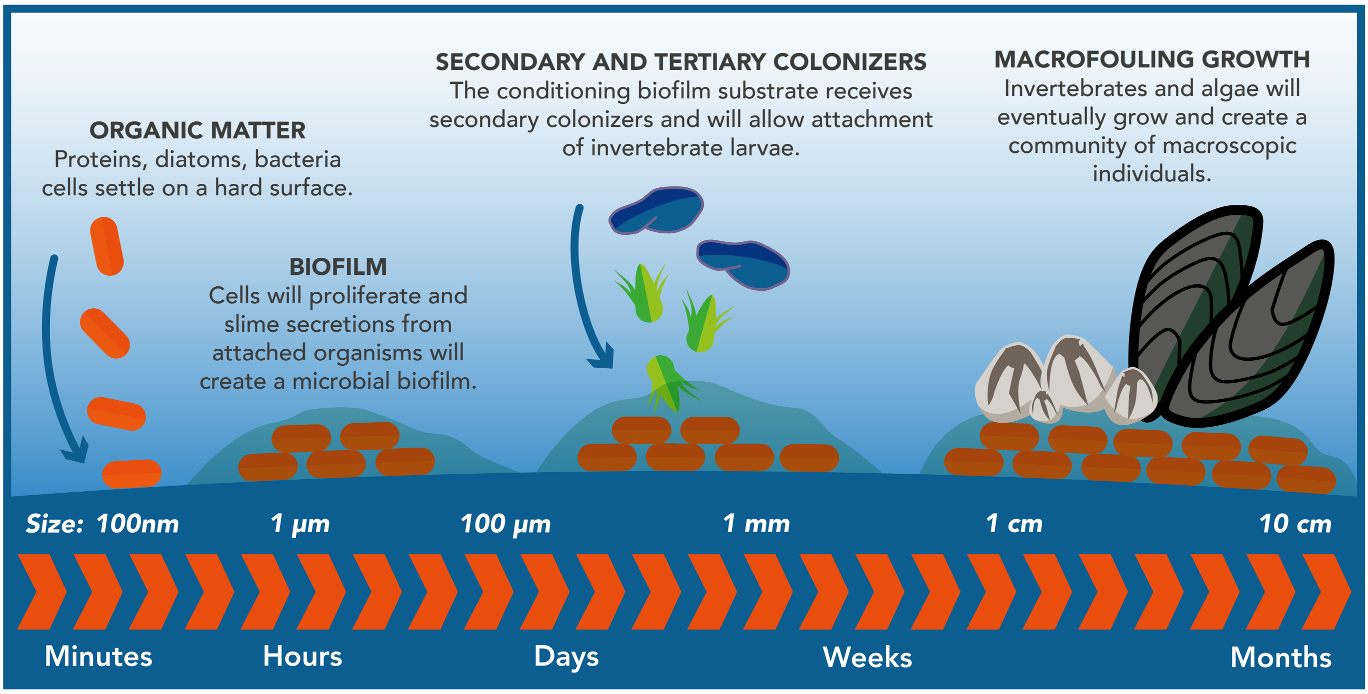


Figure 2-1: Biofouling growth process

in the matrix of other species, and in crevices or niche areas that are protected from hydrodynamic forces. Mobile fauna commonly associated with well-established biofouling communities can include snails, crabs, sea stars and sea urchins, and various species of fish (such as gobies and blennies).

Ships and structures carrying biofouling can transport these organisms over significant distances beyond the limits of their natural geographic range. However, biofouling, in and of itself, does not necessarily translate to the introduction of IAS into new environments, since this requires a number of conditions to be present, such as dislodgement or spawning, and the presence of appropriate environmental conditions for survival and reproduction. Only those organisms that survive the local conditions may become invasive in a recipient region. Many factors affect each step of the transfer (Figure 2-2, see next page), and it is thus very challenging to predict which non-indigenous marine species will become invasive.

Understanding the likelihood of IAS introduction, establishment and subsequent spread therefore, relies on information about:

1) the various pathways responsible for the initial introduction of a non-indigenous species to a new recipient region;
2) the presence of suitable substrates and environmental conditions that can facilitate the settlement of non-indigenous species once introduced to a new recipient region; and
3) the various pathways through which subsequent spreading of a non-indigenous species through a country's waters may occur.

These various elements are discussed in more detail below.

2.3 Biofouling Transfer Pathways

IAS may be introduced to new marine areas via a number of mechanisms, including intentional introduction (e.g. for fisheries or aquaculture purposes) and unintentional means, such as discharge of ships' ballast water, biofouling on ocean-going ships and other mobile structures, with aquaculture imports, aquarium escapees, marine debris, and through man-made canals (e.g. the Panama canal).

The transport of species from one location to another occurs through a number

Sequence of events for biofouling transfer on ships

	PROCESSES	CONTRIBUTING FACTORS
Donor Region	**1. Settlement & colonization on a ship or other mobile structure** • Biofilm development • Ecological succession	• Presence/absence of antifouling coating • Age of antifouling coating • Type of antifouling coating • Hull location • Residency period in donor port • Season of exposure in donor port
Transport	**2. Survival on underwater surface** • Individual survivorship & growth • Population & community growth	• Type of antifouling coating • Voyage speed • Voyage duration • Voyage route • Hull location
Recipient Region	**3. Reproduction & release** • Initial introduction to a new environment • Ship acts as a source of gamete, larval or adult propagules	• Residency period in recipient port • Hull location • Defouling activity e.g. in-water cleaning • Potential for reproduction
	4. Settlement on new substrate • Conditions support settlement • Available space facilitates settlement	• Availability and proximity of a suitable substrate • Biotic resistance • Environmental conditions, etc.
	5. Population established • Population establishment and viability • Interactions with native communities • "Infected" ports increase risk of secondary spread	• Environmental conditions • Availability of a suitable substrate • Potential for reproduction • Competition, predation etc.
	6. Spread & impacts • Population expands in size and spatial exten • Ecological, economic and human impacts • Longer-term persistent effects	• Potential for reproduction • Secondary pathways (natural and artificial) • Environmental conditions • Availability of a suitable substrate

Figure 2-2: The process of biofouling colonization, transfer and marine invasion

of recognized transfer "pathways". Pathways can generally be classified as either natural or man-made:

Natural pathways (i.e., those not aided by humans) include wind, currents (including marine debris), and other forms of natural dispersal that can bring species to a new habitat.

Man-made pathways (i.e. human-mediated) are those which are created or enhanced by human activity and may either be intentional (such as the introduction of a new species for aquaculture purposes) or unintentional (such as the transfer of an organism on a ship's hull).

Those man-made pathways that are responsible for the initial introduction of a non-indigenous fouling organism into a new recipient region, for example an international trading ship introducing a new organism from another country, are termed **"primary pathways".** Where a non-indigenous species has already been introduced to a recipient region, on the other hand, it may be distributed more widely by **"secondary pathways",** such as coastal vessels, recreational craft, or fishing vessels. The main transfer pathways are discussed below.

2.3.1 Shipping

Overview

For the purpose of this Guide, shipping refers to all vessel types - including commercial shipping, fishing vessel and recreational craft as well as activities associated with them (e.g. anti-fouling, hull cleaning, dry docking etc). As a transfer pathway, shipping can be responsible for the transport and introduction of potential IAS through ballast water, biofouling, or entangled, entrained or attached marine growth or sediments on immersible equipment.

Shipping is vital to the economies of coastal countries and small island developing states, with over 80% of imported and exported good being transported by sea. Exports of oil, ores, phosphates and other raw materials and bulk cargoes are often the primary source of revenue for developing countries and an important component of their economies. By 2050, maritime freight transport is projected to quadruple from 2010 levels, with the Asia–Pacific region expected to experience the highest growth. This projected growth is significant since, without effective management controls, the risk of IAS introduction is likely to increase in line with the increase in global shipping patterns.

The shipping sector can be classified according to whether a ship operates between countries (**"international"**) or within the territory of a single country (**"domestic"**) and whether a ship is considered to be trading, non-trading or recreational (see Table 2-1 below).

"Trading ships" are those which carry cargo for commercial purposes. According to the international Chamber of Shipping there are over 50,000 merchant ships trading internationally, transporting every kind of cargo.

Other ship types, including dredgers, fishing vessels, offshore industry support vessels, tugs and research ships are deemed to be **"non-trading".** In 2019 the global fleet of vessels over 24 metres in length (comprising commercial, naval and fishing vessels) was estimated at over 150,000 and growing annually.

"Recreational craft" can also spread IAS and are a major secondary transfer pathway for the wider distribution of IAS from a recipient port to other geographic regions. The current global size of the recreational vessel (<24m) fleet remains unknown, however in 2015 for Europe and the United States it was calculated to be almost 18 million.[8]

[8] Data extracted from USCG Boating, 2019 (https://www.uscgboating.org/library/accident-statistics/Recreational-Boating-Statistics-2019.pdf) and European Boating Industry, 2020 (https://www.europeanboatingindustry.eu/about-the-industry/facts-and-figures).

Table 2-1: Examples of different categories of ship

	Trading	Non-Trading	Recreational
International	• Liquid tankers • Bulk carriers • Refrigerated vessels • General cargo ships • Container ships • Car carriers • Roll-on/roll-off (Ro-Ro) ships	• Cruise ships • Passenger ferries • Dredgers • Barges • Ocean-going tugs • Research ships • Seismic survey ships • Drill ships • Fishing vessels • Offshore supply vessels • Anchor handling tugs • Naval/military vessels • Dive support vessels • Mobile offshore drilling rigs	• Super yachts • International cruising yachts
Domestic	• Liquid tankers • General cargo • Ro-Ro ships/ferries	• Passenger ferries • Tugs • Barges • Dredgers • Pilot vessels • Military and patrol vessels • Research vessels • Fishing vessels • Offshore supply vessels • Diving tenders	• Yachts and motor boats • Small recreational craft • Diving tenders

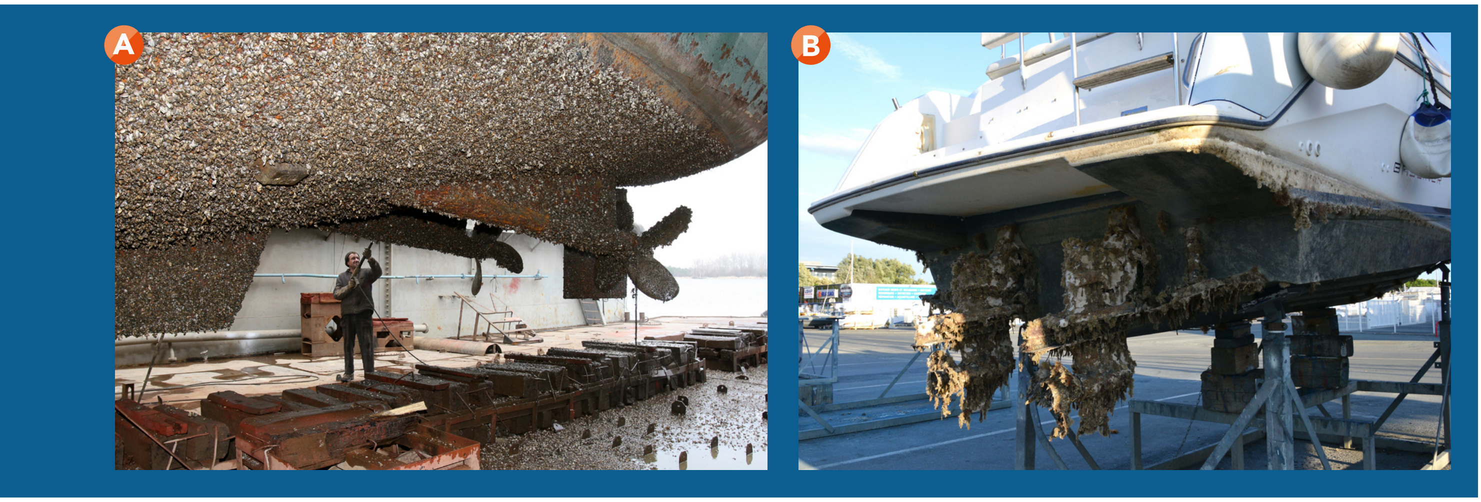


Figure 2-3: Examples of biofouling: (a) commercial vessel being hull cleaned in a floating dry dock showing hard fouling; (b) Recreational motor vessel being lifted for cleaning showing extensive macroalgae fouling

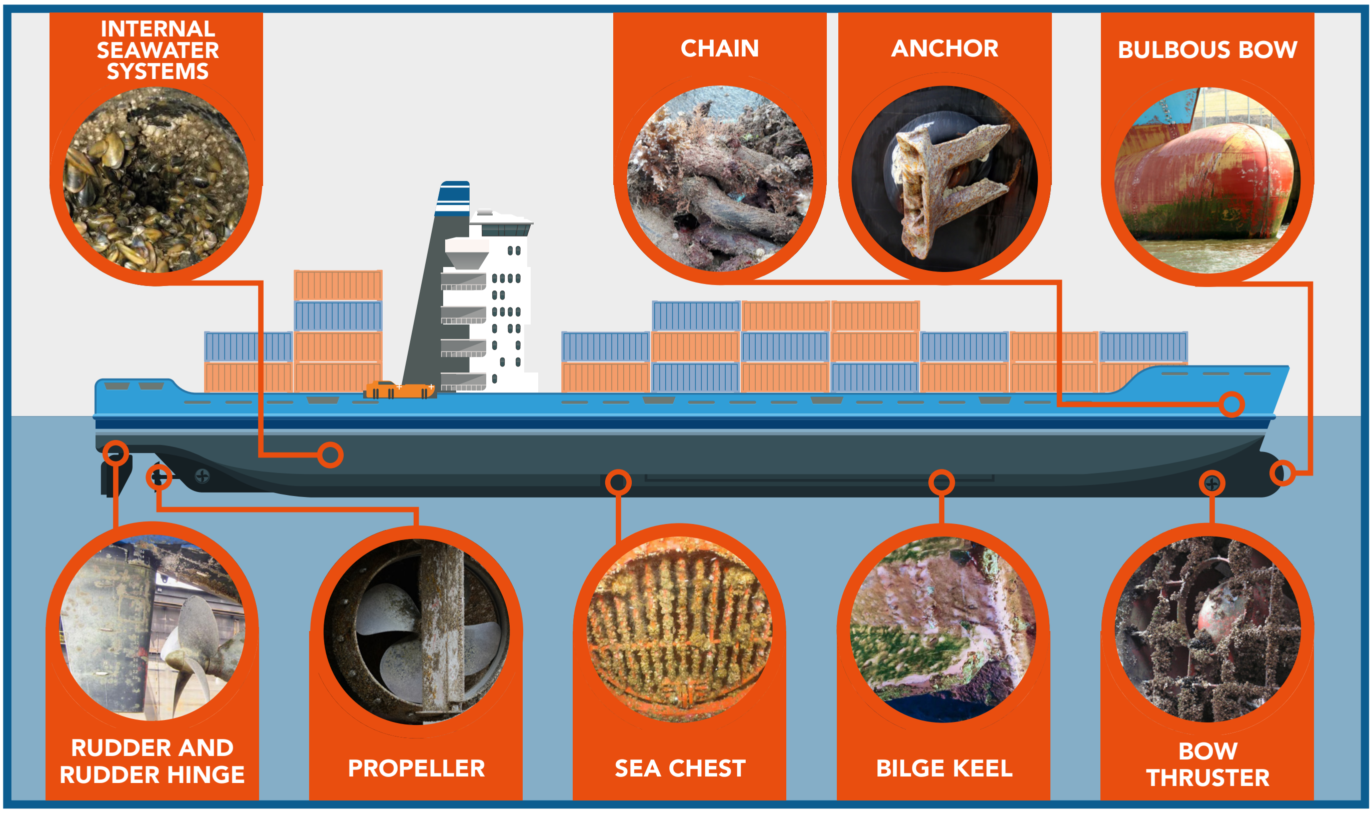
Although much of the focus to date has been on international ships, the assessment of domestic shipping activity is as important, if not more important, than international arrivals, since this pathway can spread and re-spread IAS into economically important or environmentally sensitive areas.

Biofouling Issues

Biofouling on ships is unavoidable, causing significant operational impacts, such as increased drag (leading to increased fuel consumption) and material damage to the structure of the ship. Biofouling on ships represents a significant vector for the transfer of IAS (Figure 2-3).

Examination of biofouling on active ships suggests that up to 25% of the underwater surface area of a ship, that is available to colonization by marine organisms, may be occupied by biofouling organisms, most of which can be found in hydrodynamically protected "niche" areas such as rudders, propellers and propeller shafts, sea chests and thruster tunnels (Figure 2-4). However, all surfaces, including those with anti-fouling coatings, can be colonised by biofouling organisms.

Figure 2-4: Common niche areas on a ship where biofouling can accumulate



Simplistically, the greatest biosecurity risk is presented by those vessels with the greatest levels of biofouling. This will largely be dictated by the operating characteristics of the vessel, as well as its maintenance history (see Table 2-2 below).

In addition to the transfer of biofouling into national waters or between domestic locations, the cleaning of ship hulls - either in water or in dry dock - has the potential to dislodge and introduce organisms to a new location or to inadvertently cause organisms to spawn (See Text Box on page 18). Further information relating to maintenance and cleaning facilities is provided in **ANNEX B to this Guide.**

Table 2-2: Risk indicators for biofouling on ships and structures

Risk Indicators	Factors that increase the risk of IAS transfer
Routeing	• Routing that includes ports with known IAS present could indicate a higher risk of transferring those species. • Routing that includes ports with similar environmental conditions to the recipient port could indicate a higher likelihood of settlement and survival.
Speed of travel	• Some anti-fouling coatings require movement for self-polishing to be effective. Hence, hips that travel at high speed (>10 knots) are less likely to accumulate biofouling than ships that travel at slow speed (e.g. barges). • Slow moving vessels (<10 knots) or vessels that remain in port for extended periods (cargo barges, floating dry docks, floating platforms etc.) are more likely to develop fouling than those that have short residence times and are transiting more often, although the frequency of international visits is typically less than for faster moving merchant vessels. • For modern merchant vessels that travel at relatively high speeds (such as cruise ships, container ships, tankers and bulk carriers), settlement only takes place in port regions when ship speeds are low or when ships are anchored or berthed.
Duration of stay	• The longer a ship spends in a particular port the more likely it will either attract or release IAS.
Time spent stationary	• Certain categories of ship are more likely to spend periods of time idle (e.g. barges, floating dry docks etc.). The diversity of a fouling community typically increases on surfaces which are subject to long periods of immobility. • Vessels idle for long periods can, therefore, accumulate a significant biomass, as may vessels that are either awaiting missions or de-commissioned and subsequently transported to breakers yards awaiting demolition. • Idle period of >30 days during a 12 month period presents a higher risk.
Time since last clean	• Cleaning of the hull and niche areas, whether in or out of the water, can have variable impacts on the amount of biofouling. A properly cleaned hull will result in lower biofouling risk. However, incorrect cleaning can result in damage to the anti-fouling coating, leading eventually to higher biofouling levels. • Evidence of an effective clean (or inspection that meets an equivalent standard) in the last 12 months contributes positively to the risk assessment.
Presence of a BFMP	• The presence of a Biofouling Management Plan (BFMP) provides a good indication of the management history of the ship with respect to biofouling. • A well maintained BFMP contributes positively to the risk assessment.
Quality and integrity of anti-fouling coating	• Biofouling accumulates faster on hulls where the anti-fouling has been damaged or poorly maintained. • Poorly maintained hulls and those where the anti-fouling coating has not been regularly renewed and cleaned, therefore, presents a higher risk of biofouling.

In-water cleaning as a management response for biofouling

Regular maintenance of a ship's hull and anti-fouling coating are essential to minimise the risk of IAS introduction. For large ships, on land cleaning is part of routine maintenance, usually coinciding with scheduled anti-fouling application and typically in a dry-dock or haul-out facility. Few countries, however, possess the facilities necessary to accommodate large ships.

In the absence of such facilities, many countries rely on in-water cleaning to remove accumulated biofouling. The frequency of in-water cleaning varies by ship, depending on operational characteristics, voyage routes etc.; some large commercial vessels may be cleaned once or twice between dry dock intervals, others may not be cleaned at all.

Regular proactive cleaning of a ship's hull can be undertaken to prevent biofouling. Such "hull grooming" tends to use gentle manual wiping of the hull to remove the biofilm layer. For heavier fouling, reactive hull cleaning is conducted by using divers or ROVs. Traditional cleaning methods allow all debris to fall to the ocean floor and organisms dislodged in this way have a high rate of survival.

In contrast, some recent in-water cleaning technologies capture the material, delivering solid debris and liquid process water to shore-based containment and filtration systems, whereby solids are removed for land-based disposal. Some systems also include sterilization of the effluent with ultraviolet radiation before release.

Where a heavily fouled ship arrives in a port, other than refusing entry, the only management option available to authorities may be in-water cleaning. The specific risks posed by in-water cleaning depends on a combination of risk factors (species composition, degree of fouling, and species condition), the risk of releasing organisms to the environment, and the risk posed by residual fouling remaining on the vessel after cleaning. Other debris and chemical contaminants can also be released as a result of in-water cleaning.

End of life decommissioning of ships may also result in long-periods of lay-up prior to transport to the final location where the vessel will be disposed. Similarly, the active "breaking" of obsolete ships, particularly when not undertaken at an industrial site, may result in the direct transfer of IAS.

Ship strandings and wrecks, or the intentional dumping of ship hulls to form artificial reefs, may also result in the introduction of biofouling organisms into new locations.

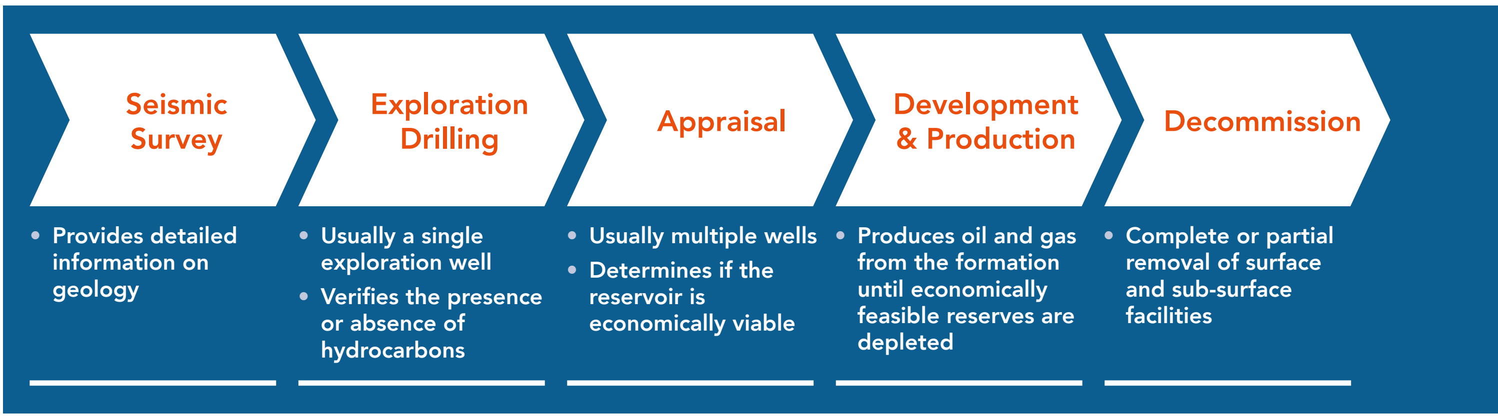
2.3.2 Offshore oil and gas structures

Overview

Around a third of the oil and gas extracted worldwide comes from offshore sources. With abundant oil and gas resources still present in deep water, offshore production rates continue to grow. Oil and gas production from offshore sources is expected to grow at about 3.5% per year up to 2030.

Offshore oil and gas production follow a defined lifecycle of discrete but inter-related stages (see Figure 2-5 below). This lifecycle may last for several decades with the stages until full production lasting several years alone.

Figure 2-5: Stages in the oil and gas exploration and production lifecycle



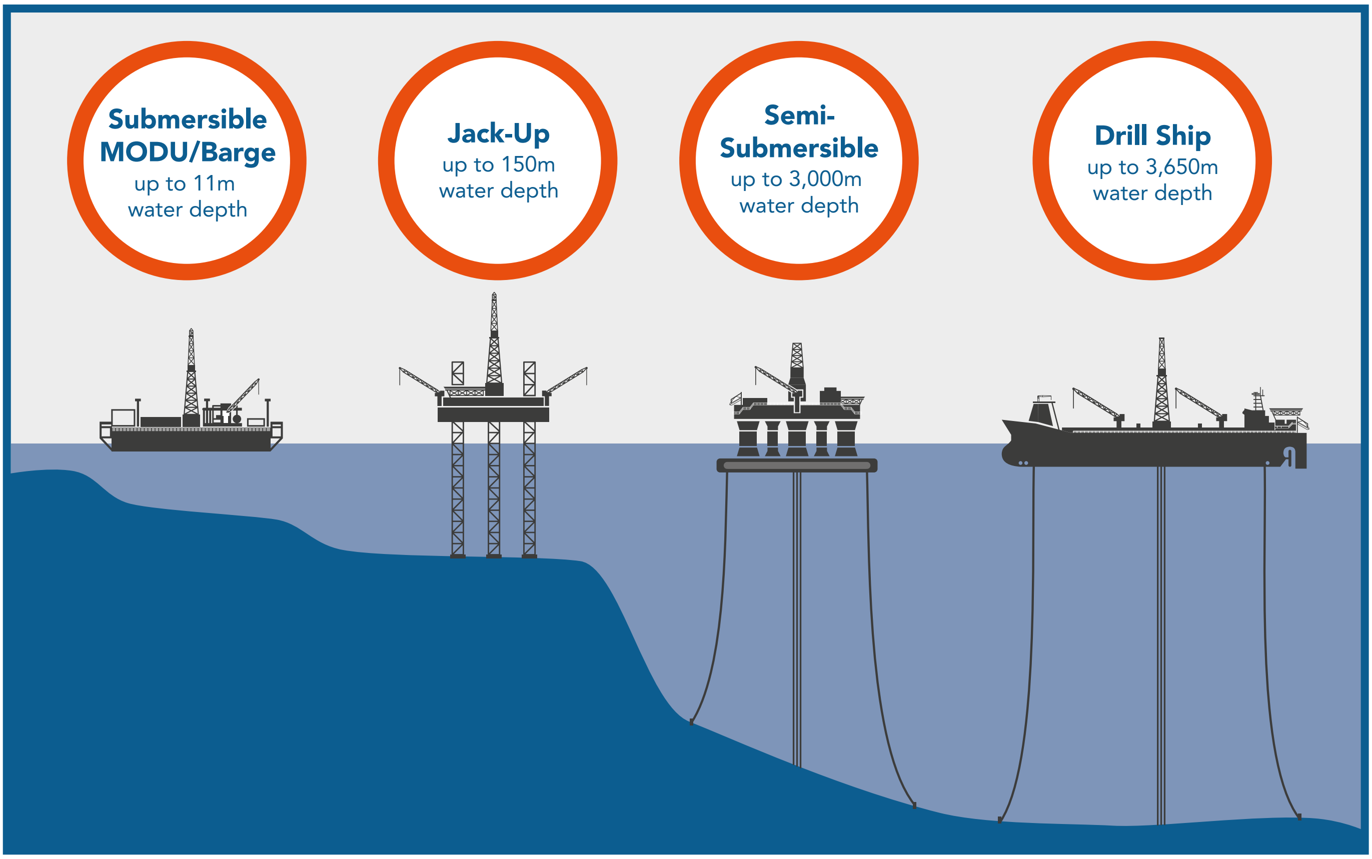


Figure 2-6: Types of offshore platforms

To support these various stages of the lifecycle a large variety of floating and fixed platforms have been developed for particular applications (see Figure 2-6 above):

Floating infrastructure Floating platforms, that include jackup rigs and semi-submersible platforms that are frequently moved between geographic areas for drilling operations, and floating [production], storage and offtake (FPSO/FSO) that are normally permanently moored to the seabed throughout the lifespan of production operations.

