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Department of Agriculture, Water and the Environment

Australian biofouling management requirements for international vessel arrivals

Regulation impact statement

Biosecurity Animal Division

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This Regulation Impact Statement (RIS) provides policy options for Australian Government action to improve the regulation of biosecurity risks associated with marine biological growth (biofouling) on vessels arriving into Australian territory.

Biofouling is a major pathway for marine pest entry into Australia. The Australian Government committed to the management of biosecurity risks associated with biofouling through implementation of the [Biosecurity Act 2015](). The Department of Agriculture, Water and the Environment has statutory powers under the Biosecurity Act to respond when a vessel's biofouling presents an unacceptable biosecurity risk of introducing and spreading marine pests and associated diseases.

This RIS focuses on how the department implements this government commitment in policy and legislation. This RIS identifies policy change that enables more effective regulation of the biosecurity risks associated with biofouling and the establishment of an efficient regulatory framework.

Current policy relies on vessel owners and operators voluntarily adopting measures to manage biosecurity risks associated with biofouling but provides little incentive to do so. The department does not undertake targeted outreach on biosecurity risks associated with biofouling, nor routinely assesses biofouling risk when targeting vessels for inspection upon arrival. The latter is due to insufficient information available to the department prior to a vessel's arrival. As a result, most vessels that pose an unacceptable biofouling risk are either not identified until the vessel is already in Australian waters, or not identified at all. This approach does not align with the department's objective to manage risks offshore, does not provide regulatory or compliance certainty to vessel operators and does not effectively or efficiently manage biosecurity risks associated with biofouling.

The most effective policy option identified in this RIS promotes and incentivises proactive, best practice management of biofouling by all vessels before coming to Australia. That policy proposes requirements for internationally arriving vessels to provide pre-arrival information that demonstrates biofouling management practices have been undertaken prior to arrival in Australian waters. The requirement will allow the department to target vessel interventions, allowing for more effective biosecurity risk management and more efficient use of resources and statutory powers to inspect vessels and respond to unacceptable biosecurity risks. Vessels that adopt proactive biofouling management practices will also receive less intervention, which will encourage the shipping industry and boaters to proactively manage biofouling prior to arrival.

A Consultation RIS (Consultation RIS; Office of Best Practice Regulation Reference 12793), developed in accordance with the Australian Government Guide to Regulatory Impact Analysis was the subject of public consultation from 1 April 2019 to 31 May 2019. Submissions received in response to the Consultation RIS were used to refine the policy options and adjust the estimated regulatory cost burdens of policy options.

This RIS assesses 4 options:

- Option 1: Status quo – maintain the current approach to biofouling risk management

- Option 1A: Increase inspections – increase vessel inspections under current approach to biofouling risk management (additional regulatory cost burden of $11.54 million over 10 years)
- Option 2: Species-based approach – regulation based on listed of species of concern (additional regulatory cost burden of $59.29 million over 10 years)
- Option 3: Proactive biofouling management – regulation to incentivise effective management practices (additional regulatory cost burden of $8.821 million over 10 years).

Option 3 is identified as the most cost-effective mechanism to manage biosecurity risk associated with biofouling. This RIS assesses the potential effectiveness of each policy option using a rubric-based method from Schneider & Arndt (2019) for evaluating the health of Australia's biosecurity system. A cost-effectiveness analysis from Boardman et al., 2018 is then used to identify the policy that most efficiently achieves the desired biosecurity outcomes. The analysis identified Option 3 as less costly and more effective than Option 1A and Option 2, and the most cost-effective of all options. Implementation of Option 3 is also expected to deliver the highest net benefit.

The department received substantial stakeholder support for the policy direction of Option 3 through formal public consultation processes:

- Review of National Marine Pest Biosecurity (Department of Agriculture and Water Resources, 2015)
- Consultation Regulation Impact Statement (OBPR reference 12793) – *Australian biofouling management requirements for international vessel arrivals* (Department of Agriculture and Water Resources, Biosecurity Animal Division, 2019).

This RIS has been developed in accordance with the *Australian Government Guide to Regulatory Impact Analysis* and in consultation with the Department of the Prime Minister and Cabinet's Office of Best Practice Regulation (OBPR).

1 Introduction and context

This decision RIS is a report to the Minister for Agriculture and Northern Australia recommending policy to improve the regulation of the biosecurity risks associated with biofouling on international vessel arrivals. It is part of government process and follows the Australian Government Guide to Regulatory Impact Analysis to ensure any regulatory amendments are carefully considered.

Biosecurity plays a critical role in reducing risk and enabling our nation to remain free from some of the world's most severe pests and diseases. Australia's geographical isolation plays a key role in maintaining this status, however our isolation as an island nation is rapidly changing as the barrier of time and distance becomes less relevant and international travel and trade increase and change. The Department of Agriculture, Water and the Environment administers the Biosecurity Act and various other Acts in order to protect Australia's animal, plant and human health status.

Marine biosecurity involves the management of risks to the economy, environment and community from the entry, establishment and spread of exotic marine plants, animals and associated diseases. Marine pests are those exotic plants or animals that present an unacceptable risk to Australia's environment, economy, human health, social or cultural values.

The department's marine biosecurity prevention measures reduce the likelihood of entry, establishment and spread of marine pests. Biofouling and ballast water are 2 major marine pest pathways which are regulated by the department through administration of the Biosecurity Act. Biofouling is the undesirable accumulation of microorganisms, plants, algae and animals on submerged structures, especially ships' hulls. Ballast water is sea water used and discharged by vessels to maintain stability and structural integrity.

The Biosecurity Act enables the department to manage suspected unacceptable biosecurity risks associated with biofouling on international vessel arrivals. Currently, the department does not receive sufficient information about vessels' biofouling to enable consistent targeting of high-risk vessels and the application of management measures to reduce biosecurity risks before vessels arrive in Australia. Vessels are not required to provide biofouling risk related information prior to arrival under current policy; the department rarely receives this information from third parties or vessels themselves. As a result, most international vessel arrivals do not have their biofouling risk assessed by the department. When a vessel is identified as presenting an unacceptable biosecurity risk associated with biofouling, it is typically already in Australian territorial waters and the options to manage biofouling risk are very restricted and can be costly.

1.1 Scope of this RIS

This RIS does not evaluate the need for Australian Government biosecurity activities and management of biosecurity risks associated with biofouling at Australia's border. The benefits of biosecurity are well established. Legislative powers to respond to biosecurity risks associated with biofouling exist under the Biosecurity Act and the need for biosecurity measures was also addressed in:

- Australian Quarantine: A shared responsibility (the Nairn review), identified biofouling and the discharge of ballast water into Australia as a proven method of introducing marine pests (Nairn, Allen, Inglis, & Tanner, 1996).
- One biosecurity: a working partnership (the Beale Review), illustrated the nature of biosecurity risks to Australia, the potentially severe consequences should an incursion occur and made recommendations about the regulation of biofouling (Beale, Fairbrother, Inglis, & Trebeck, 2008)).
- Review of National Marine Pest Biosecurity (the 2015 review), closely considered biosecurity risks associated with biofouling and made recommendations regarding the regulation of biosecurity risks associated with biofouling (Department of Agriculture and Water Resources, 2015).

The aim of the RIS is to identify the option that most effectively and efficiently improves the regulation of biosecurity risks associated with biofouling on international vessel arrivals.

This RIS recommends the option assessed as most practical to improve biosecurity outcomes, with the highest expected net benefit. The option also closely aligns with the recommendations of the 2015 Review and has the support of the majority of stakeholders.

2 Statement of the problem

The Australian Government is committed to the regulation of biosecurity risks associated with biofouling on international vessel arrivals, but the current approach is not effectively managing the risk. The consequence of an ineffective biofouling prevention measure is more frequent marine pest incursions and higher future costs associated with the impacts of incursions, eradication attempts and ongoing management and control activities.

The 2015 Review, the Beale review and the Nairn review reports (Beale, Fairbrother, Inglis, & Trebeck, 2008; Department of Agriculture and Water Resources, 2015; Nairn, Allen, Inglis, & Tanner, 1996) illustrate the nature of marine biosecurity risks to Australia, the potential consequences of incursions, as well as the need for government intervention. The 2015 Review made recommendations to improve Australia's national marine biosecurity arrangements and manage the current level of biosecurity risk Australia faces. As such, this RIS does not reiterate in detail the need for marine biosecurity policy to manage biosecurity risks associated with biofouling at Australia's border.

The department has identified 2 key reasons why the current approach does not effectively reduce the risks of marine pest incursions:

1) The current approach relies on vessels voluntarily managing biosecurity risks associated with biofouling, but:
    a) there is insufficient incentive for all vessels to adopt practices that effectively reduce biosecurity risk
    b) the current approach is not supported by clear policy and does not provide vessel operators with regulatory certainty.
2) The department does not obtain sufficient information about the risk posed by vessels prior to their arrival to adequately target high-risk vessels for intervention and inspection.

2.1 Significant consequences from marine pest incursions

Marine pests impact the economy, the environment and the community. The 2015 Review (Department of Agriculture and Water Resources, 2015) highlighted potential impacts:

- The productivity of fishing grounds and aquaculture operations can be impacted. Some pests, like the northern Pacific seastar (*Asterias amurensis*), prey on species utilised in aquaculture and fishery operations.
- Once established, marine pests can compete with native species for food and habitat and may prey directly on native species.
- Marine and industrial infrastructure such as jetties, marinas, long lines used in aquaculture and industrial water intake pipes can be damaged by marine pests.
- Marine pests can significantly increase the level of biofouling on vessel hulls and impact vessel performance by decreasing speed, increasing fuel consumption and clogging cooling water intakes.

- Some marine pests are microscopic organisms (for example, toxic dinoflagellates) that can accumulate in shellfish and in high levels are toxic to humans. Others can be a host for parasites, such as the Chinese mitten crab (*Eriocheir sinensis*), which is an intermediate host for a lung fluke parasite that infects humans (*Paragonimus westermani*) (Gollasch 2011).
- Introduced species are considered the greatest cause of the loss of biological diversity after habitat destruction (Vitousek, Mooney, Lubchenco, & Melillo, 1997). The introduction of new predators, competitors, disturbers, parasites and diseases alters the structure and biodiversity of ecosystems (Carlton, 2002).

Many exotic marine species have established throughout the world, with documented impacts on marine ecosystems and values:

- European green crab (*Carcinus maenas*) has greatly reduced the abundance of susceptible native prey species (5 to 10-fold declines) in California (Grosholz, Ruiz, Dean, & Shi, 2000). It is also known to significantly reduce eelgrass habitat in British Columbia (Howard, Francis, Côté, & Therriault, 2019).
- Carpet sea squirt (*Didemnum vexillum*) forms large colonies quickly in its invaded ranges, which can smother other seabed animals and change the seafloor community. It reduces habitat for native organisms, which can lead to changes in ecosystem structure (Fletcher, Forrest, & Bell, 2013; Morris, Carman, Hoagland, Green-Beach, & Karney, 2009). Its presence has led to reductions in sea urchins and brittle stars and number of sites available for scallops and mussels to live (Morris, Carman, Hoagland, Green-Beach, & Karney, 2009).
- *Caulerpa taxifolia* has had major impacts on ecosystems in the Mediterranean (Meinesz, 2002), vastly reducing native species diversity and fish habitat in the region (NIMPIS, 2008). The introduction of *C. taxifolia* in the Mediterranean has also led to a reduction of catches for commercial fishermen and has reduced efficiency of fishing vessels by entangling nets and boat propellers (NIMPIS, 2008). Economic impacts resulting from the cost of eradication attempts include approximately US$6 million spent in Southern California up to 2004 (Anderson, 2005) and $6 million to $8 million in South Australia (Summerson, et al., 2013).
- Chinese mitten crab (*E. sinensis*) modifies non-native habitats by causing erosion through its intensive burrowing activity (Gollasch, 2006) and costs fisheries and aquaculture several hundreds of thousands of dollars per year by consuming bait and trapped fish and damaging gear. Temporary local extinction of native invertebrates has also been recorded during migration events in its non-native range.
- Sea walnut (*Mnemiopsis leidyi)* was accidentally introduced to the Black Sea via the ballast water of ships during the 1980s, leading to serious ecosystem level changes. A major zooplankton predator, including of meroplankton (for example, fish and crustacean larvae), the species caused sharp decreases in zooplankton biodiversity, abundance and biomass (Shiganova, et al., 2004) in the Black Sea. Reductions in zooplankton also led to decreased fish stocks in the Black Sea and Sea of Azov (Shiganova, 2003) including some fishery crashes (Costello, Bayha, Mianzan, Shiganova, & Purcell, 2012).
- The Asian clam (*Potamocorbula amurensis*) reduced phytoplankton biomass in the San Francisco Estuary to critical levels (Alpine & Cloern, 1992; Kimmerer, 2002) leading to the

decline of several fish species (Sommer, et al., 2007) within the estuary, some of which were designated as endangered.

- The Pacific oyster (*Crassostrea gigas*) was intentionally introduced into many global locations for aquaculture yet is such a successful ecosystem engineer that it outcompetes native eelgrasses and oysters in Washington State, United States of America (Harris, 2008). Native oysters are now only found in low densities while the Pacific oyster, non-native clams and sea grasses dominate tidal flats. It can also be an agent for the regional spread of harmful pathogens and viruses, such as shellfish diseases.

Australian examples also demonstrate potential adverse environmental consequences of marine pests, which in many cases are not quantified (Arthur, Summerson & Mazur, 2015):

- European fanworm (*Sabella spallanzanii*), established in southern Australia, is believed to affect nitrogen cycling when in high densities and competes for space and food with benthic marine life.
- Japanese kelp (*Undaria pinnatifida*), established in Victoria and Tasmania, can competitively exclude native algal species, dominate space and disrupt food resources for native herbivores.
- The European green crab (*C. maenas*) can reduce the abundance of susceptible native prey species (Grozholz et al., cited in Arthur, Summerson & Mazur, 2015).
- Northern Pacific seastar (*A. amurensis*) has successfully invaded the southern coasts of Australia and has the potential to move as far north as Sydney. It is implicated in the decline of the critically endangered spotted handfish (*Brachionichthys hirsutus*) (NSW Department of Primary Industries, 2007) and is also considered an aquaculture pest, settling on scallop longlines, spat bags, mussel and oyster lines and salmon cages. Ross *et al* (2003) also found that the species significantly decreases adult bivalve populations and the survivorship of bivalve recruits in south-east Tasmania, including the commercial cockle species *Fulvia tenuicostata* and *Katelysia rhytiphora.*

2.1.1 Potential costs of incursions uncertain but likely substantial

The department used market and non-market valuation techniques to assess the potential economic, environmental and social impacts of marine pests on Australia's marine environment and industries. Each year marine ecosystem services contribute $69 billion to the Australian economy, of which $44 billion are contributed by marine-based industries (Eadie & Hoisington, 2011). Non-market goods and services including cultural, aesthetic and amenity values account for the remaining $25 billion (Eadie & Hoisington, 2011). At a regional scale, Sangha, Stoeckl, Crossman and Costanza (2019) valued Northern Territory marine and coastal resources at $1.3 billion per year and the economic value at $674 million to $1.4 billion per year, in addition to creating more than 6,000 jobs in the region.

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) estimated and valued the non-market environmental benefits to the community from reducing the risk of marine pest incursions in Australian waters (Mazur, Bath, Curtotti, & Summerson, 2018). The study found that Australians expect protection of the marine environment and marine industries, which have a vital role in our economy and livelihoods. Australian households were estimated to be willing to pay between $22 million and $58.8 million for marine biosecurity to protect one species and between $12.5 million and $33.4 million per 250 km of coastal area protected, if there is a 50% chance that the protection is successful (Mazur, Bath, Curtotti, & Summerson, 2018).

The challenge of quantifying the potential cost of a marine pest incursion to Australia is considerable. To inform the 2015 Review, Arthur, Summerson and Mazur (2015), used a cost range from $4 million to $1 billion per incursion, to account for the significant uncertainty of the average cost of high-impact incursions into Australia. The challenges are discussed further in Appendix B.

Box 1 Hypothetical benefit-cost analysis of an Asian green mussel (*Perna viridis*) incursion in Queensland

Asian green mussel (*Perna viridis*) is a large fouling species of mussel which generally colonises hard surfaces such as wharves, jetties, industrial pipes and vessel hulls. The species has a broad native range along the Indian coast and throughout the Indo-Pacific (Siddall, 1980) and has been introduced to Jamaica, Trinidad & Tobago, Fiji and the United States (CABI, 2021).

P. viridis is a priority pest species, having been assessed that it may cause significant impacts if it were to be introduced, establish and spread in Australia. It is listed in the National Priority List of Exotic Environmental Pests and Diseases. The species has established populations in Singapore – a major trading port with Australia.

Potential impacts include:

- Direct impacts on vessel performance and fuel consumption.
- Fouling of industrial plants, power stations, desalinisation plants and urban infrastructure including water inlets and water and sewage outlets.
- Changes in community structure and trophic relationships due to competition with native species.
- Accumulation of toxins and heavy metals and shellfish poisoning in humans.

A hypothetical benefit-cost analysis of eradicating *P. viridis* from Cairns and Gladstone ports was completed to inform management responses to marine pest incursions. Costs of response to an incursion were shown to be relatively small and potential impacts were likely to be very large. Costs for surveys, delimitation and eradication, grouped as response costs were estimated at $138,000, whilst impact costs with no treatment were estimated at about $800,000 for direct impacts and about $24 million for impacts on non-market values within the Great Barrier Reef Marine Park (Summerson, Hester, & Graham, CEBRA Project 1608E: Methodology to guide responses to marine pest incursions under the National Environmental Biosecurity Response Agreement, 2018).

2.2 Biofouling is a pathway for transfer of marine pests

Biofouling is widely recognised as a major pathway for the transfer of marine pests. In Australia, biofouling is likely to be responsible for 59% to 69% of introduced and cryptogenic species (Hewitt & Campbell, 2010).

Estimating the rate of marine pest incursions through biofouling and the potential impacts of the incursions is complex. The incursion of high-impact marine pests into Australia through biofouling on vessels has been estimated to be about once every 4 to 5 years by Hewitt & Campbell (2010) and ABARES (Arthur, Summerson, & Mazur, 2015) and every 13.5 to 16.5 years by Lewis (Lewis, 2011). In addition to these high-impact incursions, more frequent lower-impact incursions may also enter Australian waters via biofouling (Department of Agriculture and Water Resources, 2015; Arthur, Summerson, & Mazur, 2015).

2.2.1 Incursions are costly and difficult to manage

Once invasive marine species enter and establish in Australian waters, it is usually difficult and very expensive to manage. Successful eradication or containment is extremely difficult. Ongoing management of an invasive marine species to minimise impact of an incursion can involve costly measures over an extended period.

