Australian Government
Department of Agriculture and Water Resources
ABARES

An assessment of the non-market value of reducing the risk of marine pest incursions in Australia's waters

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Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Technical Report 18.2
April 2018

Cataloguing data

Mazur, K, Bath, A, Curtotti, R & Summerson, R 2018, *An assessment of the non-market value of reducing the risk of marine pest incursions in Australia's waters*, ABARES, technical report, Canberra, April. CC BY 4.0.

ISBN: 978-1-74323-380-1

ISSN: 189-3128

Technical report number: 18.2

Internet

This publication is available at agriculture.gov.au/abares/publications.

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Acknowledgements

The authors thank focus groups and survey participants for their input. Assistance in this project is gratefully acknowledged, including from Jeff Bennett and Gabriela Scheufele from Environment and Resource Economics, ABARES staff Steve Hatfield-Dodds, Alexander Koduah and scientists from state and national departments and academia. The assistance of Department of Agriculture and Water Resources staff, including Mae Allen, Sonia Gorgula, Jason Garwood, Helen Walker, Peter Wilkinson, John Gilliland, James Lavender and Emily Lawson, is also gratefully acknowledged.

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Summary

The main objective of this project is to estimate and value the non-market environmental benefits to the community from reducing the risk of marine pest incursions in Australia's waters. A non-market valuation method, choice modelling (CM), has been used. The assessment is intended to support the Department of Agriculture and Water Resources (DAWR) effort to develop and implement a national approach to managing the biosecurity risk of biofouling in Australian waters and implement the International Marine Organisation (IMO) Ballast Water Management Convention.

Key findings

- We find the Australian public places substantial value on the protection of the Australian environment from potential impacts of new marine pests.
- We find that individual households sampled in this study were on average willing to pay $16.3 per year to protect one species and $9.3 per 250 km of coastal area and adjacent waters protected if there is a 50 per cent chance that the outcome will occur.
- For Australia, it is estimated that 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 per cent chance that the outcome will occur.
- The perceived benefits of preventive action increases with probability of success, with this study finding that respondents place higher values on scenarios providing more environmental benefits and higher certainty that the particular outcomes will occur.
- Comparisons to prevention costs from other studies suggest reducing the risk of marine pest incursions would be likely to provide net benefit to the community, although each case should be assessed on its merits and specific circumstances.

Context

Non-indigenous marine species (NIMS) are plants and animals not native to Australia. These species can become invasive marine pests when established in non-native regions. Marine species are transported in a variety of ways, mostly through biofouling on submerged surfaces (accumulation of microorganisms, plants and animals) and ballast water (water carried by ships for stability). To address the risk posed by NIMS the Department of Agriculture and Water Resources is developing a regulatory approach to managing marine biosecurity risks posed by international vessel biofouling. The new regulatory approach for biofouling will complement measures recently introduced to reduce marine biosecurity risk from ballast water and sediment. The proposed biofouling regulation gives effect to the recommendations of the Review of National Marine Pest Biosecurity and is consistent with the direction set by the IMO.

More than 250 NIMS are currently present in Australia. When established in non-native environments, NIMS may become pests posing adverse effects on commercial fisheries, aquaculture, port infrastructure and the environment. Eradication of established marine pests is costly and has a low likelihood of success. Prevention and early detection are the most practical and least costly ways of management.

Identifying and assessing policies to prevent marine pests from arriving and establishing in Australia is challenging. Decision-makers need to consider different types of prevention methods, their likelihood of success, budgetary limitations and the relative costs and benefits of different prevention measures. The economic benefits to industries of reducing the risk of marine pests arriving and establishing are relatively easy to identify but limited information is available about the potential environmental benefits of these actions. Environmental benefits include prevention of potential impacts of new marine pests on native species, coastline and adjacent waters, including reduction or loss of native species, loss of amenity value of the coast or recreational use. Assessing these benefits is difficult because most environmental benefits are non-market in nature—that is, they are not traded in markets and have no price.

Methods and findings

As part of the non-market valuation study, a large-scale survey was undertaken in May and June 2017 that collected over 2,800 responses across Australia revealing people's perceptions and views. The results indicate that the Australian public values policies that reduce the risk of new marine pests arriving and establishing in Australia. Respondents were willing to pay more under policy scenarios where more native species and coastline and adjacent waters were protected, especially policy interventions that have a higher probability of leading to these outcomes.

The annual values per Australian household and for Australia for the protection of coastal areas and native species from the impact of new marine pests are presented in Table 1 and Table 2. The study calculates a range of values for Australia, based on assumptions about the degree to which the survey sample is representative of the entire population. These values are presented at 20 per cent, 50 per cent and 80 per cent probability that policy interventions will lead to these outcomes.

Table 1 Annual values for protection of native species from marine pests, per household and for Australia

Probability of success	Per household for 1 species	Australia for 1 species	Australia for 1 species
		Lower estimate [a]	Upper estimate [b]
20%	$6.5	$8.8 million	$23.5 million
50%	$16.3	$22.0 million	$58.8 million
80%	$26.1	$35.1 million	$94.1 million

Note: a – lower bound value: extrapolation of estimated household value to 16 per cent (response rate) of the Australian households; b – extrapolation of estimated household value to 43 per cent of Australian households.