Fixed platforms These types of platforms stand on legs on the seafloor and include concrete and steel jackets for production facilities; tension leg platforms and spar buoys.

Biofouling Issues

The transmission of organisms has been documented on several occasions in the oil and gas industry.[9]

Platforms used in exploration and appraisal are mobile and regularly move between geographic regions, either under tow, or on heavy lift vessels (see Figure 2-7 on page 20). A number of studies have indicated that mobile oil platforms may harbour a greater species diversity than ships, including reproductive populations of large, mobile organisms. This is due to platforms operating in single location for extended periods of time which allows complex benthic assemblages to develop.

Due to their highly mobile nature, these structures may present a significant risk of transferring biofouling organisms to new locations. In some countries, drilling rigs may remain idle in sheltered coastal waters for long periods awaiting the next deployment increasing the risk of becoming more heavily fouled and potentially transferring IAS to coastal waters.

The end-of-life removal and relocation of decommissioned platforms creates further opportunities for the direct transfer of established species since, during

[9] See for example the IPIECA/OGP Report: Alien Invasive Species and the Oil and Gas Industry: Guidance for Prevention and Management. Available online at: https://www.ipieca.org/resources/good-practice/alien-invasive-species-and-the-oil-and-gas-industry/

[10] *Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone* (IMO Resolution A.672 (16)), 1989

Figure 2-7: Semi-submersible drilling rig being transported

decommissioning, platforms may be dismantled, removed, disposed of or be repurposed as artificial reefs.

The IMO has adopted specific guidelines and standards for the decommissioning of offshore platforms.[10] While these guidelines don't specifically address the issue of IAS, they do require coastal States to broadly assess the environmental impacts associated with the decision to remove or leave in situ any offshore platforms.

In addition, the oil and gas sector relies on a broad range of ships to support offshore activities. These include seismic survey ships, dive support vessels, heavy lift cranes and barges, and offshore supply vessels. The biofouling risks associated with these vessels are the same as any other type of ship and depends on the operating profile of the ship in question.

Grounding of the drilling rig *A Turtle* on the island of Tristan de Cunha

The semi-submersible drilling rig *A Turtle* was lost at sea while being towed from Brazil to Singapore, via South Africa. After having broken loose from its ocean tug during heavy weather in 2006. The rig was adrift until it ran aground in 15m depth at Trypot Bay, Tristan de Cunha.

Shortly after grounding, a survey detected 62 non-indigenous species on the rig and witnessed several mobile species "jumping off" the structure into adjacent shallow waters. Many of the biota died due to the cold sea water temperatures of Tristan compared to Brazil, however several species survived, including the brown mussel *(Perna perna)*, a known IAS elsewhere. Of the 62 species identified, 5 were deemed to pose a higher than negligible risk. The rig remained in place for eight months and was eventually scuttled into deep water.

The grounding resulted in the introduction of the South American Silver Bream *(Diplodus argenteus argenteus)* and may have led to additional invertebrate introductions, however to date limited monitoring has occurred due to funding constraints.

Source: Wanless et al (2009).

Biofouling communities on mobile offshore drilling rigs

In 1997, a survey was undertaken of a semi-submersible drilling rig, dry docked for hull cleaning in the port of Singapore. Prior to its arrival in Singapore, the rig had spent several years operating in various parts of the northern and south eastern Pacific. During much of this period the rig was stationary for extended periods.

The submerged surface area of the rig available for biofouling was estimated at 5,344 sq.m and was entirely covered with encrusting red algae and sessile or sedentary biofouling organisms such as sponges, corals and bivalves. In addition, the survey identified 25 species of decapod crustacea, of which 13 were considered to be non-native to Singapore. These included a species of mantis shrimp, the first to be recorded in a biofouling community, as well as several species of crab. Many of these individuals were highly mobile and bearing eggs. Moreover, two of the crab species were identified as having established populations in other parts of the world, thereby indicating the possibility for colonisation in Singapore.

Unlike sessile fouling species such as bivalve molluscs, introduction or inoculation of mobile species such as crabs and mantis shrimps into new environments does not require synchronous mass spawning triggered within a short time window, but simply the organisms detaching themselves from vessels transiting in ports.

Source: Yeoa et al (2010).

2.3.3 Deep seabed mining of mineral deposits

The deep sea contains many different resources available for extraction, including silver, gold, copper, manganese, cobalt, and zinc. These raw materials are found in various forms on the sea floor (Table 2-3). A number of countries (mainly in the south western Pacific Ocean) are exploring the potential to mine these resources within their EEZs. In areas beyond national jurisdiction, seabed mining is regulated by the International Seabed Authority (ISA). [11]

Recent technological advancements have given rise to the use of remotely operated vehicles (ROVs) to collect mineral samples from prospective mine sites. Using drills and other cutting tools, the ROVs obtain samples to be analysed for precious materials. Once a site has been located, a mining ship or station is set up to mine the area. The deposits are mined using either hydraulic pumps or bucket systems that take ore to the surface to be processed (Figure 2-8).

Biofouling Issues

Biofouling risks posed by surface Production Support Vessels are identical to other ships' biofouling. Surface biofouling organisms are highly unlikely to survive the physical and biological limitations at depth including pressure, temperature and low nutrient conditions. Previous studies have indicated that macrobenthic settlement occurs at thousands of meters deep, however species diversity is restricted and colonization rates are low.

The biofouling risks of mobile submersible equipment will therefore, most likely be restricted to the transfers of seabed equipment from one region to another without cleaning between regions.

[11] https://www.isa.org.jm/

Table 2-3: Deep sea minerals and related depths

Type of Deposit	Average Depth	Resources Found
Polymetallic nodules	4,000 – 6,000 m	• Nickel, copper, cobalt, and manganese
Manganese crusts	800 – 2,400 m	• Mainly cobalt, some vanadium, molybdenum and platinum
Sulfide deposits	1,400 – 3,700 m	• Copper, lead and zinc some gold and silver

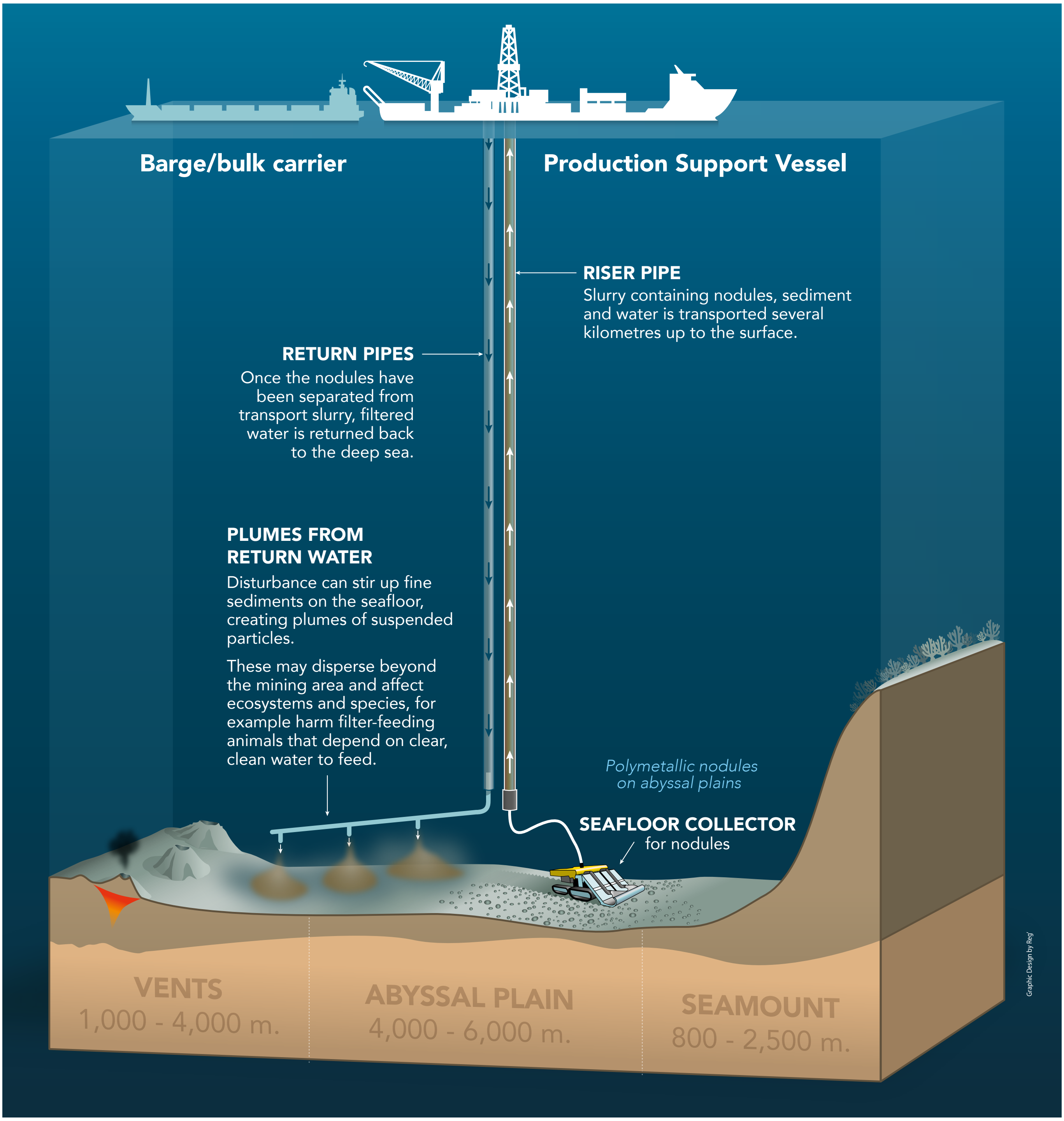


Figure 2-8: Deep sea mining activities and potential impacts[12]

2.3.4 Buoys, measuring devices and scientific instruments

Overview

The international marine and ocean science community has deployed and supports a global network of ocean observation platforms, including ships, buoys, subsurface floats, tide gauges and satellites, that collect real time data on the physical and biogeochemical profile of the ocean. The information collected is used for such diverse purposes as:

- measurements and forecasts of changes in water level;
- positions and strengths of currents;
- wave heights and forecasts of unusually high waves;
- sea ice measurements and coverage;
- rainfall measurements and forecasts (droughts and floods);
- maps and forecasts of harmful algal bloom;

[12] https://www.iucn.org/resources/issues-briefs/deep-sea-mining

- forecasts of likely weather- or climate-related disease; and
- assessments of the vulnerability of marine resources to anthropogenic changes.

Buoys, measuring devices and scientific instruments can be fixed in place, adrift, or autonomous; in nearshore or offshore waters; at the surface or at depth; and remain in place for short periods (days) to several years.

Biofouling Issues

Due to the frequency of placement and the broad proximity, fixed buoys, navigational markers, and sensor platforms can provide substantive hard benthic habitat in deep water or over soft sediment habitats, thereby potentially creating stepping stone corridors for dispersal.

Biofouling accumulation on marine scientific buoys and instruments creates hydrodynamic drag and additional weight, which can result in high mooring loads resulting in loss or submergence of floating structures. Additionally, biofouling can reduce sensor function and efficiency through obstruction and interference with water flow. Drifting buoys or autonomous vessels with lengthy deployments may lose buoyancy, navigational abilities, decrease ability to recharge due to solar panel occlusion, transmit due to interference with antennae, and reduce sensor efficiency.

Figure 2-9: Floating meteorological monitoring buoy

2.3.5 Strategies to deal with different transfer pathways

The different pathway types discussed above (particularly ships and offshore platforms) present different risk profiles and therefore, demand management strategies that are specific to those pathways. While specific international controls and guidance for anti-fouling and biofouling management do exist for international ships, similar measures do not exist for the other vectors that may be of concern. In the absence of such standards some countries have sought to adapt existing, or develop new, guidance for other maritime sectors.

Working collaboratively with industry operators has proved beneficial in some countries where specific companies and industry sectors have sought to initiative industry-led biofouling management programmes.

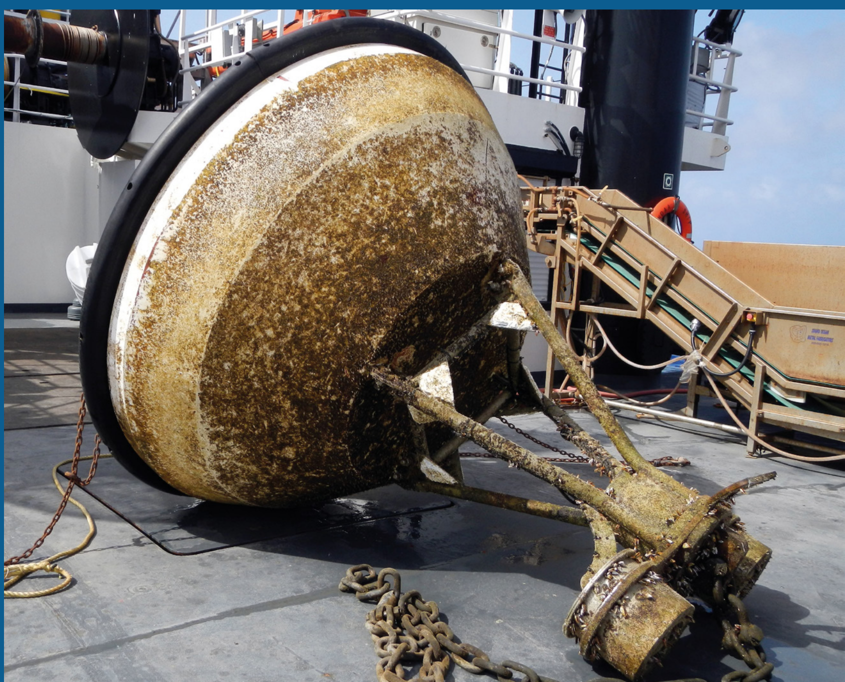


Figure 2-10: NOAA dart tsunami warning buoy recovered for cleaning and maintenance

In Australia, for example, the Department of Agriculture and Water Resources has adopted and published national biofouling management guidance for the following specific pathway types:

- Commercial [trading] vessels
- Non-trading vessels
- Commercial fishing vessels
- Petroleum exploration and production
- Aquaculture

For each of these, the guidance is premised on preventing biofouling through correct application of relevant anti-fouling systems as well as periodic cleaning to remove existing fouling. [13]

2.3.6 Assessing acceptable levels of biofouling

Assessing whether a specific pathway presents an unacceptable likelihood of introducing IAS to a new region is challenging. Several different approaches could be employed to respond to this challenge.

Species-based approaches

Traditional risk-based approaches often characterise the traits of specific invasive organisms to predict which are likely to spread and cause harm. This approach requires a detailed understanding of the invasive potential of specific organisms, as well as the ability to identify whether they are transported via a specific pathway. This approach, however, requires a high degree of scientific capacity and resources to inspect every ship and floating structure entering the country.
For this reason, a focus on assessing those pathways that present the greatest risk of IAS introduction, is considered a more precautionary and effective strategy for managing IAS.

Pathway profiling approaches

One approach to determine an acceptable level of risk for a specific pathway is to define technical "performance standards" for what constitutes a "low risk" surface in terms of biofouling. The purpose of such standards is to ensure that:

(a) any growth that does accumulate on vessels or structures does not present a significant risk; and
(b) a threshold is set above which the underwater surface must be cleaned of visible fouling organisms.

Such performance standards provide authorities with a measurable standard against which to assess whether a ship or structure is considered to be 'free' of biofouling either before or after it enters the recipient port. Ships that meet the standard are considered to be 'safe', provided that they do not remain in port for an extended period. The degree to which this standard is deviated from will be one of the primary determinants of the risk profile for the ship or structure.

One challenge with this approach is that verifying that a standard has been met requires physical inspection, the interpretation of which may be subjective unless the inspector is highly skilled and experienced. As such, it may not always be possible to verify that the standard had been achieved.

The alternative approach therefore, is to undertake biofouling management to prevent, reduce or control biofouling in manner consistent with the IMO Biofouling Guidelines. This would include development, implementation and maintenance of a Biofouling Management Plan (BFMP), and associated Biofouling Record Book (BFRB), which are:

- vessel specific, effective, and suited to the vessel's operational profile and proposed maintenance schedule; and
- regularly maintained and updated to represent best practice.

[13] Copies of the various guidance documents are available online at: https://www.marinepests.gov.au/what-we-do/publications Last accessed on 10/08/2020.

2.4 Facilities and Structures that Aid Settlement of IAS

The potential for a non-indigenous species to become established once introduced, relies on the presence of suitable substrates in a recipient region (e.g. rocky reefs, structures in a port or offshore structures) as well as favourable environmental conditions for survival. The increased urbanisation of the coastal and offshore environment provides numerous man-made substrates to facilitate the settlement and colonisation of biofouling species. Once a non-indigenous species has become established on a suitable substrate, that substrate then creates a further risk of the organism being transferred via secondary transfer pathways that move to and spend time in another locations.

For this reason, many countries have established comprehensive port/harbour/marina surveillance and monitoring programmes to survey for the presence of IAS in coastal waters and, where appropriate and feasible, to put in place management controls to reduce the risk of further secondary spread to areas that may be at greatest risk of serious environmental and economic impacts.

The following section therefore, discusses the most common types of structure that may support IAS colonisation and spread.

2.4.1 Ports and marinas

Overview

Ports are one of the primary components of the broader maritime transport sector, providing a vital means of integrating national logistics chains into the global economic system. Ports also provide critical support for inland economic activities (both for coastal and land-locked countries), since they act as a crucial connection between sea and land transport.

Port infrastructure elements include: wharfs and jetties for docking; terminals for unloading and storage; the provision of services such as shore power and bunkering; and port operational equipment such as crane and dredgers. Ports also provide a range of support services directly to the maritime transport sector (such as pilotage, towing and tug assistance, emergency repairs, anchorage berth and berthing services, etc.) as well as supporting other critical maritime economic sectors (such as commercial fishing and oil and gas).

In addition, services for long-term maintenance will be available including dry-docks and in-water biofouling removal.

Figure 2-11: Port

Biofouling Issues

When a heavily fouled vessel arrives in a port, harbour basin or estuary, environmental cues within can stimulate spawning of adults organisms within a few hours of arrival, with nearby wharf piles, jetties, breakwaters and other hard surfaces providing convenient settlement areas. Ports are therefore, often the first point of entry for non-indigenous species arriving into a new recipient region and it is notable that the majority of established IAS are found in port regions, most frequently in shallow, partly enclosed harbours. This is clearly linked, in the first instance to the fact that shipping in one form or another is responsible for the majority of transfers.

There are, however, a number of reasons that may exacerbate this, including:

- The large number of ships that present a risk of introducing non-indigenous species;
- The large number and variety of artificial physical structures present that provide a substrate for settlement of non-indigenous species and the close proximity of ships to those substrates that facilitates the settlement of even the most short-lived of organism life-stages;
- The broad range of environmental conditions that exist in such shallow semi-enclosed environments that can favour the settlement and survival of opportunistic non-indigenous species;
- The often degraded nature of native habitats making them more vulnerable to the colonisation of opportunistic non-indigenous species; and
- The facts that most vessel maintenance and cleaning facilities are located within or close to port, harbour and marina facilities - the cleaning of ship hulls - either in water or in dry dock - has the potential to dislodge and introduce organisms to a new location or to inadvertently cause organisms to spawn.

Similar factors apply to marina facilities frequented by small commercial and recreational craft, where they are not only in close proximity to other vessels from diverse parts of the world, but where the marina itself provides a substrate on which non-indigenous species can establish. Marinas can therefore, be the first entry point for IAS – via international yachts - providing suitable habitats for secondary spread via domestic ships.

Figure 2-12: Mature biofouling community established on concrete marina structure

Black-striped mussel infestation and eradiction in Darwin (Australia)

In March 1999 extensive colonies of the black-striped mussel *(Mytilopsis sallei)* were discovered in several marinas in Darwin (Australia).

M. sallei is an extremely prolific species, which can attain very large densities (more than 10,000 individuals per sq.m) rapidly becoming the dominant fouling organism in intertidal and shallow subtidal habitats. Dense aggregations of *M. sallei* cause heavy fouling on submerged surfaces such as vessel hulls, mooring buoys, piles and floating pontoons. Industrial structures for seawater intake, cooling intakes for vessels and aquaculture facilities are particularly susceptible to fouling. Dense aggregations may also smother or exclude other fouling species, altering natural biotic assemblages.

Movement of fouled structures is considered to be the main pathway for introduction and spread of *M. sallei*. Prior to its identification in the Port of Darwin it is thought to have been present for at least six months, during which time it had produced two generations and potentially infected a large number of vessels within several lock-controlled marinas.

Following its identification, local and national authorities initiated an eradication programme. The organisms were eradicated from vessels and marina infrastructure in about three weeks. During that time all vessels inside the harbour were quarantined and prevented from moving. In addition a total of 743 vessels that had left the infected marinas prior to identification were located and those found infected were cleaned. Some boats had reached Port Douglas in North Queensland and another had reached Sydney.

The cost of the eradication program and subsequent monitoring and checking exceeded US$l.6 million. This did not include the costs to the vessel owners of being laid up nor to vessel owners who had planned to visit Darwin but were denied access.

Ports, harbours and marinas are therefore, sites where there is an overlapping of a number of transfer pathways and maritime activities that play a role the introduction and transfer of biofouling IAS.

2.4.2 Offshore oil and gas platforms

Biofouling Issues

Offshore oil and gas platforms provide a suitable surface for biofouling accumulation and, unlike ships, often do not have an anti-fouling coating applied to the immersed surfaces. Biofouling on offshore oil and gas platforms can increase hydrodynamic drag and weight, and can lead to biologically induced corrosion. Periodic cleaning may therefore, be needed which may create the potential to dislodge and introduce species to new environments.

Platforms used in the production phase typically remain in one location for many years (either fixed to the sea floor or floating), having been constructed and towed on site prior to installation. The installation of such semi-permanent structures on the seafloor results in the creation of hard substrate, often in areas where no other hard substrate exists (Figure 2-13). This enables the development of attached communities and these may function as a “stepping-stone” for longer-distance dispersal of species.

Figure 2-13: Biofouling on the subsea structure of a fixed oil and gas production platform

In addition to the physical structures, offshore oil and gas operations are also associated with a wide variety of subsea infrastructure (such as cables, pipelines and sub-sea manifolds) and maritime operations (such as the movement of equipment and supplies via supply vessels and the offshore transfer of crude oil to shuttle tankers). The association between platforms and visiting vessels may further increase the risk of transfer of organisms between onshore and offshore facilities.

2.4.3 Aquaculture structures and fishing equipment

Overview

Seafood and fisheries are crucially important for the food security of coastal and island nations. Traditionally, food from the sea has been hunted and collected

Figure 2-14: Offshore fish farm operation

from the wild, relying on the natural productivity of the ocean to meet growing demand. Many small-scale fisheries in least developed countries rely on non-motorised vessels that fish locally in coastal waters and include the smallest boats used for fishing. In 2018, the world fishing fleet consisted of about 4.56 million vessels, of which about two-thirds are undecked vessels associated with small-scale coastal fisheries. In contrast, large-scale vessels over 24 meters (or larger than 100 gross tons) represent only about 3% of the total fishing fleet.[14]

In recent years, however, global fisheries have reached capacity, with 77% of stocks at or above their sustainable limit. In response, there has been a massive expansion in aquaculture, which is now the fastest-growing food production sector in the world, producing more than half of all the fish and shellfish we now consume, and predicted to rise further to 65% by 2030. [15]

Aquaculture utilises a range of different technology and structures (including ropes, pens and cages) that contain or provide substrate for the stock species. In the marine environment typical structures include floating cages for fin-fish, hanging lines for macroalgae and shellfish, and a range of seabed basket and rope systems for alga and shellfish.

Biofouling Issues

Aquaculture structures accumulate biofouling, requiring frequent cleaning to prevent impacts on the production species. This cleaning is commonly performed without waste capture, and dislodged organisms can fall to the sea floor, or organisms can be stimulated to spawn by the cleaning practices. While these structures typically remain fixed in place, the movement of fouled aquaculture equipment such as settlement lines, grow out lines, shellfish trays and fish pens between areas is a further potential vector for spreading species. For example, the movement of salmon cages contaminated with the Japanese kelp *(Undaria pinnatifida)* is believed to have been responsible for the spread of this macroalgae into the Marlborough Sounds region of New Zealand.

Similarly, some production species themselves (e.g. oysters, mussels, farmed macroalgae) are non-indigenous biofouling species that are known to cause harmful impacts when spread into the natural environment. Non-indigenous species may also be transferred as biofouling organisms attached to the shells of aquaculture species, and macroalgae including the Japanese kelp, broccoli

[14] FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. Available online at: http://www.fao.org/3/ca9229en/CA9229EN.pdf Last accessed on 10/08/2020.

[15] FAO. 2020.

weed *(Codim fragile fragile)* and several species of the red algal genus *Grateloupia* are all thought to have been introduced to the Mediterranean Sea with imported Pacific oysters. Additionally, the nearshore proliferation of aquaculture structures and their tender vessels creates pathways for the spread of biofouling species into local environments.

Figure 2-15: The Stalked Sea Squirt (Styela clava) heavily fouling underwater cages

Commercial fishing equipment, specifically lost or discarded fishing gear, can also pose a risk of biofouling accumulation and transfer of marine organisms. Lost nets are often the single largest component of floating plastic debris found washed up in coastal regions. The issue of floating plastic debris more generally is also a significant cause for concern as a transfer pathway, although one that is not addressed in this Guide.

Nets and traps that remain in the marine environment can accumulate biofouling organisms that can be transferred to new locations when collected and transferred if not cleaned between deployments (see Figure 2-15).

2.4.4 Marine renewable energy structures

Overview

Renewable energy will play a key role in the decarbonization of global energy systems in the coming decades. In 2019, around 11% of global primary energy came from renewable sources, with a total global installed capacity of approximately 3.5 million MW. While currently less than 25,000 MW of this comes from marine renewable energy (97% of which is offshore wind), there is a significant global focus on the development of this sector.

A broad range of different technologies exist for the generation of renewable power from marine sources (see Table 2-4 on page 30), although most of these (apart from wind) remain unproven commercially. Despite this, with continued political support for renewable energy as a source of clean, secure and reliable energy, technologies are expected to develop in the coming decade, and to become increasingly attractive and cost-competitive.

Biofouling Issues

As for oil and gas platforms, marine renewable energy structures may be fixed or floating, and can provide a suitable substrate for biofouling organisms.