Eradication of invasive marine species is rarely successful. Advice on eradication methods is available for a limited range of species in Australia's Rapid Response Manuals, but in many cases eradication will be impractical (see Factors affecting success of eradication). The eradication of black-striped false mussel (*Mytilopsis sallei*) from Darwin, Northern Territory in 1999 is the only known example of a successful marine pest eradication in Australia. It is estimated to have direct costs totalling over $2.2 million, excluding staff costs (Bax, et al., 2002). Summerson et al. (2013) provides detailed cost calculations for eradication of *M. sallei* in 3 case study ports: Darwin, Cairns and Dampier. Estimates ranged from $193,000 in a marina with a lock gate in Darwin, to $118 million in a large open marina in Cairns (in present value terms for a horizon of 20 years and assuming a discount rate of 7%). Summerson et al. (2013) calculated that market losses ranging from $145 million to $286 million in present value terms over a 30-year period could result from damage to Australian ports and critical coastal infrastructure caused by an incursion of *M. sallei*. Potential non-market losses were qualitatively assessed to be large, possibly exceeding market losses. Loss of biodiversity and ecosystem services was also not estimated but is anticipated to be large, given that the eradication method used in Darwin resulted in an estimated 100% mortality of the entire marine ecosystem within the marina.

Containment or management approaches may be necessary where eradication is not practicable or unsuccessful. However, containment of an invasive marine species to the location of introduction is likely to be very expensive and often unsuccessful. Many marine species display dispersal reproductive strategies; this makes them extremely difficult, if not impossible, to contain in many cases. Dispersal reproduction can include broadcast spawning of gametes, pelagic (in water column) life stages and asexual fragmentation, the spread of which are also affected by winds and tides. Australia has national control plans for 6 species and procedures in place through the NEBRA to contain or manage marine pest species.

Restricting or managing human movement can affect a degree of containment and control on spread of marine species by anthropogenic means. Available containment measures depend on the species, location and types of human activity; the costs of those measures can be extremely high (see Control measures). While an eradication attempt may last for one or 2 years, containment measures may be expected to be in place for decades. Summerson et al. (2013) estimated the cost of containing an outbreak of *M. sallei* to Darwin at nearly $400 million over 30 years (using a 7% discount rate).

One of the most extensively researched costs associated with a maritime vectored pest are those from managing freshwater zebra mussel (*Dreissena polymorpha)* and quagga mussel *(Dreissena rostriformis bugensis*) in the Great Lakes of North America. Costs have been reported at over US$500 million per year (Connelly, Charles, O'Neill, Knuth, & Brown, 2007); and include documented economic impacts to power plants, water systems, industrial complexes, boats and docks. The cost to electricity generation and drinking water plants alone was over US$267 million from 1989 to 2004 (Connelly et al., cited in Arthur, Summerson & Mazur, 2015).

2.2.2 Prevention measures are more cost-effective

Prevention measures are considered the most cost-effective for Australia's marine biosecurity system (2015 Review; Arthur, Summerson & Mazur, 2015). Prevention measures reduce the likelihood of marine pest incursions, minimise the costs associated with the impacts of an incursion and minimise the outlay of upfront costs associated with eradication attempts (and potential ongoing management and control costs).

The 2015 Review recommended a focus on prevention to strengthen Australia's national marine biosecurity arrangements and reduce biosecurity risk associated with marine pests.

2.3 Insufficient incentive for effective voluntary management of biosecurity risks

Current information suggests that there is insufficient incentive to voluntarily manage biofouling on all areas of vessels to effectively reduce biosecurity risks. Current policy does not provide regulatory certainty and vessel operators are not incentivised to manage biosecurity risks associated with biofouling, particularly in niche areas. This results in inadequate and reactive management of biosecurity risks associated with biofouling on international vessel arrivals.

2.3.1 Biosecurity risk is not the primary driver for biofouling management

Currently, minimising fuel costs is the primary incentive for vessels to reduce biofouling build-up by implementing management actions. Biofouling on laminar surfaces, such as the hull, increases drag and, as a result, operational costs. Improvements to vessel performance can be achieved by reducing biofouling on these surfaces, financially incentivising management of biofouling on these areas. This incentive also drives research and development for in-water cleaning and hull coatings; resulting in management practices improving over time (Davidson, Brown, & Sytsma, 2009).

Niche areas are of key concern to the department's management of biosecurity risks associated with biofouling because they are known hotspots for biofouling accumulation. Examples of niche areas on vessels include thrusters, rope guards, propellers, sea-chests, dry-dock support strips and internal seawater systems. Niche areas represent approximately 10% of the total hull wetted surface area of the global fleet and up to 27% of the wetted surface area of some vessel types (Moser et al., 2017). Biofouling in niche areas (with the exception of dry-dock support strips and propellers) affects vessel performance far less than laminar areas of the hull. As such, there is significantly less financial incentive to manage biofouling (and the associated biosecurity risk) in these areas (Davidson, Brown, & Sytsma, 2009). In addition, niche areas often require a tailored approach to reduce biofouling accumulation and are more difficult to safely access and clean in-water.

Whilst large savings may result from effective biofouling management, costs of biofouling management to operators act as a disincentive, including lack of cleaning facilities, cost of maintenance and administration costs. Current policy for biofouling management is not overcoming the disincentive costs of managing biofouling in niche areas; the threat of non-compliance action is low due to current inspection rates (see section 2.4) and the policy does not provide sufficient regulatory certainty or clarity (see section 2.3.2) that particular management actions taken would result in compliance.

Commercial vessel sector

A recent pilot study by the department on biofouling management practices indicated insufficient understanding of the need for effective biofouling management plans that manage biosecurity risk amongst international commercial vessels arriving in Australia (Ramboll, 2021). Only a small proportion of respondents in the study indicated that they implemented biofouling management plans for vessels. In-water inspections of those vessels showed that practices were generally ineffective and high levels of secondary and tertiary fouling were detected in niche areas. This pattern is also seen in an analysis of vessels entering New Zealand waters, showing that not all vessels are complying with good practice as set out in the International Maritime Organization's (IMO) *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (2011; IMO Biofouling Guidelines). Australia has observed an increase in the level of fouling on some ship's hulls despite also seeing a general increase in the documentation of biofouling management practices.

Recreational vessel sector

A 2018 survey of 1,585 Australian recreational boaters demonstrated low (20% of respondents) awareness of the National Biofouling Management Guidelines for Recreational Vessels (Australian Government 2009) and the National Anti-fouling and In-water Cleaning Guidelines (Australian Government 2015); despite 95% of respondents being aware that marine pests can be present as biofouling on their boat (Stenekes et al., 2018). The study reported that submerged hull surfaces and niche areas were in general not as free of biofouling as would be expected. However, improved biofouling management practices were closely linked to vessel ownership and awareness of the guidelines.

2.3.2 Vessels do not have regulatory certainty

Australia's current biofouling policy does not provide vessel managers with certainty that actions undertaken to manage biofouling prior to arrival will result in regulatory compliance. The current policy (see Option 1: Status quo) was developed to operate under the *Quarantine Act 1908* and relies on guidelines to inform vessel operators on measures that can reduce biofouling risk.

Vessel owners and operators must navigate a complex regulatory environment to ensure they meet local, national and international biofouling requirements to avoid delays or costs associated with non-compliance. At the international level, the IMO provides biofouling management guidance through the IMO Biofouling Guidelines. These guidelines are currently being reviewed in an effort to improve global uptake. Australia provides guidance to vessels at a national level through its own suite of biofouling guidelines. Some Australian states and territories maintain their own guidelines and legislative requirements related to biofouling. This has, however, resulted in an inconsistent regulatory approach across the Australian, state and territory governments. Other nations have regulations in place to minimise the risks posed by biofouling. For example, New Zealand's Craft Risk Management Standard: Biofouling on Vessels Arriving to New Zealand (CRMS) sets out the requirements for management of biofouling risks associated with vessels entering New Zealand Territorial Waters (within the 12 nm limit).

The lack of regulatory certainty is resulting in many vessels undertaking limited or no action due to vague benefits versus the cost of undertaking biosecurity risk management actions.

Regulatory uncertainty is also resulting in some vessel operators taking potentially unnecessary, and at times risky, management actions immediately prior to entry into Australian territory to ensure that vessels are not delayed upon arrival. Between July 2020 and February 2021 10 vessel owners or operators sought vessel-specific advice from the department regarding biofouling management requirements prior to entering Australian waters. Several of these vessels dry-docked or in-water cleaned in order to avoid potential delays and ensure entry into Australia. The cost to vessels of taking this type of reactive action to mitigate identified biosecurity risks can be a significant burden. Management costs are particularly high when vessels do not identify or manage biosecurity risks prior to arrival, but rather when the vessel is already in Australian territory, due to the higher costs of completing activities in Australia (see Cost assumptions).

Anecdotal evidence suggests some vessels are intentionally avoiding contacting the department to seek policy clarification due to the increased likelihood of being targeted for inspection as a result. The risk of being targeted for inspection increases because the interaction often involves divulging information that highlights the biofouling risk of the vessel in question. The department may advise management action should be undertaken before entry and the vessel flagged for inspection upon arrival. This perverse incentive encourages a 'don't-ask' approach to Australia's policy and amplifies the negative effects on biosecurity that result from current policy and the lack of regulatory certainty from Australia's biofouling management requirements.

2.4 Department is unable to target high-risk vessels

Many potentially high-risk vessels are not being inspected or risk assessed because the department is unable to assess the biosecurity risks associated with biofouling for all vessels entering Australia. Pre-arrival information is required to identify and manage risks from international vessels suspected of presenting an unacceptable biosecurity risk associated with biofouling. The department's ability to identify high-risk vessels prior to arrival and efficiently allocate resources to inspect vessels upon arrival is very limited in the absence of sufficient pre-arrival information.

Currently, the department relies on intelligence provided by external sources to target vessels suspected of presenting an unacceptable biosecurity risk associated with biofouling prior to their arrival. Information is received irregularly from overseas government biosecurity agencies, Australian state or Northern Territory biosecurity agencies, industry members and operators of vessels. In the absence of mandatory pre-arrival reporting of biofouling information under the Biosecurity Act, the department cannot require all vessels provide this information prior to arrival. The Maritime Arrivals Reporting System (MARS) is used by the department to obtain mandatory pre-arrival information required under the Biosecurity Act, assess the risk posed by vessels and to flag vessels which may need to be inspected to ensure compliance with biosecurity regulations.

The department estimates that at least a quarter of vessels arriving into Australia from overseas may require additional management of their biofouling to reduce biosecurity risk to an acceptable level. This is based on the department's understanding of existing regulatory frameworks in Australia and overseas, and the current use of proactive biofouling management plans and record books across the maritime sector and subsequent likelihood of encountering substantial biofouling in niche areas (Ramboll 2018). However, in 2019 less than 1% of the

17,301 international arrivals by 6,000 unique vessels (Australian Bureau of Infrastructure, Transport and Regional Economics, 2019) were flagged for intervention or biofouling inspection by the department based on intelligence.

Without pre-arrival information to inform the efficient allocation of department resources, the department is too heavily reliant upon post-arrival interventions to inspect and assess biofouling risks associated with vessels. Currently, targeting of vessels is not systematic. Case-by-case gathering and assessment of biofouling risk related information can be costly and time-consuming. The cost of underwater inspections for both the government and commercial vessel operators, combined with operational and time restrictions whilst a vessel is in port inhibits the department's ability to undertake more frequent hull and niche area inspections for the purpose of evaluating biosecurity risks associated with vessels' biofouling.

3 Need for government action

The objective of Australia's biosecurity system is to reduce biosecurity risk to a very low level, but not to zero. It operates to ensure the safe movement of people, animals, plants, food and cargo to and from Australia whilst avoiding undue restriction of international trade. A preventive approach has been identified as the most effective way to manage the biosecurity risks associated with biofouling (Bax, et al., 2002; Department of Agriculture and Water Resources, 2015; International Maritime Organization, 2011; Georgiades, Growcott, A, & Kluza, 2018). Minimising biosecurity risk from international vessel arrivals is integral to an effective Australian biosecurity system and its focus on prevention measures.

Australian Government action is required to establish policy that efficiently manages biosecurity risk associated with biofouling on all vessels coming to Australia; in particular, high-risk vessels. Action is needed to establish an efficient regulatory design; a regulatory framework designed to reduce biosecurity risks to an acceptable level and provides clear benchmarks and incentivise vessels towards achieving regulatory compliance.

Vessel movement patterns indicate that Australia is exposed to a high degree of biofouling risk through connectivity with known marine invasion hot spots. A large proportion of Australia's international arrivals originate from high-risk regions, with Singapore, Indonesia, China, Japan, the United States of America and Malaysia being Australia's closest trading partners. A considerable number of vessels move between South-East Asia and Australian ports each year (see Box 2). Seebens et al., (2013) identified South-East Asia, the Middle East and the USA as invasion hot spots, with Singapore, the Suez Canal (Egypt), Hong Kong and the Panama Canal being the sites of highest invasion probability. Singapore is also known to have a significant number of established invasive marine species, including the Asian green mussel (*P. viridis*) and the American brackish-water mussel (*M. strigata*) which could potentially spread to Australian waters through biofouling.

Box 2 Case study – International arrivals in South-East Asia/Singapore

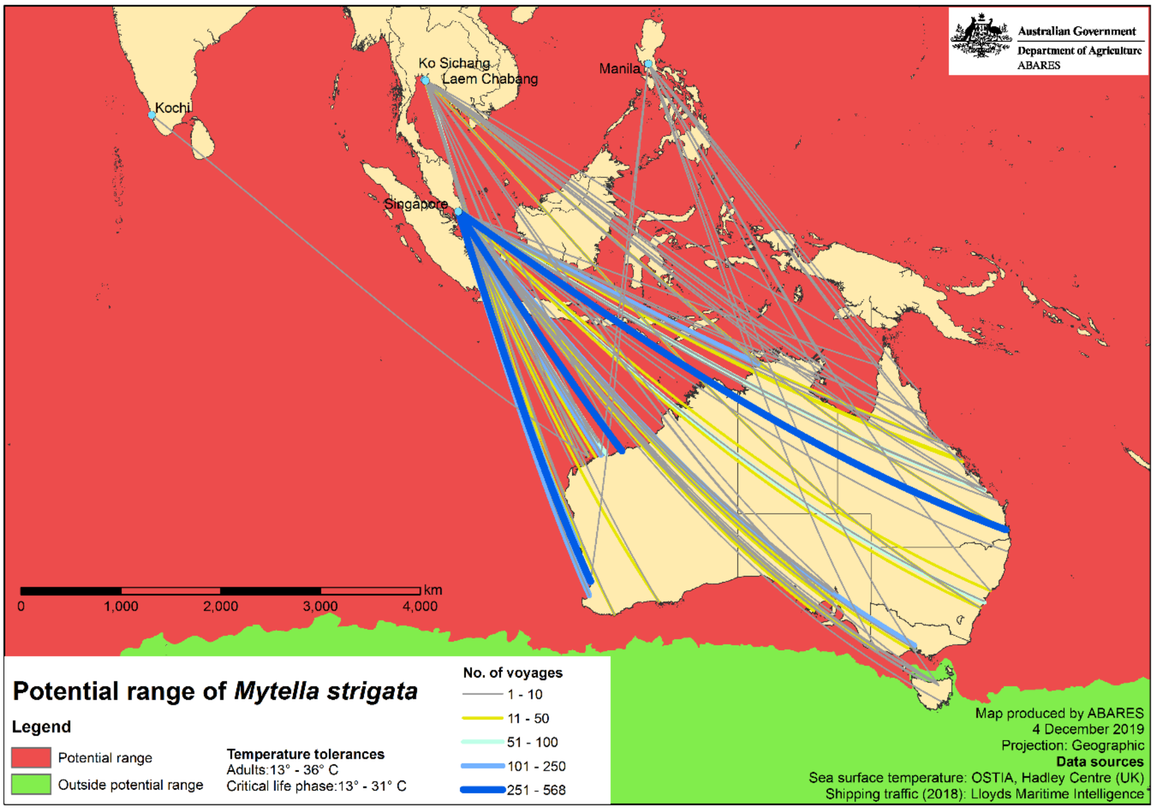
In 2016 the highly invasive American brackish-water mussel (*M. strigata*) was recorded for the first time at high densities in the Johor and Singapore Straits around Singapore. Native in Central and South America, this species has recently spread rapidly through South-East Asia and has the potential to negatively impact Asian green mussel (*P. viridis*) aquaculture stocks in the region.

Vessel movement between South-East Asia and Australian ports is considerable. Of the 17,301 international vessel arrivals Australia recorded in 2016, 2,773 voyages arrived across 73 Australian ports from Singapore alone, representing approximately 16% of all international entries. The main ports of arrival (in decreasing order of arrivals) were the ports of Port Hedland, Fremantle, Dampier, Brisbane, Darwin and Geraldton. Each of these ports have average water temperatures within *M. strigata's* tolerance range and, therefore, may provide suitable conditions for larval settlement and establishment (although it is important to note that other abiotic and biotic factors also influence the likelihood of establishment).

If established, *M. strigata* could potentially foul pearl oyster (*Pinctada maxima*) aquaculture sites in Western Australia (Bridgwood and McDonald, 2014). *P. maxima* is the most valuable aquaculture species in Western Australia; valued at $71 million in 2017 (Hart et al., 2018). It could also impact industry and social amenity, given that it fouls hard surfaces at high densities.

The recent range expansion of *M. strigata* highlights the need for effective management of biofouling on vessels arriving from these countries. Invasive species like *M. strigata* are expected to spread in the absence of effective prevention measures at Australia's border.

Map 1 Temperature tolerance range of *M. strigata* and major shipping routes to Australia



All vessels, regardless of origin, pose some biosecurity risk to Australia through biofouling. Whilst there are identifiable high-risk regions, it is well established that ports act as nodes in a global network and facilitate the spread of invasive marine species (Kaluza, Kolzsch, Gastner, & Blasius, 2010; Seebens, Gastner, & Blasius, 2013). Domestic vessel movements exacerbate species' range extension through secondary networks (Azmi, Hewutt, & Campbell, 2015). Intra-coastal shipping over shorter travel distances and often at lower speed means that biofouling communities on these vessels can be highly viable; therefore, once an introduction takes place, preventing domestic spread and avoiding impacts is near impossible.

The level of biofouling on vessels is highly variable between vessels and sectors and largely depends on operational practices. While fast-moving vessels with short port stays are observed to maintain low biofouling levels on external (laminar) hulls they can still support substantial biofouling communities within niche areas (Davidson, McCann, Fofonoff, Sytsma, & Ruiz, 2008; Davidson, Brown, Systma, & Ruiz, 2009; Coutts, Moore, & Hewitt, 2003; Coutts & Taylor, 2004; Coutts & Dodgshun, 2007). Davidson *et al.* (2009) suggest commercial vessels surveyed in California operating at moderate speeds are capable of developing and transporting biofouling communities; indicating that all vessel types pose a risk for introduction of invasive marine species.