Table 2 Annual values for protection of coastal areas

Probability of success	Per household for 250km	Australia for 250km	Australia for 250km
		Lower estimate [a]	Upper estimate [b]
20%	$3.7	$5.0 million	$13.4 million
50%	$9.3	$12.5 million	$33.4 million
80%	$14.8	$19.9 million	$53. 5 million

Note: a – extrapolation of estimated household value to 16 per cent (response rate) of the Australian households; b – extrapolation of estimated household value to 43 per cent of Australian households.

The values in Table1**Error! Reference source not found.** and Table 2 provide a basis for estimating the environmental benefits of management actions for the prevention of marine pest introductions for different scenarios and outcomes. The results suggest benefits arise from policies that reduce the chance of future incursions of marine pests. The values of environmental benefits estimated in this study together with other benefits (for example, avoided losses to impacted industries) can be compared with the cost of the policy or management actions that reduce the chance of these impacts occurring.

According to a study conducted by PricewaterhouseCoopers (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). The estimates in this study of environmental benefits alone are higher than the cost of prevention estimated by PwC (2011). However, each case should be assessed to determine whether prevention is likely to be justified on cost–benefit grounds.

Policy implications

The estimated community values for protection of Australian environment through reduction of the risk of new marine pest incursions into Australian waters can be used to identify the management option that delivers the highest benefit to the society. This project has not assessed the costs of alternative policy options to prevent incursion of marine pests. Nonetheless, the results from this study will help identify which policy option is likely to lead to the highest net benefit to the Australian community. Consideration of management actions should be informed by the environmental outcomes they can generate, the value of these outcomes to the community, and the relative likelihood of achieving these outcomes.

1 Introduction

This report was prepared for the Department of Agriculture and Water Resources. The study was undertaken to estimate the non-market value the Australian community places on reducing the risk of new marine pests incursions and the negative effects they may have on Australia's marine environment. Marine pests are non-native marine plants or animals that pose a threat to Australia's economy, environment or community if introduced into a non-native environment (Department of Agriculture and Water Resources 2014). The information from this project is an input to the department's efforts to implement an efficient biosecurity arrangement for the prevention of marine pests in Australian waters. This study provides an economic assessment of the potential environmental non-market benefits that could be gained from policy responses to improve marine biosecurity and can be used in future cost–benefit analyses of proposed marine biosecurity protection measures. In the context of this report non-market benefits are the environmental benefits flowing from prevention of introduction of new marine pests to Australia. These benefits are typically non-market in nature, meaning that they have no market price. To estimate the value of these benefits requires analytical techniques suited to estimating non-market values.

Currently Australia has no consistent national regulatory framework for managing the marine biosecurity risks of biofouling. This means that vessels may be subject to different requirements in different locations. The Australian Government is working towards a more uniform approach to international biofouling. Mandatory ballast water management requirements have been in place since 2001, but only voluntary initiatives are in place to manage the marine biosecurity risks associated with biofouling of internationally arriving vessels (Department of Agriculture and Water Resources 2017). Some states and territories have implemented local biofouling requirements but this has inadvertently created inconsistencies across Australia. Additionally, a number of state and territory jurisdictions regulate the movement of marine pests through legislation to prevent noxious species entering their jurisdictions.

Non-indigenous marine species (NIMS) are frequently transported around the world as biofouling on submerged surfaces and in ballast water (Photo 1). Some NIMS are considered marine pests if they can cause significant negative impacts on the environment, economy or society. There is limited scientific information available about the risk that marine pest introductions in Australia can have on the environment, human health, economy and social/cultural values (Department of Agriculture and Water Resources 2016). Eradication of established marine pests is costly and has a low success rate—prevention and early detection is the most practical and least costly way of management (Arthur, Summerson & Mazur 2015).

Photo 1 Biofouling and ballast water

Source: Bayview Slipway Marine Services and photo United States Coast Guard, available at Wikipedia Commons (licensed under Creative Commons)

The department is developing a national regulatory approach for managing the marine biosecurity risks posed by international biofouling, as part of improving management of those risks inherent in vessel movements. Identifying and assessing appropriate policy actions to minimise the likelihood of marine pests arriving and establishing in Australia is challenging. The department needs to consider a number of factors when developing policies, such as the risk of marine pests causing significant damage to the Australian environment and communities, the community's preferences for marine biosecurity management and the relative benefits and costs of the policy. New policy initiatives to minimise the likelihood of marine pest incursions should be justified on cost–benefit grounds. Benefits include avoided costs to industry of not dealing with marine pests and avoidance of harm to the environment arising from marine pest incursions. The cost of policy intervention includes any costs to industry in dealing with a new regulatory environment and the administrative cost to the taxpayer of implementing new biosecurity measures.