Figure 2-16: Macro-algae fouling on a tidal turbine

Offshore wind	Offshore wind is the most mature of all marine renewable energy technologies, with wind farms being constructed and operated at a large scale around the world (particularly in China, Europe, the USA and Canada). Offshore wind technology divides into two main categories: **grounded** wind turbines and **floating** wind turbines, which differ mainly by the type of their foundation. This allows for their deployment in a range of seabed types and water depths. At the end of 2018, the total worldwide offshore wind power capacity was 23,100 MW, while projections suggest there is potential for growth of a further order of magnitude by 2050.
Tidal energy	Of the current ocean energy technologies, tidal energy technology (tidal stream and tidal range) is the most mature, with reliable operational commercial-scale devices. **Tidal range** projects use the vertical difference in height between the high tide and the succeeding low tide. **Tidal stream** devices use energy from the constant flow of water as the tide ebbs and floods to drive turbines mounted on separate devices.
Wave energy	Wave energy technologies are at an earlier stage of development and not yet operating at a commercial scale. Technologies generally fall into three categories: open-water, seabed-mounted and shore-based devices. Most devices are deployed in shallower near-shore locations due to the need for onshore infrastructure. Shore-based designs (including the oscillating water column and overtopping devices) can be fixed to existing infrastructure, such as harbour breakwaters, or built directly into the shore, requiring varying degrees of shoreline modification.
Ocean thermal energy conversion (OTEC)	Ocean thermal energy conversion (OTEC) uses the temperature difference between deep (typically 1,000 m) and surface seawaters to drive a turbine connected to a generator. Since a temperature difference of at least 20°C is necessary to compensate for the operating energy of the plant and with deep waters close to an average 4°C, only intertropical zones can sustain this technology.
Salinity gradient	Salinity gradient technology uses the energy created from the difference in salt concentration between fresh and salt water, and is at an early stage of development for renewable energy purposes. Salinity technology requires an adequate and accessible river system, which is not available in coastal or island situations. The technology is at a very early stage; however, the advantages of salinity gradient technologies include reliability of energy provision and the potential to integrate with other solutions (including desalination).

Table 2-4: Types and characteristics of different marine renewable energy technologies

Biofouling can increase hydrodynamic drag and weight, or lead to biologically induced corrosion, requiring periodic cleaning which may create the potential to dislodge and introduce organisms to shallow benthic habitats or inadvertently cause organisms to spawn through cleaning practices. The nearshore proliferation of marine renewable energy structures may create potential "stepping stone" corridors for biofouling organisms.

Similarly, the offshore renewable sector also relies on a broad range of ships to support offshore activities. The biofouling risks associated with these vessels are the same as any other type of ship and depends on the operating profile of the ship in question.

2.4.5 Stepping stones and corridors

In addition to the risk of species transfer between a substrate and a secondary transfer pathway (such as a fishing vessel), the proliferation of structures to support the broad range of social and economic activities undertaken in coastal regions create links between previously unconnected geographic zones therefore, providing continuous corridors for the colonisation by benthic organisms. These so called "stepping stones" include connections along the coastline, connections between coastal and offshore habitats, and corridors across deep oceanic environments.

For example, in the UK over 260 Oil and Gas platforms and >45,000 km of subsea pipeline are currently in position on the continental shelf. The provision of hard substrate habitat associated with these structures is linked to the expansion of the cold-water corals (*Lophelia pertusa* and *Caryophyllia smithii*) in the North Sea.

In addition to individual structures, subsea pipelines and cables can form continuous or intermittent hard substrate across soft sediments, creating corridors for the movement and dispersal of biofouling species between coastal and offshore areas. These structures may be surface laid or buried, however buried structures may become exposed due to currents or interaction with fishing activities (e.g. trawling and dredging) and rapidly become colonised by organisms.

2.5 Impacts of IAS

Species introduced via biofouling can give rise to a range of adverse impacts, namely:

- Impacts to biodiversity, habitats or ecological processes (Ecological impacts);
- Impacts to economic activities and infrastructure (Economic impacts); and
- Socio-cultural impacts (including to human health).

2.5.1 Ecological impacts

The ecological impacts of IAS can occur through changes to the local biodiversity and/or alteration of ecological processes caused by that species. While the initial impacts may not be apparent, as a population increases over time impacts may increase in severity and include:

- Competition with native species for space and food;
- Predation upon native species;
- Changes to, or replacement of habitat, that lead to loss of native species diversity, alteration of food webs or even local extinctions;
- Alteration of environmental conditions (e.g. decreased water clarity).

Ecological impacts of non-indigenous species introduced by biofouling are not widely documented because, for most, their opportunistic traits result in poor competitiveness against native species within healthy ecosystems. However, there are exceptions, including the invasion of rocky shores in Europe by the Australasian barnacle *Austrominius modestus* following its introduction in the 1940s, and the European blue mussel *Mytilus galloprovincialis* spreading along more than 2,800 km of the coast of southern Africa since introduction in the 1970s.

IAS may be able to colonise a vacant niche in a native ecosystem with low biodiversity, or a new habitat unsuitable to local native species, such as man-made habitat in ports and harbours.

2.5.2 Economic impacts

Economic impacts can occur both as a consequence of fouling on the structure itself (e.g. fouling of ships' hulls) and fouling in the new location (e.g. other vessels, fouling of water intake pipes and other infrastructure). As such, biofouling can have serious implications for a broad range of coastal economic sectors.
These impacts can include:

- Costs associated with control and eradication efforts;
- Direct and indirect impacts to infrastructure (e.g. biologically induced corrosion);

Ecosystem modification by IAS

Some species are notorious 'ecosystem engineers'. For example:

1) The cryptogenic tube worm *(Ficopomatus enigmaticus)* is an exotic reef-building tubeworm distributed in most brackish waters across the globe, being widely present throughout the Pacific and Atlantic Ocean basins. The species grows fast, has a high tolerance to variable environmental conditions and forms large reef-like structures in estuarine and coastal environments.

These reefs can act as efficient traps for sediments and can promote changes in the abundance and distribution of native benthic communities. As such the species has caused important ecological impacts in several regions by modifying the ecological and the physical processes of the ecosystems and altering physical habitat characteristics. For example, in *Laguna de Mar Chiquita* (Argentina), the most well studied ecosystem affected by this polychaete, the presence of *F. enigmaticus* has substantially modified the landscape, promoting serious ecological alterations.

F. enigmaticus also causes negative economic impacts. For example, in Uruguay large tubes (twice the size of those found in its native environment) have been recorded obstructing the cooling system of the country's only oil refinery. Having grown inside the pipes the organism then dies, accumulating inside and causing a decrease in the flow of the water. This results in the need for costly shut-down and maintenance work.

Source: Muniz, Clemente and Brugnoli (2005).

2) The burrowing isopod *(Sphaeroma quoianum)* was introduced to the Pacific coast of North America during the late 19th century, most likely through ship boring or fouling from Australia and New Zealand. Today, populations of *S. quoianum* have been reported in fifteen estuaries from subtropical San Quintin Bay, Baja California to temperate Yaquina Bay, Oregon

S. quoianum invades estuarine environments burrowing into a variety of intertidal and shallow subtidal substrata including marsh banks (formed of mud, clay, or peat), friable rock (sandstone, mudstone, or claystone), concrete, Styrofoam floats, sponges, and wood. The creation of numerous interconnected burrows weakens substrata, accelerates erosion, and damages maritime structures.

As such *S. quoianum* is a major intertidal 'bioeroder', having the ability to increase erosion amounts by up to 240% when densities are sufficiently high.

Source: Davidson T.M. (2008).

Orange Sun Coral invasions in Brazil

Orange Sun Coral *(Tubastraea spp.)* is a group of hard coral species native to the Indo-Pacific, that are now established throughout the Tropical Western Atlantic, including the Caribbean and Gulf of Mexico where they may have been introduced in the 1940s as fouling organisms.

Sun corals are highly invasive and widespread, often competing with other benthic invertebrates for substratum space. According to some researchers, on natural reefs, sun corals compete with native corals, change reef communities and processes, and modify seascapes. Local exclusion or extinction of native species may occur and the removal of the native corals may reduce the production of the entire ecosystem, compromising ecosystem functions.

Tubastraea was first reported in Brazil in the 1980s as fouling organisms on oil and gas platforms in the Campos Oil Basin. Since then, it is thought that the associated structures (such as buoys) and the year around movement of associated platforms and offshore support fleet shorewards have acted as secondary transfer pathways for spreading *Tubastraea spp.* along the Brazilian coast. The distributional range of *Tubastraea spp.* in the Southwestern Atlantic appears to be directly associated with disturbed sites with intense ship traffic and waterway terminals.

Tubastraea spp is reported to be widespread on rocky shores and artificial substrates (oil platforms, buoys, wrecks, piers, and drillships) along more than 3,500 km of coastline. At the end of the 1990s the sun corals began to establish within native communities on rocky reefs at Ilha Grande Bay, State of Rio de Janeiro, a region considered to be relatively biodiverse for Brazil. Given the extent of this expansion, it has been argued that secondary transfer pathways have played a key role in *Tubastraea spp.* dispersion along the Southwestern Atlantic.

Sources: Capel et al (2019); Miranda, Cruz & Barros (2016); Mantellato and Creed (2015).

- Costs associated with replacing and repairing structures due to premature aging and degradation;
- Decreased operational efficiencies (e.g. frictional drag on vessels creating increased fuel costs; increased cleaning frequencies; increased drag and weight on structures);
- Loss of aquaculture products due to biofouling of pens and nets, smothering of stock, and predation.

Shipping

The primary cost associated with fouling of ships is due to increased fuel consumption attributable to increased frictional drag. The impact of fouling on ship performance is greatly dependent on the type and coverage of fouling. Slime fouling on the hulls of ships has been calculated to increase in shaft power consumption of 11-21%, and light to heavy hard-shelled fouling by 35-86%, with consequent increases in a ship's fuel consumption.[16] Where defects in the anti-fouling surface exists, hard-shelled barnacles can also undercut and lift paint coatings, leading to other problems such as corrosion.

Biofouling in internal niche areas, such as internal spaces and seawater systems (e.g., pipework, sea chests, and strainers) can be difficult to manage, as surfaces are not

[16] Galil *et al* (2019).

Economic costs associated with the Carpet Sea Squirt *(Didemnum vexillum)*

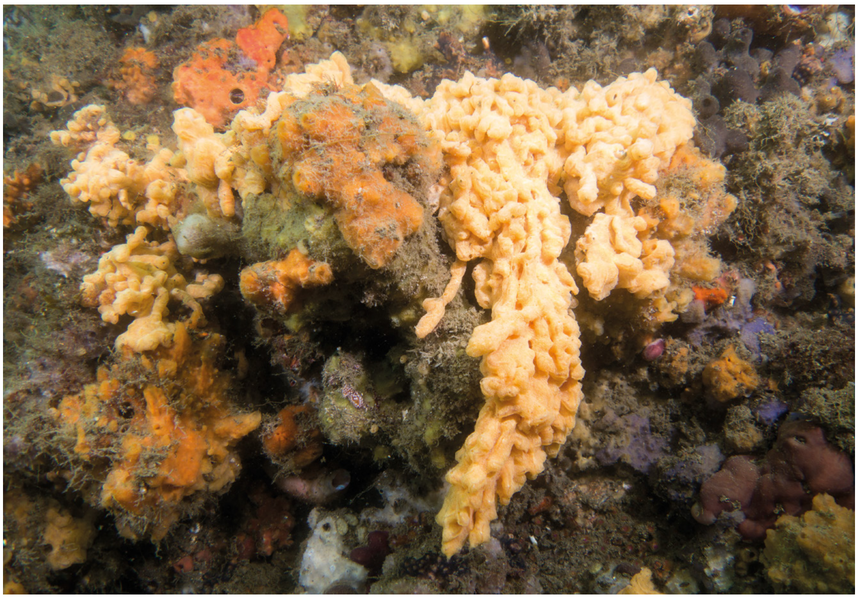
The economic costs of vessel biofouling can be illustrated in a case study of the Carpet Sea Squirt *(Didemnum vexillum)*. This invasive organism can encrust a wide range of substrates, fouling artificial submerged structures and overgrowing natural habitats, thereby greatly altering submerged structures and their accompanying biota.

Didemnum has been spread with fouled shellfish and vessels to Europe, North America and New Zealand. In New Zealand, attempts to eradicate approximately 1 sq. km of *Didemnum* fouling in Shakespeare Bay failed, despite authorities spending NZ$650 000 on the eradication programme.

Due to concerns regarding impacts to nearby mussel farms, in July 2006 authorities commenced an intensive surveillance and eradication program throughout the Marlborough Sounds region (an area of some 750 sq.km). The programme lasted for two years until eradication was no longer considered feasible. Cessation of control efforts resulted in rapid re-infestation.

A similar eradication programme was attempted at Holyhead Harbour, Wales, where Didemnum was confined to a small marina and unrecorded elsewhere, at an estimated cost of £350,000. Eradication was initially successful, but the marina was rapidly recolonized and *Didemnum* ultimately spread via befouled vessels all around the UK coastline.

Source: Galil et al (2019).



a) IAS Didemnum vexillum

(b) IAS Didemnum vexillum

Impact of biofouling on ship performance

A report commissioned by the Global Industry Alliance for Marine Biosafety compiled all studies on the impact of biofouling on the energy efficiency of ships and highlighted the inherent ability of biofilms and slime to induce an effective roughness that is well in excess of what its physicalappearance would traditionally suggest. For example, a layer of slime as thin as 0.5 mm covering up to 50% of a hull surface could trigger an increase of GHG emissions of up to 25% depending on ship characteristics, its speed and other prevailing conditions. For more severe biofouling conditions, such as a light layer of small calcareous growth (barnacles or tubeworms), an average-length container ship could see an increase in GHG emissions of up to 60%, dependent on ship characteristics and speed. For the medium calcareous fouling surfaces, the increase in GHG emissions could be as high as 90%.

GloFouling (2022).

Despite the difficulty of extrapolating figures to the global fleet without more data, some studies have tried to estimate the potential savings that could be achieved through improved biofouling prevention and management. Another report published in 2022 roughly calculated that if all international ships maintained a smooth condition, free from biofouling, global GHG emissions from ships could be reduced by at least 19% per year (or 198 million tons of CO2e), with similar levels of fuel savings worth billions of US dollars.

Swain et al. (2022)

often able to be painted or, if painted (e.g. sea chest walls), the coatings do not function as effectively as on external hulls.. Thus, they are considered to be high-risk areas for biofouling. Biofouling in heat exchangers and cooling systems may restrict flow, which reduces efficiency and can consequently increase fuel consumption.

Thus, the primary cost associated with biofouling is the increased fuel consumption attributed to increased frictional drag. The fuel efficiency of ships is consequential, as increased fuel consumption not only represents significant cost increases for an industry operating on very slight margins, but it will also result in increased emission of greenhouse gasses.

Fisheries and Aquaculture

Biofouling can affect fisheries and aquaculture equipment, infrastructure and stock, and can result in significant costs to these industries through:

- Colonisation of culture infrastructure, leading to reduced water flow, waste build-up, decreased oxygen levels and reduced food availability;
- Increased weight from biofouling biomass on stock and equipment (e.g. panels, nets, ropes and floats;
- Physical damage of stock species by invasive boring organisms or epibiotic organisms growing on the shell surface;
- Mechanical interference of shell function affecting feeding ability and susceptibility to predators; and
- Biological competition for food and space, affecting growth and condition.

Marine structures and coastal Infrastructure

Biofouling of marine structures and equipment (such as offshore oil and gas platforms, marine renewable energy structures and floating buoys) is of concern, due to increased weight, hydrodynamic drag and loading, accelerated corrosion, impacts on cooling and heating systems and hindrance of underwater inspection and maintenance. Biofouling can require installations designed for oil and gas and energy production to make long, costly production stoppages for maintenance. Similarly, biofouling growth in seawater intakes can reduce the efficiency of, or cause failures, in these facilities and in some instances can cause additional maintenance costs unless effective marine growth prevention systems are fitted that dose systems with copper, chlorine or other biocidal agents to prevent biofouling accumulation.

2.5.3 Socio-cultural impacts

Socio-cultural (including human health) impacts can include reduction in recre-

Transport of human pathogens in biofouling

Marine plastic debris is well characterized in terms of its ability to negatively impact terrestrial and marine environments, endanger coastal wildlife, and interfere with navigation, tourism and commercial fisheries. However, recent studies have suggested that floating plastic marine litter (PML) might offer a protective niche capable of supporting a diversity of different microorganisms, and be a pathway in the transfer of human diseases. While the interaction between PML and pathogens is still poorly understood, a number of emerging studies indicate the ability of PML to act as an important vector for the persistence and spread of pathogens, faecal indicator organisms and harmful algal bloom species across beach and bathing environments.

Source: Keswani *et al* (2016).

Studies have also highlighted the role that hull fouling communities on ships could play in the transfer of pathogens, particularly Vibrio parahaemolyticus, a worldwide recognized food-borne human pathogen. This suggests that biofouling could be an important reservoir and vector of pathogenic vibrios, that can potentially serious gastrointestinal illness.

Source: Revilla-Castellanos et al (2015).

ational amenity values associated with habitat and beach alteration, and reduction and loss of iconic and culturally significant species through predation and competition.

Additionally, several species can affect human health through physical harm such cuts and lacerations (eg Pacific oyster creation of biogenic reefs) as well as the spread of viral and bacterial mediated diseases.

2.5.4 Assessing impacts

The ability to predict impacts and their magnitude is notoriously difficult, due to the ecological complexities involved. Not only is there a need to know what specific organisms are transported via a specific pathway, but knowledge of how each organism may react once released, including the impacts it may have on different environmental economic and social values, is also necessary.
One approach to address this is to make assumptions based on prior knowledge of a specific organism's behaviour in other environments similar to the recipient port or region. Such predictors may include:

- Concrete evidence that the organism has invaded other region/s and caused demonstrable harm;
- A body of evidence to suggest that the organism of interest is potentially invasive and capable of causing harm;
- The degree of similarity between the environmental conditions of the receiving region and those colonised by the organisms of interest in their natural and other introduced ranges;
- The degree of 'invader friendliness' of the waters where the AIS introduction may occur. For example:
  - evidence of other recently established IAS;
  - the presence of artificial, heavily modified or disturbed habitats that offer vacant niches due to the novelty of new surfaces or unsuitability of the modified environment to native assemblages;
  - the presence of environmentally compromised native communities through, for example, pollution, overfishing, physical habit damage etc;
- The range of secondary pathways available to aid regional spread; and
- The presence of biological communities offering naturally vacant niche space owing to relatively low biodiversity.

Even with this approach, it may not be possible to accurately predict the impacts, which may only become apparent after they have occurred and been observed through monitoring.

3

Acquiring the Necessary Baseline Information

Defining the steps required to establish a comprehensive biofouling management framework, such as that described in Annex B, requires the collection and analysis of a wide range of "baseline" information organised around the following questions:

1. What potential exists for the introduction and subsequent spread of IAS?
2. What resources may be vulnerable to, or impacted by, the introduction and spread of IAS?
3. What socio-economic activities may be affected by the introduction and spread of IAS? and
4. What policy, legal and institutional arrangements exist to manage and control the risks associated with biofouling (For further information refer to **Annex B**)?

For each of the questions listed above, this chapter presents a series of tables illustrating the type of information needed, as well as possible sources for that information. These information sources can be augmented by additional publicly available information, such as those listed in Section 6.3.

It should be stressed that not all of the information listed below is essential to complete a basic National Self-Assessment, with some information being more important than others. To assist the reader, two levels of information are indicated as follows:

1) **Core information** deemed essential to assess whether a country is at risk from the introduction and/or spread of IAS as a result of biofouling. The priority for the assessment team should be to collect and analyse this information; and
2) **Supplementary information** considered desirable, but not essential, that would provide greater detail and strengthen the overall National Status Assessment. The assessment team should consider whether this level of information is readily available and accessible.

3.1 Potential for Introduction and Spread of IAS?

The development of a comprehensive national biofouling management framework requires attention to the identification and assessment of the relative importance of different transfer pathways (see Section 2.3 on page 13). To assess the extent to which these may be relevant the following questions and sources of information may be helpful.

In considering these, it should be understood that some socio-economic activities vulnerable to IAS also facilitate those pathways that may increase the risk of IAS transfer. For example, while aquaculture structures (such as sea cages) may be seriously affected by fouling organisms, leading to structural damage and impacts to cultured species, the movement of such structures may also facilitate the transfer of fouling organisms from one region to another. Similarly, a range of nearshore and offshore structures provide opportunities for settlement and spreading of biofouling organisms but may also be directly impacted for biofouling (for example due to the need for shut down, cleaning and maintenance of offshore platforms).

3.1.1 Transfer pathways

Table 3-1: Baseline information needs for transfer pathways

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(a): International shipping (Refer to Table 2-1)		
International shipping arrivals The more ships that visit, the greater the risk of IAS transfer. The risk profile is not, however, simply a function of the number of 'port visits' but rather a function of the number, types and operating characteristics of ships that visit. Different ships and vessels have different risk factors based on their operating profile. Understanding the different profiles of vessels visiting will assist in understanding the overall risk profile of this pathway. The following types of information will assist with assessing the likelihood of non-indigenous species being introduced via international shipping; - **Types and numbers** of international trading and non-trading ships arriving in the country (refer to Table 2-2 on page 17) - The **time spent in port** for individual ships/ship types (The longer a ship is in port, the greater the chance species have of transferring to hard substrates in that port). - The **time spent stationary** (idle time) for individual ships/ship types (Ships can spend extended periods idle in coastal waters queuing for access to the port or waiting for the next contract. Some types of non-trading ships may spend significant periods idle between contracts. The length of this "idle time" is an important risk factor to take into account). - **Maintenance and cleaning history** of ships (Poorly maintained hulls and those where the anti-fouling coating has not been regularly renewed and cleaned present a higher risk of biofouling) - **Application of the IMO Biofouling Guidelines** (ships that apply the Biofouling Guidelines and have a BFMP and BFRB are less likely to pose a risk if introducing non-indigenous species) - Current **pre-arrival inspection and notification procedures** for international ships (the application pre-arrival inspection and notification procedures will contribute significant to a better understanding of the biofouling risks associated with international shipping).		• National Maritime Authority • Port records • National Statistics Office • Customs Department • Coastguard • IMO GISIS (for information on ships registered with a flag administration) or national Ship registries

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(a): International shipping (Refer to Table 2-1) - continued		
The main shipping routes in and out of the country Where a ship has come from and the route it has taken can provide useful information about whether a ship is likely to host IAS. E.g. are ports previously visited during the voyage known to have IAS present? Are the conditions of previous ports similar to the recipient port? Has the ship travelled from temperate to tropical waters, or vice versa? The following types of information will assist with understand potential sources of non-indigenous species: - **Port of last departure** for international trading and non-trading ships arriving in the country - **Previous ports visited** during the voyage - Transit through **waters of similar environmental conditions** as the recipient port **The primary ports used by international ships** - Knowledge of the ports of first entry will help authorities to better understand where the areas of greatest risk of IAS introduction may be and to target inspection activities.	**Any offshore areas designated for specific purposes** In some countries, authorities have predetermined specific areas as being available for certain activities (for example place of refuge, offshore bunkering/ lightering, anchoring or no-anchoring). These areas may indicate areas where the risk of IAS introduction is high/more likely that may warrant additional management controls. Accordingly the assessment team should identify such areas and the specific activities and types of ship that occur in them.	• National Maritime Authority • Coastguard • Vessel tracking data (e.g. AIS) • National vessel routing system • Port records • Hydrographic charts • Coastal pilot • Notice to Mariners • Marine spatial plans
Knowledge of previous IAS introduced via international shipping Any information about previous IAS incursions will give important information about how effective current controls are for managing biofouling on international shipping.		• National biosecurity agencies • Scientific research institutions and research reports • National Maritime Authority
Foreign flagged fishing vessels The more fishing vessels that visit, the greater the risk of IAS transfer. Fishing vessels are also an important secondary transfer pathway and visit many different offshore areas to fish. Understanding the numbers and types of fishing vessels originating from overseas will help authorities to develop an overall picture of the risks they present. The following types of information will assist with assessing the likelihood of non-indigenous species being introduced via foreign-flagged fishing vessels; - **Numbers of foreign flagged fishing vessels** operating in national waters - **Home port/country of origin** (Potential IAS can colonise vessels during extended periods in the home port, then continue to grow when the vessels are at sea (particularly in warm/tropical waters) undertaking low speed operations)	**Whether fishing vessels travel to/spend any time in sensitive sea areas** Understanding whether sensitive marine areas (such as marine protected areas) are likely to be exposed to, and therefore, impacted by, IAS is an important element in controlling significant environmental impacts.	• Fishery Department records - e.g. vessel licence records • Vessel Monitoring Service (VMS) data tracking of fishing vessels • Fishing sector profiles undertaken by government • Port companies/ Harbour authorities • National Maritime Authority • International and national trade associations

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(a): International shipping (Refer to Table 2-1) - continued		
- **Ports visited** to offload and rotate crew (Understanding which ports and harbours are used by foreign flagged fishing vessels will assist authorities to understand possible introduction sites. secondary transfer pathways, particularly if IAS have been identified at specific ports/harbours) - The **time alongside** for foreign flagged fishing vessels - particularly between fishing seasons (The longer a fishing boat is in port, the greater the chance IAS have of transferring to hard substrates in the recipient port. Fishing vessels may not be as well maintained as trading vessels and may therefore, have higher rates of biofouling) - **Maintenance and cleaning history** (Understanding how well biofouling is understood and managed for fishing vessels will assist authorities in understanding the scale of the risk this sector poses, and where education should be focussed)		
International recreational craft (e.g. yachts and super yachts) Some countries are a favourite destination for private yachts. These can present a similar or even higher risk of IAS introduction to internationally trading vessels and often remain in port/marina for extended periods of time. Understanding the numbers and types of recreational craft will help authorities to develop an overall picture of the risks they present. The following types of information will assist with assessing the likelihood of non-indigenous species being introduced via recreational craft; - **Numbers of international recreational craft** visiting the country - **Main ports/marinas utilised by international recreational craft** (Information on the number and location of marinas, the average number of vessels in each, and whether vessels are moored against jetties or on swing moorings will all be useful in understand possible hotspots for IAS settlement) - **Home port/country of origin** (Potential IAS can colonise vessels during extended periods in the home port, then continue to grow when the vessels are at sea (particularly in warm/tropical waters) - Transit through **waters of similar environmental conditions** as the recipient port - The **time spent in other countries during the voyage** (The longer a vessel boat is in port, the greater the chance IAS have of transferring to hard substrates in the recipient port) - **Maintenance and cleaning history** (Understanding how well biofouling is understood and managed for recreational craft will assist authorities in understanding the scale of the risk this sector poses).	Current **pre-arrival inspection and notification procedures** for recreational craft (the application pre-arrival inspection and notification procedures will contribute significant to a better understanding of the biofouling risks associated with international recreational craft).	• National Maritime Authority • Local authorities • Port companies and Harbour Authorities • Marina operators

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(b): Offshore oil & gas		
Note: If no oil and gas activity is undertaken or planned then this pathway can be ignored for the assessment. **Mobile drilling platform arrivals** Mobile drilling platforms may present a significant risk of IAS introduction due to the nature of biofouling on these structures. The following types of information will assist with assessing the likelihood of non-indigenous species being introduced via mobile drilling platforms; - **Numbers of mobile drilling platforms** entering the country's waters - **Areas where mobile/floating platforms are temporarily anchored** (Even if no oil and gas production is undertaken, some countries offer suitable places for 'stacking' mobile drilling rigs between jobs. These present another possible transfer pathway) - **Main ports utilised by mobile drilling platforms** (Countries with large deepwater ports and harbours may provide the facilities to bring mobile drilling platforms into those ports/ harbours. This increases the potential for IAS of transfer to hard substrates in the recipient port) - **Region/country of last deployment and the length of that deployment** (Potential IAS can colonise drilling platforms during extended drilling campaigns, then continue to grow when the platforms are transported to the next deployment) - **Duration of transit voyage from last deployment** and the route of the transit - Typical **time mobile drilling platforms spend in the country** - **Inspection and/or cleaning history prior to arrival in country** (Given the higher levels of biofouling associated with mobile drilling platforms it is essential that they are inspected and appropriately cleaned prior to arriving in country. If this can't be demonstrated this could indicate a high risk of IAS introduction) - Current **pre-arrival inspection, cleaning and notification procedures** for mobile oil and gas platforms craft (the application pre-arrival inspection and notification procedures will contribute significant to a better understanding of the biofouling risks associated with oil and gas facilities)	**Movements of shuttle tankers and supply vessels to/from offshore areas** The movement of shuttle tankers (from overseas) and supply vessels (from coastal waters) may present an additional pathway for the introduction and transfer of IAS from/to offshore oil and gas structures. Shuttle tankers, because they do not enter a port directly, may be subject to less PSC scrutiny and may transfer IAS directly to an offshore platform. These may then be transferred back to port via supply vessels. **Main ports that service the offshore oil and gas sector** Knowledge of the main ports that service the oil and gas sector will help authorities to better understand where the areas of greatest risk of IAS introduction may be from this sector. **Knowledge about industry specific initiatives to address biofouling** Oil and gas companies may have their own internal procedures and initiatives to deal with biofouling. These can be a useful source of information and capacity development in countries with limited IAS experience.	• National economic development plans • Marine spatial plans • Port companies/ Harbour authorities • National Maritime Authority • National oil and gas licencing authority • Oil and gas companies • Oil and gas industry regulators • Service companies • International and national trade associations