The department does not expect current policy and regulation to result in a significant increase in voluntary uptake of biofouling management measures that effectively address biosecurity risks. The hurdles to uptake of voluntary IMO guidelines are consistent with Australia's experience in the implementation of national biofouling guidelines. In addition to the lack of incentive discussed in section 2.3, significant hurdles to implementation of the IMO guidelines have been identified by a number of IMO member states, including:

- port restrictions for underwater maintenance and cleaning operations
- full implementation of the recommendations of the guidelines can be costly
- increased administration workloads without regulatory certainty
- lack of availability of cleaning and maintenance facilities
- lack of availability of equipment, tools or techniques for proactive biofouling management
- lack of clear in-water cleaning regulations and complex jurisdictional arrangements which result in unclear approval processes
- seasonality of navigation and voyage patterns, such as short voyages or if deviations are required and the challenges this creates for preventing biofouling on hulls and in niches.

A recent Australian study showed that high levels of fouling were found on vessels despite them indicating they voluntarily implemented biofouling management plans. This indicating that the practices being implemented were not effective in managing the biosecurity risk associated with biofouling (Ramboll 2021).

4 Objectives of government action

The objectives of government action to address problems with regulation of biosecurity risks associated with biofouling on international vessel arrivals are to:

- manage Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to an acceptable level
- maximise the efficiency of biosecurity risk management by having the smallest necessary regulatory impact on vessels and Australia’s trade.

5 Policy options

This RIS assesses the ability of 4 policy options to effectively and efficiently achieve the objectives stated in section 4. This RIS contains 3 options for government action and an option to maintain the status quo, which acts as a baseline from which to compare the 3 alternatives.

- **Option 1: Status quo** – maintain the current regulatory approach to biofouling risk management
- **Option 1A: Increased inspections** – increase vessel inspections under current approach
- **Option 2: Species-based approach** – additional regulatory action to prevent introduction of listed species of concern
- **Option 3: Proactive biofouling management** – additional regulatory action to improve practices that minimise biosecurity risks associated with biofouling.

The development of each policy option considered in the context of Australian Government biosecurity activities and priorities for the management of biosecurity risks, including:

- Past government reviews of the biosecurity system identify the need for regulatory measures to address biosecurity risks associated with marine pests and biofouling on international vessels.
- Prevention, including the management of the vessel biofouling pathway, is the most cost-effective approach to management of marine pest incursions.
- The current regulatory framework, including the Biosecurity Act, which contains powers for the management of unacceptable biosecurity risks associated with biofouling on international vessel arrivals.
- The biosecurity system is strengthened by working with partners and through innovation and business transformation to continuously improve regulatory efficiency and effectiveness.

5.1 Option 1: Status quo

Under Option 1 there would be no change to the department’s current approach to biofouling management. This option would maintain the status quo, which is a mixture of voluntary self-management by vessels and the use of existing statutory powers under the Biosecurity Act to manage unacceptable biosecurity risks associated with biofouling.

5.1.1 Voluntary self-management of biosecurity risks

Under the status quo, international vessels would be encouraged to adopt biofouling management practices that reduce biosecurity risk prior to their arrival in Australia.

The Australian Government would continue to recommend uptake of Australia’s suite of national biofouling guidelines and the IMO Biofouling Guidelines when responding to enquiries from vessels about biofouling requirements.

The department would maintain the non-mandatory national biofouling guidelines and the Australian Anti-Fouling and In-water Cleaning Guidelines to inform vessels of best practice management biosecurity risks associated with biofouling.

5.1.2 Use of existing statutory powers

The department would continue to use statutory powers under the Biosecurity Act to assess and manage suspected unacceptable biosecurity risks associated with biofouling.

The process used to assess and manage biosecurity risk would be:

- Vessels biosecurity risk may be assessed prior to arrival using information provided voluntarily and irregularly to the department by vessel operators or third parties. Vessels would not be routinely assessed for biofouling risk prior to arrival
- On arrival, a vessel may be risk assessed and a biosecurity officer may conduct a detailed documentary inspection. This may occur where:
  - A vessel is flagged for biofouling risk assessment based on intelligence gathered prior to arrival, including past inspection history
  - A biosecurity officer suspects an unacceptable biosecurity risk associated with biofouling during a routine vessel inspection
  - A vessel voluntarily provides information post-arrival to a biosecurity officer that indicates potential unacceptable biosecurity risk
- Biosecurity officers may inspect a vessel upon arrival, and ask questions or require information or documents to be provided to inform an assessment of biosecurity risks in accordance with the Biosecurity Act
- An in-water inspection of biofouling may be required by the department to inform the risk assessment of a likely high-risk vessel
- Powers under the Biosecurity Act may be used, where necessary, to manage suspected unacceptable biosecurity risk. This may include, but is not limited to, vessel operators being issued movement directions or directions to treat biosecurity risks.

5.2 Option 1A: Increased inspections

Under Option 1A: Increased inspections, the department would significantly increase post-arrival inspections of international vessel arrivals for biofouling risk assessment. There would be no other changes to the department’s current approach to biofouling management outlined in Option 1.

5.2.1 Voluntary self-management of biosecurity risks

The aspects of Option 1A that would be equivalent to Option 1 are:

- encouragement of international vessels to adopt biofouling management practices by reference to Australia’s national biofouling guidelines and the IMO Biofouling Guidelines
- reference to biofouling guidelines in responses to vessel enquiries from vessels about biofouling management requirements
- maintenance of Australia’s National Biofouling Management Guidelines and the Australian Anti-Fouling and In-water Cleaning Guidelines.

5.2.2 Use of existing statutory powers

The use of statutory powers to manage biosecurity risk and the processes used to assess and manage biosecurity risk would remain unchanged from the status quo.

The number of unique vessels inspected for biofouling risk upon arrival would be 100% in the first year. The department would incorporate biofouling inspection and risk assessment outcomes into the Vessel Compliance Scheme (VCS), which would result in an overall reduction in the rate of biofouling inspections over time.

Vessel Compliance Scheme

VCS reduces the number of inspections for vessels found to be compliant from repeat inspections. The use of the VCS by the department does not replace any other enforcement actions available to the department under the Biosecurity Act. A master or agent that commits an offence may be liable to penalties under the Biosecurity Act in addition to any administrative action taken under the VCS.

All biofouling inspections conducted by biosecurity officers would involve a detailed documentary inspection and gather information to inform an assessment of the biosecurity risk associated with biofouling. This information would be:

- the presence of, name, age and service life of fouling control system applied to hull sides, hull bottom, sea chests, sea chest gratings, propeller, rope guard/propeller shaft, thrusters, rudder and shaft, bilge keels
- a copy of the vessel's Anti-Fouling System Certificates
- information on the presence and operation of marine growth prevention systems (MGPS) in niche areas
- information on most recent dry-docking, hull inspection and removal of all biofouling
- information on how often the vessels' internal seawater pipework, sea chests and sea strainers are treated to prevent marine growth
- copies of the vessel's records of biofouling management actions
- average speed while underway and typical operating voyage (set route or itinerant)
- duration of stays in overseas locations, including:
  - in the last year, how many times the vessel stayed in a single location for greater than 10, 20 and 30 days since delivery or exiting dry-dock
- expected duration in Australian coastal water and duration in each Australian port during current voyage
- whether the vessel will be in-water cleaned in Australian territorial sea during its voyage.

5.3 Option 2: Species-based approach

Under Option 2: Species-based approach, vessels would be required to be free from listed species of concern. This policy approach reduces biosecurity risk by reducing the likelihood of incursions of species identified as a potential high-impact marine pest.

Vessels would also be required to use a specified risk assessment tool prior to arrival. The tool would determine the likelihood of harbouring a listed species of concern and would trigger specified compliance and enforcement actions based on the risk assessment outcome.

5.3.1 Mandatory requirements for vessels

Under Option 2, requirements for vessels to be free from listed species of concern, and to provide information relevant to the assessment of the likelihood of a vessel harboring a listed pest, would be established under the Biosecurity Act.

All vessels would be required to provide extensive biofouling risk information prior to each arrival by using a Marine Growth Risk Assessment (MGRA) tool. The MGRA would be developed by the department as a standalone tool or incorporated into MARS. The Biosecurity Act would be amended to require vessels to provide information on:

- vessel particulars (last port of call, arrival date, name, type, IMO number, build date and gross tonnage)
- presence and age of anti-fouling coating
- recent hull survey and marine growth inspection information
- treatment of internal seawater systems
- duration of stays in overseas locations
- expected duration in Australian ports or coastal waters.

5.3.2 Compliance and enforcement

The MGRA tool would be used to automatically assess the likelihood that a vessel is harbouring a listed species of concern and assign a risk status of unknown, moderate, high or extreme. The department would not take non-compliance actions on vessels identified by MGRA to pose a moderate risk.

Biosecurity officers would inspect all vessels on arrival that are identified by MGRA as high or extreme risk and conduct random inspections of vessels assigned an ‘unknown’ risk status. Risk classifications may change based on outcomes of inspections. Commercial vessels that are confirmed high and extreme risk would be subject to operating time restrictions while in Australian waters. Actions such as hull and niche area inspections and treatment may be required if those vessels wish to stay in, or return to, Australian waters.

Recreational vessels assessed as high and extreme risk would be required to have a hull inspection, treatment or undertake an alternative biofouling management activity upon arrival.

If a vessel is found to harbour a listed species of concern, the responsible party would need to demonstrate how the risk has been addressed. If treatment facilities such as dry docks, slips or approved in-water cleaning operations are not available in Australia, the vessel would be able to complete its voyage (within operating time restrictions) but would not be permitted to return to Australian waters until it could demonstrate the absence of species of concern. The department would lead the development of a national standard for in-water cleaning to support vessels undertaking biosecurity risk management measures. Relevant regulators and authorities would be able to use the standard as a benchmark approval process for addressing biosecurity and contaminant risks associated with in-water cleaning of biofouling from vessels.

An educational approach to non-compliances would be adopted for the first 2 years of policy implementation. That period would be used to ensure effective communication of the requirements to vessel owners and operators and work with other stakeholders to improve accuracy of the MGRA.

5.4 Option 3: Proactive biofouling management

Under Option 3: Proactive biofouling management, regulatory action would be taken to enable the department to proactively manage biosecurity risks and incentivise vessel operators to adopt proactive management. Option 3 reduces biosecurity risks from all fouling species by minimising the amount of biofouling on all international vessel arrivals and promoting practices that minimise biosecurity risks associated with biofouling.

Under Option 3 all vessel operators would be required to provide information on biofouling management practices prior to the arrival of a vessel in Australian territory. Vessels that demonstrate implementation of proactive biofouling management practices through a Biofouling Management Plan (BFMP) and a Biofouling Record Book (BFRB) would be assigned a low-intervention status.

5.4.1 Mandatory requirements for vessels

Under Option 3 vessels would be required to provide information prior to arrival in Australian territory, requiring amendment to the *Biosecurity Regulation 2016*.

The department would publish Australian Biofouling Management Requirements prior to the policy implementation date. This would detail the requirements, actions and documentary evidence required by vessels to comply with the policy and the Biosecurity Act. The Australian Biofouling Management Requirements would also provide detailed guidance on how to answer pre-arrival reporting questions.

Vessels would be required to provide responses to pre-arrival questions, on whether the vessel has:

- implemented a BFMP and BFRB
- treated or cleaned the vessel hull and niche areas before arrival in Australia
- implemented an alternative biofouling risk management practice that has been approved by the department prior to the vessel's arrival in Australian territory
- an intention to undertake acceptable in-water cleaning in Australian waters.

The department would use information from pre-arrival reports and gathered intelligence, to determine whether arriving vessels are eligible for low-intervention status based on biofouling management actions of the vessel to minimise biofouling growth on the hull and niche areas.

Low-intervention status

Low-intervention status signifies that the information available to the department indicates a low likelihood of unacceptable biosecurity risk associated with biofouling. Vessels assigned low-intervention status are not routinely targeted for intervention (for example, inspection) to assess or manage biofouling related biosecurity risk on that voyage.

Vessels would be required to implement a BFMP and BFRB in accordance with an implementation schedule to be assigned a low-intervention status. The BFMP and BFRB must be:

- consistent with Australian Biofouling Management Requirements (based upon the IMO Biofouling Guidelines)
- vessel specific and effective, including:
  - that it is suited to the vessels' operational profile and maintenance schedule
  - that it demonstrates a regular and proactive approach to maintaining biofouling growth on laminar hull surfaces and in niche areas
  - it contains contingency measures that apply when significant deviations from normal operations occur.
- regularly maintained and updated as necessary, including:
  - updates to reflect changes in industry best practice for continual biofouling maintenance
  - reviewed to assess the effectiveness of biofouling management measures
  - updated in response to regulator or expert advice.

The requirement to have a BFMP and BFRB to be assigned low-intervention status would be phased in over a 5-year implementation period (see section 9.1.1). Vessels that are not assigned low-intervention status may be required to provide additional risk-based information prior to arrival and be subject to a biofouling inspection upon arrival.

5.4.2 Compliance and enforcement

Under Option 3 the department would use existing powers under the Biosecurity Act to assess and manage suspected unacceptable biosecurity risk associated with biofouling. The department would also use administrative tools (for example, MARS), incentive based schemes (including VCS and appropriate private sector developed systems) to enable more effective and efficient targeting of high-risk vessels and behaviours and reduce the burden on those that are compliant.

A biofouling inspection of a vessel would assess documentation and interview the responsible officer of the vessel. The inspection will confirm accuracy of information submitted in pre-arrival reports, consider evidence of biofouling management actions undertaken and identify any mitigating circumstances to determine whether the vessel is likely to have reduced biofouling risk to as low as reasonably practicable.

If the initial biofouling inspection indicates documentary irregularities or insufficient biofouling management actions, then an in-water inspection and detailed assessment of the vessel's biosecurity risk associated with biofouling may be deemed necessary. In-water inspection would provide information relating to the level of biofouling on a vessel.

Non-compliance action would be undertaken on a case-by-case basis and potential actions would be consistent with Option 2.

Threshold for unacceptable level of biofouling

Under Option 3 the Biosecurity Requirements would not prescribe a performance standard – such as a threshold level of biofouling – to define whether the biosecurity risk of a vessel is unacceptable. The level of biofouling would be one of a combination of factors considered in the assessment of the biosecurity risk of a vessel. A range of factors would also be considered to determine the intervention required to manage unacceptable biosecurity risks; including level of biofouling, biofouling management practices, planned activities and length of stay in Australian waters.

The department would lead the development of national standards for in-water cleaning to support vessels undertaking biosecurity risk management measures in Australia. Relevant regulators and authorities would be able to use the standards to address biosecurity and contaminant risks associated with in-water cleaning of biofouling from vessels within their jurisdiction.

An education–first approach to non-compliances would be adopted for the first year of implementation. That period would be used to ensure effective communication of Australian Biofouling Management Requirements to vessel owners and operators.

6 Analysis of options

This section analyses the potential for each policy option to deliver the desired objectives of government action (section 5). It identifies the option that most efficiently improves the effectiveness of current regulation of biosecurity risks associated with biofouling.

The regulatory burden of each option is estimated in accordance with the Australian Government Guide to Regulatory Impact Analysis, to measure the financial impact to industry and the public in dealing with a new regulatory environment.

A cost-effectiveness analysis is conducted following the Australian Government Guide to Regulatory Impact Analysis, and the methodology in Boardman et al., (2018) to inform assessment of the potential impacts and efficiency of government action.

6.1 Assessment of regulatory burden

The regulatory burden of each option has been estimated using assumed actions taken by vessel owners and operators in response to each of the policy options. This RIS estimates the regulatory burden of each policy option on businesses and individuals operating vessels that enter Australian territory and are subject to biosecurity control under the Biosecurity Act.

This RIS uses Lloyd's data provided by Informa for vessels that entered Australian waters in 2019 (Lloyds 2019 data). The 2019 data is used to estimate regulatory cost burden over the 10-year timeframe for RIS regulatory cost estimates. The regulatory burden of each policy have been estimated with the support of ABARES, and in accordance with The Australian Government Guide to Regulation and in consultation with the Office of Best Practice Regulation (OBPR).

Burden assigned to commercial vessels and non-commercial vessels

The RIS uses commercial vessel entry numbers to assess regulatory burden on impacted businesses. 5,860 unique commercial vessels entered Australian territory in 2019 (Lloyds 2019 data). Non-commercial vessel (for example, private yachts) entry numbers are used to assess regulatory burden on impacted individuals. 667 non-commercial vessels entered Australian territory in 2019 based on the departments Vessel Monitoring System. Community organisations were not identified as being significantly impacted.

The estimated total regulatory impact over a 10-year period calculated using the department's Regulatory Impact Costing Tool is shown in Table 1. The costs are presented as incremental costs in comparison to the status quo, therefore Option 1: Status quo has no additional regulatory burden.

Table 1 Summary of estimated additional regulatory costs, by policy option

Policy option	Annual cost to businesses ($m)	Annual cost to individuals ($m)	Total annual costs ($m)	Total costs over 10-year period ($m)
Option 1	n/a	n/a	n/a	n/a
Option 1A	1.153	0.000	1.153	11.540
Option 2	5.709	0.219	5.928	59.285
Option 3	0.828	0.054	0.882	8.821

n/a Not applicable.

Burden on all international vessel arrivals

This RIS considers significant costs to international vessel arrivals regardless of ownership or where the vessel is registered. The regulatory cost burden to only Australian owned vessels would be significantly less; approximately 1% of the commercial vessel costs in this RIS.

This includes all vessel types and floating structures, including merchant ships, offshore support vessels, fishing vessels, bulkers, towed structures and recreational craft.

Non-compliance costs are not included

The cost of not complying with regulations, also known as enforcement or non-compliance cost, is not factored into the regulatory cost burden estimates.

6.2 Assessment of government administrative costs

The government administrative costs are the costs of development, administration and enforcement (such as inspections and risk assessments) of a policy by the Australian Government. This calculation of costs considers the cumulative time required for departmental staff to administer the policy options presented in this RIS based on estimates of the rates at which vessel arrivals result in various administration activities taking place.

Table 2 provides a summary of the estimated government administration costs for each policy option. The government administrative costs are presented as incremental costs in comparison to the status quo.

It identifies Option 3 as having the lowest administrative cost, followed by Option 1A, with Option 2 having the highest government administrative cost.

Table 2 Summary of estimated government administration costs, by policy option

Policy option	Total annual costs ($m)	Total cost over 10 years ($m)
Option 1	n/a	n/a
Option 1A	0.80	8.02
Option 2	2.27	22.66
Option 3	0.37	3.68

n/a Not applicable.

6.2.1 Issues impacting administrative costs of implementation

Vessel inspections conducted by the department under Option 1 are not biofouling specific. Biofouling specific inspections rely on externally provided information or a biosecurity officer to notice biofouling at the waterline during a routine vessel inspection (RVI) and follow up by asking the master a series of biofouling specific questions. The number of RVI inspections under Option 1 are not expected to vary from the current scenario of 47% of commercial vessels based on the current rate of RVIs conducted by the department. The remaining 53% of commercial vessel arrivals are not inspected as a result of the VCS.

There is significant administrative burden on the department associated with assessments of large amounts of biosecurity risk related information collected during post-arrival inspections under Option 1A. Vessel inspections conducted by the department are predicted to commence at 100% of vessel arrivals in the first year. This would reduce to 47% of commercial vessels by year 3, based on the current rate of RVIs conducted by the department. Currently, RVIs are not conducted on 53% of commercial vessel arrivals as a result of the VCS. The administrative burden associated with Option 1A is expected to be higher than Option 3 due to the high inspection rate and associated risk assessments required to address the lack of pre-arrival reporting.

The government administrative costs associated with Option 2 are largely as a result of the development and use of an effective MGRA tool, the administrative burden associated with regulating a list of species of concerns in order to determine non-compliances with regulations, and acting on risk assessment outcomes of MGRA. The administrative burden associated with Option 2 is expected to be higher than all other options over a 10-year timeframe due to the complexity of assessing and responding to non-compliance with a list of species of concern.

The pre-arrival reported information and intelligence gathered by the department is predicted to enable more efficient desk-based and documentary inspections under Option 3, reducing government's administrative costs associated with compliance inspections. The administrative burden associated with Option 3 is expected to be less than Option 1A or Option 2 over a 10-year timeframe. Vessel compliance inspections conducted under Option 3 are expected to increase over the first 5 years as the requirements come into force, then decrease as vessels adapt and comply with the requirements.

The assessment of administrative costs does not identify which activities may be cost-recoverable under the department's current cost recovery system. If changes to government cost-recovery would be required to implement the preferred policy, then consultation with affected stakeholders would occur through the established cost-recovery consultation process.

6.3 Cost-effectiveness analysis

This RIS uses cost-effectiveness analysis (CEA) to compare the options in terms of the ratio of their costs to how effectively they may achieve the desired objectives of government action.

The CEA involves determining an adjusted cost-effectiveness (CE) ratio:

$$CE(adjusted) = \frac{(Administrative\ Gov.Costs\ +\ Social\ Costs - Other\ Social\ Benefits)}{Effectiveness}$$

Administrative costs to government are added to the social costs to more closely align the CEA to allocative efficiency than use of administrative costs to government alone (Boardman et al., 2018). The calculated administrative costs to government are contained in Table 2. This RIS assumes that social costs are equivalent to the calculated regulatory burdens for each policy option as shown in Table 1. The other social benefits (benefits other than biosecurity) to biofouling management include operational and fuel efficiency of vessels. However, this RIS does not calculate an amount for other social benefits, primarily because calculating a causal link between other potential benefits and a policy targeting biosecurity risks associated with biofouling is considered too uncertain (see Additional social benefits – Fuel efficiency).

6.3.1 Effectiveness assessment using rubrics

This RIS uses a rubric-based method to assess the potential effectiveness of each policy option to deliver the desired objectives from government action.

The rubrics method assesses the potential effectiveness at reducing the approach and leakage rate of vessels that represent an unacceptably high risk of translocating a potential marine pest through biofouling. Approach rate is the proportion of high biosecurity risk vessels that reach the Australian border and leakage rate is the proportion of high-risk vessels which are not intercepted at the border. The potential effectiveness of each policy option to reduce the approach rate and leakage rate of potential marine pests has been selected as a proxy for a policy's effectiveness to deliver the desired objectives from government action. Increasing levels of biofouling are associated with a higher likelihood of a vessel harbouring a marine pest (Bell et al., 2011). Therefore, it is assumed that a reduction in the number of vessels with unacceptable biofouling levels will lead to a reduction in the approach rate of potential marine pests and further, a reduction in the likelihood of establishment within Australian territorial waters.

This RIS uses rubrics adapted from Schneider & Arndt (2019) to assess each policy against a set of effectiveness criteria which are compiled and weighted by importance. The outcomes of the Rubrics analysis are overall effectiveness scores for each policy option, which are used in the CEA. Qualitative assessments of each options' potential impact on key components of biosecurity risk management are used in the analysis of options contained in sections 6.4 to 6.7. Additional information on the use of rubrics is contained in section 14.5.

The rubrics used to assess each policy option, focus on the biosecurity system's ability to anticipate, screen, prevent and adapt to biosecurity risks associated with biofouling on international vessel arrivals. These are the 4 major components of effective biosecurity management required to meet the objectives for government action (section 4). They are necessary functions of the biosecurity system in order to reduce approach rate and leakage rate of international vessel arrivals that represent an unacceptable biosecurity risk.

A group of 7 department and ABARES staff, representing a range of experience and knowledge in marine pest biosecurity scored each effectiveness criteria from 0 (insufficient information) to 4 (excellent performance). The score from these assessments was compiled and weighted by importance. Table 9 is a guide used to interpret the overall effectiveness rating of each policy option discussed in section 6 of this RIS.

Anticipate
The Anticipate rubric evaluated the extent to which each policy may identify, assess and prioritise biosecurity risks posed by biofouling on internationally arriving vessels. Participants evaluated how each policy would be expected to perform in development, application and sharing of biofouling related intelligence, risk identification and prioritisation and the expected proportion of high priority risk vessels which would be captured under each policy.

Screen
The Screen rubric assessed each of the policy's potential to reduce the number of potential pests and diseases approaching the border (the approach rate) through detections of non-compliant vessels at the pre-border stage (thus reducing the leakage rate). The assessment included evaluation of the extent to which each policy would achieve a low leakage rate through efficient and effective profiling and the proportion of risk vessels that would be captured by the system at the border.

Prevent

The Prevent rubric assessed the potential to reduce the number of potential pests and diseases approaching the border. This rubric focuses on the extent to which each policy can incentivise vessels to manage their biofouling appropriately before they reach Australian territory.

Dynamic efficiency

The dynamic efficiency rubric assessed the ability to improve efficiency through innovation and long-term impact scanning to produce better outcomes, for example, a reduction in approach rate and leakage rate, whilst maximising the utilisation of inputs. A dynamically efficient policy will be nationally consistent, capture sufficient data to feed into analysis systems and reduce the biosecurity risk posed by biofouling on internationally arriving vessels.

6.3.2 Adjusted cost-effectiveness ratio

The calculation of adjusted CE ratios for each policy option, shown in Table 3, identifies Option 3 as the most cost-effective of the options (lowest CE ratio). The costs and effectiveness are presented as incremental in comparison to the status quo.

Table 3 also shows that Option 1A and Option 2 are both more costly and less effective than Option 3. As a result, these 2 options are dominated alternatives; they are removed from further consideration in the analysis (Boardman, Greenburg, Vining, & Weimer, 2018).

Table 3 Outputs of adjusted cost-effectiveness analysis, by policy option

Policy option	Administrative costs ($m per annum)	Other social costs ($m per annum)	Other social benefits ($m per annum)	Effectiveness at achieving biosecurity outcome (weighted percentage)	CE ratio (adjusted)
Option 1	n/a	n/a	n/a	n/a	n/a
Option 1A	0.80	1.153	0	29%	6.74
Option 2	2.27	5.928	0	34%	23.92
Option 3	0.37	0.882	0	50%	2.50

n/a Not applicable.

6.3.3 Option with highest expected net benefit

The adjusted CEA ratios in Table 3 inform the recommendation of a policy option. However, it is necessary to consider the societal value (shadow price) for a unit of effectiveness in order to make a policy recommendation based on net benefit. This is because it is not possible to obtain a single measure of net benefits using the cost and effectiveness ratios in Table 3 alone (Boardman, Greenburg, Vining, & Weimer, 2018). The incremental cost-effectiveness ratios (ICER) of the policy options are calculated to facilitate a recommendation based on expected net benefit.

The ICERs measure the incremental cost per unit improvement in effectiveness relative to the next less costly alternative. The ICER of Option 1 is equal to the adjusted CE ratio previously calculated and shown in Table 3. ICERs of Option 1A and Option 2 are not calculated as both of these options are dominated by Option 3; both options are more costly and less effective than Option 3 and would always have a lower net benefit than Option 3 for any possible value of the effectiveness measure (Boardman, Greenburg, Vining, & Weimer, 2018). The ICER of Option 3, is calculated relative to Option 1 using the formula:

$$ICER = \frac{Costs\ Option\ 3 - Costs\ Option\ 1}{Effectiveness\ Option\ 3 - Effectiveness\ Option\ 1}$$

The calculation is illustrated in Table 4. The costs and effectiveness are presented as incremental in comparison to the status quo.

Table 4 Calculation of incremental cost-effectiveness ratios for Option 1 and Option 3

Cost and effectiveness	Unit	Option 1	Option 3
Costs (administrative plus social)	$m per annum	n/a	4.88
Effectiveness(weighted)	%	n/a	50
Costs (Option 3) less costs (Option 1)	$m per annum	n/a	1.25
Effectiveness (Option 3) less effectiveness (Option 1)	%	n/a	50
ICER	$m per annum	n/a	0.025
ICER (Upper 90CL)	$m per annum	n/a	0.017
ICER (Lower 90CL)	$m per annum	n/a	0.034

ICER incremental cost-effectiveness ratio.
n/a Not applicable.

Table 4 shows Option 3 with an ICER of $25,000, which is the amount to increase the effectiveness of biosecurity outcome by 1% under Option 3 compared to the status quo. If the societal value of a unit of effectiveness is greater than $25,000 then Option 3 should be selected as the option with the highest expected net benefit. If it is less than $25,000 then no policy change should be made and the status quo (Option 1) should remain by default.

Table 4 also shows the outcome of sensitivity analysis to calculate ICERs for lower (lowest cost, highest effectiveness) and upper (highest cost, lowest effectiveness) bounds, with a 90% confidence level that the ICER for Option 3 lies between $17,000 and $34,000. The sensitivity analysis used Monte Carlo simulations to help address some of the uncertainty of the assessment of administrative costs and regulatory burden of policy options. The 90% confidence interval for the effectiveness scores of policies were derived from the minimum and maximum score for each evaluation criteria.

This RIS estimates the societal value of a unit of effectiveness to be higher than the threshold for selection of Option 3, and the upper 90% confidence level, which is expected to deliver the highest net benefit of all the options. This is based on the findings of Mazur et al. (2018) and their estimates and valuations of the non-market environmental benefits to the community from reducing risk of marine pest incursions. The study was undertaken to support the department's effort to develop and implement policy to manage the biosecurity risk of biofouling in Australian waters. It found that the Australian public places substantial value on the protection of the Australian environment from potential impacts of new marine pests. Australians are also willing to pay more under policy interventions that have a higher probability of successfully preventing marine pest impacts (Mazur, Bath, Curtotti, & Summerson, 2018). The study estimates that Australian households together are willing to pay between $22.0 million and $58.8 million to protect one species and $12.5 million and $33.4 million per 250 km of coastal area and adjacent waters protected if there is a 50% chance that the outcome will occur (Mazur, Bath, Curtotti, & Summerson, 2018).

This RIS does not provide a monetary estimate for all biosecurity benefits resulting from the policy options due to the large number of assumptions and uncertainties involved. The issues associated with assigning a monetary value to benefits of managing the biosecurity risks associated with biofouling (as an avoided cost of marine pest impacts through better biosecurity outcomes) is discussed in Appendix B: Cost-effectiveness. It is relevant to note that the estimated costs of policies in this RIS are less than the environmental benefits of prevention estimated by Mazur et al. (2018) alone. The combined administrative costs and regulatory burdens of biofouling prevention policy options in this RIS range from $3 million to $10 million per year, which are less than the conservative estimates of environmental benefits by Mazur et al. (2018). This suggests that all policy options in this RIS could be expected to deliver a net benefit, and Option 3 expected to deliver the highest net benefit.

6.4 Option 1: Status quo

Maintenance of the status quo is not expected to elicit any significant improvement in biofouling management practices to reduce the biosecurity risk posed to Australia by biofouling on international vessel arrivals. The highly variable level of biofouling management amongst international vessel arrivals is expected to continue.

The status quo does not support incorporation of behavioural based devices into the biosecurity system and the design of biosecurity interventions. These devices are integral to the department improving policy effectiveness and efficiency over time through implementation review and adaptation.

6.4.1 Effectiveness

The status quo is assessed to have poor potential (37%) to be effective at delivering the objectives of government action. This equates to a poor likelihood that policy is able to manage biosecurity risks associated with biofouling to an acceptable level. The approach and leakage rate of vessels that pose a high risk of translocating a marine pest to Australian territorial waters is expected to be unchanged by maintaining the status quo.

Anticipate high-risk vessels

Maintaining the status quo is expected to be 35% effective at contributing to the biosecurity system's ability to anticipate biosecurity risks of internationally arriving vessels. The status quo has a poor likelihood of adequately identifying, assessing and prioritising vessels that present a biosecurity risk.

Prevent high-risk vessels

Maintaining the status quo is expected to be 48% (poor) effective at contributing to the biosecurity system's ability to prevent biosecurity risks. It would have a minimal contribution to the reduction in the number of high-risk vessels approaching the border. The effectiveness of option 1 is influenced by 3 limitations:

1) the lack of policy incentives and regulatory certainty for vessel operators to adopt effective biofouling management practices
2) the lack of pre-arrival reporting is an information constraint which affects the system's ability to target potential high-risk vessels for assessment

3) the lack of pre-arrival reporting also constrains the use of existing powers under the Biosecurity Act that enable the department to proactively manage biosecurity risks associated with biofouling prior to a vessel's arrival.

See section 2.3 and section 2.4 for more information.

Screen high-risk vessels

Maintaining the status quo is expected to be 29% (very poor) effective at contributing to the biosecurity system's ability to screen the biosecurity risk of vessels. The policy option does not take a systematic approach to the use of assessment and inspection outcomes. Therefore, screening of vessels for risks would be ineffective or non-existent. Vessel risk profiling would be ineffective at reducing the leakage rate of high-risk vessels.

Dynamic efficiency

Maintaining the status quo is assessed to have a 32% (very poor) potential to efficiently allocate resources that maximise the system's capacity to prevent, anticipate and screen biosecurity risks over time. Policy under the status quo is not sufficiently practical to be developed into a nationally consistent approach to biofouling management that can be supported by all state and Northern Territory governments.

The status quo is consistent with the international approach taken at the IMO to encourage implementation of the IMO Biofouling Guidelines for all vessels. However, the policy does not provide a mechanism for vessels to demonstrate and be rewarded for adopting proactive and adaptive biofouling management practices consistent with the IMO Biofouling Guidelines.

Other considerations

The status quo does not align with the recommendations of the 2015 Review. The public expectation for protection of the marine environment and marine industries identified by ABARES (Mazur et al., 2018) is also unlikely to be satisfied by implementation of this policy option.

6.4.2 Regulatory cost burden

The costs associated with Option 1: Status Quo have been estimated to better understand the impacts of the policy over the 10-year timeframe of RIS regulatory cost estimates.

Pre-arrival biofouling management

It has been estimated that 1% of commercial vessels in the first year will undertake a voluntary pre-arrival in-water inspection (increasing by 1% each year) prior to departing for Australia. This is estimated on average to cost $10,000 per vessel, which is the approximate cost of one dive day in Singapore.

Pre-arrival reporting

There is no pre-arrival reporting cost burden under Option 1.

Post arrival biofouling management

It has been estimated that 2 vessels in the first year and an increase of one vessel per year after that will undertake a voluntary in-water inspection after arriving in Australia to demonstrate that the vessel is not an unacceptable biosecurity risk to avoid non-compliance action. The cost of an in-water inspection in Australia has been estimated at $7,500. This cost considers that an in-water inspection could be done using a remotely operated vehicle or local diver conducting a simple vessel or niche area inspection, or a complex or large vessel inspection.

Some vessels may be delayed up to 48 hours while waiting for information from the department regarding the biofouling requirements for entry into Australia. This is estimated to cost the vessel $120,000; assuming the vessel's voyage would not proceed until advice was received from the department. The number of vessels delayed each year is estimated to be 8 in the first year, increasing by 2 each year thereafter.

Individuals
It has been estimated that there would be no additional cost burden to the individual (recreational) sector as they are unlikely to take additional actions to manage biofouling on their hull or within internal sea water systems for biosecurity compliance. Biofouling would continue to be managed to improve operational efficiency which is not considered a cost associated with biosecurity regulations.

Estimated total cost
There are regulatory cost burdens associated with Option 1. However, those costs are presented in this RIS as incremental in comparison to the status quo. Therefore Option 1: Status quo has no additional regulatory burden (Table 5).

Table 5 Average annual estimate of additional regulatory burden for Option 1, by sector

Category	Businesses	Community organisations	Individuals	Change in costs
Estimated average additional regulatory burden ($m per annum)	n/a	n/a	n/a	n/a

n/a Not applicable.

6.5 Option 1A: Increased inspections

Option 1A meets the government objectives of biofouling regulations more effectively than the status quo, but through higher regulatory cost burden resulting in significantly higher government administration costs. The high number of biofouling inspections under Option 1A is the primary source of the options effectiveness and costs. Like the status quo, Option 1A does not provide additional mechanisms to overcome the current information asymmetries and mismatched incentives that constrain delivery of government objectives (see section 2.3 and section 2.4). Option 1A provides limited support to the incorporation of behavioural based devices into regulation of biofouling and design of biosecurity interventions.

The high number of biofouling inspections conducted under Option 1A is expected to result in some long-term improvements to voluntary management of biofouling on vessels arriving and operating in Australian territory. This includes more voluntary in-water inspections for biofouling, action to manage biofouling in niche areas and more diligence in the selection, application and maintenance of anti-fouling coatings.

There is low potential for Option 1A to result in Australian biosecurity risks being managed to an acceptable level. There is also a low likelihood that implementing the policy can maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.

6.5.1 Effectiveness

Option 1A is assessed to have good potential (67%) to be effective at delivering the objections of government action. It is likely that implementation of the policy is able to result in management of biosecurity risks to an acceptable level. Adoption of Option 1A is assessed to be 28% more effective at delivering the objectives of government action than maintaining the status quo but 5% less effective than Option 2 and 23% less effective than Option 3.

Option 1A is the most effective option for screening of biosecurity risks. Option 1A would deliver the greatest reduction to the leakage rate of vessels that pose a high risk of translocating a marine pest to Australian territorial waters.

Anticipate high-risk vessels

Implementation of Option 1A is expected to be 54% (low) effective at contributing to the biosecurity system's ability to anticipate biosecurity risks through the identification, assessment and prioritisation of biosecurity risks associated with biofouling.

Prevent high-risk vessels

Implementation of Option 1A is assessed to be 55% (low) effective at contributing to the biosecurity system's ability to prevent biosecurity risks through the reduction in the number of priority pests and diseases associated with biofouling approaching the border.

Without pre-arrival information the department remains almost entirely reliant on post-arrival intervention to inspect and assess biofouling risks associated with vessels.

Screen high-risk vessels

Implementation of Option 1A is assessed to be 66% (good) effective in contributing to the biosecurity system's ability to screen biosecurity risks associated with biofouling.

The increased vessel inspections under Option 1A would overcome the ineffectiveness of targeting sufficient high-risk vessels to effectively manage biosecurity risks under Option 1. However, like Option 1, Option 1A would have limited ability to identify risk vessels prior to their arrival (limited pre-arrival screening capacity). Under Option 1A, vessels would be inspected regardless of their pre-arrival management actions or likelihood of presenting an unacceptable biosecurity risk. Initially all vessels would be targeted for inspection. Post-arrival interventions by biosecurity officers would be relied upon to identify and manage biosecurity risks.