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(c): Domestic shipping (Refer to Table 2-1)		
Domestic shipping profile and movements Domestic trading and non-trading ships generally operate with the coastal and offshore waters of a country and repeatedly visit the same ports and coastal areas and will tend to visit many more areas than internationally trading ships. This raising the likelihood of being in a port at the time of a spawning event. As a result, domestic ships are an important secondary transfer pathway. Understanding the size of the fleet and the nature of their movements around the coast will be important to understand the extent to which this pathway presents a risk of IAS spreading. The following types of information will assist with assessing the likelihood of non-indigenous species being transported by domestic shipping; - **Types and numbers** of domestic trading and non-trading ships registered/operating in the country (refer to Table 2-2 on page 17) - Typical **areas of operation** including home ports and coastal/offshore areas frequented. (Areas that are subject to the highest shipping pressure should be the initial focus of attention in terms of the potential impacts IAS may have on those areas and the likelihood of secondary transfer to those areas) - The **time spent in port/stationary** for individual ships/ship types (Some types of non-trading ships may spend significant period idle. The longer a ship is idle the greater the chance species have of transferring to the hull and subsequently being transported) - **Maintenance and cleaning history** of ships (Poorly maintained hulls and those where the anti-fouling coating has not been regularly renewed and cleaned present a higher risk of biofouling) **Existing rules and operating practices for anti-fouling and biofouling management on domestic ships** Understanding how well biofouling is controlled on domestic ships will assist in understanding what the risk is of secondary transfer around the country. The assessment team should assess what current management practices are common with the domestic fleet, what maintenance facilities are available, where hull cleaning and maintenance activities take place etc.	**Whether domestic ships travel to/spend any time in sensitive sea areas** Understanding whether sensitive marine areas (e.g. marine protected areas) are likely to be exposed to, and therefore, potentially impacted by, IAS is an important element in controlling significant environmental impacts. **Other ports or regions in the country that international ships might visit after the initial entry point** Where an internationally trading ship makes more than one stop in the same country, this might indicate a risk of secondary transfer of IAS if it is either (a) already on the ship; or (b) in the port of first entry. **Any offshore areas designated for specific purposes** In some countries, authorities have predetermined specific areas as being available for certain activities (for example place of refuge, offshore bunkering/ lightering, anchoring or no-anchoring). These areas may indicate areas where the risk of IAS introduction is high/more likely that may warrant additional management controls. Accordingly the assessment team should identify such areas and the specific activities and types of ship that occur in them.	• National Maritime Authority • Coastguard • Hydrographic charts • Vessel tracking data (e.g. AIS) • National vessel routing system • Coastal pilot • Marine spatial plans

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(c): Domestic shipping (Refer to Table 2-1) - continued		
Domestic fishing vessels Fishing vessels may be an important secondary transfer pathway and operate through the country's coastal and offshore waters. Although large domestic fishing vessels present a similar risk of IAS spreading as domestic trading and non-trading ships, the sources of information may be different. Small fishing vessels, on the other hand, are likely to have poor maintenance practices and may present a higher risk of IAS spreading. The following types of information will assist with assessing the likelihood of non-indigenous species being transported by domestic shipping; - **Types and numbers** of domestic fishing vessels registered/operating in the country - Typical **areas of operation** including home ports and coastal/offshore areas frequented. (Areas that are subject to the highest shipping pressure should be the initial focus of attention in terms of the potential impacts IAS may have on those areas and the likelihood of secondary transfer to those areas) - The **time spent in alongside** - particularly between fishing seasons (The longer a fishing boat is in port, the greater the chance IAS have of transferring to hard substrates in the recipient port. Fishing vessels may not be as well maintained as commercial ships and may therefore, have higher rates of biofouling) - **Maintenance and cleaning history** of fishing vessels (Poorly maintained hulls and those where the anti-fouling coating has not been regularly renewed and cleaned present a higher risk of biofouling)	**Whether fishing vessels travel to/spend any time in sensitive sea areas** Understanding whether sensitive marine areas (such as marine protected areas) are likely to be exposed to, and therefore, impacted by, IAS is an important element in controlling significant environmental impacts.	• Fishery Department records - e.g. vessel licence records • Vessel Monitoring Service (VMS) data tracking of fishing vessels • Fishing sector profiles undertaken by government • Port companies/ Harbour authorities • National Maritime Authority • International and national trade associations
Recreational craft Recreational craft are also an important secondary transfer pathway and can access coastal areas that bigger ships can't access. Typically, they may also be less well maintained and may therefore, present a higher risk of IAS transfer around the coast. The following types of information will assist with assessing the likelihood of non-indigenous species being introduced via recreational craft; - **Numbers and types** of recreational craft active in the country - **Main ports/marinas utilised by recreational craft** (Understanding where recreational craft are moored and travel to/from will assist authorities to understand possible secondary transfer pathways, particularly if IAS have been identified at local marinas and mooring areas)	**Whether recreational craft travel to/spend any time in sensitive sea areas** Understanding whether sensitive marine areas (such as marine protected areas) are likely to be exposed to, and therefore, impacted by, IAS is an important element in controlling significant environmental impacts.	• National Maritime Authority • Local authorities • Port companies and Harbour Authorities • Marina operators

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(c): Domestic shipping (Refer to Table 2-1) - continued		
Existing rules and operating practices for anti-fouling and biofouling management on recreational craft Recreational craft are often poorly regulated and poorly maintained. Understanding how well biofouling is controlled on recreational craft will assist in understanding what the risk is of secondary transfer around the country.		
3-1(d): Deep sea mining		
Note: If no deep sea mining activity is undertaken or planned then this pathway can be ignored for the assessment. **The main risks associated with deep sea mining relate to support ships and are addressed under shipping above.**	**The presence or absence of deep sea mining in the country** If no seabed mining activity is undertaken or planned then this pathway can be ignored for the assessment. **Types of mining equipment and vessels present in the country** Different types of equipment and ships present different risk profiles. Mobile subsea equipment should be thoroughly assessed before it is deployed offshore to ensure it is clean from previous activities. **The primary ports used by the deep sea mining sector** Knowledge of the ports used to support the mining industry will help authorities to better understand where the areas of greatest risk are for this pathway.	• National economic development plans • Marine spatial plans • Port companies/ Harbour authorities • National Maritime Authority • National mineral licencing authority • Mining companies • Oil and gas industry regulators • Service companies • International and national trade associations

Table 3-1: Baseline information needs for transfer pathways - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-1(e): Buoys, measuring devices & scientific instruments		
	Whether scientific instruments are deployed in the country's waters and, if so, how they are tracked and maintained Floating buoys can be an important pathway for IAS since they are left in the water for extended period and can drift unattended for extended period. Understanding how these are maintained and how they are tracked is important to assessing whether they present a risk of IAS introduction/ transfer.	• Universities • National research institutes • National GOOS coordinator

3.1.2 Facilities and structures that aid settlement of IAS

Table 3-2: Baseline information needs for facilities and structures

Core Information Needs	Supplementary Information Needs	Information Sources
3-2(a): Port & marina facilities		
Countrywide port facilities Understanding the relative importance of different ports and the movements of ships and structures between them will allow the assessment team to better understand what the relative risks/impacts may be for different ports around the country, thereby allowing a process of risk prioritisation. The following types of information will assist with assessing the risks associated with IAS settlement in ports; - Location of primary and secondary ports - Knowledge about the types of infrastructure/ construction present in ports (Understanding the sorts of structures and the type of construction will provide important information to assess how susceptible they are to IAS colonisation) - Knowledge about the facilities and services provided in ports (Certain maintenance activities (e.g. in-water cleaning and grooming, and hull cleaning on a hard stand without containment of waste) may increase the risk of IAS spread through the direct release of organisms to the water column or by promoting spawning. The type of facility offered in a port, and the control in place at that facility, can have a significant bearing on whether IAS are more likely to be released to the marine environment) - Knowledge about the sectors supported by different ports and the movements of vessels between them.		• Hydrographic charts • Marine spatial planning maps • National economic development plans • Port companies/ Harbour authorities

Table 3-2: Baseline information needs for facilities and structures - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-2(a): Port & marina facilities - continued		
	Knowledge of previous IAS incursions in ports Any information about previous IAS incursions will give important information about how susceptible different port facilities may be the introduction and spread of new IAS. Information relating to how well understood and described local oceanographic conditions are. Understanding oceanographic conditions is an important factor in understanding how IAS may be naturally spread from region to region, as well as understanding which areas may have environmental conditions that may favour the settlement and spread of certain IAS.	• National biosecurity agencies • Scientific research institutions and research reports • Tidal atlas - for general coastal currents • Hydrodynamic modelling - for more detailed coastal and offshore currents. • Areas of known upwelling and high productivity • Environmental status assessment reports - such as the diagnostic analysis created under the GEF supported LME Programme
Marinas and other recreational boating centres Marina facilities are frequented by small commercial and recreational craft and can therefore, be the first entry point for IAS providing suitable habitats for secondary spread via domestic craft. Understanding the nature of marine facilities and the movement of vessels between them will allow the assessment team to better understand what the relative risks/impacts may be for marine facilities. The following types of information will assist with assessing the risks associated with IAS settlement in marinas; - **Location of marina and mooring facilities** - **Knowledge about the types of infrastructure at marinas and other recreational boating centres** (Understanding the sorts of structures and the type of construction will provide important information to assess how susceptible recreational boating infrastructure is to IAS colonisation). - **Knowledge about the types of facilities/ services provided at marinas and other recreational boating centres** (Understanding what specific support services (e.g. vessel repair and maintenance facilities) will provide information whether specific facilities are at a greater risk of IAS introduction than others.	**Compliance with environmental requirement** The level of compliance to environmental requirements, such as containment of chemical and biological wastes, by individuals and facilities undertaking vessel maintenance will inform risk.	• Hydrographic charts • Marine spatial planning maps • Harbour master / marine operators • National Maritime Authority • Port companies/ Harbour authorities • Recreational boating associations and industry trade groups

Table 3-2: Baseline information needs for facilities and structures - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-2(b): Offshore oil & gas		
Note: If no oil and gas activity is undertaken or planned then this sector can be ignored for the assessment. **Offshore oil and gas operations** Offshore oil and gas platforms provide a suitable surface for biofouling accumulation which, because of the length of time they spend in water, can support extensive and well developed biofouling communities. These communities can then provide a source of biofouling organisms that can be spread via natural and human mediated transfer pathways (e.g. offshore supply vessels). Understanding the risks and control measures associated with is sector. The following types of information will assist with assessing the risks associated with IAS settlement on and transfer from offshore platforms; - **Areas where offshore oil and gas operations are undertaken** - **Types of platform present including construction type and nature of operation** (Different types of structure present different risk profiles. For example, while fixed platforms will remain in situ for the duration of production operations, floating offtake and production facilities may be disconnected and brought into ports for maintenance or to avoid severe weather) - **Location of ports that service the offshore oil and gas sector** - **Movements of shuttle tankers and supply vessels to/from offshore areas** (As noted above, the movement of supply vessels (from coastal waters) may present an additional pathway for the introduction and transfer of IAS from/to offshore oil and gas structures)	**Knowledge about subsea infrastructure such as pipelines** Hard surfaces such as pipelines can provide a useful substrate for the settlement and dispersion of fouling organisms, thereby acting as stepping stones between different geographic areas and facilitating the natural spread of IAS. **Knowledge of previous IAS incursions on oil and gas platform and infrastructure** Any information about previous IAS incursions will give important information about how susceptible offshore facilities may be the introduction and spread of new IAS. **Information relating to the decommissioning of existing oil and gas platforms** The decommissioning and subsequent removal/ abandonment of oil and gas platforms can increase the risk of IAS release and transfer to coastal waters. Understanding how decommissioned platform are managed is an important element in understanding the risks associated with this sector. **Knowledge about industry specific initiatives to address biofouling** Oil and gas companies may have their own internal procedures and initiatives to deal with IAS. These can be a useful source of information and capacity development in countries with limited IAS experience.	• National economic development plans • Marine spatial plans • Port companies/ Harbour authorities • National Maritime Authority • National oil and gas licencing authority • Oil and gas companies • Oil and gas industry regulators • Service companies • International and national trade associations

Table 3-2: Baseline information needs for facilities and structures - continued

<table>
<tr><th>Core Information Needs</th><th>Supplementary Information Needs</th><th>Information Sources</th></tr>
<tr><td colspan="3">3-2(c): Aquaculture</td></tr>
<tr><td>Note: If no aquaculture activity is undertaken or planned then this pathway can be ignored for the assessment.

The following types of information will assist with assessing the risks associated with IAS settlement on and transfer from offshore platforms;
- Main areas of aquaculture operation (Knowing where aquaculture operations are carried out and their proximity to areas where IAS may be present (e.g. ports and shipping routes) will assist authorities to understand what the risk is of fouling associated with this sector. Also proximity to sensitive marine habitats such as MPAS should be considered in terms of the risk of IAS spread)
- Types of aquaculture structures/species cultured in the country (Any immersed structure or surface will be colonised by biofouling unless effective anti-fouling systems are in use. The location, density and proximity of different farms will also provide useful information about the risk of this pathway spreading IAS)</td><td>Presence of IAS
Aquaculture equipment and infrastructure needs to be surveyed for established IAS which could be spread to other facilities or the environment by farming operations

Knowledge of how aquaculture structures are transported to sites and how they are treated/prepared before deployment
Knowledge of current inspection and cleaning practices will allow authorities to assess if existing biofouling management practices are sufficient to manage any risks. Having quarantine conditions for imported aquaculture equipment and how these are enforced is an important element in this regard.

Knowledge about industry specific initiatives to address biofouling
Aquaculture companies may have their own internal procedures and initiatives to deal with biofouling and IAS. These can be a useful source of information and capacity development in countries with limited IAS experience.</td><td>• Fishery Department records - e.g. aquaculture licence records
• Aquaculture industry
• Marine spatial plans
• International and national trade associations</td></tr>
</table>

Table 3-2: Baseline information needs for facilities and structures - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-2(d): Marine renewable energy		
Note: If no marine renewable activity is undertaken or planned then this sector can be ignored for the assessment.	**The presence or absence of renewable energy structures in the country** If marine renewable energy is not currently or planned as part of the power generation infrastructure then this pathway can be ignored for the assessment. **Types of renewable energy structure in the country** Any immersed structure or surface will be colonised by biofouling unless effective anti-fouling systems are in use. The density and proximity of different offshore energy areas will also provide useful information about the risk of this pathway spreading IAS. **Main areas of marine renewable energy generation** Knowing the main areas where marine renewable energy is generated (e.g offshore wind farms) and their proximity to areas where IAS may be present (e.g. ports and shipping routes) will assist authorities to understand what the risk is of fouling associated with this sector. Also proximity to sensitive marine habitats such as MPAS should be considered in terms of the risk of IAS spread. **Movements of support vessels to offshore areas** The movement of support vessels such as heavy lift cranes (from overseas or from coastal waters) and supply vessels (from national ports) may present an additional pathway for the introduction and transfer of IAS from/to renewable energy structures.	• National Maritime Authority • Energy ministry • National power/utility companies • Marine spatial plans • International and national trade associations

Table 3-2: Baseline information needs for facilities and structures - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-2(d): Marine renewable energy - continued		
	Knowledge about industry specific initiatives to address biofouling Energy companies may have their own internal procedures and initiatives to deal with biofouling and its impact on operations. These can be a useful source of information and capacity development in countries with limited IAS experience.	

3.2 Marine Environmental Resources at Risk

The habitats and features along the world's coastline are highly varied—from the flat, tidal deltas of South Asia, to the mangrove and coral reef-lined shores of tropical regions (such as the Caribbean Sea), to the rugged, rocky coastline of North East Europe (see below).

Ecosystem Type	Description	Habitat types supported
Marine inlets and tidal waters	Ecosystems on the land-water surface under the influence of tides. They include coastal wetlands, lagoons, estuaries and other transitional (tidal) waters, fjords and other embayments.	• Mangroves • Salt marshes • Sea grass beds • Mud flats • Rocky shores and sea cliffs
Coastal areas	Coastal, shallow, subtidal, marine systems that experience significant land-based influences. These systems undergo daily fluctuations in temperature, salinity and turbidity and are subject to wave disturbance. Depth is up to 50-70 m.	• Sea grass beds • Kelp forests and rocky reefs • Biogenic (coral, bryozoan, oyster) reefs
Shelf	Marine systems away from coastal influence, down to the shelf break. They experience more stable temperature salinity regimes than coastal systems and their seabed is below wave disturbance. Depth is up to 200 m.	• Soft sediments • Deep water corals • Sponge beds • Hydrothermal vent systems • Pelagic water column • Deep seabed
Open ocean	Marine systems beyond the shelf break with stable temperature and salinity profiles, in particular in the deep sea bed. Depth is beyond 200 m.	• Pelagic water column • Deep seabed

Being among the most productive waters in the world, coastal and shallow shelf ecosystems support a broad range of uses and activities as well as providing important services that support livelihoods and protection of coastal communities. These include:

- marine habitats and ecosystems that provide many of the services provided by the ocean (for example: fish stocks; coral reef systems; beach and water quality; mangroves; etc.), which help support the more visible economic outputs such as employment and wealth creation, as well as various non-market contributions such as the cultural and amenity values that society enjoys;
- living marine resources that are harvested (such as for fisheries), that support the livelihoods of communities and contribute significantly to global protein supplies; and
- non-living marine resources extracted from the seabed (such as oil and gas and minerals), that provide a range of raw materials and energy sources.

The specific type of habitat present determines the resources that may be present and is therefore, a factor in determining both the potential for IAS settlement/ spreading and the vulnerability and resilience of an area to a particular pressure including IAS. Environmental stressors may also increase the vulnerability of coastal ecosystems to IAS. For example, coastal ecosystems that are heavily degraded (e.g. through habitat disturbance, coastal constructions, overfishing or marine pollution) may be more vulnerable to the impacts of IAS than healthy and diverse marine habitats.

Table 3-3: Baseline information needs for marine environmental resources

Core Information Needs	Supplementary Information Needs	Information Sources
3-3(a): Marine environmental resources		
Information about the presence and distribution of key coastal habitat types such as rocky reefs, coral reefs, mangroves, seagrasses etc Knowledge about different types of habitat and the resources they support is important in determining how likely it is that IAS may settle and spread as well as the potential impacts that IAS may have on local ecosystems. Such information may be present in a wide range of different formats and coverage is likely to vary around the coast. Understanding how accurate surveys are, when they were last conducted and what percentage of the coastal line has been comprehensively surveyed will all contribute to understanding how reliable any assessment of IAS impact may be.	**The extent to which critical habitats (e.g. spawning and nursery areas) have been surveyed and mapped** In terms of assessing impacts, the most sensitive and vulnerable sites may be those that are highly productive and that are keystone habitats for local marine ecosystems. For the most environmentally important areas, these may have been identified as marine protected areas or marine reserves and may have site specific management plans that provide vital information about their location and the resources they support.	• Hydrographic charts • Marine landscape and habitat maps • National GIS data services • Coastal sensitivity maps - such as those prepared as part of an oil spill contingency plan • Coastal resources atlas • MPA management plans • Environmental status assessment reports • Environmental impact assessment reports • Marine spatial planning maps • Scientific research studies • Local knowledge (e.g. fishermen and indigenous communities)

Table 3-3: Baseline information needs for marine environmental resources - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-3(a): Marine environmental resources - continued		
Knowledge about which marine resources are considered economically important and their relative importance A critical need in understanding risk to assess those biological resources that might be of economic as well as environmental importance. This particularly include fishery resources but also areas that support ecotourism operations such as SCUBA diving, wildlife watching etc)	**How well understood the diversity and abundance of marine biodiversity is** A healthy and diverse marine ecosystem is more resistant to the introduction of IAS. Understanding ecosystem health and the level of marine biodiversity will enable authorities to better understand how resilient marine ecosystems may be to AS introduction and what, if any, environmental impacts may arise. **The key areas supporting biodiversity and their location** Some areas may be considered to be "biodiversity hotspots" and may warrant a greater level of scrutiny and protection to ensure they are not adversely impacted by. This is important if resources are limited and efforts to control and manage need to be prioritised. For the most environmentally important areas, these may have been identified as marine protected areas or marine reserves and may have site specific management plans that provide vital information about their location and the resources they support. **Knowledge about species that are endangered or at risk (such as those listed in the IUCN Red List)** Similarly, knowledge about species "at risk" needs to be included in any assessment of potential impacts.	

Table 3-3: Baseline information needs for marine environmental resources - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-3(b): Protected areas or areas of special significance		
	Knowledge of what areas have been designated for special protection either under international law or domestic law (eg Marine Parks, Conservation Areas, World Heritage Estates, Culturally Significant Areas, PSSAs, Ramsar wetlands) As noted above, certain areas may be considered to be “biodiversity hotspots” and may warrant a greater level of scrutiny and protection to ensure they are not adversely impacted by IAS. This is important if resources are limited and efforts to control and manage IAS need to be prioritised. Information should be included relating to areal coverage, accessibility types (I.e. use for tourism, artisanal / traditional fishing practices, etc.) **Knowledge about areas that might have special or traditional management rights (e.g. under cultural or traditional governance structures)** Many countries recognize local community and traditional forms of coastal management and stewardship that may contrast or conflict with more contemporary governance arrangements. In these cases, the engagement of local communities and traditional managers is of vital importance to ensure they are involved in decision-making.	• Hydrographic charts • Marine spatial planning maps • National Maritime Authorities • National or State Conservation Agencies • Biodiversity Action Plans • MPA management plans

Table 3-3: Baseline information needs for marine environmental resources - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-3(c): History of adverse environmental impacts		
Evidence of a history of environmental decline (e.g. through coastal pollution, habitat modification or overfishing) and knowledge of what other environmental threats are known to impact the area (e.g. areas of high coastal population or industry) It is well understood that those coastal habitats and ecosystems that are compromised or stressed are more vulnerable to external threats such as from IAS. Understanding which habitats have been impacted and the extent of the impact may be a good predictor of which areas may be most at risk of IAS introduction and spread. **Evidence or knowledge of previous IAS introductions and impacts** Again, this might be an important predictor of the potential impacts of IAS and how they might react if introduced in specific areas. Furthermore, this information may highlight the existence of certain regions in the country that can be more susceptible to the secondary spread of IAS, indicating the need to monitor pathways to other regions in the country.		• Environmental status assessment reports - such as the diagnostic analysis created under the GEF supported Large Marine Ecosystem Programme • National State of the Marine Environment Reports • Regular environmental quality monitoring undertaken by Environmental management Agencies • Environmental impact assessment reports - such as those prepared in support of offshore oil and gas projects • Local knowledge (e.g. fishermen) • Scientific research studies

3.3 Socio-Economic Activities at Risk

3.3.1 Fisheries & aquaculture

Seafood and fisheries have traditionally been crucially important for the food security of coastal and island nations. For some less well-developed countries, seafood and fishery products represent the primary source of animal protein for the local population. Marine fisheries also represent an important part of the local economy providing food security, job opportunities, income and livelihoods as well as traditional cultural identity. In 2018, an estimated 39 million people were engaged (on a full-time, part-time or occasional basis) in the primary sector of capture fisheries. Maintaining the long-term prosperity and sustainability of marine fisheries is therefore, not only of ecological importance but also of economic and social significance.

As noted in Section 3.2, aquaculture has increased significantly in recent years as a response to the dwindling natural stocks of fish. Aquaculture is now the fastest growing food production sector in the world and over half of all the fish and shellfish we now consume is produced through aquaculture. In addition, the growing development of seaweed aquaculture now represents almost half of global mariculture production. Aquaculture therefore, represents a significant and high value economic sector in many coastal and island nations.

Table 3-4: Baseline information needs for fisheries and aquaculture

Core Information Needs	Supplementary Information Needs	Information Sources
3-4(a): Capture fisheries		
Economic importance of fisheries to the country Fisheries can play an important (and often complex) role in the economies of coastal and island nations. Depending on the species harvested, fisheries may be highly vulnerable to the introduction and spread of IAS. In order to understand the potential economic impacts of IAS to the fisheries sector it is necessary to understand how fisheries contributes to the local economy. Consider metrics such as (landed value; % GDP; number of jobs supported; number of households supported etc).	**The types of fishing activity that are characteristic of the sector (e.g. artisanal versus industrial) and the main fishing areas** Understanding the different components of the fishery, what types of vessel and equipment are used, and where fishing effort takes place will be useful to understand whether the risk across the fisheries sector is equal or whether certain sub-sectors may be more at risk. This could particularly be the case where large vessels that fish overseas are also operating in national waters. **Knowledge of the critical species fished, the status of those stocks and knowledge about the critical areas for fisheries** Information about the key species fished is not only important from an economic perspective but also to understand how vulnerable key fishery resources may be to IAS. In addition, knowledge about the key areas that support fisheries (e.g. spawning and nursery sites) will provide important information about those areas that may require greater scrutiny in terms of IAS species that may result in ecosystem modification.	• National economic development plans • Economic indicators relating to the fishery value chain • Fishery Department records - e.g. vessel licence records • Historical catch/ landing statistics • Fishing sector profiles undertaken by government • Fishery stock assessments • Habitat and species distribution maps • Fishery management plans • Fishing industry • Scientific research studies
How IAS may impact fisheries and knowledge of any previous IAS incursions Any information about previous IAS incursions will give important information about how susceptible capture fisheries may be the introduction and spread of new IAS.		• National biosecurity agencies • Fishing industry • Fishery Department • Scientific research institutions and research reports

Table 3-4: Baseline information needs for fisheries and aquaculture - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-4(a): Capture fisheries - continued		
	Existence of any traditional, cultural or community-based fishery managed arrangements In some countries, governance of fisheries may include a level of local/ community engagement through, for example, community based fishery cooperatives of traditional fishery management practices. In these cases it will be necessary to engage directly with those groups with responsibility for managing local fishery resources in order to: (a) raise awareness of the risks posed by IAS; (b) better understand the specific nature of the fishery resource at risk; and (c) to agree on what, if any, management measures may be	• Fishing sector profiles undertaken by government • Fishery management plans • Fishery Department records • Community fishery cooperatives • Local NGOs
3-4(b): Aquaculture		
The economic value of the aquaculture sector In order to understand the potential economic impacts of IAS to the aquaculture sector it is necessary to understand how aquaculture contributes to the local economy. Consider metrics such as: total aquaculture production by target species; contribution to GDP; number of jobs supported; number of households supported etc. **Main areas for aquaculture development** Similarly, understand the proximity of key aquaculture sites to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable aquaculture facilities might be to the spread of IAS once introduced.	**Species cultured and types of aquaculture are practiced** IAS may impact both the culture species directly (e.g. impacting growth of shellfish) or indirectly by fouling the structures that support them (e.g. through affecting the flow of water through sea cages) Depending on the species cultured therefore, aquaculture may be highly vulnerable to the introduction and spread of IAS. It is important therefore, to understand what types of culture and species are present in the specific country.	• National economic development plans • Marine spatial planning maps • Fishery Department records - e.g. aquaculture licence records • Aquaculture industry
How IAS may impact aquacultures and knowledge of any previous IAS incursions Any information about previous IAS incursions will give important information about how susceptible aquaculture may be the introduction and spread of new IAS.		• National biosecurity agencies • Fishing industry • Fishery Department • Scientific research institutions and research reports

3.3.2 Tourism, leisure and amenity

For many coastal and island nations, the tourism and leisure sector represents one of the primary and most consistent income generators. In many islands, tourism receipts can represent in excess of 50% of GDP and a significant proportion of the country's exports. Tourism can also be a major generator of employment with millions of workers directly depending on tourism for their living in sectors such as hotels, travel agents, airlines and other passenger transportation services.

In addition, tourism not only generates economic activity and provides direct employment for many individuals but also makes an indirect contribution to economic activity in other industries such as agriculture, distribution and construction.

The tourism sector supports a number of different maritime subsectors. These include cruise ships, underwater viewing (e.g. snorkelling, SCUBA diving, glass bottomed boats etc), sport fishing and recreational boating. As a result, tourism, perhaps more so than any other economic activity, is strongly reliant on a healthy and productive marine environment. Obvious impacts to coral reefs or to fish stocks may have direct and significant impacts on tourist numbers and therefore, local jobs and government tax receipts.

IAS have been implicated in significant impacts to the tourism sector both through degradation of values associated with a "pristine" ecosystem and through impacts to the amenity of tourism resources. Biofouling can also directly impact upon tourism infrastructure and tourist craft resulting in reduced profitability of tourism operations due to cleaning requirements.

Separate to tourism, which tends to be largely a service provided for overseas visitors, coastal areas can provide significant leisure and amenity opportunities for the local population. Aside from recreational boating, which is specifically addressed under Table 3.5(c) (see page 60), such leisure and local amenity opportunities may include: leisure activities such as fishing and watersports; the availability of amenity areas for relaxation and socialising (such as beaches); and the intrinsic value of "natural space" and wildlife.

While not all of these activities may have a direct economic value associated with them, they are nevertheless extremely important from a social perspective. In addition, many coastal communities have strong traditional and cultural links and belief systems that are intrinsic to their way of life.

The importance of these leisure and amenity values should not be underestimated when assessing the potential impacts of IAS introduction and spread.

Table 3-5: Baseline information needs for tourism, leisure & amenity

Core Information Needs	Supplementary Information Needs	Information Sources
3-5(a): Tourism		
Economic importance of tourism to the country In many coastal and island nations, tourism is the single most significant driver of economic activity, supporting jobs, a strong value chain that includes numerous small and medium sized enterprises and ultimately generating government revenue. Understanding how important the sector is to the national economy is vital in understanding how the country may be impacted if IAS affects tourism facilities and services. Information such as the types and numbers of tourists visiting (e.g. cruise ship versus stay-over) and the direct and indirect economic contributions are important metrics to measure.	**The key sub-sectors of the overall tourism sector and their relative importance in terms of economic activity** The tourism sector is rarely homogeneous and different countries will develop different sub-sectors based on the specific resources that are available (e.g. SCUBA, eco-tourism, beach and resort tourism, sailing etc). In order to better understand how vulnerable the overall sector is it is important to be able to characterise the different sub-sectors and to understand how each may be impacted by IAS.	• National Statistics Office • Tourism Master Plans • Tourism companies • Tourism industry regulators
	Main areas of coastal tourism activity and the facilities/services they support Similarly, understanding the proximity of tourist areas to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable these areas may be in terms of direct impacts to the main tourist areas as well as impacts to infrastructure that supports tourism (e.g. floating platforms on coral reefs).	• Tourism Master Plans • National economic development plans • Land use plans • Marine spatial planning maps • Tourism companies • Tourism industry regulators or National Tourism Associations
	Existence of any traditional, cultural or community-managed tourism areas In some countries, access to and management of coastal areas may be either exclusively or jointly controlled by local community groups, especially where areas traditional/cultural importance are located. In these cases it will be necessary to engage directly with those groups with responsibility for managing those areas in order to: (a) raise awareness of the risks posed by IAS; (b) better understand the specific nature of what may be at risk; and (c) to agree on what, if any, management measures may be necessary to protect the areas in question.	• Tourism companies • Tourism industry regulators or National Tourism Associations • Community cooperatives • Local NGOs

Table 3-5: Baseline information needs for tourism, leisure & amenity - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-5(a): Tourism - continued		
How IAS may impact the tourism sector (and sub-sectors) and knowledge of any previous IAS incursions in respect of coastal tourism activities Any information about previous IAS incursions will give important information about how susceptible coastal tourism may be the introduction and spread of new IAS.		• Tourism companies • Tourism industry regulators or National Tourism Associations • National biosecurity agencies • Scientific research institutions and research reports
3-5(b): Leisure		
	Major uses of the coastal marine area for local leisure activities and how important these are at the national level Understanding how important coastal marine areas are from a domestic leisure perspective is an important as assessing direct economic contributions although the broad range of leisure uses may make this harder to characterise. The assessment team will need to determine the most common/ popular leisure activities and how IAS may impact them either directly or indirectly. Similarly, understanding the proximity of leisure areas to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable these areas may be. A key issue with respect to the local community will be to raise awareness of the risks associated with IAS introduction and transfer and to raise educate communities on the role they can play to prevent IAS spread through leisure activities. **Main areas for leisure and local amenity** Understanding the proximity of leisure/amenity areas to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable these areas may.	• Tourism Master Plans • National economic development plans • Land use plans • Marine spatial planning maps • Tourism companies • Tourism industry regulators or National Tourism Associations

Table 3-5: Baseline information needs for tourism, leisure & amenity - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-5(b): Leisure - continued		
	How IAS may impact leisure activities and knowledge of any previous IAS incursions in respect of coastal leisure activities Any information about previous IAS incursions will give important information about how susceptible coastal leisure may be the introduction and spread of new IAS.	• Sport and leisure companies • National biosecurity agencies • Scientific research institutions and research reports
3-5(c): Local amenity & cultural values		
	Areas or resources that are considered to have particular amenity value for coastal communities and society at large Some coastal areas will be considered "important" just because of what they are or what they offer. Such "intrinsic values", or ecosystem services, are as important to identify as more direct socio-economic benefits	• Tourism companies • Tourism industry regulators or National Tourism Associations • Community cooperatives • Local NGOs
	Existence of specific traditional or cultural linkages or belief systems with respect to coastal marine waters In some countries, the relationship between the marine environment and the local population goes further than a simple appreciation of the amenity value. Many contemporary cultures retain deep rooted cultural connections and strong cultural belief systems relating to the environment in general and the marine environment specifically. This is particularly true where areas of high traditional/ cultural importance are located, which may also include a degree of traditional community-based governance or co-management. In those countries where such cultural ties persist, understanding these relationships and the potential implications of IAS to local communities will be a critical aspect of the national self-assessment.	• Government agencies responsible for cultural affairs and indigenous peoples interests • Community cooperatives • Local NGOs

3.3.3 Critical infrastructure

Coastal regions support a wide range of infrastructure that may be critical for a country's economic development. In the context of biofouling the two categories of infrastructure that may be of most importance are desalination plants and power generation plants.

Recent climate change forecasts suggest that projected temperature increases may correlate with a decrease in annual precipitation. For many least developed countries, these projections are particularly troubling given that, in many countries, access to fresh water is already limited. To supplement their existing groundwater supplies, and to provide a degree of redundancy against drought conditions, many coastal and island countries utilise desalination as a source of supply. Most desalination plants use sea water or brackish water as their sources. Similarly, where power generation plants are located in coastal areas, they often rely on the abstraction of seawater as a coolant to maintain operational limits of the plants.

Table 3-6: Baseline information needs for critical infrastructure

Core Information Needs	Supplementary Information Needs	Information Sources
3-6(a): Desalination		
The use or potential use of desalination as a component of the national potable/ sweet water supply and the relative importance of this source at the national level Salt water intakes for desalination plants can be seriously affected by fouling organisms, resulting in costly maintenance and repair activities and potentially directly impacted fresh water supply in those areas that rely largely or exclusively on desalination. It is important to understand how important the contribution of desalinated water to the over fresh water supply is in countries that use this technology. **The location of existing desalination facilities and their proximity to major ports and other maritime support facilities** Knowledge of where such facilities exist and their proximity to areas that may pose a risk of IAS introduction is an important element in understand the risk to these facilities.		• National infrastructure plans • National utility operators • Relevant line ministry • Plant operators • Topographic maps • Hydrographic charts • National economic development plans

Table 3-6: Baseline information needs for critical infrastructure - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-6(a): Desalination - continued		
How IAS may impact existing desalination infrastructure and knowledge of any previous IAS incursions that have affected desalination infrastructure Any information about previous biofouling issues at desalination facilities will give important information about how susceptible such infrastructure may be the introduction and spread of new IAS. This should include details about what, if any, facility specific contingency plans exist to deal with IAS incursion should one occur.		
3-6(b): Power generation		
The existence of any power generation plants that utilise seawater cooling systems, and the relative importance of such facilities in terms of the overall national power generation capacity Salt water intakes for power generation plants can be seriously affected by fouling organisms, resulting in costly maintenance and repair activities and potentially directly impacted power supply to those areas that rely on these plants. It is important to understand how what proportion of energy may be generated from such coastal plants in order to understand how vulnerable the overall power supply may be to IAS incursions. **The location of existing power generation plants and their proximity to major ports and other maritime support facilities** Knowledge of where such facilities exist and their proximity to areas that may pose a risk of IAS introduction is an important element in understand the risk to these facilities. **How IAS may impact existing power generation plants and knowledge of any previous IAS incursions that have affected desalination infrastructure** Any information about previous biofouling issues at power generation plants will give important information about how susceptible such infrastructure may be the introduction and spread of new IAS. This should include details about what, if any, facility specific contingency plans exist to deal with IAS incursion should one occur.		• Topographic maps • Hydrographic charts • National economic development plans • National infrastructure plans • National utility operators • Relevant line ministry • Plant operators

3.3.4 Offshore oil and gas

In 2015, more than 27 million barrels of oil were produced offshore in more than 50 different countries.[17] As such offshore oil and gas resources is an important component of the national economies of many countries.

While some maritime industries generate significant numbers of (often low skilled) jobs, the offshore oil and gas supports far fewer jobs and is often reliant, initially at least, on the support of highly skilled expatriate workers. However, in countries that have developed emerging offshore oil and gas industries, the key benefit in terms of employment comes from the provision of education and training for local workers who are then employed in high skilled positions such as heavy engineering, science and business administration.

By far the greatest economic contribution derived by countries for the oil and gas sector comes, however, from the significant government revenue streams that can be levied on the production and export of oil and gas. In some cases, these revenues can be sufficient to transform entire economies and to support significant government investment in national infrastructure, which in turn can catalyse investment in other economic sectors.

[17] Source: US Energy Information Administration. https://www.eia.gov/todayinenergy/detail.php?id=28492

Table 3-7: Baseline information needs for offshore oil and gas

Core Information Needs	Supplementary Information Needs	Information Sources
3-7(a): Offshore oil & gas		
	Economic importance of oil and gas to the country Understanding how important oil and gas is to the national economy is important in understanding how the country may be impacted if IAS affects offshore production activities. While IAS is unlikely to have long-term economic impacts, the need to clean and maintain facilities, as a result of fouling, may require lengthy shut production shut-downs which may, in turn, impact government revenue flows in the short-term.	• Historical production statistics • Treasury/Finance indicators relating the oil and gas sector • National Statistics Office • National oil and gas licencing authority
	Main areas of oil and gas exploration and production Similarly, understand the proximity of offshore oil and gas concessions to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable oil and gas infrastructure may be to the spread of IAS once introduced.	• Hydrographic charts • Marine spatial planning maps • National oil and gas licencing authority • National Maritime Authority • Oil and gas companies

Table 3-7: Baseline information needs for offshore oil and gas - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-7(a): Offshore oil & gas - continued		
	How IAS may impact the oil and gas sector and knowledge of any previous IAS incursions in respect of oil and gas operations Any information about previous IAS incursions will give important information about how susceptible the oil and gas sector may be the introduction and spread of new IAS.	• Oil and gas companies • National biosecurity agencies • Scientific research institutions and research reports

3.3.5 Marine renewable energy

With global concerns increasing over the impacts of climate change, and the need to decarbonise economies, for countries and territories that have extensive maritime areas, renewable marine energy can make a significant contribution to low-carbon electricity production in the energy mix. This is particularly the case with islands that are not interconnected with continental networks, and which rely on the import of oil and gas-based fuels such as diesel and heavy fuel oil for power generation.

For large countries, with the right infrastructure, the marine renewable energy sector may provide opportunities to develop engineering and support services geared towards the development of the sector both at home and in neighbouring countries. For all countries, given the right economies of scale, investment in renewable energy supplies can provide additional security of supply, driving investment in local businesses thereby helping to create jobs and lift living standards.

Table 3-8: Baseline information needs for marine renewable energy

Core Information Needs	Supplementary Information Needs	Information Sources
3-8(a): Marine renewable energy		
	Economic importance renewable energy to the country Understanding how important renewable energy is to the national economy is important in understanding how the country may be impacted if IAS affects offshore production activities. The need to clean and maintain facilities, as a result of fouling, may require lengthy production shut-downs which may, in turn, impact energy supply. Consider metrics such as (% electricity generated; carbon reduction targets; number of households supplied; number of jobs supported etc).	• Ministry responsible for energy • National economic development plans • Sector development plans or strategies • National Statistic Department

Table 3-8: Baseline information needs for marine renewable energy - continued

Core Information Needs	Supplementary Information Needs	Information Sources
3-8(a): Marine renewable energy - continued		
	Main areas of marine renewable energy activity Similarly, understand the proximity of marine renewable energy areas to other areas that may pose a risk of IAS introduction (e.g. ports) will provide vital information to understand how vulnerable renewable energy infrastructure may be to the spread of IAS once introduced.	• Hydrographic charts • Offshore licence block maps - usually through the relevant ministry responsible for energy of marine planning • Marine spatial planning maps • National Maritime Authority
	How IAS may impact the renewable energy sector and knowledge of any previous IAS incursions in respect of marine renewable energy operations Any information about previous IAS incursions will give important information about how susceptible the energy infrastructure may be the introduction and spread of new IAS.	• Energy companies • National biosecurity agencies • Scientific research institutions and research reports

3.4 Existing Policy, Legal and Institutional Arrangements

The development of any new biofouling management framework will not occur in isolation, but in the broader context of what arrangements currently exist to address IAS. The specific elements of such a framework were discussed in section 3.2, namely:

- Policy and legal frameworks to establish national standards against which such risks can be assessed and controlled
- Institutional arrangements to manage and respond to the risks posed by biofouling
- Technical capacity to effectively implement those policy and legal frameworks
- Relevant infrastructure and facilities to respond to an identified biofouling risk; and
- Emergency response capacity to deal with biofouling incursions

To determine what, if any reforms may be required, it is necessary to broadly understand the existing arrangements as part of the baseline assessment. The information outlined in Table 3-9 (see next page) should be considered to be core information.

Table 3-9: Baseline information needs for biofouling management arrangements

Core Information Needs	Information Sources
3-9(a): Policy & legal framework	
Knowledge of those international instruments the Government is party to with respect to biofouling and IAS management This is helpful in understanding the Government's overall commitment to dealing with biofouling/IAS issues and may also indicate the existence of policy and institutional arrangements that may easily be adapted to biofouling management. **Existing national legal instruments in place that give effect to relevant international instruments and/or address biofouling management** Similarly this may indicate an existing legal framework that may already address biofouling or can easily be adopted for biofouling. This could either be in the form of an overarching Biofouling Act or the treatment of IAS/biofouling in sector-specific legislation (e.g. a Shipping Act) **Existing national policy framework relating to biofouling management and IAS** The existence of a policy framework that addresses IAS/biofouling (e.g. a Biosecurity Policy or a National Ocean Policy) is important to establish the high level goals and objectives for the government in terms of tackling biofouling risks. If it exists, it may provide useful guidance for the subsequent development of the national biofouling management framework. The assessment team should seek to understand and characterise the overall policy and legal arrangements that may exist for biofouling/IAS management in order to present a comprehensive picture of what, if any, policy and legal arrangements already exist.	• Ministry responsible for Foreign Affairs • National Maritime Administration • National biosecurity agency • Other agencies responsible for managing specific marine sectors and maritime space.
3-9(b): Institutional arrangements	
Existing government structures at the national level, including whether any devolved authorities have functional and statutory responsibility for biofouling and IAS (e.g. States or Provinces) Responsibility for managing biofouling and IAS incursions may fall under different jurisdictions depending on the specific government structures in place. For example, in a Federal/State system, different levels of government will have responsibility for biofouling/IAS but in different parts of the country's offshore waters. It is critical to understand: (a) what these jurisdictional boundaries are; and (b) how the different levels of government coordinate to ensure seamless management of this cross-border issue.	• Cabinet office • National Maritime Administration • National biosecurity agency • Other agencies responsible for managing specific marine sectors and maritime space.

Table 3-9: Baseline information needs for biofouling management arrangements - continued

<table>
<tr><th>Core Information Needs</th><th>Information Sources</th></tr>
<tr><td colspan="2">3-9(b): Institutional arrangements - continued</td></tr>
<tr><td>Which agencies have primary responsibility for managing and responding to IAS incursions
There is a need to ensure that at least one government agency has oversight and responsibility for biofouling/IAS management to ensure that an effective biofouling management framework can be implemented, at least in part.

The assessment team should seek to understand which agencies might have responsibility either in terms of an existing statutory role or based on historical acceptance that the agency is responsible for this. This will help in informing the future design of appropriate institutional reforms for biofouling management.

The assessment team should seek to determine such as aspects as:
• The current capacity that exists within the main agencies to address biofouling management.
• Existing coordination mechanisms to allow across government coordination of biofouling/IAS matters.
• The role, if any, that the private sector plays in terms of biofouling management and decision-making.</td><td>• Ministry responsible for Foreign Affairs
• National Maritime Administration
• National biosecurity agency
• Other agencies responsible for managing specific marine sectors and maritime space.</td></tr>
<tr><td colspan="2">3-9(c): Technical capacity</td></tr>
<tr><td>The technical capacity that currently exists and what, if any, capacity gaps can be identified
As noted above, in order to fulfil the specific management requirements relating to biofouling, some capacity may be required at different levels within government.

The assessment team should refer to Section 3.1 (see page 36) above to identify what capacity currently exists, where the capacity gaps lie and what are the perceived priorities in terms of filling identified capacity gaps.</td><td>• All agencies and institutions that may be involved in or have a role to play in biofouling management.</td></tr>
<tr><td colspan="2">3-9(d): Infrastructure & facilities</td></tr>
<tr><td>Existing infrastructure and facilities to provide services to support the control and management of ships and mobile structures identified as presenting a high risk of IAS introduction
In order to understand how authorities might be able to deal with ships and mobile structures that are heavily bio fouled, it is important that the assessment identifies the full range of facilities that are available throughout the country. This should include dry-dock facilities, haul out and hardstand facilities and in water cleaning capability.

For each of these it will be important to note what the maximum size of ships/structure is that can be accommodated and what, if any, controls exist to ensure that the facility does not increase the risk of IAS release to the marine environment.

Details of the existing legal controls that exist in relation to these facilities and activities will also be useful in determining how easily they can be deployed in an emergency situation.</td><td>• Marine spatial plans
• Port companies and Harbour Authorities
• National Maritime Authority
• Local authorities
• Service companies</td></tr>
</table>

Table 3-9: Baseline information needs for biofouling management arrangements - continued

Core Information Needs	Information Sources
3-9(e): Emergency response capacity	
Whether emergency response procedures exist to deal with the spread of IAS once released into coastal waters In the event that a ship or floating structure is identified with high levels of biofouling, or where an IAS is identified as having established in coastal waters, it will be important for the relevant authorities to mount an effective and timely response to mitigate the risk. Many countries will already have contingency planning arrangement in place for other types of emergency response (e.g. oil spills, fire etc). Similarly, a national biofouling contingency plan will assist with defining roles and responsibilities of the various agencies that need to be involved. The assessment team should determine whether any such response arrangements currently exist (and have been tested).	• National biosecurity management agency

4 Evaluating Biofouling Risks

It is widely accepted that proactively preventing the introduction of an IAS is a more effective strategy than reactively eliminating one that has already become established. To this end, several countries have adopted risk-based approaches to assess and prioritise the different transfer pathways, in combination with management controls for detecting and responding to border incursions.

Having gathered the baseline information that is described in Chapter 3, the next step is to assess and interpret that information to determine whether there is a risk of IAS introduction via biofouling.

Understanding the risk of IAS establishment and impact relies on information about the probability of a potential IAS arriving via a specific transfer pathway, the favourability of the environment and ecosystems to IAS establishment and spread, the specific resources that may be at risk from the impacts of IAS and the measures or controls in place to manage the risk.

4.1 Assessing the Likelihood of IAS Introduction

The ability to identify and assess pathways that are considered to be 'high risk' is an important consideration in establishing a national biofouling management framework. The first step in determining the overall risk of IAS introduction is therefore, to identify and assess all available biofouling transfer pathways in terms of: its capacity to transfer organisms; its geographic origin and its relative size/frequency compared to other pathways.

The first question that should be posed by the assessment team therefore, should be:

IS THERE A LIKELIHOOD OF IAS BEING INTRODUCED INTO THE COUNTRY VIA BIOFOULING?

The following questions may help to frame this analysis:

1) Which specific primary transfer pathways are known to exist?
The presence of a transfer pathway makes IAS introduction possible. The presence or absence of a specific pathway therefore, allows the assessment team to determine whether that pathway presents a risk of IAS introduction or not. In many countries shipping may be the only identifiable pathway, in which case the assessment team need only focus on information relating to shipping. In other countries, several pathways may be known to exist and may therefore, require a greater effort in terms of interpretation and analysis.

The various transfer pathways are described in *Section 2.3* (see page 13). Information collected under *Table 3-1(a)* (see page 37) will allow the assessment team to determine which, if any, primary transfer pathways exist that could introduce IAS to the country.

2) For each transfer pathway known to exist, what is the profile for each pathway in terms of the level of activity and the specific types of ship or structure visiting?
For each of the pathways known to exist in the country the degree to which it is present will have a direct bearing on the level of risk. In simple terms, the greater the number of ships or structures that visit the country's waters, the greater the chance of IAS introduction. Within this cumulative risk, the numbers of a specific type of ship or structure contribute individual risk, and these may each have different risk profiles based on the factors described in *Table 2-2* (see page 17).

Information relating to biofouling for the various transfer pathways is also presented in *Section 2.3* (see page 13). The information collected under *Table 3-1(a)* (see page 37) will help to determine the specific profile associated which each of the existing pathways.

3) Have any of the existing transfer pathways travelled from/through areas that have similar environmental conditions to the recipient port/region?
IAS have a greater chance of settling and establishing in waters that have similar environmental conditions to the waters of origin. Knowing where specific pathways originate will help to understand this factor.

Information collected under *Table 3-1(a)* (see page 37) will help to determine the specific routes that certain pathways follow, while information collected under *Table 3-3* (see page 51) will help to characterise the environmental conditions present in the recipient region.

4) Have any of the existing transfer pathways travelled from/through areas known to have IAS already present?
Knowledge or areas visited that are already known to have been invaded by IAS may indicate an increased risk of IAS transfer from pathways travelling from those areas. Of importance are locations where a vessel may have spent extended periods, particularly if idle or operating at only low speeds. The extent to which a country already has arrangements to share information with other Coastal States (such as through the various PSC Agreements) may assist in understanding this issue.

4.2 Assessing the Likelihood of IAS Spreading

Once settled and established in an area, the subsequent spreading and distribution of an organism can be by natural dispersal, if conditions are favourable, or through the presence of secondary transfer pathways. Built structures, such as piers and marinas, may also act as 'stepping stones' to facilitate range expansion. Identifying and assessing such secondary pathways is therefore, the next step in determining the overall risk associated with IAS introduction.

The second question that should be posed by the assessment team therefore, should be:

ONCE INTRODUCED, IS THERE A LIKELIHOOD THAT IAS MAY BE SPREAD MORE WIDELY THROUGHOUT THE COUNTRY'S COASTAL WATERS?

The following questions may help to frame this analysis:

1) What possible facilities could act as settlement sinks and sources for secondary transfer for IAS?
The potential for an IAS to become established once introduced relies on the presence of suitable substrates, which then present the risk of the organism being transported to other regions via secondary transfer pathways.

Information collected under *Table 3-2* (see page 45) will provide information to assess the range of suitable substrates. The focus should be on those facilities and structures that might facilitate the settlement and subsequent spreading of IAS once introduced via a primary pathway as well as the presence and proximity of hard structures that could act as stepping stones.

2) If IAS have already been identified in the country, which areas/regions are known to be affected?
If a country has a history of previous incursions this may provide an indication that the country may have: (a) favourable environmental conditions to facilitate the establishment and spread of IAS; and/or (b) inadequate border control measures to prevent IAS incursion. Knowledge of areas where IAS may already exist, in combination with knowledge about the presence and distribution of secondary transfer pathways may indicate a far greater likelihood of IAS transfer and spreading more widely around the coast.

The information collected under *Table 3-3(c)* (see page 54) will provide information to assist in determining those areas of that may have already been compromised by IAS introduction or that may be more susceptible to IAS colonisation due to being degraded by other pressures. Areas such as ports and marinas would be particularly important in this regard.

3) Which specific secondary transfer pathways are known to exist?
Knowledge about the secondary transfer pathways and the areas in which they operate, will allow the assessment team to better understand the potential for spreading of IAS between: (a) different coastal regions; and (b) offshore and nearshore areas.

The information collected under *Table 3-1(b)* (see page 40) will help to determine which specific secondary pathways exist. The focus should be on those ships and small craft that move between different regions of the coast.

4) For those secondary transfer pathways identified, how intensive is the level of activity associated with each pathway?
For each of the secondary pathways known to exist in the country the degree to which it is present will have a direct bearing on the level of risk. The greater the number of ships and small craft moving around the coast and the number of hard structures present in coastal waters, the greater the chance of IAS spreading.

Again, the information collected under *Table 3-1(b) & (c)* (see pages 40 and 41) will help to determine the specific profile associated which each of the identified secondary pathways.

4.3 Assessing the Potential Impacts of IAS Introduction

Section 2.5 (see page 31) provides relevant background information relating to the potential impacts of IAS once established in a new region. As noted in that section, predicting impacts and their magnitude is notoriously difficult, due to the ecological complexities involved. The information collected during the national self-assessment will not be sufficient to allow an assessment of the specific impacts associated with IAS. However the information WILL allow the assessment team to answer the following question:

ARE RESOURCES AT RISK FROM THE IMPACTS OF IAS AND ARE SUCH IMPACTS CONSIDERED TO BE ACCEPTABLE OR NOT?

The following questions may help to frame this analysis:

1) What resources (environmental and socio-economic) may be impacted by IAS?
Understanding which resources may be impacted by IAS is a critical step in understanding the potential consequences of the introduction of IAS. The various environmental and socio-economic resources are described in *Table 3-4 to 3-8* (see pages 55 and 64).