The high number of post-arrival vessel interventions and non-compliance actions taken by the department under Option 1A is anticipated to act as significant incentive for action on biofouling management prior to arrival. A significant increase in the risk of being issued a direction to manage biosecurity risk, and potential delay to voyages after arrival, is a potentially strong incentive to commercial vessel operators. Voyage delays and reactive biofouling management actions post-arrival can cost in the tens to hundreds of thousands of dollars per voyage (see Assumptions of costs and benefits).

Dynamic efficiency

Option 1A is assessed to have a 32% (very poor) dynamic efficiency, equating to a very poor potential to allocate resources that maximise the system's capacity to prevent, anticipate and screen biosecurity risks over time.

Reduction of regulatory burden through national consistency is unlikely under Option 1A. The policy underlying Option 1A is not sufficiently clear and practical to be developed into a nationally consistent approach to biofouling management that can be supported by all state and Northern Territory governments.

Option 1A is reliant on the departments VCS to deliver efficiencies over time. The VCS is able to improve efficiency of inspection targeting and reduce the number of inspections for vessels that are consistently compliant with all biosecurity requirements under the Biosecurity Act. However, VCS is most effective in conjunction with transparent biosecurity requirements and policy; neither of which Option 1A provides. The value of VCS as an incentive for compliance with biofouling requirements was also questioned by stakeholders in response to the Consultation RIS.

The increased inspections under Option 1A incurs a significant inefficiency burden to effectively manage biosecurity risk. There are also significant administrative costs associated with inspections and risk assessments, some of which would be borne by the department and others directly passed on to vessels.

Option 1A relies upon the department interacting with vessels post-arrival to minimise biosecurity risks associated with biofouling, which has a higher regulatory impact to reducing biosecurity risk reduction than Option 2 and Option 3. Conversely, Option 2 and Option 3 use clear policy, incentives and pre-arrival reporting to engage vessels prior to arrival and target compliance inspections. The uncertainty of policy underpinning Option 1A, coupled with high inspection rates, results in operational risks for vessels and likely behavioural shifts towards a precautionary approach that may result in vessels implementing more costly preventive measures, such as pre-arrival in-water cleaning, than necessary. Whilst those measures may reduce biosecurity risk, some management actions such as in-water cleaning can have a negative impact on the long-term effectiveness of anti-fouling coatings. The high number of vessels needing to undertake reactive measures to clean biofouling from vessels post-arrival, and the regulatory burden of vessels undertaking these measures under this option is higher than for Option 2 or Option 3 and may have flow-on impacts to Australia's trade.

Other considerations

Option 1A is consistent with the IMO's approach, which is to encourage implementation of the IMO Biofouling Guidelines for all vessels. This will enable improvements to the uptake and effectiveness of the IMO Biofouling Guidelines to have a direct impact on biosecurity risk management and over time reduce the regulatory burden associated with implementation of Option 1A. However, the reduction in burden would be limited as Option 1A does not provide a mechanism for vessels to demonstrate and be rewarded for adopting proactive biofouling management practices consistent with the IMO Biofouling Guidelines.

There is a risk that implementation of Option 1A may present an organisational resilience risk to the department caused by diversion of significant inspection resources. The increased risk of an incursion of brown marmorated stink bug required the diversion of resources in the 2018-2019 season (1 September to 30 April), which, according to the Inspector-General of Biosecurity, stretched Australia's border biosecurity system close to breaking point and imposed significant costs on sections of the shipping and importing industries (Inspector-General of Biosecurity 2019).

6.5.2 Regulatory cost burden

It is estimated that 2,096 unique commercial vessels may be affected by the implementation of Option 1A and this number has been used to generate regulatory cost burden.

Inspections

It has been estimated that in the first year 5% of commercial vessel arrivals (increasing by 1% every year) are expected to undertake voluntary in-water biofouling inspections to demonstrate effective biofouling management prior to departing for Australia. This is estimated to cost $10,000 per vessel, which is the approximate cost of a single dive day in Singapore.

Commercial vessels identified as potentially representing a biosecurity risk during a detailed documentary inspection by the department may elect to undertake an in-water inspection in Australia to demonstrate the biofouling related risk is acceptably low. In addition, an in-water inspection may be required by the department to inform risk assessments or to determine appropriate non-compliance action to manage suspected unacceptable biosecurity risk.

Pre-arrival biofouling management

In-water cleaning prior to arrival is expected to increase under Option 1A, in part, due to lack of clear policy. In-water cleaning would provide the most regulatory certainty for vessels seeking to avoid potential regulatory costs associated with voyage delays and non-compliance action. The assumed increase of in-water cleaning is based on the increased number of applications for in-water cleaning received by the department following New Zealand's implementation of the Craft Risk Management Standard: Biofouling on vessels arriving to New Zealand in 2018.

Regulatory burden is expected to be incurred equivalent to 6 additional vessels conducting an in-water clean of their niche/internal seawater systems prior to arrival in Australia. This is based on California State Lands Commission inspection information that suggests that 70% of vessels were managing biofouling in their sea chests with either a marine growth prevention system, anti-fouling system or regular cleaning. Therefore, the remaining 30% of vessels (628) may not be managing biofouling in their niche or internal seawater systems and we have estimated that 1% of these vessels will undertake an in-water clean of their niche or internal seawater systems prior to arriving in Australia with a 1% increase each year. The average cost is estimated at $10,000 per vessel, which is the cost of a single dive day in Singapore.

Pre-arrival reporting

There would be no pre-arrival reporting cost burden under Option 1A.

Post-arrival biofouling management

It is estimated that 5% of vessels in year 1 will voluntarily undertake an in-water inspection post arrival to demonstrate that they don't present an unacceptable biosecurity risk to Australia. This will remain at 5% for the first 5 years and then decrease by 1% per year and remain at 1% in year 10. The cost is estimated at $7,500 and is based on a single dive day in Australia (average, not regional specific). The definition of an in-water inspection includes whole vessel inspections and partial inspections focusing on niche areas by either divers or ROVs.

Some vessels may be delayed up to 48 hours while waiting for information from the department regarding the biofouling requirements for entry into Australia. This is estimated to cost the vessel $120,000; it is reasonable to assume that the vessel would not proceed with its voyage until the advice was received from the department. The number of vessels delayed each year is estimated to be 12 due to the lack of clear policy on biofouling management requirements, and the increased number of vessels being screened by the department.

It has been estimated that 5 vessels per year for the first 5 years will elect to conduct in-water cleaning of their niche/internal seawater systems to demonstrate that they do not present an unacceptable biosecurity risk to Australia. This number is expected to reduce by 1 each year after year 5. Cleaning the sides and flat bottom of the ship have been excluded from this estimate given these areas are generally cleaned for fuel efficiency gains rather than meeting biosecurity regulations. Floerl et al. (2010) estimated that to clean the niche areas only on a 200 m vessel ranged from $9,300 to $21,800, we have therefore estimated the cost to be $15,000 for the purpose of this RIS.

Individuals

It has been estimated that there would be no additional cost burden to the individuals as they are unlikely to voluntarily take additional action to manage biofouling in their niche areas/internal sea water systems for biosecurity. It is far more likely that biofouling would be managed to increase vessel efficiency and is therefore not considered a cost associated with biofouling requirements.

Estimated total cost

The estimated total regulatory cost burden of Option 1A over the 10-year timeframe is $11.54 million. This figure is an incremental cost in comparison to the status quo.

Table 6 Average annual estimate of regulatory burden for Option 1A, by sector

Category	Businesses	Community organisations	Individuals	Change in costs
Estimated average annual additional regulatory burden ($m per annum)	$ 1.153	n/a	$ 0.000	$ 1.153

n/a Not applicable.

6.6 Option 2: Species-based approach

Option 2 is assessed to be more effective at meeting the objectives of government action to manage biosecurity risks associated with biofouling than the status quo; however, Option 2 incurs the highest regulatory cost burden of all options considered. There is also a very low likelihood that the implementation of the policy can maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.

6.6.1 Effectiveness

Option 2 is assessed to potentially be 73% (good) effective at delivering the objections of government action. Adoption of Option 2 is assessed to be more effective at delivering the objectives of government action than the status quo and Option 1A, and less effective than Option 3.

The establishment of statutory requirements under Option 2 to actively deter vessels from harbouring listed biofouling species of concern is expected to be the primary mechanism to reduce biosecurity risks associated with biofouling on international vessel arrivals. However, the species-based approach and strong focus on use of non-compliance penalties, which underpins the statutory requirements of Option 2 impacts the efficiency of biofouling management.

Anticipate high-risk vessels

Implementation of policy Option 2 is assessed to be 64% (low) effective at contributing to the biosecurity system's ability to anticipate biosecurity risks associated with biofouling. This indicates that policy Option 2 has low potential to contribute to the identification, assessment and prioritisation of biosecurity risks associated with biofouling. A significant contributing factor to this assessment is the difficulty in anticipating vessels that present a high risk of not complying with regulatory requirements of Option 2, which are based on risk assessments of listed species of concern.

Prevent high-risk vessels

Implementation of Option 2 is assessed to be 78% (good) effective at contributing to the biosecurity system's ability to prevent biosecurity risks associated with biofouling.

This indicates that Option 2 has good potential to contribute to the reduction in the number of priority pests and diseases approaching the border. The potential for non-compliance and enforcement action to result from bringing in a listed species is expected to result in an increase of vessels taking additional action to manage biofouling prior to arrival. This particularly includes more in-water inspections for listed species of concern and subsequent taxonomic identification of species, action to manage biofouling in niche areas (such as installation of MGPS) and in-water cleaning.

In-water cleaning prior to arrival is expected to significantly increase under Option 2, as it would provide the most regulatory certainty for vessel operators seeking to comply with requirements and be able to demonstrate vessels are not harbouring a species of concern. The increase is linked to difficulty in obtaining relevant taxonomic expertise pre-arrival to assess absence of all listed species of concern, which is expected to push towards precautionary cleaning. The assumed increase of in-water cleaning is based on the increased number of applications for in-water cleaning received by the department following New Zealand's implementation of the Craft Risk Management Standard: Biofouling on vessels arriving to New Zealand in 2018.

Screen high-risk vessels

Implementation of Option 2 is assessed to have good potential (69%) of effectively contributing to the biosecurity system's ability to screen biosecurity risks associated with biofouling. This indicates that Option 2 will likely contribute to a systematic approach to the use of assessment and inspection outcomes to improve vessel risk profiling.

Under Option 2 the number of inspections would significantly increase once regulations come into force and would stay at a high level as part of the MGRA assessment outcomes referred to in section 5.3.1. Post-arrival in-water inspections are also expected to increase under Option 2, as it is the main mechanism under the policy for vessels identified as high or extreme risk to demonstrate they are not harbouring a species of concern and avoid regulator-imposed operating restrictions.

Dynamic efficiency

Option 2 is assessed to have a 54% dynamic efficiency, equating to a low potential to allocate resources that maximise the system's capacity to prevent, anticipate and screen biosecurity risks over time.

Reduction of regulatory burden through national consistency is unlikely under Option 2. The reliance on regulating listed biofouling species of concern would substantially reduce the likelihood of national consistency in approach. There is a large variation in current lists of species of concern between jurisdictions. This is because the risks of certain exotic species vary across Australia and marine pests are established in some locations and not others. The costs of developing and maintaining a species of concern list, and the cost of collection and identification of listed species by taxonomists is high, time consuming and the relevant taxonomic expertise is not always readily available in Australia, indicating the potential to create significant delays for vessels and decision makers.

Other considerations

The 2011 RIS was developed and released for consultation by the department for a vessel biofouling policy to operate under the *Quarantine Act 1908*. At that time, Option 2 was developed based on the best available information and stakeholder support was variable. Under the *Quarantine Act 1908*, a requirement that vessels be free of biofouling species of concern was deemed the most appropriate way to regulate biofouling. Option 2 will result in significant reduction in the likelihood of vessels harbouring biofouling and, therefore, incursions into Australia of a listed species of concern. However, the potential risk to Australia from other biofouling species not listed would not be directly regulated. During the 2011 RIS consultation the department received feedback that a focussed and collaborative education program to promote the uptake of the IMO Biofouling Guidelines would be a more appropriate approach than Option 2 to reduce biofouling risk across the global shipping fleet. At that time, the IMO Biofouling Guidelines had only been recently adopted and not yet finalised for recreational craft.

The department received feedback in response to the Consultation RIS that confirmed views expressed during extensive stakeholder consultation undertaken during the 2015 Review. Some of the issues associated with managing marine biosecurity risk under Option 2 include:

- The development of an appropriately refined species of concern list can be very time consuming and comes with a range of challenges. Key challenges are associated with predicting and forecasting species that would have an unacceptable impact to qualify for listing. This includes obtaining sufficient accurate and suitable information to accurately assess species of concern to Australia. During development of this policy option in 2010 approximately 50 species were proposed for listing, however, the list of species would be reviewed prior to policy implementation.
- Once developed the costs to maintain and update an accurate species of concern list would be considerable and ongoing.
- Positive identification of species of concern is challenging and costly for industry prior to arrival. These challenges also apply to species identification by the department post–arrival, where rapid identification is required to identify non-compliance and appropriate enforcement action.

- Administrative, voyage time and cost burdens associated with not being assigned low-risk status under Option 2 would be significant and potentially not commensurate with the actual biosecurity risk posed.

Option 2 is not consistent with international approach taken at the IMO to encourage implementation of the IMO Biofouling Guidelines for all vessels. Improvements to the uptake and effectiveness of the IMO biofouling Guidelines will have minimal reduction in the regulatory burden associated with implementation of Option 2.

6.6.2 Regulatory cost burden

The estimated percentages of vessels impacted by implementation of Option 2 are largely taken from the 2011 RIS when the department developed the Option 2 as a species-based approach to regulation of biosecurity risks associated with biofouling.

All vessel arrivals are expected to incur a regulatory cost burden associated with pre-arrival reporting. Other regulatory cost burdens associated with Option 2, including voluntary in-water inspections, are estimated to affect 2,979 individual commercial vessels and 667 recreational vessels. Those vessels are estimated to make a combined 9,540 entries into Australia per year. This is the estimated number of vessels entering Australian waters that have not entered Western Australia (where species-based biofouling management requirements apply) in their last ten ports of call.

Inspections

The estimated number of vessels that will elect to have a pre-arrival in-water inspection to demonstrate they do not harbour a listed species of concern is 7.5% in the third year due to the 2-year phase-in period. It is expected that the number of voluntary in-water inspections would decline with time following implementation. The cost of an in-water inspection is estimated at $10,000 per vessel which is the approximate cost of a single dive day in Singapore, it does not include loss associated with vessel down time.

Pre-arrival biofouling management

The estimated number of vessels that will elect to have a pre-arrival in-water clean would be approximately 20% of vessels expected to undertake an in-water inspection. This estimate is based on vessel inspections conducted by the department, and information obtained from commercial biofouling inspectors, regarding the likelihood of finding a species of concern on a vessel that had elected to undertake in-water inspection. It is expected that the percentage of pre-arrival in-water cleaning will not appreciably decline with time following implementation.

It is anticipated that some vessel charterers would require compliance with the biofouling management requirements as part of charter arrangements, or target vessels that are able to demonstrate that they meet requirements. This may result in some commercial vessels not coming to Australia and may affect trade.

Pre-arrival reporting

Under Option 2, all commercial vessels would be required to provide additional information relating to biofouling management in their pre-arrival report through a marine growth risk assessment tool. The cost of development and use of an MGRA tool for pre-arrival reporting questions under Option 2 is estimated to be significantly higher than the costs associated with the use of MARS for this function under Option 3. The total cost of regulatory burden for pre-arrival reporting requirements is estimated to be $710,200 per year, based on all 17,755 vessel entries being required to input information into the MGRA. All vessels would be required to use the MGRA tool which would be mandatory after a 2-year phase-in period, therefore costs incurred are calculated from the third year.

Post arrival biofouling management
If Option 2 were implemented, it is estimated that 14% of commercial vessel entries would have a post arrival in-water inspection to meet the requirements. It is anticipated that the number of vessels undertaking a post arrival in-water inspection would decline in the following years to 10% in year 4 and 8% from year 5 onwards.

The establishment of a national in-water cleaning standard is anticipated to facilitate an increase in the number of locations around Australia where vessels can undertake an in-water clean. This is expected to reduce the regulatory burden associated with voluntary in-water cleaning in Australia.

Individuals
It is estimated that 90% of recreational vessels are expected to have a post-arrival in-water inspection, with an average regulatory cost burden of $500, this is equivalent to the service cost to the department conducting the inspection using a remote camera. Whilst the cost for this activity has been included in the regulatory cost burdens in this RIS, consultation relating to cost-recovery for implementation of a biofouling policy would be required to determine the actual cost to non-commercial vessel owners.

Estimated total cost
The estimated total regulatory cost burden of Option 2 to commercial vessels over the 10-year timeframe is $57.09 million.

The total regulatory cost burden to the recreational sector is $2.193 million and 3,045 hours over the 10-year timeframe. This figure is an incremental cost in comparison to the status quo.

Table 7 Average annual estimate of regulatory burden for Option 2, by sector

Category	Business	Community organisations	Individuals	Change in costs
Estimated average additional regulatory burden ($m per annum)	5.709	n/a	0.219	5.928

n/a Not applicable.

6.7 Option 3: Proactive biofouling management practices

Option 3 most effectively meets the objectives of government action to manage biosecurity risks associated with biofouling. It incurs a lower regulatory cost burden than Option 1A and Option 2 and marginally higher than Option 1.

Option 3 is assessed as having a high potential to result in Australian biosecurity risks associated with biofouling on international vessel arrivals being managed to an acceptable level. There is high likelihood that the implementation of the policy maximises the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.

6.7.1 Effectiveness

Option 3 is assessed to potentially be 88% (excellent) effective at delivering the objections of government action. Adoption of Option 3 is assessed to be 50% more effective at delivering the objectives of government action than maintaining the status quo, 21% more effective than Option 1A and 16% more effective than Option 2.

The establishment of mandatory pre-arrival reporting requirements under option 3 will overcome the information asymmetry, support incorporation of behavioural based devices into the biosecurity system and the design of effective, efficient and adaptive biosecurity interventions. Option 3 incentivises vessel managers to reduce the likelihood of harbouring a marine pest by undertaking proactive and reactive vessel biofouling management activities. The effectiveness of any incentive developed under Option 3 relies upon the assumption that vessels conforming to best practice biofouling management practices will have lower levels of biofouling and pose a lower biosecurity risk.

Anticipate high-risk vessels

Implementation of Option 3 is assessed to be 90% (excellent) effective at contributing to the biosecurity system's ability to anticipate biosecurity risks associated with biofouling. This indicates that Option 3 has excellent potential to contribute to the identification, assessment and prioritisation of biosecurity risk.