2) Are there identifiable secondary pathway links between: (a) areas of high likelihood of IAS introduction or known areas where IAS exist; and (b) areas of high ecological value or important economic activity?
Knowledge of the existence of transfer pathways that connect to areas of high ecological value or economic importance may indicate a heightened risk of those resources being impacted by IAS. Hence understanding the geographic spread of high value resources and their proximity to where IAS may be introduced and pathways that can introduce or spread IAS will be an important component of the assessment. If there are no obvious connections between areas of high ecological value or economic importance and areas where IAS may be introduced then the risk to these resources should be considered to be low.

4.4 Assessing the Country's Level of Preparedness to Manage Biofouling

No matter how effective a country may be at recognizing potential high risk pathways, if the country is not prepared - with measures in place to inspect ships and structures, identify those which present a high risk of IAS introduction and appropriate controls to manage high risk pathways - there is a risk that fouled ships and structures will introduce IAS.

The fourth and final question that should be posed by the assessment team therefore, should be:

IS THE COUNTRY EFFECTIVELY PREPARED TO IDENTIFY AND RESPOND TO THE ARRIVAL OF SHIPS AND STRUCTURES ON WHICH BIOFOULING IS NOT EFFECTIVELY MANAGED?

The key elements for a national biofouling management framework are presented in Annex B of this Guide. Using the information collected under *Table 3-9* (see page 66) will allow the assessment team to determine what measures currently exist at the national level to manage and respond to bio-fouled ships and structures and what, if any, gaps are identifiable in the existing framework.

It should be noted that, since the different pathways present a different risk profile each may demand management strategies that are specific to those pathways.

4.5 Assessing the Outcome of the Risk Evaluation

At the end of the risk evaluation process the self-assessment team should be able answer the following question:

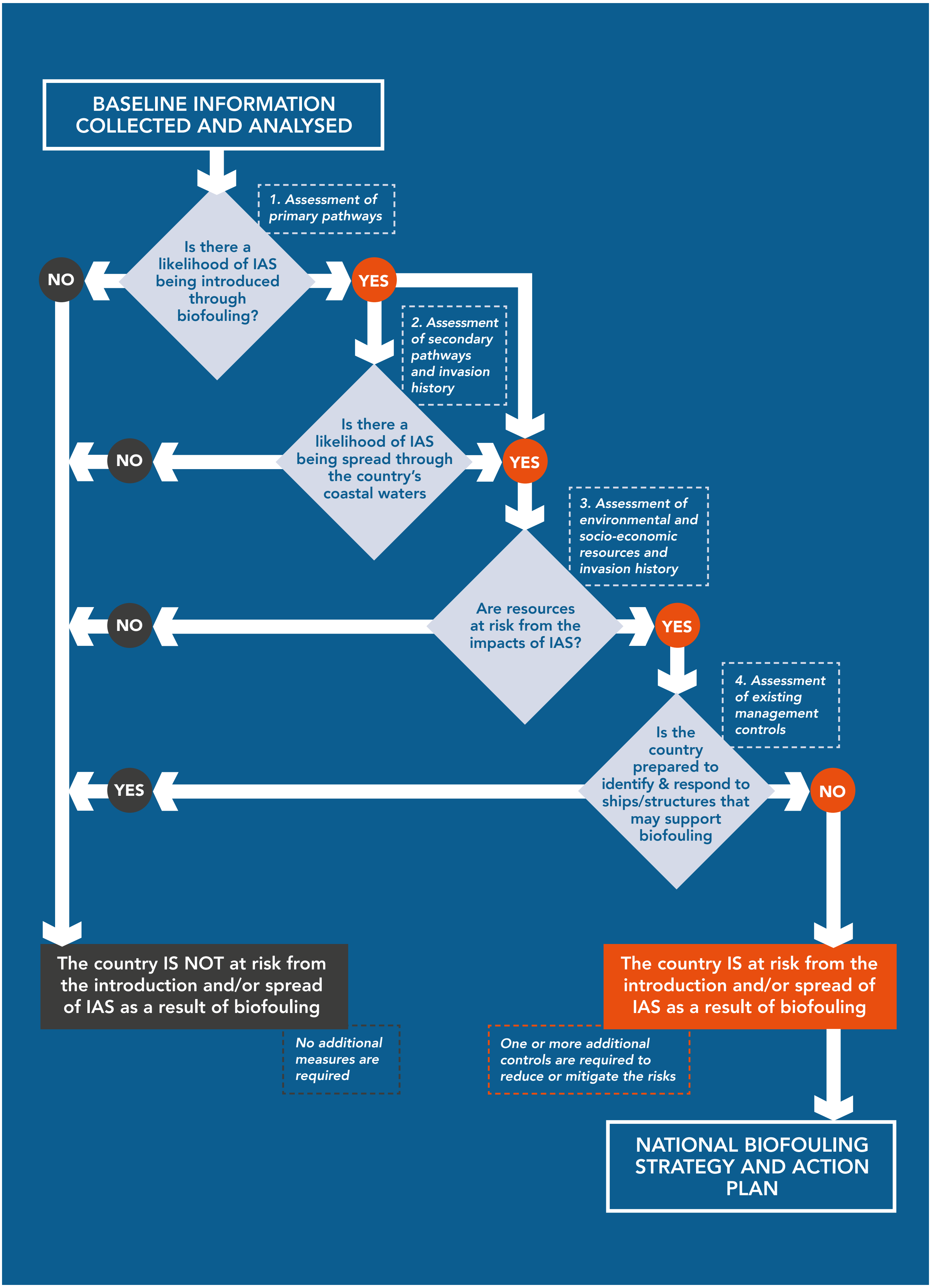
IS THE COUNTRY AT RISK FROM THE INTRODUCTION AND/OR SPREAD OF IAS AS A RESULT OF BIOFOULING?

If the answer to this overarching question is YES, this would indicate that measures need to be identified and implemented to mitigate that risk. This may demand management strategies that are specific to the various pathways that have been identified during the self-assessment process. While this may be relatively straightforward for shipping, since specific international controls and guidance for anti-fouling and biofouling management do exist for ships, similar measures do not exist for the other pathways that may be of concern.

The identification, prioritisation and implementation of such measures will be informed by the development of country-specific National Biofouling Strategy to define the approach needed for the establishment of a comprehensive national biofouling management framework.

Figure 4-1 (see next page) summarises the steps involved in evaluating the overall biofouling risks.

Figure 4-1: Overview of the risk evaluation process



5 Undertaking a National Status Assessment

5.1 Undertaking the Self-Assessment

In order to complete the National Status Assessment, the following steps are recommended:

STEP 1: Convene the self-assessment team

While it is possible for the Self-Assessment to be undertaken by an individual, it is recommended that a team be convened that consists of different disciplines that complement each other. As a minimum, the following team members are suggested:

- **Team leader** - A senior official from the agency with overall responsibility for biofouling management.
- **Technical specialist** - A technical or scientific expert who understands IAS and biofouling risks and management.
- **Legal and policy specialist** - An expert who understands the legal and policy issues relating to AIS and biofouling, particularly with regard to Port and Coastal State rights and obligations with respect to international trading vessels.

STEP 2: Define the scope of the self-assessment

Before commencing the process, the self-assessment team should define the scope of the assessments in terms of:

- the sectors to be included in the assessment;
- identifying and requesting copies of relevant key documents (such as policies, legislation, national action plans, national environmental assessments, research and monitoring reports etc); and
- identifying those elements of the national biofouling management framework, suggested in this Guide, that do/do not apply to the specific country context.

STEP 3: Identify and engage with interested stakeholders

Securing effective engagement of those stakeholders with an interest in biofouling will be critical to the success of any future biofouling management framework. The range of stakeholders to be considered includes sector-specific government agencies, industry operators, environmental agencies, scientists, civil society and many other oceans interests at the local, provincial and national levels.

In the specific context of undertaking the NSA, the purpose of stakeholder identification and engagement is to determine the importance of key people, groups of people, or institutions that may have an interest in, or be affected in some way by, the establishment (or lack thereof) of biofouling management controls. In this regard, information should be collected relating to:

- The type of stakeholder and their specific interests in biofouling management;
- The potential influence or impact each stakeholder may have on the establishment and implementation of biofouling management controls; and
- The extent and nature of the engagement required between authorities and each stakeholder.

One approach to assessing how to engage with different stakeholders is to undertake a Stakeholder Analysis that classifies stakeholders based on their influence and level of interest in biofouling management. It allocates the stakeholders to one of the categories:

- 'High influence/ High interest'
- 'High influence / Low interest'
- 'Low influence / High interest'
- 'Low influence / Low interest'

Depending on the category, different stakeholders will require different levels of engagement as outlined in Figure 5-1 (see next page).

Figure 5-1: Example of a stakeholder analysis matrix

STEP 4: Collect information concerning the mechanisms by which IAS may be transferred as biofouling

A broad range of information is indicated in this Guide with respect to the various pathways through which IAS may be transferred. The assessment team should refer to the various Tables provided in Chapter 4 to guide the collection of relevant information.

This is necessary in order to be able to understand and assess which pathways present the greatest risk of IAS introduction biofouling and, if possible, how well biofouling is managed for each of those pathways.

STEP 5: Collect information concerning the various resources and socio-economic activities at risk from biofouling

Information on the environmental and socio-economic values that are vulnerable to the impacts of AIS is a necessary prerequisite to understanding the overall biofouling risk.

This is necessary in order to understand what impacts may occur if IAS are introduced into the country's coastal waters. It also allows the assessment of which resources and socio-economic activities may be of greatest environmental and economic value.

STEP 6: Examine the performance of existing biofouling management arrangements

The self-assessment checklist provides the initial framework for determining the extent to which those elements of the national biofouling management framework, suggested in this Guide, exist or are accommodated within the existing framework of each country and therefore, the extent by which they might need to be amended or added to.

STEP 7: Identify the existing gaps, capacity needs and required reforms

This step must be accurate and comprehensive. It demands an honest assessment of the gaps between the existing national arrangements, identified in STEP 5, and what is needed to effectively implement a national biofouling management framework, in terms of the elements outlined in this Guide.

5.2 Self-Assessment Checklist

To help complete the National Status Assessment, **Annex C** of this Guide provides a *Self-Assessment Checklist* that will guide assessors through the self-assessment process. The Self-Assessment Checklist was developed in an easy-to-use format with clear steps that States may wish to follow when assessing their existing systems and needs.

The checklist will guide the assessment team through the process of collecting and analysing the various baseline information, required to complete the assessment, in a systematic way. This allows for comparison of existing national arrangements, knowledge and information with the requirements for a comprehensive national biofouling management framework suggested in **Annex B** of this Guide.

Accordingly, the *Self-Assessment Checklist* should be completed by reference to the information presented in this Guide. To assist with this, each section of the checklist identifies the relevant section of this Guide to which it is cross-referenced. This will allow the user to better understand the specific information requirements, the types of questions to ask and why the information is relevant.

5.2.1 Using the self-assessment checklist

The *Self-Assessment Checklist* provides the assessment team with a structured approach to guide the identification and collection of the broad range of information required to complete the National Status Assessment. Not all of the information indicated in the checklist will be relevant to every country, since not all of the transfer pathways and resources at risk will be present. It is up to the assessment team to determine which information is relevant and which is not, based on the specific circumstances of the country in question.

Furthermore, information relating to existing (known) pathways and resources may not be readily available or accessible to the assessment team. In these cases, identifying what information is lacking is an important element of the baseline, since it will inform what gaps may need to be filled in future.

The self-assessment checklist is divided into five separate sections, which broadly correspond to the information requirements indicated in Chapter 3 of this Guide. Each section therefore, corresponds to a specific section of this Guide and to the individual baseline information tables contained therein.

A range of different information types will be needed in order to complete the self-assessment, including:

- Information contained in publicly available government documents (such as policy and legal documents, strategies and plans and annual reports).
- Information that is collected through interviews with key stakeholders.
- Data that is held by individual Government agencies (such as GIS habitat mapping data, environmental monitoring data, and inspection databases).
- Data held by trade bodies and industry associated (such as private marina facilities, tourism resorts and operators).
- Scientific research information and reports (such as the results of previous port and harbour surveys).

When starting to complete each section of the checklist, the assessment team should therefore, review the corresponding section in this Guide and the tables of indicated baseline information and information sources. This will assist in determining with whom the assessment team should meet and what types of information they should be seeking in order to complete each section.

The checklist also requires information to be presented in different ways (formats) such as:

- Specific quantitative information (such as the economic contribution of a sector or the number of ships known to visit).
- Descriptive information providing general information about a specific topic (such as an overview of the structure of the marine capture fisheries sector).
- Evaluation type information that indicates the level of confidence in the extent and completeness of individual data sources (such as how well mapped coastal habitats and resources are).
- In some cases, a simple YES/NO answer may be all that is required. However, in these cases further explanatory information will most likely be required.

It is not anticipated that the self-assessment process will be completed in a single attempt. Information collected will need to be reviewed and additional follow up requests and interviews may be required to further clarify and gaps or outstanding matters.

Furthermore, since a broad range of different agencies and stakeholders should be engaged with throughout the process, it is suggested that the assessment team hold individual meetings/briefings with those agencies covering similar or the same mandates together to reduce the level of effort required. The assessment team should communicate the specific questions and types of information that they wish to collect in advance of such meetings/briefings in order to provide stakeholders with the opportunity to gather and collate whatever information they can.

To this end, it is recommended that the assessment team prepare a comprehensive assessment schedule, detailing:

- the necessary meetings and data collection activities;
- the agencies and stakeholders with whom they wish to meet;
- specific objectives and data requirements for each meeting; and
- allowance for review, analysis and follow up on data and information collected.

5.3 Interpreting and Communicating the Results of the Self-Assessment

Having completed the self-assessment process, the final step is to formally document and communicate the outcome of the assessment, including the identified gaps and the critical reforms that will be required to implement. A transparent mechanism to present this information is through a National Biofouling Status Report that:

- Highlights the current risks associated with IAS introduction via biofouling;
- Summarises the current arrangements that exist with respect to biofouling management in each country;
- Identifies those stakeholders with whom the assessment team engaged throughout the assessment and the information that was reviewed;
- Provides a summary of the key findings of the self-assessment process; and
- Highlights critical gaps identified during the assessment that need to be addressed.

This information will inform the development of the National Biofouling Management Strategy and Action Plan.

To assist in the preparation of this report, **Annex D** of this Guide provides an annotated table of contents for the National Biofouling Status Report. For ease of use, the various chapters of the National Biofouling Status Report correspond to the various sections of the Self-Assessment Checklist (**Annex C**).

5.3.1 Communicating the results

Having prepared the National Biofouling Status Report, an important final step is to present the report to those stakeholders that were engaged in the process.

This provides both a validation of the assessment process and ensures that stakeholders are aware of any recommended reforms, arising from the assessment, that may impact them.

While it may be expedient to simply circulate a copy of the National Biofouling Status Report to stakeholders for their comments and feedback, a more effective communication approach is to present the findings of the National Status Assessment directly to stakeholders via one or more national face-to-face "Validation" sessions. The validation sessions provide an opportunity for the assessment team to present the findings of their assessment directly to stakeholders, and for stakeholders to validate that the conclusions and assumptions made by the assessment team are sound. The assessment team should therefore, identify a range of possible avenues to undertake such validation work including:

- Public meetings/briefings
- Stakeholder workshops arranged for different types of stakeholders (e.g. government agencies, private sector etc)
- Targeted bi-lateral meetings with key stakeholders or stakeholders groups (e.g. shipping industry, aquaculture industry, NGOs etc)
- One-to-one meetings with key individuals (e.g. the Chief Executive/Director General of the national biosecurity management agency)

The delivery of such sessions should focus primarily on the following key messages:

- Overview of the self-assessment methodology (including Assessment Team, timeframes, assessment methodology etc);
- A summary of the results of the baseline assessment including a summary of the key pathways and possible impacts identified and the status of existing arrangements;
- A summary of the stakeholders that were involved in the self-assessment process;
- Summary of the key findings arising from the National Self-Assessment process;
- Summary of the critical gaps identified compared with the elements described in Chapter 4 of this Guide; and
- Prioritised list of recommended reforms.

The draft National Biofouling Status Report should be circulated to all agencies and stakeholders well in advance of the validation workshop and a reasonable period provided following the workshop, for comments and suggested revisions to be submitted to the assessment team for their inclusion in the final version of the National Status Report.

Given that the final National Status Assessment Report may be lengthy, the assessment team may feel it is more appropriate to provide a summary report. To this end it is recommended that the final National Status Assessment Report includes an Executive Summary that can be read as a standalone summary of the overall report.

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6.3 Public Sources of Information

Resource	FAO Fishery and Aquaculture Country Profiles
Link	http://www.fao.org/fishery/countryprofiles/search/en

Prepared by the FAO Fisheries Division, the country profiles provide a comprehensive overview of the fisheries and aquaculture sector for each country (or areas/territories recognized by the Organization and with important fishery sector).

Each profile includes: data compiled, analysed and regularly-updated by FAO such as Fishery statistics, a general summary specifically prepared from national sources and additional maps and data.

Resource	CBD Country Profiles
Link	https://www.cbd.int/countries

Prepared by the CBD Secretariat, these country profiles provide all the national information that has been made available by that country and it can provide information on the institutional structures and legislative, administrative or policy measures in place with respect to the management of biodiversity.

Resource	World Bank Country Profiles
Link	https://data.worldbank.org/country

Prepared by the World Bank, these country profiles present the latest key development data drawn from the World Development Indicators (WDI) database, the World Bank's primary database for cross-country comparable development data.

Resource	UNCTAD Country General Profile
Link	https://unctadstat.unctad.org/countryprofile/en-gb/index.html

Prepared by UNCTAD, these country profiles provide key economic statistics by country. They include a wide range of internationally comparable indicators allowing users to assess and compare countries. Two different profiles can be accessed, namely (i) General Profile, which provides a basic snapshot of a country's economic and financial situation; and (ii) Maritime Profile, which provides a basic snapshot of a country's situation on maritime transport and international trade.

Resource	IMO Status of Conventions
Link	http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/-Default.aspx

Prepared by the IMO, this site provides comprehensive information on the status of every instrument adopted by the IMO including Signatories, Contracting States, declarations, reservations, objections and amendments.

Resource	Seas Around Us Country Fisheries Data
Link	http://www.seaaroundus.org/

Developed and hosted by the University of British Columbia, this data base provides comprehensive information on fisheries and fisheries-related data at spatial scales that have ecological and policy relevance, such as by Exclusive Economic Zones, High Seas, or Large Marine Ecosystems.

Users can access a broad range of country-specific data either in graphic form or database form.

Resource	IUCN - World Database on Protected Areas
Link	https://www.protectedplanet.net/

Managed by the United UNEP-World Conservation Monitoring Centre (UNEP-WCMC) with support from IUCN and its World Commission on Protected Areas (WCPA), this platform provides a comprehensive source of information on protected areas, updated monthly with submissions from governments, non-governmental organizations, landowners and communities.

The data is publicly and users can discover terrestrial and marine protected areas, access related statistics and download data from the World Database on Protected Areas (WDPA).

Resource	UNEP-WCMC Ocean Data Viewer
Link	https://data.unep-wcmc.org/

Developed and hosted by UNEP-WCMC, this platform offers users the opportunity to view and download a range of spatial datasets that are useful for informing decisions regarding the conservation of marine and coastal biodiversity. These data come from internationally respected scientific institutions and other organizations that have agreed to make their data available to the global community.

The Ocean Data Viewer is primarily a mechanism to view and download data and is not intended to be used for analysis or to query data.

Resource	IUCN - Global Invasive Species Database (GISD)
Link	http://www.iucngisd.org/gisd

Hosted by IUCN, this platform is a free, online searchable source of information about alien and invasive species that negatively impact biodiversity. The GISD aims to increase public awareness about invasive species and to facilitate effective prevention and management activities by disseminating specialist's knowledge and experience to a broad global audience. It focuses on invasive alien species that threaten native biodiversity and natural areas and covers all taxonomic groups from micro-organisms to animals and plants.

Annex A

The Regulatory Response to Biofouling Risks

International Regulatory Arrangements for Biofouling Management

Damage to the marine environment and marine biodiversity are often long-term and, in many cases, the long-term impacts of human activities may be uncertain. To address this, the internationally accepted "precautionary principle" calls for early prevention, to avoid and relieve uncertain serious and irreversible damage to marine ecosystems, and has come to the fore in decision-making since the principle was adopted in the 1992 Rio Declaration. Since then, the principle has been involved in more and more international instruments, some of which relate to protection of the marine environment generally and IAS specifically.

Since IAS are introduced or spread by global transport and trade and just as often have transboundary impacts, their prevention and management is an international issue requiring global policy. To date, only two global instruments are strictly legally binding and place a number of obligations on countries to address the risks posed by biofouling and other mechanisms for the transfer and introduction of IAS. Existing international instruments, in combination with the IMO Biofouling Guidelines, do provide a basis to guide the development of National Biofouling Management Strategies and associated Action Plans.

International regulatory framework on IAS

The international framework driving the response to IAS in the marine environment comprises a complex network of international and regional agreements, intergovernmental organizations and economic based drivers. These include:

United Nations Convention on the Law of the Sea

The overarching legally binding framework governing the ocean and its use is provided by the *1982 United Nations Convention on the Law of the Sea* (UNCLOS). UNCLOS contains an internationally agreed framework of rules and principles governing the use of ocean space and resources, including comprehensive provisions on the protection and preservation of the marine environment.

At a broad level UNCLOS fixes international obligations for Governments to protect the marine environment in three main ways:

- Governments are explicitly obligated to protect and preserve the marine environment;
- Governments are obligated to cooperate on both a global and regional basis. This involves a fundamental commitment to make rules, regulations and standards that underpin the obligation to protect and preserve the marine environment; and
- Governments are obligated to adopt, enact and enforce, at the national level, internationally agreed-upon standards for protecting the marine environment.

With respect to IAS, UNCLOS provides that:
"States shall take all measures necessary to prevent, reduce and control … the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto".

Convention on Biological Diversity

The *1992 Convention on Biological Diversity* (CBD) is a comprehensive and legally binding instrument for the protection of biodiversity. It is one of the few instruments that explicitly addresses the obligations on Parties to manage invasive species through the prevention or minimization of introductions, spread and impacts.

With respect to invasive species, the CBD places a number of obligations on Parties, including:

- To ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction;

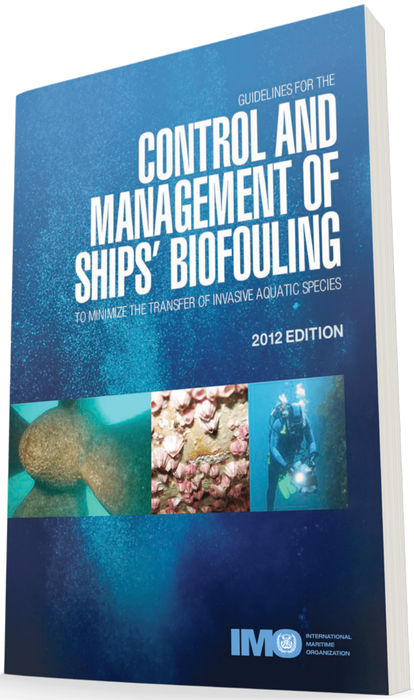
- To prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species; and
- To ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly considered.

The CBD has established an extensive programme of work and supports the Global Invasive Species Program (GISP), an international partnership dedicated to addressing the global threat of invasive species.[18]

In 2010, the tenth meeting of the Conference of Parties (COP) of the CBD adopted a revised and updated Strategic Plan for Biodiversity, including the *20 Aichi Biodiversity Targets,* for the 2011-2020 period, which set, as a specific target:
"By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment." [19]

The fifth edition of the Global Biodiversity Outlook, published by the Secretariat of the CBD, provides a summary of progress towards the Aichi Biodiversity Targets. With respect to Target 9, the report notes that, while good progress has been made during the past decade on identifying and prioritizing invasive alien species in terms of the risk they present, there is no evidence of a slowing down in the number of new introductions of alien species.

The Aichi Targets expire in 2020 and the CBD is now in the process of defining the *Post-2020 Global Biodiversity Framework* which includes, as one of its draft targets:
"Control all pathways for the introduction of invasive alien species, achieving by 2030 a [50%] reduction in the rate of new introductions, and eradicate or control invasive alien species to eliminate or reduce their impacts by 2030 in at least [50%] of priority sites". [20]



The IMO Biofouling Guidelines

In July 2011, IMO adopted the Biofouling Guidelines, in response to concerns raised by its member States about the risks posed by biofouling on ships.[21] The applicability of the Biofouling Guidelines is directly related to a comprehensive definition of the term "ships" as meaning:
"A vessel of any type whatsoever operating in the aquatic environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, fixed or floating platforms, floating storage units (FSUs) and floating production storage and off-loading units (FPSOs)."

As such, it can be seen that the scope of the Biofouling Guidelines is quite broad in their application.

The Biofouling Guidelines are premised on the recognition that implementing practices to control and manage biofouling can greatly assist in reducing the risk of the transfer of Invasive Aquatic Species. They also acknowledge that such management practices can improve a ship's hydrodynamic performance and can therefore, be effective tools in enhancing energy efficiency and reducing air emissions from ships. According to Article 4.1 of the Guidelines, the objectives is to:
"provide practical guidance to States, ship masters, operators and owners, shipbuilders, ship repair, dry-docking and recycling facilities, ship cleaning and maintenance operators, ship designers, classification societies, anti-fouling paint manufacturers and suppliers and any other interested parties, on measures to minimize the risk of transferring invasive aquatic species from ships' biofouling."

[18] Further information can be found on the GISP website. https://www.gisp.org/

[19] Aichi Target 9.

[20] Draft Target 3.

[21] More information can be found on the GloFouling Project website. https://www.glofouling.imo.org/

The Biofouling Guidelines recognize that effective anti-fouling application and maintenance are the primary means of biofouling prevention and control for existing ships' submerged surfaces, including the hull and niche areas. Guidance is provided on such operational aspects as:

- choosing an appropriate anti-fouling system;
- best operating practices for the application and maintenance of anti-fouling systems including with respect to niche-areas such as thrusters, sea chests and inlets/outlets;
- operating procedures for ship maintenance and recycling facilities including the treatment and handling of removed fouling material; and
- in water inspection, cleaning and maintenance of hulls and structures.

The Biofouling Guidelines recommend that every ship have a Biofouling Management Plan that is included in the ship's operational documentation. As noted above the use of the term 'ship' in the context of the Biofouling Guidelines refers more broadly to a range of floating vessels and structures. The management plan is to be ship-specific and is to provide a description of the biofouling management strategy for the ship with sufficient details to allow the ship's Master and crew members to understand and implement the biofouling management strategy.[22] Such a plan should address, at a minimum, the following:

- Type(s), location and specifications of anti-fouling systems used (effective life, cleaning requirements, etc.);
- Ship operating profile, including typical operating speeds; ship periods at sea, berthed, anchored or moored; typical operating areas or trading routes; and planned duration between dry dockings;
- Areas of the ship particularly susceptible to biofouling (including the management actions required for each area and management actions to be undertaken if the ship operates outside its usual operating profile);
- Operation and maintenance of the anti-fouling system;
- Safety procedures for the ship and the crew for the management of the system;
- Procedures for disposing of biological waste generated by treatment or cleaning process;
- Crew training.