Option 3 aims to minimise the amount of biofouling on vessels arriving in Australian territory to manage biosecurity risk, rather than focussing on risks associated with identified species of concern.

The establishment of regulatory requirements for pre-arrival reporting would overcome information asymmetry which affects the effectiveness of Options 1 and Option 1A. The development of clear policy under Option 3 also enables the department to more proactively manage risk prior to a vessel's arrival, which would reduce non-compliance burden associated with the department taking action to manage unacceptable biosecurity risks of vessels upon arrival.

Prevent high-risk vessels

Implementation of Option 3 is assessed to be 86% (excellent) effective at contributing to the biosecurity system's ability to prevent biosecurity risks associated with biofouling. This indicates that Option 3 has high potential to contribute to the reduction in the number of priority pests and diseases approaching the border through increased proactive management of biofouling by all vessels entering Australian territory.

Providing vessels with a clear path to regulatory certainty, coupled with mandatory pre-arrival reporting, is predicted to result in behavioural change from vessel owners and operators. It is anticipated that some vessel charterers would require compliance with the biofouling requirements or target vessels that are able to demonstrate that they meet requirements to obtain low-intervention status. This may result in some commercial vessels not coming to Australia but is not expected to significantly affect trade.

Implementation of Option 3 will require amendment of the *Biosecurity Regulation 2016* to require vessel pre-arrival reports to include information identifying and describing the management practices used to manage biofouling.

Screen high-risk vessels

Implementation of Option 3 is assessed to potentially be 84% effective at contributing to the biosecurity system's ability to screen biosecurity risks associated with biofouling. Option 3 enables the use of pre-arrival reported information to target inspections to vessels that are unable to demonstrate implementation of effective biofouling management practices or are suspected of representing an unacceptable biosecurity risk.

Dynamic efficiency

Option 3 is assessed to have 82% dynamic efficiency, equating to a high potential to allocate resources that maximise the system's capacity to prevent, anticipate and screen biosecurity risks over time.

Option 3 enables the establishment of incentive-based biosecurity mechanisms to improve vessel biofouling management practices, and information gathered through pre-arrival reporting to efficiently allocate departmental resources. The pre-arrival reporting and regulatory policy focus on incentive-based mechanisms to overcome the current misaligned incentives of the department and vessel operators for the management of biofouling; these mechanisms can be reviewed and improved over time.

Vessel managers possess the critical information required by the department to design economically efficient biosecurity mechanisms. Pre-arrival reporting enables the department to overcome this information asymmetry. Option 3 is also aligned with privately developed online tools that seek to improve the quality of biofouling management practices and reduce regulatory burden; this may also be leveraged to further overcome information asymmetry and for efficient allocation of department resources.

Other considerations

Option 3 is most consistent with current international approaches and regulations for the management of biofouling. It aligns in approach with the IMO Biofouling Guidelines and mandatory biofouling regulations of New Zealand and California. Option 3 promotes the adoption of proactive biofouling management practices that are consistent with international best practice for biofouling management and provides clear, practical policy that can be supported by state and territory agencies to enable national consistency. Option 3 is consistent with the international approach taken at the IMO to encourage implementation of the IMO Biofouling Guidelines for all vessels. Option 3 also provides clear mechanisms for vessels to demonstrate, and be rewarded for adopting, proactive biofouling management practices consistent with the IMO Biofouling Guidelines. Improvements to the uptake and effectiveness of the IMO biofouling Guidelines will result in improved effectiveness and less potential impact on Australia's trade.

6.7.2 Regulatory cost burden

All vessel arrivals will have an additional regulatory cost burden under Option 3 associated with pre-arrival reporting into MARS.

Commercial vessels arriving in Australian territory from overseas that have visited Western Australia, California or New Zealand in their last 10 ports of call are assumed to not incur a regulatory cost burden associated with management of biofouling. This is a result of the vessels undertaking biofouling management in response to regulations in those jurisdictions which would be equivalent to, or more stringent than, Option 3. It is estimated that of the 5,860 unique commercial vessels that entered Australian territory in 2019, close to 2 thirds visited either Western Australia, California or New Zealand in their last 10 ports of call.

Pre-arrival biofouling management
A regulatory cost burden for the development and maintenance of a BFMP and BFRB associated with Option 3 is estimated for 2,096 commercial vessels each year. This is based on assumptions that mirror those detailed in section 6.5.2. It is anticipated that 19% of affected vessels would develop a BFMP and BFRB each year over the first 5 years, resulting in 95% of impacted vessels (1,991 vessels) implementing BFMPs and BFRBs each year for the last 6 years of the costing timeframe. The total regulatory cost burden associated with implementation of BFMPs and BFRBs is estimated to be $23,894,400 over the 10-year timeframe.

For each year of the first 5 years, it is estimated that 126 vessels will either install a MGPS (or adopt another technological approach) or clean their internal seawater systems, at an average cost of $10,000 each. Based on data collected by the California State Land Commission, it is estimated that 70% of vessels manage biofouling in sea chests with either MGPS, fouling control systems or regular cleaning.

Pre-arrival reporting
All commercial vessels would be required to answer questions relating to biofouling management in their pre-arrival report through MARS. A regulatory burden of $25 for pre-arrival reporting is estimated for 17,755 vessel entries at a total cost of $443,875 each year for 10 years.

Post arrival biofouling management
On average, it is anticipated that less than 10 vessels annually will voluntarily (without department intervention) undertake a biofouling specific hull inspection in Australia. The estimated average cost of the in-water inspection is $7,500, based on a single day inspection in Australia (this is an average for partial and full inspections conducted by ROV or diver). It is expected that the number of vessels that will undertake an inspection in Australia will increase for the first 5 years then decrease each following year as vessels become more aware of, and implement, more effective and proactive biofouling management practices.

The establishment of a national in-water cleaning standard is anticipated to facilitate an increase in the number of locations around Australia where vessels can undertake an in-water clean. This is expected to reduce the regulatory burden associated with voluntary in-water cleaning in Australia.

Individuals
It is estimated that 20% of recreational vessels are expected to have a post-arrival in-water inspection, with an average regulatory cost burden of $500, this is equivalent to the service cost to the department conducting the inspection using a remote camera. Whilst the cost for this activity has been included in the regulatory cost burdens in this RIS, consultation relating to cost-recovery for implementation of a biofouling policy would be required to determine the actual cost to non-commercial vessel owners.

A time burden associated with development of BFMPs and BFRBs by non-commercial vessels is estimated at an averaged 3.57 hours per vessel; a total of 2,700 hours of work for the recreational sector over the 10-year period.

Estimated total cost

The estimated total regulatory cost burden of Option 3 to the commercial vessel sector over the 10-year timeframe is $8.281 million. The total regulatory cost burden for the non-commercial sector is $0.540 million; a total of 2,700 hours over the 10-year period. These figures are incremental costs in comparison to the status quo.

Table 8 Average annual estimate of regulatory burden for Option 3, by sector

Category	Business	Community organisations	Individuals	Change in costs
Estimated average annual additional regulatory burden ($m per annum)	0.828	n/a	0.054	0.882

n/a Not applicable.

7 Preferred option

Option 3: Proactive biofouling management practices

This RIS identifies that Option 3 best manages the biosecurity risks posed by biofouling and is the most cost-effective option for implementation.

Implementing Option 3 will strengthen Australia's marine biosecurity system by:

- establishing policy that focuses on minimising the amount of biofouling on vessels arriving into Australian territory and reducing the risks of fouling
- reducing marine biosecurity risks prior to vessel arrivals and promoting increased proactive management of biofouling by all vessels entering Australian territory
- being more consistent with international approaches to vessel biofouling management and with less impact on Australia's maritime trade and vessels
- providing a clear and practical policy that can be supported by state and Northern Territory governments and support implementation of nationally consistent biofouling management and in-water cleaning policy.

Adoption of Option 3 also closely aligns with the recommendations of the 2015 Review and has the support of the majority of stakeholders. Consultation by the department over many years has established that the most effective and efficient approach to strengthening Australia's marine biosecurity system is by minimising biofouling associated biosecurity risks by targeting high risk vessels arriving into Australian territory. Option 3 presents a relatively low regulatory burden on stakeholders for a potentially high level of effectiveness.

The benefits of Option 3 over the status quo result from a clearer policy approach to screening vessels upon entry and providing regulatory certainty to vessels that manage their biofouling effectively. Option 3 provides the least necessary regulatory impact to minimise Australian biosecurity risks associated with biofouling on international vessel arrivals.

Option 3 is expected to deliver the highest net benefit.

8 Consultation on biofouling policy

The policy options in this RIS were developed following public consultation through a Consultation RIS from 1 April 2019 to 31 May 2019.

The department sought marine biosecurity stakeholders' input to refine the preferred policy option and establish the right balance between managing biosecurity risks associated with biofouling and potential regulatory impacts. The department considered issues raised in submissions, the department's experience, scientific literature, potential risks and the regulatory burden implications for stakeholders.

Stakeholder feedback was welcomed on all options contained in this RIS, but was specifically sought on the costs, benefits and issues related to Option 3. The Consultation RIS explained why Option 3 was recommended and provided Option 1 as an explanation of the current policy approach. Option 2 was provided as an alternative policy option on the advice of OBPR; Option 2 was the subject of consultation by the department in the 2011 RIS. Issues previously raised by stakeholders with Option 2 were outlined in the Consultation RIS and additional views were also invited.

In addition to a full public consultation through the Consultation RIS process, the options presented in this RIS were guided by the department's stakeholder consultation on:

- the department's 2015 Review of National Marine Pest Biosecurity
- the implementation of the Biosecurity Act
- amendment of the Biosecurity Act for the implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments.

Policy Option 1A was not included in the Consultation RIS. It was developed as an additional non-regulatory option based on feedback received on the potential for increasing inspections to more effectively manage biosecurity risks than the status quo.

8.1 Approach to consultation on this RIS

The department takes a proactive, ongoing and thorough approach to consultation on marine biosecurity and management of biosecurity risks associated with biofouling. The Consultation RIS intended to:

- Inform stakeholders of policy options, the preferred option, including key policy and implementation details
- Provide opportunity for stakeholders to consider the regulatory impact of the options and to provide feedback to inform next steps in improving Australia's biofouling management requirements.

As part of the Consultation RIS process, the department utilised various forums to facilitate and elicit feedback from stakeholders, including:

- An online platform 'Have Your Say' was used for stakeholders to complete an online survey and provide submissions electronically

- Existing forums and engagement opportunities – where possible, the department leveraged existing forums and opportunities to consult stakeholders. Forums, such as the Marine Pest Sectoral Committee or peak body member meetings, are regular meetings that provide the department with engagement with key stakeholders. Using these existing forums (rather than creating additional forums) helped to minimise stakeholder fatigue and burden during consultation
- Stakeholder and industry meetings – the department used regular meetings and, where appropriate, coordinated meetings and forums with key stakeholders including peak industry bodies, shipping representatives, other government agencies and industry forums
- Subscription and stakeholder lists – the department used a subscriber base of over 500 domestic and international stakeholders who registered with the department to receive information and updates relating to marine biosecurity and the Consultation RIS
- Social media and publications – the department used social media to communicate the release of the RIS. The department also prepared publication items for industry to use in their communication materials to notify their members and networks about the RIS consultation process
- A webinar was held to communicate directly with a broad range of stakeholders. The platform incorporated an interactive section where stakeholders could ask questions of the department and hear their responses live. A recording and transcript of the webinar is available on the department's website.

The feedback provided on the Consultation RIS was used to review and improve proposed policies in this RIS. Stakeholders who provided feedback and submissions were contacted to acknowledge receipt of their submission and, where appropriate, follow-up consultation was undertaken; stakeholders were advised of any actions taken in response to their feedback.

8.2 Key stakeholders

The department identified key stakeholders for targeted consultation including:

- State and territory governments – Government representatives were engaged through established working groups to ensure they were informed about the RIS and proposed policy
- Maritime Industry Australia Limited and Shipping Australia Limited – These peak industry bodies represent a significant portion of the maritime and shipping sector in Australia. They provide information to a wide audience and valuable feedback on the preferred policy option
- Ports Australia, port operators and port staff – Key industry members that liaise regularly with biosecurity officers and vessels
- Shipping agents – Agents are key stakeholders linking the international shipping community to government requirements
- Registered organisations – Play a critical role in the survey and maintenance of vessels
- Marina Industries Association and recreational vessel representative bodies, including Australian Sailing

- Other members, observers and partners of the Marine Pest Sectoral Committee as key stakeholders in Australia's marine biosecurity, including MPSC Partners covering the marine research sector, museums and universities
- Other stakeholders as identified through research and industry discussions.

8.3 Feedback used to refine policy

Submissions received in response to the Consultation RIS were used to prepare this RIS and develop the recommended policy option for Australian Government action. The recommended policy option and implementation approach has been refined to better achieve the desired outcomes that can be feasibly implemented and has the highest net benefit.

The department encouraged submissions from stakeholders that may be affected by, or have information relevant to, proposed changes to the Australian Government's management of biosecurity risk associated with biofouling. Feedback was received across a range of topics related to the regulation of biosecurity risks associated with biofouling. Whilst not all feedback resulted in changes to the RIS, it did highlight key areas of stakeholder concern, which will enable the department to better focus future communications and engagement. For example, feedback confirmed a key industry concern with potential impacts on supply chains and the costs associated with non-compliance and action taken by the department that may delay vessel or port operations.

8.3.1 Pre-arrival reporting requirements

Questions asked in pre-arrival reporting forms will elicit information to identify vessels for further intervention and be used by the department to assess biofouling risk posed by vessels. Feedback on the Consultation RIS indicated stakeholders were generally in agreement with the questions, however stakeholders raised concerns over the options available during the transition phase, to treat or clean the vessel hull and niche areas less than 30 days before arrival in Australia. Stakeholders noted that vessels may take longer than 30 days to reach Australia and preferred a policy that is based on a vessel being cleaned within a defined number of days prior to departure for Australia. The department has kept the option for vessels to clean prior to arrival and will undertake further consultation prior to finalising the Australian Biofouling Management Requirements to ensure that the time period allowed is feasible for industry and is adequate to manage the biosecurity risk associated with biofouling build up between vessel cleaning and arrival in Australian territory.

8.3.2 Biofouling management plans and record books

Stakeholders identified a lack of detailed guidance on what information had to be included in a BFMP and BFRB to meet best practice. This was a concern for the stakeholders that seek certainty about what they need to do to comply. Stakeholders noted that the current quality of BFMPs and BFRBs varies significantly across the shipping industry. The department will address this issue through convening a group of experts, including researchers, regulators and industry, to come together and agree to the minimum requirements for an effective BFMP and BFRB. These standards will be communicated to stakeholders prior to implementation of the requirements. They will also be communicated to international stakeholders in order to seek international consistency for how BFMPs are assessed. The department would also undertake ongoing monitoring and evaluation to ensure the reliance on vessels implementing effective BFMPs and BFRBs achieves the intended aim of driving better management of biosecurity risks.

Evaluation and review of the efficacy of BFMPs and BFRBs in achieving biosecurity outcomes will also be undertaken by the department as part of ongoing, periodic policy reviews.

8.3.3 Implementation schedule (phase-in of requirements)

Feedback on the Consultation RIS indicated that the majority of stakeholders consider the transition phase and implementation schedule appropriate and allowed sufficient time for industry to prepare for regulatory changes. An implementation schedule describing the transition from current requirements to mandatory requirements is described in section 9.

8.3.4 Regulatory burden cost estimates

Stakeholders identified a range of concerns relating to underlying assumptions and estimates behind the calculations of regulatory burdens for the policy options. The assumptions and cost estimates for both Option 1 and 3 were reassessed in detail. Significant changes were made following stakeholder feedback and information gathered by the department since the release of the Consultation RIS.

A concern frequently expressed by industry stakeholders was the potential down-stream or supply chain impacts that result from regulatory action taken against non-compliances, which are not taken into consideration in the RIS.

8.3.5 In-water cleaning

The development of a national in-water cleaning standard was added to Option 2 and Option 3 as it is quasi-regulatory measure to address stakeholder concerns with a fragmented approach to management of in-water cleaning issues. The issues associated with in-water cleaning of biofouling from vessels were frequently raised in the submissions, survey responses and face to face consultation. Stakeholders identify in-water cleaning as an important issue that is interlinked with the introduction of any mandatory biofouling requirements.

8.3.6 International consistency

Many stakeholders advocated for international consistency and supported the IMO consistent direction of Option 3. Stakeholders also raised the need for a harmonised approach with jurisdictions that already have biofouling requirements (for example, New Zealand and California) to avoid vessels needing to maintain and meet multiple requirements. However, other stakeholders added their concern that Australia’s shipping and trade environment is different to New Zealand and emphasised that Australia’s requirements should take these differences into account.

8.3.7 National consistency

Stakeholders including industry and government identified national consistency in biofouling regulation as a key aim or necessity. Although the proposed policies in the RIS do not cover all vessel movements within Australian waters or between the states and Northern Territory, the department is working with the jurisdictions through the Marine Pest Sectoral Committee to identify the best mechanism to achieve consistency and collaboration, in the management of biosecurity risks associated with biofouling.

8.3.8 Preference for status quo

Some stakeholders, in particular international shipping companies, indicated their preference for the status quo. A key justification for this position is that the IMO Biofouling Guidelines are currently being reviewed under an international process through the IMO, involving input from a wide variety of member states and stakeholders. There is concern that Australia's requirements could be inconsistent with, or more onerous than, the review outcomes. The department is taking a proactive role in the review. This should continue to ensure there is practical alignment between Australia's requirements and any revisions to the IMO Biofouling Guidelines.

9 Implementation and review

The biofouling management requirements of Option 3 would apply to all operators and owners of vessels that enter Australian territory and are subject to biosecurity control under the Biosecurity Act. This includes all vessel types and floating structures, including merchant ships, offshore support vessels, fishing vessels, bulkers, towed structures and recreational craft. The requirements would not apply to vessels that move within Australian territory that are not subject to biosecurity control.

Australian Biofouling Management Requirements would be published on the department's website to provide clear detail and guidance on the requirements, actions and documentary evidence required by vessels under Option 3. The department would also undertake targeted education and provide tools to support vessels to achieve compliance with biofouling management requirements. Tools would be developed in consultation with stakeholders to aid implementation. These may include facilitating self-assessment of vessel biofouling risk and examples and templates of acceptable BFMPs, BFRBs and other documentary evidence.

During the phase-in period, the department would monitor implementation and consult regularly with stakeholders to ensure the policy is efficiently and effectively achieving biosecurity risk management objectives. Opportunities for improvement or information gaps will be addressed as a matter of priority. The implemented policy and supporting implementation arrangements will be comprehensively reviewed at 5-year intervals. The reviews will consider the effectiveness of the policy, whether vessels are implementing industry best practice for biofouling management; the extent that implementation has minimised biosecurity risk; and whether the regulatory burden could be reduced. The department would continue to work with the state and Northern Territory governments, maritime industry and researchers in Australia and international regulators to promote and continuously improve global best practice for vessel biofouling management.

Additional consultation will occur in preparation for implementation and will involve detailed education and engagement on the policy implementation. The aim of the implementation consultation will be to prepare industry by providing information, tools and assistance to understand and comply with the incoming requirements. The department would also work with vessels, shipping industry and other stakeholders to ensure adoption of best practice biofouling management results in effective management of biosecurity risks associated with biofouling.

If changes to government cost-recovery would be required to implement Option 3, then consultation with affected stakeholders will occur through the department's established cost-recovery consultation process.

9.1 Phase-in of Option 3 policy and interim arrangements

The date for commencement of Option 3 is proposed to be one year from government policy approval.

9.1.1 Phase-in of requirement to implement a BFMP and BFRB

The requirement for vessels to have a BFMP and BFRB to demonstrate proactive biofouling management practices and be assigned low-intervention status will phase-in over 5 years. To be assigned low-intervention status, a vessel will need to have a BFMP and BFRB once it has completed it's scheduled out of water maintenance or is delivered from dry-dock (for new builds) and all vessels would need to comply 5 years from policy commencement.

If a vessel does not have a BFMP and BFRB in accordance with the implementation schedule it would not be assigned low-intervention status for arrival in Australian territory, meaning that the vessel would likely be targeted for inspection.

Vessels that do not need to have a BFMP and BFRB in accordance with the implementation schedule may be assigned low-intervention status through adoption of any of these options:

- implement a BFMP and BFRB that meets the standard specified by the department
- treat or clean the vessel hull and niche areas prior to arrival in Australia, or
- implement an alternative biofouling risk management practice that has been approved by the department prior to the vessel's arrival in Australian territory.

The department would assess a proposed alternative biofouling risk management practice by considering whether it represents industry best practice and determining the biosecurity risks associated with the practice. Approved alternative practices may include:

- In-water cleaning (to a specified standard by an approved provider) within 48 hours of arrival in Australian territory
- Dry-dock and clean within 48 hours after arrival in Australian territory
- Evidence that the vessel's biofouling does not present an unacceptable biosecurity risk (inspection report or risk assessment)
- Meeting the requirements of overseas jurisdictions that regulate biofouling consistent with the direction of the IMO Biofouling Guidelines such as New Zealand or California (commercial vessels) within a reasonable timeframe prior to arrival in Australia.

9.1.2 Pre-arrival reporting during phase-in

Pre-arrival reporting would become mandatory on the date of commencement.

During phase-in, pre-arrival reporting will require responses to biofouling management specific questions on whether a vessel has:

- implemented a BFMP and BFRB
- treated or cleaned the vessel hull and niche areas before arrival in Australia
- implemented an alternative biofouling risk management practice that has been approved by the department prior to the vessel's arrival in Australian territory, and
- intention to undertake in-water cleaning in Australian waters.

9.1.3 Timeline for policy phase-in

- **Policy approval date**
  - Upon policy approval the department will communicate the new policy for biofouling management requirements and encourage voluntary compliance for one year, until policy commencement.

- **Policy commencement date**

  Upon policy commencement these will apply:

  – Vessels will be required to pre-arrival report and will be assessed for low-intervention eligibility prior to arrival
  – To be assigned low-intervention, vessels must meet at least one of these criteria:
    - have a BFMP and BFRB that meets the standard specified by the department
    - have treated or cleaned the vessel hull and niche areas prior to arrival in Australia
    - have implemented a pre-approved alternative biofouling risk management method.
  – The department would adopt a principle of education first approach to non-compliances for the first year of implementation of the mandatory requirements.

- **Policy commencement date +1 year**

  One year after the commencement date:

  – Vessels will be required to pre-arrival report and will be assessed for low-intervention eligibility prior to arrival
  – A vessel must have a BFMP and BFRB to be assigned low-intervention status if either:
    - the vessel is newly constructed and delivered into service on or after the first anniversary of the commencement date
    - the vessel has completed out-of-water maintenance after the first anniversary of the commencement date
  – If neither apply, then to be assigned low-intervention a vessel must meet at least:
    - have a BFMP and BFRB that meets the standard specified by the department
    - have treated or cleaned the vessel hull and niche areas prior to arrival in Australia
    - have implemented a pre-approved alternative biofouling risk management method.

- **Policy commencement date +4 years**

  Four years after commencement date:

  – Vessels will be required to pre-arrival report and will be assessed for low-intervention eligibility prior to arrival
  – A vessel must have a BFMP and BFRB to be assigned low-intervention status.

10 Glossary

Term	Definition
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
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.
Approach rate	An estimate of the likelihood of entry of pests and diseases determined through inspection results.
Ballast water	Water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship.
BFMP	Biofouling management plan
BFRB	Biofouling record book
Biofouling	The attachment or accumulation of aquatic organisms such as microorganisms, plants and animals, to any part of a vessel, on surfaces and structures immersed in or exposed to the aquatic environment. Biofouling is also known as hull fouling.
Biosecurity	The management of the risks to the economy, the environment and the community, of pests and diseases entering, emerging, establishing or spreading.
CEA	Cost-effectiveness analysis
Exotic marine species	Any species not normally considered to occur and that may or may not be present in Australia's marine environment.
Fouling control system	A coating, paint, surface treatment, surface, or device that is used on a ship to control or prevent attachment of unwanted organisms.
IGA	Inter-governmental agreement
IMO	International Maritime Organization
International vessel arrivals	Vessels that enter Australian territory and are subject to biosecurity control under the Biosecurity Act. This includes all vessel types and floating structures ranging from merchant ships, offshore support vessels, fishing vessels, bulkers, towed structures and recreational craft.
Intervention	A department-initiated interaction with the owner or operator of a vessel. An intervention may include, but not be limited to, requiring information, inspecting the vessel or issuing a direction in relation to the vessel.
Introduced marine species	A species that is found in Australia as a result of human activity, whether by accidental or intentional release, escape, dissemination or placement.
Invasive aquatic species	Species which may pose threats to human, animal and plant life, economic and cultural activities and the aquatic environment.
Marine growth prevention system (MGPS)	System used for the prevention of biofouling accumulation in internal seawater cooling systems and sea chests; includes sacrificial anodes, chemical injection systems and electrolysis.
MARS	Maritime arrivals reporting system
MGRA	Marine growth risk assessment
Marine pest	An exotic marine species that is the subject of national marine pest biosecurity; it causes, or is likely to cause, unacceptable impacts to the environment, economy, human health or social values.
Niche areas	Areas on a vessel that may be more susceptible to biofouling due to different hydrodynamic forces, susceptibility to coating system wear or damage, or being inadequately painted (for example, sea chests, bow thruster tunnels, propeller shafts, inlet gratings, dry dock support strips).
Regulation	A rule or order, as for conduct, prescribed by authority; a governing direction or law.

Term	Definition
RIS	Regulation impact statement
Routine vessel inspection (RVI)	Routine vessel inspections are undertaken by a department biosecurity officer to ensure that biosecurity risks are identified and treated accordingly. An RVI includes the inspection of all galleys, pantries, provision stores, management of the vessel's waste facilities, ballast water verification, cabins and inspection of any other areas of the vessel as required, or as deemed appropriate by the biosecurity officer. Currently an RVI does not routinely involve inspection of biofouling risk related documentation or a vessel's biofouling.
Sea chest	A sea-chest is a protected cavity that is built into the hull of a vessel and typically covered in metal grates. Adult mobile marine organisms are transported in vessel sea-chests (Coutts and Dodgshun., 2007).
VCS	Vessel compliance scheme
Vessels	A vessel of any type operating in the marine environment and includes submersibles, floating craft, fixed or floating platforms, floating storage units and floating production storage and off-loading units.

11 References

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12 Appendix A: Timeline of Australian biofouling policy development

1996 to 2000

The Department of Primary Industries and Energy published the Nairn review in 1996 to address a range of quarantine challenges faced by Australia. The Nairn committee complimented Australia's strong stance internationally and its leadership in addressing the difficult issue of ship fouling and ballast water (Nairn et al*.,* 1996). The Nairn review supported strengthened engagement with New Zealand to obtain mutual benefits and improve consistency, citing benefits to the entire region.

In 1999, an incursion of black-striped mussel (*M. sallei*) in Darwin Harbour, Northern Territory (NT) accelerated government involvement in marine bioinvasions in Australia. In response to the detection of black-striped mussel, a successful eradication campaign was undertaken and the NT government amended the NT *Fisheries Act 1988* to list the mussel as an aquatic pest. The NT government implemented a mandatory regime requiring all recreational vessels to report their arrival when entering a marina in Darwin. Vessels are assessed for their potential marine biosecurity risk which may include an inspection and treatment for marine pests; this service continues to be provided by the NT government.

The black-striped mussel incursion also led to the establishment of the National Taskforce on the Prevention and Management of Marine Pest Incursions to propose interim and longer-term strategies to address marine pest incursions. The taskforce proposed a National System for the Prevention and Management of Introduced Marine Pests (the National System) and detailed recommendations to establish 3 main components of the National System: prevention, emergency response and ongoing management and control.

2000 to 2012

In April 2005 the National System was formalised through an intergovernmental agreement (Marine IGA) between the Australian, state and Northern Territory governments. The Marine IGA was not signed by all parties, however all signatories agreed to act as if the Marine IGA was in force.

In 2006 the department released a voluntary biofouling protocol for small international vessels and apprehended vessels arriving into Australia to minimise the risk of introduced marine pests. In 2009, the National Biofouling Management Guidelines were developed in consultation with the Marine Pest Sectoral Committee and published by the department to encourage proactive, best practice management of biofouling risk by industry. The guidelines included recommendations for commercial, fishing, recreational, non-trading and petroleum production and exploration industry vessels and structures; guidelines for the aquaculture sector were published in 2013.

In 2008 an independent review of Australia's quarantine and biosecurity arrangements was undertaken through the Beale Review. The Beale Review recommended that existing intergovernmental agreements (including the Marine IGA) be examined and incorporated into the National Biosecurity Agreement, which ultimately led to the establishment of the Intergovernmental Agreement on Biosecurity in January 2012.

One Biosecurity: a working partnership 2008, made specific recommendations in relation to biofouling; namely that: 'The Commonwealth should promote the development of an international convention and agreed standards for biofouling management through the IMO' and that '…the Commonwealth's legislative reach should be restricted to international vessels arriving in Australia, with the states and territories retaining responsibility for domestic biofouling requirements' (Beale et al., 2008). These recommendations were agreed to by the Australian Government in principle.

The department developed and released a consultation RIS in 2011 for a vessel biofouling policy that could apply under the provisions of the *Quarantine Act 1908*. This approach was based on the requirement that all vessels arriving into Australia to be free of biofouling species of concern specified under legislation (the species-based approach). At the time, the species-based approach was appropriate to give effect to the provisions of the *Quarantine Act 1908* and a list of species was prepared for proclamation. An external risk assessment identified 41 biofouling species of concern. These exotic species were identified as the most likely to arrive and cause unacceptable harm to Australia's environment, economy, human health and social/cultural values.

In 2012 the Western Australian Department of Fisheries implemented mandatory biofouling requirements for all vessels operating in Western Australian waters. Under Western Australian legislation it is an offence to translocate live non-endemic species as biofouling, as specified in the *Fisheries Resources Management Regulations 1995*. The Western Australian Department of Fisheries promotes a 'Clean before you leave' initiative and a voluntary self-assessment risk tool 'Vessel Check' to encourage the uptake and implementation of good biofouling practices. The Western Australian policy is primarily a species-based approach but does recommend owners and operators of vessel implement some aspects of the IMO Biofouling Guidelines such as maintaining effective management plans and record books as evidence of their biofouling risk management activities.

2013 to now

In 2013 implementation of the species-based approach was put on hold with the development of the Biosecurity Act and the commencement of an Australian Government review into national marine pest biosecurity arrangements. The Australian Government committed $5 million over 4 years to undertake a detailed assessment and improvement of national marine pest biosecurity arrangements.

During the 2014-15 financial year the department consulted extensively with 90 stakeholders representing government, maritime and boating industries, private operators and research groups. Consultation was broad, covering all aspects of the biosecurity continuum from prevention, response, ongoing management, monitoring, development, surveillance and research. It included:

- The release of an issues paper for a 6-week comment period in October 2014.
- The public release of a discussion paper in April 2015 focused on those issues identified by stakeholders and the department as the major topics of interest.

- A series of workshops held in major capital cities and receipt of verbal and written submissions. Biofouling regulation was a major topic of discussion and stakeholders were asked:
  - What are the best ways to manage and monitor the biosecurity risks of biofouling on vessels?
  - If the Commonwealth progresses to regulate the management of biofouling on international vessels, what role should it take in the development of domestic controls by the states and territories?
  - Should the department consider a regulatory framework for international biofouling management that is:
    - A species-based approach (proposed in the 2011 RIS)?
    - An approach based on a requirement for vessel operators to adopt IMO Biofouling Guidelines, including on-board a biofouling management plan and record book?

The 2015 Review of National Marine Pest Biosecurity made 12 recommendations, which were accepted by government in-principle, including recommendations relevant to the regulation of biofouling risk. During 2016-2018 the department gathered a range of information to inform the development of a Commonwealth regulatory approach to managing vessels' biofouling consistent with the recommendations of the 2015 Review. This included pilot studies to inform baseline assessments of biofouling risk posed by international vessels, awareness and uptake of biofouling management strategies by Australian boaters and a non-market valuation of public preferences and perspectives on preventative marine biosecurity strategies.

13 Appendix B: Cost-effectiveness

13.1 Monetary estimate for policy benefits

This RIS does not provide a monetary estimate for all benefits of each of the policy options due to the large number of assumptions and uncertainties involved. The benefits of managing the biosecurity risks associated with biofouling and marine pests (as an avoided cost of marine pest impacts through better biosecurity outcomes) are the avoided costs of:

1) eradication attempts
2) the costs of control and containment if eradication is unsuccessful
3) the impacts of the organism on people, business and the environment over time.

Determining what these costs are, or might be, is dependent on the species, the location and the length of time the species has been there.

13.1.1 Predicting marine pest impacts

Determining the cost of marine pest impacts associated with biofouling is impeded by the scarcity of documented impact information relevant to Australian marine pest biosecurity. This makes it difficult to provide a quantitative cost-benefit analysis, particularly one that assigns a monetary value to social and environmental impacts. Cost-benefit analyses are limited in their application as they are scenario specific, meaning that costs are likely to vary significantly from case to case depending on a number of complex factors including location, time between establishment and identification, biotic and abiotic factors, etc. Additionally, many case studies are from international incursions. Australia’s geographic isolation means that its marine communities often differ significantly from those which exist under similar environmental conditions elsewhere; assuming marine pest incursions would have similar impacts in these unique environments is fraught with issues. Even for Australian examples, theoretical estimations are unlikely to be a true reflection of the actual impacts and costs, because:

- impacts on industry may not have been costed or directly attributed to an introduced marine pest
- there is a scarcity of baseline information on marine environments prior to the arrival of exotic marine pests making it difficult to determine impacts on the marine environment
- impacts on the environment may not become evident until many years after a pest’s first detection and can be extremely difficult to measure.

Due to the complexities of the marine environment and marine species, it is not possible to accurately predict the potential economic (or other) impact of exotic marine species that may arrive in the future (Arthur, Summerson & Mazur 2015).

A Consultation RIS on proposed biofouling management requirements (2011 RIS; Price Waterhouse Cooper 2011) sought to express in dollar terms impacts of pest incursions as a means of estimating the benefit of biofouling prevention measures. The 2011 RIS also acknowledged the challenges and deficiencies related to determining the economic benefits to the environment of managing biofouling and the need for caution in relying on data it provided. This RIS also has not used the estimated benefits contained in the 2011 RIS, instead this RIS summarises some of the other more recent methods used by the department to determine which prevention measures are the most cost-effective means to managing biosecurity risks associated with biofouling on international vessel arrivals.

13.1.2 Establishment and incursion rate

Estimating the rate of incursion through the biofouling pathway, and the potential impacts of these incursions is complex, in part due to our limited understanding of the factors involved in an invasive marine species becoming established (Bax & Dunstan 2005). Additionally, evidence of a species establishing as a pest elsewhere does not provide sufficient information to determine the likelihood of establishment or the potential impacts a species could have under Australian conditions. For example, interspecific interactions may preclude a highly invasive species from establishing in Australian waters.

13.2 Cost effectiveness of prevention

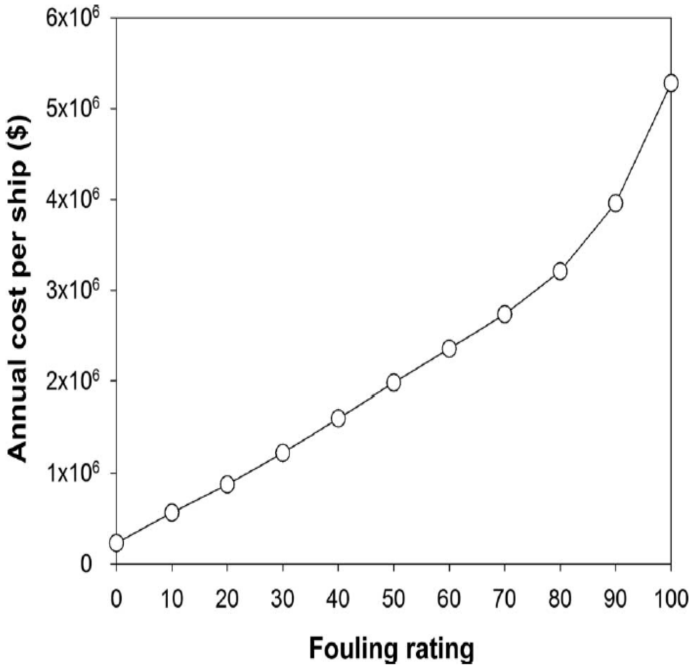
The value of marine biosecurity prevention measures was considered extensively as part of the 2015 Review. To inform the 2015 Review, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) assessed the costs and effectiveness of prevention measures when considered against the potential costs and effectiveness of eradication, containment and protection of assets associated with a marine pest incursion. The ABARES report (Arthur, Summerson & Mazur, 2015) estimated the rate of incursion of high-impact marine pests through ballast water translocations at 0.08 (once every 12.5 years). Arthur, Summerson & Mazur (2015) also estimated the rate of incursion of high-impact marine pests through biofouling on vessels to be approximately 3 times that of ballast water. That is about once every 4 years (0.25 per year).

Even though the cost of any future biofouling regulatory approach was yet to be established, the potential value of biofouling management measures was also noted by Arthur, Summerson & Mazur (2015). They noted that a biofouling regulatory approach could be assumed to have similar costs to industry as the estimated cost of ballast water management ($37 million per year). At an incursion rate of 0.25 high impact pests per year through biofouling, prevention becomes the cheaper approach when the total average cost of response (containment costs, asset protection costs, environmental impacts and non-market costs such as recreational use) with each high-impact incursion exceeds $180 million (Arthur, Summerson & Mazur 2015). The 2015 Review subsequently recommended minimising the likelihood of incursions through a focus on prevention activities, as it is more cost-effective, and has a greater chance of success, than attempting eradication after a marine pest has established.