In addition to the Biofouling Management Plan, the Guidelines also recommend that every vessel should maintain a Biofouling Record Book to record details of all inspections and biofouling management measures undertaken on the vessel. This not only assists the shipowner and operator to evaluate the efficacy of the specific anti-fouling systems and operational practices on the vessel in particular, but also assists interested State authorities to quickly and efficiently assess the potential biofouling risk of the vessel, and thus minimize delays to ship operations.

These two documents may be either standalone, or integrated, in part or fully, into the ship's existing operational and procedural manuals and/or planned maintenance programme.

In addition to the 2011 Biofouling Guidelines, the IMO has also adopted the *Guidance for Minimizing the Transfer of Invasive Aquatic Species as Biofouling (Hull Fouling) for Recreational Craft* (MEPC.1/Circ.792). The guidance is for use by all owners and operators of recreational craft less than 24 metres in length and provides recommendations on anti-fouling systems and good maintenance practices, including cleaning of the hull and niche areas. [23]

Other Relevant IMO Conventions

In addition to the Biofouling Guidelines, which specifically address IAS through biofouling, a number of other IMO instruments are relevant in terms of biofouling management.

[22] For an overview of the recommended format and content of the BFMP refer to Appendix 1 of the IMO Biofouling Guidelines.

[23] *Guidance for Minimizing the Transfer of Invasive Aquatic Species as Biofouling (Hull Fouling) for Recreational Craft* (MEPC.1/Circ.792), 12 November 2012.

International Convention on the Control of Harmful Anti-fouling Systems on Ships

In response to concerns over the toxicity of Tributyltin (TBT)-based anti-fouling coatings, [24] in 2001 the IMO adopted the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention). The AFS Convention prohibited the use of organotin-based anti-fouling systems on ships from 2008, and establishes a mechanism to prevent the potential future use of other harmful substances in anti-fouling.

Parties to the convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party. This applies to all ships (excluding fixed and floating offshore oil installations).

While the application and effectiveness of anti-fouling systems is fundamental for the control of biofouling, it must be understood that, while the AFS Convention acknowledges the role of anti-fouling systems in controlling AIS, the convention is not intended to manage biofouling, but rather to provide a framework to ensure the application of anti-fouling systems which are effective from the standpoint of the ship's performance, while not being harmful to the marine environment.

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)

The *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972,* (London Convention), is one of the first global conventions designed to protect the marine environment from human activities. The Convention's objective is to prevent pollution of the sea by dumping of wastes and other matter. In 1996, the London Protocol was agreed to further modernize the Convention and, eventually, replace it. The purpose of the Protocol is similar to that of the Convention but is more restrictive. A "reverse list" approach is adopted, which implies that all dumping is prohibited unless explicitly permitted.

While the Convention and its Protocol do not address biofouling or IAS, the dumping of certain classes of material may pose a risk of transfer of IAS. These include man-made structures (such as ships and platforms) and dredge spoil. The Protocol requires that an assessment of the environmental impacts of such dumping be undertaken. As such, consideration of the spread of IAS should be a consideration when licensing the disposal of such materials at sea.

Hong Kong Convention for the Safe and Environmentally Sound Recycling of Ships (HKC)

As noted in section 2.3.1 (see page 14), the end of life decommissioning of ships may pose an increased risk of IAS transfer due to the fact that vessels are laid up for long-periods prior to transport to the final destination. Moreover, many of the current ship breaking practices do not account for the environmental risks posed by IAS.

The 2009 Hong Kong Convention (yet to enter into force) sets standards for ship recycling and places responsibilities on both the flag State and the recycling State to ensure protection of the marine environment and human safety. While the Hong Kong Convention highlights environmental protection from "hazardous materials', this is restricted to chemical compounds associated with the ship's structure and equipment, and operational wastes including ballast water, sewage, medical/infectious waste, and residues, but does not include biofouling.

Implementing Biofouling Management Controls at the National Level

Although voluntary, the Biofouling Guidelines do not preclude individual States from applying additional measures to provide additional protection from invasive

[24] Anti-fouling coatings containing organotin-based compounds, especially tributyltin (TBT), were widely used in the 1970s and 1980s because of their superior anti-fouling properties compared to alternative anti-fouling paints. However, over time it became increasingly evident that these substances gave rise to significant harmful effects to marine life, the environment and human health.

biofouling organisms within their jurisdiction. As such, a number of national and regional authorities have now established legal requirements that visiting vessels and structures should have effective biofouling management systems in place e.g. through the application of vessel/structure-specific Biofouling Management Plans and maintaining a record of the biofouling management and maintenance activities (e.g. hull cleaning). While regulations vary among jurisdictions due to their different legislative frameworks, it is notable that many are aligned and consistent with the Biofouling Guidelines.

Table A-1: Examples of specific international, national and regional biofouling requirements

Jurisdiction	Requirements
International	
IMO	• Voluntary guidelines based on minimizing fouling through improved design and ongoing maintenance using best practice. • Details recorded in a Biofouling Management Plan and record book. • Calls for dissemination of information on State requirements and research • Not mandatory.
National	
New Zealand	• Biofouling is currently addressed under the Biosecurity Act, 1993 • Vessels to arrive in New Zealand with a "clean" hull, defined according to vessel category: long-stay, or short stay. • Measures to meet the requirement include cleaning before arrival, following the IMO Biofouling Guidelines, or application of approved treatments. • Applies to all ship types.
Australia	• Biofouling is currently addressed under the Biosecurity Act, 2015 • Mandatory reporting in relation to biofouling prior to arrival within the Australian Territorial seas (12 NM) currently under development. • Requirement to be that vessels implement effective and vessel-specific biofouling management practices consistent with the IMO Biofouling Guidelines
USA - Environmental Protection Agency	• Ship owners must minimize the transport of attached living organisms when traveling into US waters from outside the US EEZ. • The requirements are consistent with management principles established in the IMO guidelines, but not currently an enforcement priority. • *The Vessel Incidental Discharge Act* (VIDA) was signed into law in late 2018 (anticipated to come into force in 2022). VIDA requires EPA to develop new national performance standards for incidental discharges from commercial vessel. The US Coast Guard is required to develop corresponding implementing regulations. • The above regulations are primarily directed at commercial vessels. • Development of standards for recreational vessels is under the *Clean Boating Act.*
USA - US Coast Guard	• Remove fouling organisms from the vessel's hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations. • Rinse anchors and anchor chains when the anchor is retrieved to remove organisms and sediments at their places of origin. • Carrying a Biofouling Management Plan in accordance with the IMO guidelines is one way of fulfilling the requirements.

Table A-1: Examples of specific international, national and regional biofouling requirements - continued

Jurisdiction	Requirements
Regional/State	
Western Australia (Australia)	• Under the Fisheries Resource Management Act vessels must not bring in any non-endemic fish (which includes fish, invertebrates, algae, etc.). • Vessels associated with resource or development projects may have extra prescribed Ministerial conditions which vary according to the risk posed. These may include compulsory risk assessment, inspections and proof of 'pest free' status. • Future management will require vessels to be subject to a Departmentally approved risk assessment (Vessel Check) process and provide evidence of up to date Biofouling Management Plans and record books (consistent with IMO guidelines).
California (USA)	• Annual submission of Annual Vessel Reporting Form. • Able to provide an up to date Biofouling Management Plan and Biofouling Record Book (largely in line with IMO guidelines), including mandatory management of specific niche areas (additional to IMO guidelines). • Applies to vessels capable of carrying ballast 300 gross registered tons.

Annex B

Key Elements of a National Biofouling Management Framework

Some countries responded to the risks posed by biofouling by implementing national measures that give domestic legal effect to the Biofouling Guidelines for international ships arriving in their waters, reflecting a policy intent to implement mandatory biofouling management requirements, in line with international obligations and guidance. Analysis of these arrangements indicates that, to be effective, a number of different but related elements must be present, including:

- Policy and legal frameworks to establish national standards against which such risks can be assessed and controlled;
- Institutional arrangements to manage and respond to biofouling risks;
- Technical capacity to effectively implement and enforce those policy and legal frameworks;
- Relevant infrastructure and facilities to respond to an identified biofouling risk; and
- Emergency response capacity to deal with IAS incursions.

These are discussed below, although it should be stressed that this is not a prescriptive list of requirements, but rather a summary of elements that are found in existing frameworks.

Policy and Legal Framework

National policy framework addressing biofouling: In order to establish the overarching national priorities vis-à-vis management of IAS, some form of National Policy Statement is considered desirable. A policy statement is simply a statement of the government's intent with respect to a specific policy issue (in this case marine IAS and biofouling). Such a policy statement will define, among other things:

- The government's overarching goal with respect to the specific policy issue and the specific problem that the policy is designed to address;
- the scope of the policy;
- specific policy objectives and, if appropriate, actions to achieve those objectives; and,
- the roles and responsibilities of different stakeholders.

In this regard, the policy statement provides guidance to the various stakeholders, which may have different sector-specific interests, of the Government's overarching policy goal, thereby enabling alignment of sector-specific policies with the national policy direction.

A number of options may be considered for the promulgation of such a policy statement including:

- Specific inclusion of IAS/biofouling in a National Biosecurity Policy;
- Specific inclusion of biosecurity issues in a National Oceans Policy; and
- Specific inclusion of biosecurity issues in sector-specific policies (for example Fisheries Policy, Environmental Policy and Maritime Transport Policy).

If the latter approach is taken, however, it is important that different sector-specific policy goals and objectives are aligned to avoid confusion. For this reason, many countries have developed a national-level policy first, under a single lead agency, with any sector-specific policies being aligned with that policy.

National Invasive Alien Species Strategy and Action Plan for the Republic of Mauritius [25]

Following its accession to the CBD in 1992, the Mauritian conservation community was very actively engaged in the Global Invasive Species Programme (GISP) to encourage the adoption of measures to prevent the introduction of alien species that threaten Mauritius' natural environment.

As a result, the government developed and adopted the National Invasive Alien Species Strategy and Action Plan (NIASSAP) for the Republic of Mauritius. The NIASSAP presents a vision in which the negative impacts of IAS on the economy, environment and society are avoided, eliminated or minimised.

The strategy is based on the assumptions that an effective biosecurity system is built upon a risk analysis framework and that its success depends upon effective collaboration between all those concerned with invasion pathways.

The Strategy comprises ten interlinked elements: five hierarchical "Management Elements" that directly address the Strategy's vision and five "Cross Cutting [enabling] Elements".

Management Elements

1. Prevention - to minimise the number of IAS introductions;
2. Early detection and rapid response - to minimise the number of IAS that go on to have harmful consequences once they are introduced;
3. Eradication – an agreed framework for eradication priorities in place, eradications undertaken as necessary and results disseminated;
4. Control and management – to contain the distribution and abundance of IAS to a long-term acceptable level; and
5. Restoration – to undertake ecosystem restoration where necessary to achieve long-term ecosystem goals.

Cross Cutting Elements

6. Legal, policy and institutional frameworks – to have a coordinated policy and management framework that minimise the risk of IAS;
7. Capacity building and education – to make available appropriately skilled personnel to implement all aspects of IAS management;
8. Information management and research – (i) To have a clear understanding of the impacts of IAS; (ii) to have ready access to critical information that will support IAS management programmes; and (iii) to provide a strong scientific c basis for decision-making and resource allocation;
9. Public awareness and engagement – all stakeholders should have a high level of awareness of IAS risks and the benefits of IAS prevention and management;
10. International cooperation – (i) access to the necessary information, technical and financial support to effectively meet its international obligations; (ii) Mauritian IAS experiences and lessons learnt effectively disseminated to help IAS initiatives regionally and internationally; and (iii) Mauritius is not a source of IAS for other countries.

Legal instruments: In addition to defining an overarching policy position with respect to IAS/biofouling, a critical need to enable effective action to manage biofouling risks is the legal authority to act. As such, an essential component of a national biofouling management framework is the adoption of a specific legal instrument addressing marine biofouling.

As with the national policy, such an instrument may take numerous forms:

- Specific inclusion of IAS/biofouling in a national Biosecurity Act that addresses all types of biosecurity risk;
- Development of specific regulations addressing biofouling risks under an existing parent act (e.g. *Environmental Protection Act*);
- Specific inclusion of IAS/biofouling in sector specific legislation or regulations promulgated pursuant to such an act (e.g. *Maritime Transport Act*).

It does not matter under which instrument the legal powers reside, provided that the relevant legal instrument clearly identifies the entity with responsibility for

[25] The abbreviation "IAS" in this text box refers to "Invasive Alien Species", not "Invasive Aquatic Species".

giving effect to the legislation and clearly specifies the legal functions, powers and duties of that entity.

That said, as with the development of policy statement, the proliferation of -sector-specific legal instruments each dealing with IAS/biofouling must be undertaken in a manner that avoids confusion, duplication of effort or, worse, gaps in the legislation. For this reason, it is suggested that countries ensure that biofouling is addressed in the national legal framework. This may either be in the form of a an overarching national-level legal instrument addressing biosecurity risks and/or provisions relating to biofouling management in the relevant sector specific legislation under which the various relevant transfer pathways are regulated. The establishment of mandatory requirements, consistent with the IMO Biofouling Guidelines, if correctly implemented on a vessel-by-vessel basis, will go a long way towards ensuring that the risk of introducing IAS via biofouling is kept to a minimum.

Jurisdictional boundaries: While many countries have centralised systems of government, with most policy and decision-making authority vested in a national Government structure (Unitary Government) many have devolved systems of government, which operate at multiple levels (for example Federal - State/Province). In these cases, it is not uncommon for policy issues to be addressed at both the national (Federal) level and at the regional (State/Province) level.

In the context of the management of maritime space, the jurisdictional boundaries between these two levels of government are normally defined on the basis of distance from the coast (for example, the State may have jurisdiction out to a distance of 3 nautical miles whereas Federal control might extend from 3 nautical miles out to the outer limits of the exclusive economic zone). In addition, this devolved power may not apply to all policy issues. For example, State powers may apply to marine pollution in State waters but may not apply to national security, which may be a Federal responsibility throughout the country's maritime space.

This issue has the potential to create confusion if the regimes addressing the same policy issue in State and Federal waters are not consistent with each other. For example, if drilling for oil and gas is to be undertaken both in State and Federal waters, the operator of an offshore drilling may have to respond to different requirements if the laws governing offshore drilling in State waters differ from those in Federal waters.

This highlights the importance of establishing a national policy position with respect to IAS to ensure that the issue is addressed consistently across different maritime jurisdictional boundaries.

Institutional Arrangements

Decision-making authority: An essential requirement to ensure that identified risks can be managed effectively and in a timely manner is that the roles and responsibilities for giving effect to the relevant policy and legal framework (outlined in Section 3.4 on page 65) are clearly understood by all agencies (and other stakeholders) involved. The policy and legal framework should identify a decision-making authority, which may be achieved either on a sector-by-sector level, through specific agencies (e.g. maritime administration, fisheries agency etc) or, more commonly, through a single agency with overall responsibility for national biosecurity management (terrestrial, fresh water and marine).

In some cases, these arrangements may have already been implemented, for example where a country has already given effect to the IMO Ballast Water Convention.

Whatever institutional arrangements are chosen, it is important that the relevant agency has a legal mandate to act and that no duplication of responsibilities exists, as this could lead to confusion and delays in critical decision-making.

Inter-agency cooperation: Notwithstanding the need for a single lead agency, it is not uncommon for multiple agencies to have an interest in specific IAS incursions. For example, while a national biosecurity agency may well be the lead agency, in the event of a ship with hull fouling, state and/or local governments could be involved in the response, the port authority and maritime administration in the management of the vessels, and conservation and fisheries agencies on the impact to environmental and economic resources.

In such cases, it is common for the government to establish some form of multi-agency cooperation platform, usually under the coordination of the lead agency. This allows the views and concerns of multiple stakeholders to be considered in the decision-making process and ensures that stakeholders are kept informed of developments in the response.

Such a body must be explicitly mandated to take on this role and to provide a coordination role among all national agencies with a mandate for the management of ocean space generally and IAS specifically.

Inspection and enforcement mechanisms: An important element for any national biofouling management framework is a system for inspection and compliance/enforcement for ships and other structures. For domestic ships and most types of fixed and floating platforms, such a system relies on domestic quarantine standards of coastal states and the relevant institutional arrangements established to implement and enforce those standards. For marine structures that may arrive via air or land routes (for example aquaculture equipment and marine scientific monitoring instrumentation) these systems may be less important, since the structures can be inspected, assessed and cleaned (as necessary) prior to their deployment into coastal or offshore waters. Nonetheless, in these cases a procedure is required to ensure that the structures are inspected and assessed against the relevant quarantine standards prior to their deployment.

For internationally trading ships, the system is slightly more complex, since it relies primarily on the Flag State to enforce relevant international standards augmented by the inspection of foreign vessels in ports undertaken by Coastal/Port State authorities.

An important mechanism to facilitate such inspection and enforcement mechanisms, at least with respect to international trading vessels is therefore, the mechanism established under the various Port State Control (PSC) Memorandum of Understanding (MoU) for cooperation between MoU parties. PSC regimes carry out inspections on ships to monitor and enforce compliance with international regulations.

A growing number of PSC regimes have implemented targeted inspections mechanisms, as well as incentive schemes, so that ships found in compliance with international standards are subject to fewer inspections, while ships that are found to be non-compliant with one or more accepted standards may be subject to delays while remedial actions are undertaken to address any identified deficiencies. They may subsequently be subject to increased scrutiny in other ports due to the perception that they present a high risk. A ship going to a port in one country will normally visit other countries in the region and it can therefore, be more efficient if inspections can be closely coordinated in order to focus on substandard ships and to avoid multiple inspections.

However, it should be stressed that, in order for a Coastal/Port State to take any action against a ship, there must be appropriate domestic legal requirements in place against which to measure compliance. The ability to carry out inspections and enforcement with respect to biofouling and IAS is therefore, strongly linked to the establishment of a national legal framework for biofouling.

Scientific, research and monitoring institutions: As well as the ability to make decisions and manage the response to an IAS incursion, many countries have general scientific and technical capacity that may be deployed to support activities such as environmental sampling and monitoring, species identification, habitat/resource surveying and mapping, environmental risk assessment and environmental modelling.

In some cases, this capacity will reside within a dedicated government research institution or the research arm of a sectoral agency (e.g. Department of Fisheries). In other cases, this capacity may be provided by a national or regional university (or similar higher education institution) although it is not uncommon for both capacities to exist simultaneously.

Capacity to Implement and Enforce Management Measures

In order to fulfil the specific management requirements that arise from issues relating to biofouling, some capacity may be required at different levels within government. Table below illustrates some of the key competencies that may be needed to support implementation of a national biofouling management framework.

Table B-1: Indicative capacity needs for a national biofouling management framework

Expertise Required	Skills & Knowledge Required
Leadership & Coordination	
Leadership & decision-making	• Leadership/executive team familiar with IAS • Relationship management. • Stakeholder engagement
Policy & Legal	
Legal expert	• International maritime/law of the sea • Port State and Coastal State jurisdiction • IMO instruments • Legislative drafting
Policy expert	• Policy development and interpretation
Inspection & Enforcement	
Port State Control inspection & surveys	• Sector knowledge (maritime, offshore oil and gas etc) • IMO rules and procedures • Maritime inspection and enforcement procedures including knowledge of Port State Control inspection and reporting • Knowledge of IAS and biofouling • Development of standards for recreational vessels is under the *Clean Boating Act.*
Vessel/structure inspection	• Underwater inspection techniques • Knowledge and identification of biofouling levels • Knowledge of IAS and biofouling

Table B-1: Indicative capacity needs for a national biofouling management framework - continued

Expertise Required	Skills & Knowledge Required
Technical & Inspection	
Marine science and environmental management	• Knowledge of marine ecosystems and resources • Knowledge of local marine environmental conditions • Knowledge of environmental stressors and impacts • Knowledge of marine habitats and biodiversity and ability to interpret environmental data. • Analysis of environmental conditions environmental analyses (e.g. oceanographers, ecologists, geologists, fishery scientists).
Maritime sector expertise (fisheries; shipping; oil and gas; biodiversity & conservation).	• Relevant sector-specific knowledge and experience • Understanding of BFMP and BFRBs

A focus on building or augmenting such capacity should be an essential component of developing a national biofouling management framework.

Infrastructure and Facilities to Respond to High Risk Ships and Structures

Several of the national response strategies that may be available to authorities responding to a fouled ship or structure include the option to clean those structures. Such cleaning may either take place on land or in-water. The options available to a country to respond to a biofouled ship or structure will depend on the facilities that are available in that country.

Removing the ship or structure from the water for cleaning is considered the most effective strategy, in terms of reducing the risk of release to the wider environment. The two most common facilities to enable this are:

Dry dock facilities

When a vessel has its hull or niche areas cleaned, the risk of IAS transfer is the lowest when the vessel is cleaned on land or in a dry-dock where the waste is

Figure B-1: Example of a floating dry-dock facility

Figure B-2: Example of a slipway and haul out facility

collected and disposed of via on-land facilities. The safest strategy therefore, is to require the ship or structure to be removed from the water for cleaning.

The main limitation of dry-docking facilities is the size of the structure they can accommodate. Few countries possess the facilities necessary to accommodate the larger internationally trading ships, so this option will usually be limited to smaller commercial vessels, fishing vessels and recreational craft. Such facilities tend to be associated with large ports with established ship building and maintenance industries.

Alternatively, floating dry-dock facilities exist that can be submerged and then floated with a vessel or structure on board **(Error! Reference source not found.)**

Slipway and haul out facilities

Slipways allow a vessel to be hauled or lifted onto a slipway or hard stand using cranes, cradles or dedicated travel lifts. Once again, the chief limitation relates to the size of vessel that can be accommodated.

An important element of a national biofouling management framework is therefore, knowledge of the dry-dock and haul-out facilities available including:

- Location and access arrangements for each facility;
- The types of vessels and structures they can accommodate;
- The maximum size limit they can accommodate; and
- How fouling material removed from the structure is managed to avoid it being released back into the environment.

In-water cleaning

In the absence of a land-based cleaning facility, apart from requiring a vessel to depart to a country where suitable facilities exist, the only alternative solution is in-water cleaning. A broad range of in-water cleaning technologies now exist, some of which present a lower risk of releasing IAS than others, since there is always the potential for the release of viable fouling organisms during cleaning. The specific risks posed will depend on the type of fouling organisms, their reproductive status, and environmental conditions. The impact will thus be very variable and difficult to predict for each cleaning. If, however, the alternative to in-water cleaning is that no actions are taken, this may still present a risk of IAS introduction.

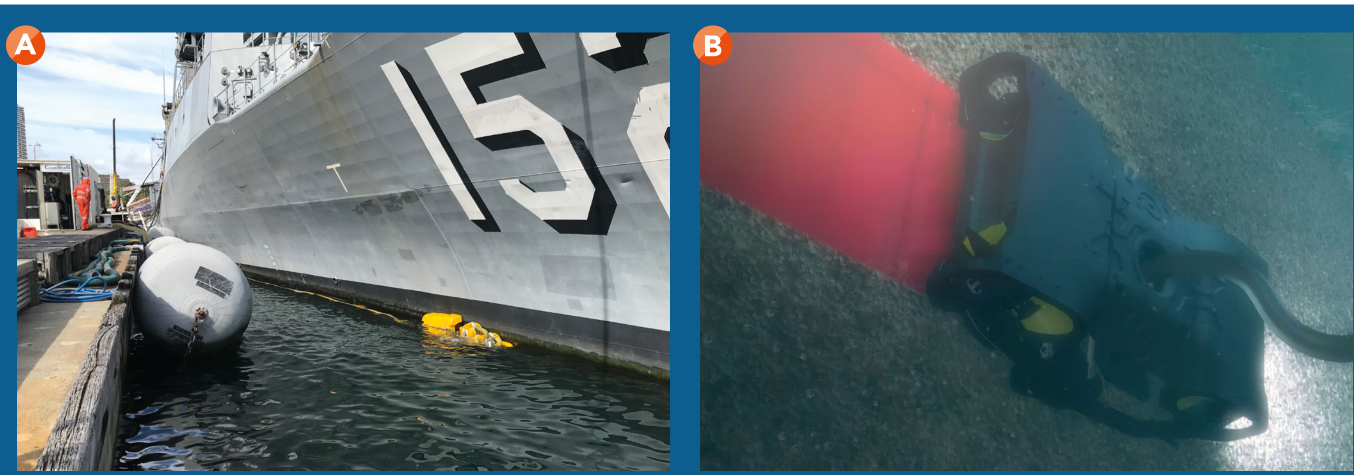


Figure B-3: Examples of in-water cleaning ROWs

Examples of in-water hull cleaning equipment

In-water cleaning must be undertaken in accordance with any relevant national requirements and may require permission to undertake the in-water cleaning from the relevant state/territory/port authority. National authorities may therefore, wish to consider how best to assess and regulate underwater cleaning technologies to ensure that they do not increase the risk of IAS release and spread. This may require a multi-agency coordination, since different aspects of the cleaning may fall under the jurisdiction of different regulatory agencies (e.g. IAS is a biosecurity issue whereas the release of anti-fouling biocides and particulate matter to the marine environment may be an environmental management issue).

Procedures also need to be in place to ensure that service providers have appropriate qualifications and certification and that operations are undertaken in accord with OH&S requirements.

Emergency response capacity

Even the best risk management practices may not prevent all incursions of IAS into a country's coastal waters. In the event of a suspected IAS release, it may be necessary to undertake measures to mitigate the impact of that release.
A typical mechanism to facilitate such mitigation measures is the use of a National Contingency Plan that specifies a range of technical response and control strategies to activate in the event of a national marine IAS emergency. It should, however, be acknowledged that tools for eradicating or managing an established marine IAS are limited, difficult to perform, and expensive. There have been very few successful eradications of IAS that have colonised a new location, and the circumstances that facilitated the success were highly unusual.

Annex C
Self-Assessment Survey Checklist

1 Assessing the Likelihood of IAS Introduction

1.1 Primary Transfer Pathways

a) Which of the following potential primary biofouling transfer pathways are known to exist in the country?		*TABLE 3-1(a)*
- International trading and non-trading ships		Refer to Section (b) below
- Fishing vessels (Foreign-flagged and domestic)		Refer to Section (c) below
- International recreational craft (e.g. super yachts)		Refer to Section (d) below
- Mobile oil and gas platforms		Refer to Section (e) below
b) International shipping arrivals		*TABLE 3-1(a)*
What is the breakdown of international trading and non-trading ships visiting each year? (In terms of numbers of port visits and the types of ship)		
How many international ships visit ports annually?		
What is the average duration for which international-trading ships remain in port?		
Do international-trading ships remain in port for extended periods (e.g. more than 5 days)?		
What are the main shipping routes in and out of the country including knowledge of the main ports of origin?		
Which primary ports are used by international ships?		
Are international ships required to notify authorities in advance of their arrival in port?		
Are international ships currently inspected for compliance with the IMO Biofouling Guidelines?		
Are facilities available in port for the maintenance and cleaning of international ships?		
Is there any historical evidence of IAS being introduced by international shipping?		
c) Foreign flagged fishing vessels		*TABLE 3-1(a)*
How many foreign-flagged fishing vessels operate in the country?		
Is information available about the home ports (country of origin) for foreign flagged fishing vessels?		
Which primary ports are used by foreign fishing fleets?		
Do foreign-flagged fishing vessels spend extended periods alongside in port?		
Are facilities available in port for the maintenance and cleaning of foreign-flagged fishing vessels?		

1.1 Primary Transfer Pathways - continued

c) Foreign flagged fishing vessels - continued	*TABLE 3-1(a)*		
Are foreign-flagged fishing vessels required to notify authorities in advance of their arrival in port?			
Are foreign-flagged fishing vessels inspected to determine the level of fouling present?			
Is there any historical evidence of IAS being introduced by foreign flagged fishing vessels?			
d) International pleasure craft	*TABLE 3-1(a)*		
Is information available about the numbers and movements of international pleasure craft?			
Where are the major marina/berthing facilities used by international pleasure craft located and what services/facilities do they provide?			
Are facilities available in marinas (or ports) for the maintenance and cleaning of international pleasure craft?			
Are international pleasure craft required to notify authorities in advance of their arrival in port?			
Is there any historical evidence of IAS being introduced by international pleasure craft?			
e) Offshore oil & gas platforms	*TABLE 3-1(b)*		
Which of the following facilities may be brought into the country?			
- Mobile offshore drilling rigs			
- Jack-up rigs (normally towed on a barge)			
- Heavy lift cranes and barges			
- Floating Production Storage & Offtake vessels			
- Supply vessels and anchor handling tugs			
- Shuttle/offtake tankers			
What is the breakdown of mobile oil and gas platforms operating in the country? (In terms of numbers and the types of structure)			
What is the average duration for which mobile oil and gas platforms remain in country?			
Which ports are used to service the petroleum sector?			
Are offshore areas used to temporarily anchor floating installations?	Y		N
If YES, provide details. Of the location of the areas; their proximity to other coastal resources and infrastructure; how installations at anchor may be serviced from ashore etc.			
Are mobile oil and gas platforms required to notify authorities in advance of their arrival?			
Are mobile oil and gas platforms currently inspected for compliance with the IMO Biofouling Guidelines prior to their arrival?			
Are facilities available for the maintenance and cleaning of mobile oil and gas platforms?			
Is there any historical evidence of IAS being introduced by mobile oil and gas platforms?			

2 Assessing the Likelihood of IAS Spreading

2.1 Facilities and Structures that Aid IAS Settlement				
a) Which of the following are known to exist in the country?		*TABLE 3-2*		
- Ports and harbor facilities		Refer to Section (b) below		
- Marinas and recreational boating facilities		Refer to Section (c) below		
- Offshore oil and gas platforms		Refer to Section (d) below		
- Aquaculture structures		Refer to Section (e) below		
- Marine renewable energy structures		Refer to Section (f) below		
b) Ports & harbour facilities		*TABLE 3-2(a)*		
Where are the main (primary) ports of entry located and what sectors do they support?				
Where are the secondary ports located and what sectors do they support?				
What are the types of infrastructure and structures found in ports?				
Has an assessment been undertaken of the vulnerability of port operations and infrastructure to IAS?				
What additional facilities/infrastructure (e.g. ship cleaning and maitenance facilities) are located within ports?				
Is information about the movement of ships and structures between different ports available?				
c) Marinas and other recreational boating centres		*TABLE 3-2(a)*		
Are the locations of marinas and small boat harbours known?				
What vessel maintenance and cleaning facilities are available at marinas?				
Do some marinas service specific sectors (e.g. luxury yachts)?				
Is there an evidence of previous impacts of IAS to marinas and mooring areas?				
Has an assessment been undertaken to assess the vulnerability of marinas and infrastructure to IAS?				
d) Offshore oil & gas platforms		*TABLE 3-2(b)*		
Which of the following facilities are known to operate?				
- Fixed production platforms				
- Floating production storage and offtake (FPSO) facilities				
Which ports are used by the petroleum sector generally?				
Are there offshore pipelines and cables running ashore?				
Are offshore areas serviced by support vessels?	Y		N	
If YES, provide details of the numbers of supply vessels, their regular schedules and the main ports that support them.				
e) Aquaculture		*TABLE 3-2(c)*		
What, if any, types of aquaculture are undertaken? (Types of structure and species farmed)				
Where are the main areas for aquaculture operations?				

2.2 Secondary Transfer Pathways

a) Which of the following potential secondary biofouling transfer pathways are known to exist in the country?		*TABLE 3-1(c)*
- Domestic trading and non-trading ships		Refer to Section (b) below
- Fishing vessels		Refer to Section (c) below
- Recreational craft		Refer to Section (d) below

b) Domestic shipping	*TABLE 3-1(c)*
How many domestic ships are registered and operate in the country's waters?	
What types of domestic ship operate in the country's waters?	
Which ports are used by domestic shipping?	
Is information about the movements of domestic ships available?	

c) Fishing vessels	*TABLE 3-1(c)*
Which ports are used by fishing vessels (both domestic and foreign flagged) operating in the countries waters?	
How many fishing vessels operate in the countries waters?	
What types of fishing vessel operate in the countries waters. In terms of size, type of fishing equipment, species harvested etc)	

d) Recreational craft	*TABLE 3-1(c)*
Is information about the movements of recreational craft available?	
Where are the major mooring and marina facilities located and what services/facilities do they provide?	
What are the main areas frequented by recreational craft?	

3 Assessing the Potential Impacts of IAS Introduction

3.1 Marine Environmental Resources at Risk

a) State of knowledge about the marine environment					***TABLES 3-3(a)***	
How well described/documented are the following?						
Level of information available: 1. No information; 2. Limited information; 3. Information for most important areas; 4. Full coverage	**1**	**2**	**3**	**4**	**Comments**	
Seabed types						
Coastal and marine habitats						
Areas of high biodiversity						
Critical and endangered marine species						
Sensitive environmental sites (e.g. spawning/nursery areas)						
Coastal and offshore currents and circulation						
Coastal productivity and upwelling areas						
b) Coastal and marine living resources					***TABLES 3-3(a)***	
Which marine species are considered commercially important? If possible, provide an estimate of their economic value and why they are important.						
c) History of Adverse Environmental Impacts					***TABLES 3-3(c)***	
Which of the following environmental threats is widespread in coastal areas?						
- Land-based sources of pollution (sewage, stormwater, solid waste etc)						
- Marine pollution (from ports, shipping and offshore sources)						
- Coastal habitat modification, damage and destruction						
- Unsustainable or harmful fishing practices						
Have IAS previously been introduced to the country through marine pathways? If YES, provide details.	Y		N		Not Known	
Are any existing biofouling research or monitoring programmes underway? If YES, provide details.	Y				N	
Is there prior experience of managing IAS through ballast water management? If YES, provide details.	Y				N	

3.2 Socio-Economic Resources at Risk

a) Which of the following sicio-economic resources (activities) are considered to be potentially at risk from IAS?		*TABLE 3-4*
- Capture fisheries		Refer to Section (b) below
- Aquaculture		Refer to Section (c) below
- Tourism		Refer to Section (d) below
- Leisure & local community amenity		Refer to Appendix
- Coastal desalination facilities		Refer to Section (e) below
- Coastal energy generation plants		Refer to Section (f) below
- Oil & gas		Refer to Appendix
- Marine renewable energy		Refer to Appendix

b) Capture fisheries	*TABLE 3-4 (a)*
What is the economic importance of fisheries to the country? Provide details such as: economic benefits (e.g. people employed, contribution to GDP etc); health and livelihood benefits (e.g. food security); value chain components (e.g. boat building and maintenance, fish processing etc).	
How many local fishing vessels are registered?	
Is there an evidence of previous impacts of IAS to fisheries?	

c) Aquaculture	*TABLE 3-4(b)*
What is the economic value of the sector? Provide details such as: economic benefits (e.g. people employed, contribution to GDP etc); health and livelihood benefits (e.g. food security); value chain components (e.g. boat building and maintenance, fish processing etc).	
Where are the main areas for mariculture development?	
Is there an evidence of previous impacts of IAS to aquaculture?	

d) Tourism	*TABLE 3-5(a)*
What is the economic importance of the tourism? Provide details of any existing activities including: key tourist areas; economic benefits (e.g. people employed, contribution to GDP etc); any unique features of the local tourism product (e.g. whale watching).	
Has an assessment been undertaken to assess the vulnerability of the tourism sector and sub-sectors to IAS?	
Is there an evidence of previous impacts of IAS to tourism activities?	

e) Coastal desalination facilities				*TABLE 3-6(a)*
Do coastal desalination plants operate or are they planned for the future?	Y		N	
If YES, provide details: Include the number and location of plants; production capacity as a % of total water usage;				
How importants to national water supply is coastal desalination?				
Has an assessment been undertaken to assess the vulnerability of desalination facilities to IAS?				
Is there an evidence of previous impacts of IAS to desalination facilities either in the country or in neighbouring countries?				
What contingency plans are in place for the protection and sustained operation of desalination facilities?				

3.2 Socio-Economic Resources at Risk - continued				
f) Coastal power generation				*TABLE 3-6(b)*
Are there any coastal power plants that use seawater for cooling?	Y		N	
If YES, provide details: Include the number and location of plants; power generation capacity as a % of total natial power output/usage;				
How important to national power supply are these plants?				
Has an assessment been undertaken to assess the vulnerability of coastal power plants to IAS?				
Is there an evidence of previous impacts of IAS to power plants either in the country or in neighbouring countries?				
What contingency plans are in place for the protection and sustained operation of power plants?				

4 Existing Policy, Legal and Institutional Arrangements

4.1 Existing Arrangements to Manage and Control Biofouling Risks				
a) Policy & Legal Framework				*TABLE 3-9(a)*
Has a national policy been developed that addresses biofouling?	Y		N	
If YES, under what specific national policy is biofouling addressed? (E.g. Biosecurity Policy, National Oceans Policy, Biodiversity Policy etc)?				
Is the policy consistent with the IMO Biofouling Guidelines?	Y		N	
Has the Anti-fouling Systems Convention been implemented in domestic law?	Y		N	
Has the Ballast Water Convention been implemented in domestic law?	Y		N	
Have the Biofouling Guidelines been implemented in domestic law?	Y		N	
Under what legislation have any of the instruments above been given legal effect?				
Is ballast water managed as part of Port State Control?	Y		N	
If YES, provide details of what reporting and inspection measures are in place to enforce requirements?				
Does the existing legal framework provide for the establishment of a Government position with statutory responsibility for decision-making with respect to biofouling? (Statutory Authority)	Y		N	
If YES, where does the "statutory authority" to act reside? (e.g. with Cabinet, a Minister, or a designated official such as the CEO of the lead agency)?				
b) Institutional Arrangements				*TABLE 3-9(b)*
Existing Institutional Arrangements - Unitary Government				
Is there a single agency with overall responsibility for biofouling management?	Y		N	
If YES, which agency?				
If NO, which entity (agency/authority) has primary responsibility for managing biofouling?				

4.1 Existing Arrangements to Manage and Control Biofouling Risks - continued

b) Institutional Arrangements - continued				*TABLE 3-9(b)*
Which other government departments/agencies are involved in managing biofouling?				
How do the various regulatory agencies coordinate among themselves to address biofouling risks? (e.g. is there a dedicated committee or task force for invasive marine species at the national/regional levels?)				
How are the private sector and non-governmental interests involved in decision-making and management?				
Existing Institutional Arrangements - Federal/State Government				
Is there a single agency at the Federal level with overall responsibility for biofouling management?	Y		N	
If YES, which agency?				
Which States, Provinces or Regions are engaged in biofouling management?				
Which agency, at the State/Province/Regional level, is primarily responsible for biofouling management?				
Describe the statutory functions, powers and duties of the different tiers of government, with respect to biofouling management.				
How do the regulatory agencies within the different tiers of government coordinate among themselves to address biofouling risks?				

c) Technical Capacity					*TABLE 3-9(c)*
What is the existing level of capacity with respect to biofouling management?					
Level of capacity: 1. Non-existent; 2. Partially in place; 3. Mostly in place; 4. Fully in place.	**Capacity**				**Comments**
	1	**2**	**3**	**4**	
Leadership and decision making with regard to IAS					
Policy making, interpretation and implementation					
Understand and apply international law relating coastal States' rights and obligations					
Port State Control surveys and inspections					
Visual inspections of fouled vessels and structures					
Understand and apply risk assessment processes					
Identification and classification of "high risk" organisms					

d) Infrastructure & Facilities	*TABLE 3-9(d)*
Do any of the following maintenance/cleaning facilities exist?	
- Dry dock (including floating dry dock facilities)	
- Haul out and slipway facilities	
- Underwater cleaning	
Provide details for any facilities that exist including: type of facility, location, handling capacity, services provided etc.	
Are any of the facilities listed above subject to environmental regulations? (e.g. water quality standards etc)	

4.1 Existing Arrangements to Manage and Control Biofouling Risks - continued

e) Emergency response capacity				*TABLE 3-9(e)*
Do emergency response procedures exist to respond to "high risk" ships or structures or IAS incursions?	Y		N	
If YES, provide details.				

f) Interested Stakeholders	*Section 5.1*
List any stakeholders engaged with through the self-assessment process	
What stakeholder engagement mechanisms were employed during the self-assessment	
- National stakeholder workshops	
- Sector-specific stakeholder workshops	
- Public information meetings	
- Bilateral meetings	
- Informal briefings	
- Use of media and multimedia	
- Identification and resolution of user conflicts	

Appendix: Supplementary Information

A.1 Primary Transfer Pathways

a) International shipping arrivals	*TABLE 3-1(a)*
Are any offshore areas designated for specific purposes? (e.g. places of refuge, offshore bunkering, anchoring/no-anchoring, in-water cleaning, ship-breaking, artillery ranges, offshore dumping areas, artificial reefs)	
b) Foreign flagged fishing vessels	***TABLE 3-1(a)***
Do foreign-flagged fishing vessels travel to or spend time in sensitive marine areas?	
c) International pleasure craft	***TABLE 3-1(a)***
Is information available about the numbers and movements of international pleasure craft?	
Where are the major marina/berthing facilities used by international pleasure craft located and what services/facilities do they provide?	
Are facilities available in marinas (or ports) for the maintenance and cleaning of international pleasure craft?	
Are international pleasure craft required to notify authorities in advance of their arrival in port?	
Is there any historical evidence of IAS being introduced by international pleasure craft?	

A.1 Primary Transfer Pathways - continued

d) Offshore oil & gas platforms				*TABLE 3-1(b)*
Do shuttle tankers regularly visit offshore platforms?	Y		N	
If YES, provide details of where they might operate.				
Is information available about the movement of supply vessel between ports and offshore platforms?	Y		N	
Are there industry specific initiatives to address biofouling?				
Is there any historical evidence of IAS being introduced by oil and gas operations?				

e) Deep sea mining	*TABLE 3-1(d)*
Where are the main areas for deep sea mineral exploration and exploitation?	
Which of the following types of mining currently occurs or is planned for the future?	
- Seafloor massive sulphides	
- Ferromanganese nodules	
- Cobalt crusts	
Which of the following facilities may be brought into the country?	
- Mining support vessels	
- Offtake vessels and barges	
- Sub-sea mining equipment	
Are there industry specific initiatives to address biofouling?	

A.2 Facilities and Structures that Aid IAS Settlement

a) Ports & harbour facilities	*TABLE 3-2(a)*
What is the economic importance of ports to the country?	
What are the upstream linkages between the port and other parts of the country, or other countries?	
Are any domestic commercial sectors/activities reliant on the port for distribution?	
What other facilities/infrastructure are located in close proximity to ports?	
Are particular ports used by specific maritime secrors? i.e. are some ports more important than others in terms of economic activities?	
Is there an evidence of previous impacts of IAS to ports and port infrastructure?	

b) Marinas and other recreational boating centres	*TABLE 3-2(a)*
How important to the local economy is recreational boating?	

A.2 Facilities and Structures that Aid IAS Settlement - continued

c) Offshore oil & gas platforms		*TABLE 3-2(b)*		
Are there offshore pipelines and cables running ashore?				
Have any decomissioning activities been undertaken or are any planned for the future?				
Are there industry specific initiatives to address biofouling?				
Is there any historical evidence of IAS being spread by offshore supply vessels or via offshore structures acting as stepping stones?				
d) Aquaculture		*TABLE 3-2(c)*		
How are aquaculture structures transported to site and deployed?				
Are there industry specific initiatives to address biofouling?				
Is there any historical evidence of IAS being spread by aquaculture operations?				
e) Marine renewable energy		*TABLE 3-2(d)*		
Are offshore areas serviced by support vessels?	Y		N	
If YES, provide details of the numbers of support vessels, their regular schedules and the main ports that support them.				
Are there offshore cables running ashore?				
Which ports are used by the renewable energy sector generally?				
Have any decomissioning activities been undertaken or are any planned for the future?				
Are there industry specific initiatives to address biofouling?				
Is there any historical evidence of IAS being spread by offshore support vessels or via offshore structures acting as stepping stones?				

A.3 Secondary Transfer Pathways

a) Domestic shipping		*TABLE 3-1(c)*		
Do domestic ships travel to, or spend any time in, sensitive sea areas or marine protected areas?				
Is there any historical evidence of IAS being spread by domestic shipping undertaking coastal passages?				
b) Fishing vessels		*TABLE 3-1(c)*		
Do domestic fishing vessels travel to, or spend any time in, sensitive sea areas or marine protected areas? If YES, provide details.	Y		N	
Is there any historical evidence of IAS being spread by fishing vessels operating along the coast?				
c) Recreational craft		*TABLE 3-1(c)*		
Is there any historical evidence of IAS being spread by recreational craft?				

A.4 Marine Environmental Resources at Risk

a) Coastal and marine living resources						TABLES 3-3(a)
Have the key areas supporting biodiversity been identified, documented and mapped?						
Are any marine species considered to be threatened, endangered or otherwise at risk? According to the IUCN Red List of Threatened Species.						
b) Protected areas or areas of special significance						***TABLES 3-3(b)***
Which of the following types of spatial management tools exist?						
- Marine Protected Area / Marine Reserve						
- Ramsar Sites						
- Biosphere site						
- World Heritage Site						
- Particularly Sensitive Sea Area (PSSA)						
Provide details of any that exist. (Location, size, conservation objectives, management plans, administration etc)						
c) History of Adverse Environmental Impacts						***TABLES 3-3(c)***
Is there a programme of marine environmental quality monitoring and reporting? If YES, provide details.	Y		N		Not Known	
Are coastal areas that are heavily degraded by human activities documented and well understood. If YES, provide details.	Y		N		Not Known	

A.5 Socio-Economic Resources at Risk

a) Capture fisheries	TABLE 3-4(a)
What types of fishing activity are characteristic of the sector?	
Where are the main fishing areas?	
What are the critical species fished and the status of those stocks?	
Have critical areas for fishing been identified and mapped? If YES, provide details.	
b) Aquaculture	***TABLE 3-4(b)***
What types of mariculture are practiced? Provide details such as types of culture, species cultured etc.	

A.5 Socio-Economic Resources at Risk - continued

c) Tourism	*TABLE 3-5(a)*
Where are the major tourism areas located and what amenities do they provide?	
What are the key natural resources that underpin the tourism sector (e.g. coral reefs, beaches etc)?	
Which sub-sectors operate?	
- Beach tourism and resorts	
- Cruise ship tourism	
- Underwater viewing (e.g. SCUBA, snorkelling, submarine, glass bottom boats)	
- Eco-tourism (e.g. whale watching)	
- Recreational water craft	
Provide details of any existing sub-sectors including: key activity areas (e.g. coral reefs), numbers of people employed, number of operators, throughput of tourists, key resources that support the sub-sectors.	
d) Leisure	*TABLE 3-5(b)*
What are the major uses of the coastal marine area for local leisure purposes and how important are these at the national level?	
Where are the major leisure areas located and what amenities do they provide?	
Is there an evidence of previous impacts of IAS to leisure uses?	
e) Local amenity and cultural values	*TABLE 3-5(c)*
Are there any coastal areas that are considered to have particularly high amenity value for coastal communities/local populations? If YES, provide details.	
Are there specific traditional and/or cultural linkages and belief systems with respect to coastal and marine areas? If YES, provide details.	
What are the key natural resources that underpin local amenity sites (e.g. coral reefs, beaches etc)?	
Is there an evidence of previous impacts of IAS to these high amenity areas?	
f) Offshore oil & gas	*TABLE 3-7(a)*
What is the economic importance of the sector? Provide details such as: direct economic benefits (e.g. people employed, government revenue, contribution to GDP etc); supply chain links, social benefits (e.g. infrastructure benefits).	
How many existing fields produce oil and gas? Provide details below.	
Is there an evidence of previous impacts of IAS to oil & gas operations?	
g) Marine renewable energy	*TABLE 3-8(a)*
How much energy is produced by marine renewable energy?	
Is there a policy intent to invest in marine renewable energy in the future?	
Provide details below of any existing activities.	
Is there an evidence of previous impacts of IAS to marine renewable energy operations?	

Annex D

Annotated Table of Contents for the National Biofouling Status Report

EXECUTIVE SUMMARY

- Overview of the self-assessment process (team members, timeframes, methodology etc)
- Summary of the key findings presented in section 7.1 of the National Status Assessment Report
- Summary of the critical gaps identified and presented in section 7.2 of the National Status Assessment Report
- Prioritised list of recommended reforms

1. INTRODUCTION

1.1 Background
- Biofouling problem definition (Sections 2.1, 2 .2)
- Reasons for undertaking a national biofouling self-assessment (Section 1.1)
- Summary of the self-assessment process (Section 5.1)
- Self-assessment team composition

1.2 Scope and Elements of the Report
- Brief section-by-section overview of the National Biofouling Status Report
- How the report should be interpreted and applied (Section 5.2)

2. NATIONAL CONTEXT

2.1 Country Overview (Relevant resources indicated in Section 6.3)
- General country overview (e.g. geographic location, proximity, size of country, population etc)
- Overview of the country's maritime space (e.g. geographic area of the country's EEZ, maritime boundaries agreed or under dispute, areas of extended continental shelf etc)
- Summary of key development indicators (e.g. GDP and other socio-economic indicators, key economic activities)

2.2 Overview of National Government Arrangements (Annex A; Table 3-9)
- Brief description of existing government arrangements (Unitary, Federal/State etc)
- Brief overview of the key sector-specific agencies (include an organo-gram if possible)

3. KNOWLEDGE OF BIOFOULING TRANSFER PATHWAYS

3.1 Summary of Known Biofouling Pathways (Sections 2.3, 2.4, 4.1, 4.2; Table 3-1)
- Brief description of those transfer pathways identified as being of greatest threat - this would include primary and secondary pathways
- Brief description of those structures and infrastructure that could provide suitable substrate for the settlement of IAS, including structures that could act as "stepping stones" for IAS.

4. RESOURCES AT RISK FROM BIOFOULING

4.1 Marine Habitats and Resources (Sections 3.2, 4.3; Table 3-3)
A general description of coastal environments, with more detail for areas considered at highest risk
- Coastal habitat types - general description of the key habitat types (e.g. mangrove, seagrass, estuarine/delta, coral reef, rocky shore, etc), areal coverage (include a map)
- Marine biodiversity – details of key biodiversity including areas of high biodiversity value, critical and endangered species, sensitive environ-mental sites etc
- Oceanographic conditions - general coastal topography/hydrography, coastal and offshore currents and circulation, significant fresh water inputs, general climate conditions

- Areas of significant environmental/conservation importance - marine protected areas (including Ramsar, Biosphere and World Heritage sites), no-take zones etc, critical habitat areas (e.g. fish spawning, nursery, marine mammal feeding etc)

4.2 History of Adverse Environmental Impacts (Sections 3.2, 4.3; Table 3-3(c))
- Details of key threats to the marine environment including any monitoring and reporting of this in the past
- Details of any known (existing or historical) IAS incursions
- Details of any existing research programmes/monitoring underway with respect to IAS including specific research institutions engaged in this area

4.3 Marine Socio-Economic Sectors and Activities (Sections 3.3, 4.3; Tables 3-4, 3-5, 3-7, 3-8)
A general description of the main marine economic activities
- Capture fisheries - profile of the fisheries sector (types of fishery, vessel types and numbers), key species exploited, annual landings, socio-economic contribution
- Aquaculture - areas of existing/planned activity (include a map), key species farmed, farm structures/systems (cage/pond/rope etc)
- Maritime and coastal tourism - profile of the tourism sector (tourism sub-sectors, socio-economic importance), most important tourism areas (include a map), importance of the marine environment to tourismOffshore oil and gas - areas of existing/planned activity (include a map), existing activities, structures and infrastructure, structures and infrastructure, major companies
- Marine renewable energy - areas of existing/planned activity (include a map), level of existing activities (exploration, production, decommissioning), major companies

4.4 Critical Infrastructure at Risk from Biofouling (Sections 3.3.3; Table 3-6)
- Summary of coastal infrastructure at risk of fouling and the economic importance of that infrastructure (e.g. coastal power station cooling water intakes, desalination facilities)

5. EXISTING ARRANGEMENTS TO MANAGE AND CONTROL BIOFOULING RISKS

5.1 Policy and Legal Framework (Annex A; Table 3-9(a))
- Key international/regional policies and agreements that [COUNTRY NAME] is party to (include as an Annex)
- Status of the AFS Convention and the IMO Biofouling Guidelines in [COUNTRY NAME]
- Summary of specific policy requirements for biofouling (e.g. Biosecurity Policy, Oceans Policy)
- List and describe the key legal instruments under which IAS are regulated
- Should include specific details of the functions, powers and duties that the legislation provides for in terms of managing IAS risks including any "Statutory Positions" designated under the legislation
- If none identified highlight those instruments under which such controls could be promulgated

5.2 Existing Institutional Arrangements (Annex A; Table 3-9(b))
- Brief description of each of the agencies involved in management and control of IAS including any "Lead Agency" identified at the national level
- Details of inter-agency cooperation mechanisms (e.g. committees and working groups)

5.3 Technical Capacity (Annex A; Table 3-9(c))
- Summary of existing capacity to address biofouling and any identified gaps that require capacity building

5.4 Infrastructure and Facilities (Annex A; Table 3-9(d))
- List the key facilities available for cleaning fouled structures including their location, capacity and services provided
- Provide details of any regulatory requirements/barriers to using these facilities for biofouling management (e.g. water quality standards etc)

5.5 Emergency response procedures (Annex A; Table 3-9(e))
- List the key measures in place to respond to the presence of a high risk ship or structure in the country or the identification of an IAS that has settled and spread
- Provide details of the institutional arrangements to implement such procedures

5.6 Marine Stakeholders (Section 5.1 (Step 3))
- List key marine stakeholders and summarise any consultations under taken during the self-assessment process

6. EVALUATING BIOFOULING RISK

6.1 Assessing the likelihood of IAS introduction (Section 4.1)
- Details of identified primary transfer pathways and their relative risk profiles
- Details of any previous incursion of IAS associated with existing pathways

6.2 Assessing the likelihood of IAS spreading (Section 4.2)
- Details of identified secondary transfer pathways and their relative risk profiles
- Details of any previous IAS transfer associated with secondary pathways

6.3 Assessing the potential impacts of IAS introduction (Section 4.3)
- Details of any resources that may be vulnerable to the impacts of IAS
- Identification of "high value" resources and the likelihood that they may be exposed to IAS

6.4 Assessing the country's level of preparedness to manage biofouling (Section 4.4)
- Existing survey capacity including legal basis for undertaking ship surveys
- Data collection, handling and storage
- Underwater inspection capacity

7. OUTCOME OF THE NATIONAL SELF-ASSESSMENT PROCESS

7.1 Key Findings
- Summary of the key findings arising from the National Self-Assessment process (Section 4.5)
- Status of existing arrangements compared with the elements described in Section 3.2 of the Guide

7.2 Critical Gaps Identified
- Summary of what gaps have been identified - what is not working well, what needs to change (this information will help the development of the National Biofouling Management Strategy and Action Plan)

8. REFERENCES

List all sources of information collected and reviewed during the self-assessment

SUGGESTED ANNEXES

List of stakeholders engaged during the process

Completed Self-Assessment Checklist

SUSTAINABLE DEVELOPMENT GOALS

5 GENDER EQUALITY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

17 PARTNERSHIPS FOR THE GOALS

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