In actuality, biofouling management is likely to have lesser costs than that of ballast water management, as vessels already dry dock and manage anti-fouling coatings to increase vessel efficiency and minimise fuel costs. It is well established that biofouling on ships increases the surface roughness of the hull which, in turn, causes increased frictional resistance and fuel consumption and decreases top speed and range (for example, Kempf, 1937; Benson et al., 1938; Denny 1951; Watanabe et al., 1969; Lewthwaite et al., 1985; Leer-Andersen & Larsson, 2003; Schultz, 2007).

The impacts of fouling on fuel consumption are clearly established by Shultz et al. (2011). In their analysis of Australian naval vessels, Shultz et al. (2011) found the cost of propulsive fuel for the baseline, hydraulically- smooth DDG-51 class hull to be $11.1 million per ship per year. Increasing fouling to Fouling Rating- 30 (FR-30), a level typical of the DDG-51 class as a whole, increased fuel consumption by 10.3% and fuel costs by approximately $1.15M per ship per year. As the fouling rating increased, costs associated with hull fouling increased in a nearly linear fashion for fouling ratings less than or equal to FR-70 (Figure 1).

Figure 1: Annual costs (per ship) for a range of hull fouling levels (FR). The cleaning and coating costs are assumed to be the same as present practice.



Based on this analysis, Shultz et al. (2011) note that the costs related to hull cleaning and painting are much lower than the fuel costs incurred by insufficient management. Taking into account the additional environmental and social costs that are avoided by minimising the likelihood of an invasive marine species incursion, the benefit of undertaking effective biofouling management is likely to greatly outweigh the cost to operators.

Recreational voluntary survey results – Cost of effective prevention

Boaters in Australia were surveyed about 6 types of biofouling management actions they were already taking, despite being mostly unaware of national biofouling guidelines for recreational craft.

1) Boat hull being cleaned in the water
2) Boat being taken out of the water for cleaning
3) Niche areas cleaned
4) Cleaning the boat before moving it to another location
5) Anti-fouling coating being applied to the boat hull and niche areas
6) Biofouling waste capture and disposal.

More than 50% of respondents carried out most of these actions to a level assessed to be best practice. The exception was cleaning the boat before moving it to another location in which only

27% of respondents conformed to best practice. Expert elicitation identified cleaning before movement of a vessel to a new location as the most important management action for minimising biofouling risk, so minimal uptake of this action should not be underestimated.

Respondents also indicated that biofouling management plans and record books were not being implemented by recreational boat operators. Further, there were mixed responses as to how frequently in-water cleaning was undertaken. 43% of respondents undertook very low levels of proactive biofouling management practices, 19% managed biofouling to a high level and 38% took some action. The most common barrier to implementation of biofouling guidance for recreational craft were the costs of managing biofouling both in and out of water.

Three groups or types of boat-owner were identified:

1) "Minimalists/DIY owners", who comprised 43% of survey respondents
2) "Comprehensive regime/active club members", who comprised 19%
3) "OK but could improve" group, who comprised 38%.

As the names of the groups imply, the comprehensive regime/active club members were doing the most to address biofouling and therefore represented the lowest biosecurity risk. The minimalists represented the highest biosecurity risk and the others fell somewhere between. It is probably the case, therefore, that the majority (>50%) of recreational boaters represent a biosecurity risk in one way or another. It was found that a large proportion of boat owners were interested in doing the right thing but that there seemed to be some confusion about appropriate management actions, for example, in-water cleaning and that most boaters were getting their information from sources other than government.

13.3 Factors affecting success of eradication

Factors affecting the likelihood of eradication success include:

- Type of species. A sessile clumping organism is easier to eradicate than mobile dispersing organisms (Hayes, Cannon, Neil, & Inglis, 2005)
- The length of time it has been resident before being detected. The longer it has been resident the more likely it will have reproduced
- Substrate being colonised. A rocky shoreline is more difficult to clear than smooth walls
- Procedures in place to identify a novel species. An active surveillance system is more likely to detect an incursion than passive surveillance
- Water turbidity. The ability for humans to see a novel organism and its spread.

In many situations eradication will be impractical because one or more of these factors will be unfavourable. Advice is available on eradication methods for a limited range of species in the Rapid Response Manuals.

13.4 Control measures

Indicative control measures include:

- Restrictions on commercial vessel time in port

- Mandatory management of ballast water taken up in the port
- Restrictions on keeping recreational vessels in the water
- Inspections of and cleaning recreational vessels before leaving the port
- Increased surveillance both at the infected locality and at ports receiving vessels from the infected port
- Temporary suspension of dredging.

13.5 Policy effectiveness analysis using rubrics

This RIS uses qualitative assessment rubrics to evaluate the potential effectiveness of each policy option. The rubrics assessment process involves assessing policy options against evaluation criteria for 'Anticipate', 'Respond', 'Screen', and 'Dynamic efficiency' aspects of the biosecurity system. The assessment also identifies key areas of potential policy limitation to inform policy assessment in section 6 of the RIS. A rubric was developed for each of the 4 aspects of the biosecurity system, with between 2 and 6 evaluation criteria within each rubric. The rubrics are based on the Health of Australia's Biosecurity System Report completed by Schneider & Arndt (2019). Table 9 is a guide used to develop the evaluation criteria.

Seven assessors were tasked to assess each of the 4 policy options contained in section 5 of this RIS, against evaluation criteria for 'Anticipate', 'Respond', 'Screen', and 'Dynamic efficiency' aspects of the biosecurity system. The assessors were required to give a score from 0 – *insufficient* to 4 – *excellent performance* for each evaluation criteria. The mean of assessors' scores was used to calculate a percentage effectiveness score of a policy for each evaluation criteria, each rubric, and the overall effectiveness score. The overall effectiveness score for each policy option is a weighted mean (calculated using logit function) of a policy scores for each assessment rubric. Table 9 is a guide used to interpret the overall effectiveness rating of each policy option discussed in section 6 of this RIS.

Table 9 Guide for interpreting overall effectiveness performance ratings

Overall performance rating	Score (%)	Effectiveness
Excellent	>80	There is a high likelihood that implementation of the policy is able to result in Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to be managed to an acceptable level. There is a very high likelihood that the implementation of the policy is able to maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.
Good	65 - 80	There is a medium likelihood that implementation of the policy is able to result in Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to be managed to an acceptable level. It is likely that the implementation of the policy is able to maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.
Low	50 – 65	There is a low likelihood that implementation of the policy is able to result in Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to be managed to an acceptable level. There is a low likelihood that the implementation of the policy is able to maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.
Poor	35 – 50	There is a poor likelihood that implementation of the policy is able to result in Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to be managed to an acceptable level. There is a poor likelihood that the implementation of the policy is able to maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.

Very poor	<35	It is very unlikely that implementation of the policy is able to result in Australian biosecurity risks associated with biofouling (such as introduction of marine pests) on international vessel arrivals to be managed to an acceptable level. It is very unlikely that the implementation of the policy is able to maximise the efficiency of the biosecurity risk management by having the least necessary regulatory impact on vessels and Australia's trade.

Table 10 General evaluation criteria development and assessment guide

Evaluation Criteria	Excellent (4)	Good (3)	Minimal (2)	Inadequate (1)	Insufficient information (-)
	High likelihood of very strong or exemplary performance in relation to the question. Any gaps or weaknesses are not significant and are managed effectively No clear limitations or weaknesses that need to be overcome. Minor limitations or weaknesses may have a minor impact on potential performance.	Likelihood of generally strong performance in relation to the question. Unlikely to be significant gaps or major weaknesses, and less significant gaps or weaknesses are mostly managed effectively. No clear limitations or weaknesses that need to be overcome. Minor limitations or weaknesses are likely that need to be managed and overcome, if unmanaged are likely to have a minor impact on potential performance.	Performance is likely to be inconsistent in relation to the question. Some gaps and weaknesses are very likely. Unlikely to always meet minimum expectations or requirements. One or more clear potential limitations and weaknesses that may be overcome. Limitations and weaknesses are likely to have an impact on the potential performance of policy.	Performance is likely to be unacceptably weak in relation to the question. Very unlikely to meet minimum expectations or requirements. There are one or more clear fundamental limitations or weaknesses that are unlikely to be overcome. Limitations and weaknesses expected to impact the potential performance of policy.	Information is unavailable or of insufficient quality to assess likely performance.

14 Appendix C: Assumptions of costs and benefits

14.1 Cost assumptions

14.1.1 Non-compliance and enforcement costs

Although not factored into cost burden estimates, the non-compliance and enforcement costs of Option 2 were estimated as part of the 2011 RIS to be more than $380 million over the 10-year timeframe.

It is also estimated that enforcement costs would be higher under Option 1A than Option 3. This is due to Option 1A not providing clear biofouling management requirements for vessels, which inform vessels about actions to take prior to departure for Australia to minimise the likelihood of non-compliance or enforcement action being taken upon arrival. The non-compliance costs under Option 1A are also expected to be higher than Option 3 due to the significantly higher number of inspections.

14.1.2 Compliance cost for non-commercial vessels

For non-commercial vessels, such as yachts, the regulatory costs associated with inspection of vessels and the time taken to implement biofouling management plans and record books have been included. Whilst these costs are largely time, a monetary cost estimate has been made of an underwater inspection conducted at first port of call taking into account uncertainties around frequency and duration of these inspections. The New Zealand Ministry for Primary Industries' successful engagement with the recreational sector on biofouling management requirements suggests there would be a very low likelihood that regulatory burden would result in recreational vessels choosing not to come to Australia as a result of any of the policies contained in this RIS.

14.1.3 Cost of vessel inspection by biosecurity officer

The cost of the inspection is recovered from the vessel being inspected. A biosecurity officer's time during inspection is currently charged in $50 per 15 minute units.

Inspection costs under Option 1A:

- For 47% of commercial vessel arrivals – an out of office inspection fee (2×¼ hour unit) 2 × $50 = $100 for first 3 years. Reducing to (1×¼ hour unit) 1 × $50 = $50
- For remaining 53% (reducing each year, to zero in year 3) of commercial vessel arrivals – for first year
  - In-office assessment fee (Documents) 1 × $30 = $30
  - Out-of-office inspection fee (2 × ¼ hour units) 2 × $50 = $130
- For recreational vessels an additional out of office inspection fee (1 × ¼ hour unit) 1 × $50 = $50

Inspection costs under Option 2:
A container vessel (commercial vessel) is arriving in Sydney ex Singapore to discharge and load cargo prior to departing. Prior to arrival the agent submitted the Pre-Arrival Report, Ballast Water Report and Crew Change request in MARS, leading to a Routine Vessel Inspection and Crew Change inspection being queued by MARS. Prior to leaving the office, an appointment was generated in MARS and the crew change request was assessed via inspection to determine if the departing crew had declared anything of biosecurity concern. This took 15 minutes. The RVI inspection including a ballast water verification (75 min) and detailed documentary biofouling inspection (30 min) was completed in 105 minutes. A Crew Change inspection was not required. These charges apply:

- Vessel (≥25 m) arrival charge 1 × $1,054 = $1,054
- In-office assessment fee (documents) 1 × $30 = $30
- Out-of-office inspection fee (7 × ¼ hour units) 7 × $50 = $350
- (Biofouling inspection component of fee (2 × ¼ hour unites; 2 × $50 =$100)

Total $1,434

Scenario – Less than 25 m – Non-commercial vessel (itinerant yacht less than 25m in length) arrives in Brisbane ex India. The vessel reported its pending arrival in Brisbane to the Department of Immigration and Border Protection. An officer attends the vessel in order to undertake a Pratique and Timber Vessel inspection. The pratique inspection takes 30 minutes, the timber vessel inspection takes 60 minutes and biofouling inspection takes 15 minutes. (Total 105 mins). The officer issues a Record of Service for charges incurred. The Record of Service is entered on return to the office. This takes 15 minutes. These charges apply:

- Vessel (<25m) arrival charge = $120
- Out-of-office inspection (7 × 15 minutes) 7 × $50 = $350
- In-office assessment fee (1 × 15 minutes) 1 × $30 = $30
- (Biofouling inspection component of fee (1 × ¼ hour units; 1 × $50 =$50)

Total $500

14.1.4 Cost of underwater inspection

The cost of underwater inspections is dependent on a number of factors, especially location. For example, inspections at remote ports such as Darwin, Port Hedland and Dampier are significantly more expensive than east coast ports. Additionally, commercial diving regulations set minimum personnel requirements to ensure that Work Health and Safety standards are met. Under these regulations, a diving team must comprise at least 3 people: the diver, a supervisor and a standby. More people may be necessary if the risks demand it. Commercial diving operators also dictate a minimum and maximum numbers of hours that may be worked. Example rates for an underwater biofouling inspection are:

- Newcastle: 3-person team for 8 hours plus work boat and underwater video: $3,000,
- Melbourne: 4-person team plus boat and video: $5,100.
- Brisbane, Gladstone & Townsville: $4,000, including dive boat.

14.1.5 Dry-docking and application of fouling control system

The costs associated with application of fouling control systems to the hull have been excluded from this RIS on the basis that this biofouling prevention measure is principally adopted by vessels for reasons of fuel and operational efficiency rather than biosecurity. However, an estimate is made of the costs associated with management of niche areas of commercial vessels, where biosecurity considerations may be a larger factor in decision making.

There are a number of complications in establishing the costs of dry docking, which include that it is usually done overseas and the costs are confidential. There are also many components to the cost structure and it is sometimes not clear whether they are intrinsic to fouling control system application or are required for another reason, such as Class survey. With the help of Dr Ralitsa Mihaylova of Safinah Group, indicative costings of dry docking and re-application of anti-fouling coatings have been compiled.

For a 214 m length, 40,000 DWT containership, it is estimated that the dry docking and re-painting costs at a dry dock in Dubai would be approximately AU$260,000 (plus the cost of 3 coats of AFC).

Costs to sail from an Australian port to Singapore. Singapore was chosen as the nearest location with dry docking facilities for large commercial vessels.

The nearest major Australian port to Singapore is Dampier at a distance of about 3,100 km, depending on the exact route taken. At a speed of 13 knots (24 km/h), typical for a bulk carrier, this would take about 5 days and 9 hours. In 2016, 185 bulk carriers arrived from Singapore. Containerships typically travel at 24 knots (44 km/h) so this would take about 2 days and 22 hours. No containership arrived in Dampier from Singapore in 2016, however.

Assuming a daily charter rate of US$10,000 for both a supramax bulk carrier (50,000 DWT) and a 4,000 TEU containership, this represents a cost of US$60,000 in charter time only.

At the other end of the scale, Sydney is about 8,000 km from Singapore and is roughly equidistant via the northern route (through Torres Strait) and southern route (via Bass Strait). It is therefore about 13 days 21 hours steaming for a bulk carrier and 7 days 14 hours for a containership. Charter costs would therefore be US$140,000 and US$80,000 respectively.

Fuel costs are calculated in a similar way and are shown in Table 11. Note that all calculations, in both charter and fuel costs, are approximate and indicative only and are based on figures found on the Internet, many of which are not up to date for confidentiality reasons.

Note also that these figures are for a one-way voyage only. If the vessel intends to return to the same port, for example, Dampier or Sydney from Singapore these costs should be doubled.

Table 11 Distances travelled, fuel consumption and cost for vessel types

Vessel type	Origin	Destination	Dist. (km)	Speed	Time (days)	Fuel use (tonnes/day)	Cost (US$)
Bulker	Dampier	Singapore	3,100	24	5.38	50	132,751
Container	Dampier	Singapore	3,100	44	2.92	150	215,153
Bulker	Sydney	Singapore	8,000	24	13.88	50	342,489

Container	Sydney	Singapore	8,000	44	7.58	150	561,109

Note: Ship types are supramax (50,000 DWT) bulk carrier and 4,000 TEU containership. According to Ship and Bunker, fuel cost of low sulphur marine gas oil (LSMGO), Singapore price, (pre-COVID-19 25 February 2020) US$493.50 per tonne.

14.1.6 Voyage delays

An average cost of $120,000 is estimated to account for daily berth, charter and operational costs associated with potential voyage delays relating to biosecurity risk assessments. Vessels may be delayed up to 48 hours while an assessment is made to determine level of biosecurity risk and any necessary risk management requirements to be imposed. Vessels that have previously been identified as representing an unacceptable biosecurity risk associated with biofouling are more likely to be delayed on subsequent voyages while the biosecurity risk is being assessed.

14.1.7 Pre-arrival reporting costs

The costs of completing pre-arrival reporting are estimated based on the involvement of shipping agents, the master and or other officers on the vessel such as first-mate. $50 per use of MGRA (as a new tool under Option 2) and $25 for MARS (for cost of additional responses in existing use of MARS under Option 3) are used as the basis for pre-arrival reporting cost estimates together with total port arrival for 2019.

14.1.8 Port arrivals

The top 10 ports in terms of arrival numbers and the numbers of vessels are shown in Table 12.

Table 12 Top 10 Australian ports for international vessel arrivals

Arrival port	Arrivals
Port Hedland	2745
Newcastle	1859
Dampier	1372
Brisbane	1305
Gladstone	1220
Fremantle	1147
Hay Point	1073
Port Walcott	994
Port Botany	860
Melbourne	524

In 2016, 65 types of vessels arrived from international ports. Table 13 lists the 3 most populous vessel type.

Table 13 Top 3 vessel type arrivals into Australia by number

Vessel type	Count
Bulk carrier	11,751
Fully cellular containership	1,614
Tanker	1,225

14.2 Benefits

14.2.1 Environmental benefits

According to the 2011 RIS (PwC 2011), the net present value of implementation of a national approach to biofouling is estimated to range from $146 million to $225 million (in 2016–17 dollars) for a 10-year period (an average of $14.6 million to $22.5 million per year). Mazur et al, 2018 estimated the environmental benefits alone to be higher than the cost of prevention estimated in the 2011 RIS.

14.2.2 Additional social benefits – Fuel efficiency

Benefits to vessel's fuel efficiency, including green-house gas emission reductions and vessel safety that arise from planned and effective biofouling management have not been quantified. This is particularly relevant to consideration of the benefits associated with Option 3, which promotes the implementation of BFMPs and BFRBs by all vessels. Effective BFMPs and BFRBs enable vessels to improve biofouling management over time and therefore gain significant fuel efficiency and associated cost savings. However, calculating a causal link between potential benefits and a policy targeting biosecurity risks associated with biofouling is considered too uncertain. This is primarily because the application of anti-fouling coatings are principally commercial considerations and are measures that are primarily adopted by the shipping industry for reasons of fuel efficiency rather than preventing the spread of marine pests.

14.2.3 Secondary benefits

Potential secondary or flow-on benefits to organisations supplying goods or services for biofouling management have not been estimated. The department is aware that the implementation of new policy will have an impact on the operations of goods and service providers, including private biofouling inspectors and risk assessors, in-water cleaning operators, dry-dock operators and fouling control technology providers. However, the department has insufficient information to estimate the benefits and potential costs to these organisations.