The costs of prevention of marine pests and benefits for industry can be estimated in monetary terms but limited information is available about the potential value of environmental benefits of these actions. Predicting whether species will become invasive if introduced outside of their native environment is difficult, as is the scale of potential environmental impacts because species often behave differently when exposed to new environments. Assessing the value of the environmental benefits involves additional challenges because most of these benefits are non-market in nature. A reliable information on the nature and scale of potential costs and benefits when considering the implementation of new policy options can help in the decision process. Therefore the community's value for protecting the marine environment from the impacts of new marine pests can help to better understand the Australian community's preferences for marine biosecurity management.

For this study ABARES used the non-market valuation technique of choice modelling (CM), which is commonly used to estimate values that have an inherent non-market nature.

2 Marine pest prevalence and policy context

Increasing global demand and trade has significantly increased international vessel movements. In 2014–15 more than 16,000 foreign-flagged vessels reportedly visited Australian ports, almost double that in 2004–05 (BITRE 2017). The growth in vessel movements and changes in voyage patterns is likely to have increased the likelihood of new marine pests being introduced to Australia. Marine pests can have significant economic, social and environmental impacts on aquaculture operations, commercial and recreational fishing, boating, tourism and international and domestic shipping. Marine pests can damage fishing gear, clog industrial water intake pipes, cover jetties and marinas, damage vessels and affect the attractiveness and amenity of the coastline (Department of Agriculture and Water Resources 2014). In addition, marine pests can contribute to the decline of some native species through predation and competition for food and territory (Department of Agriculture and Water Resources 2014).

Marine pest prevalence and impacts in Australia

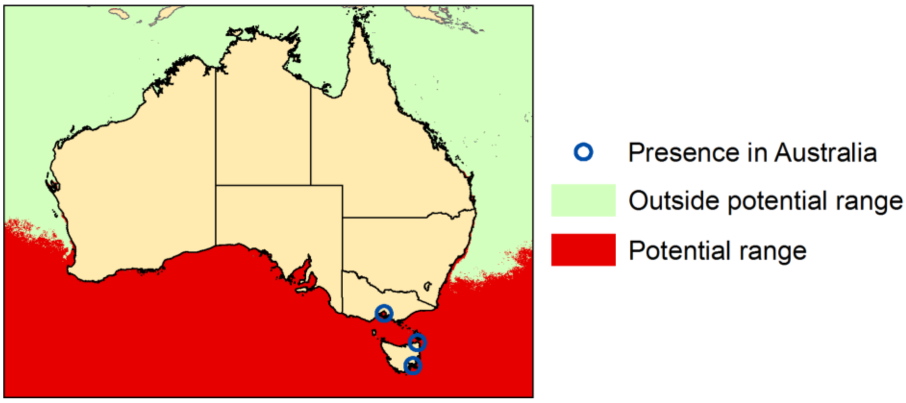
Australia has over 250 NIMS and approximately 15 of them are recognised as invasive (that is, causing or capable of causing impacts) (Department of Agriculture and Water Resources 2016; Kinloch, Summerson & Curran 2003). These species have been introduced into Australian waters in various ways including through ballast water and biofouling. An estimated 30 per cent of the invasive marine species in Australia have arrived via ballast water (water carried by ships for stability) (Department of Agriculture and Water Resources 2016). Most of the other marine pests have arrived through biofouling—when marine organisms have attached to boat and ship surfaces (Department of Agriculture and Water Resources 2016; Kinloch, Summerson & Curran 2003). Treatment of ballast water has proven to be highly effective (Cangelosi et al. 1999; Kazumi 2007; Rigby, Hallegraeff & Sutton 1999). However, the effectiveness of anti-fouling methods and technologies is difficult to determine because the effectiveness of an anti-fouling coating highly depends on its application.

Three examples of marine pests that have established in Australia and become invasive are *Asterias amurensis* (northern Pacific seastar), *Sabella spallanzanii* (European fan worm) and *Carcinus maenas* (European shore crab). The northern Pacific seastar (Photo 2) was first found in Tasmania in 1986, most likely introduced through ballast water. The northern Pacific seastar has been identified as a threat to many native species, contributing to the threatened status of species such as the native spotted handfish (*Brachionichthys hirsutus*) and the Tasmanian live-bearing seastar (*Parvulastra vivipara*) (MESA 2017). The European fan worm was first discovered in Western Australia in 1965 and was likely transported to Australia as biofouling (DPI 2017). This species forms a 'carpet' on the seabed, smothering native species for food and space and altering the marine habitat to meet its own needs (Map 1, Map 3). The European shore crab (Map 2), present in southern Australia, is a voracious predator that threatens some native species through competition for food and space (DPI 2017). Invasive marine species are costly to control and almost impossible to eradicate once they establish. Accordingly, prevention and early detection are recognised management priorities. Some potential spread of marine pests that are already in Australia and new marine species that may establish in Australia was simulated by Richmond, Darbyshire & Summerson (2010) based on surface water temperature.

Photo 2 Northern Pacific seastar

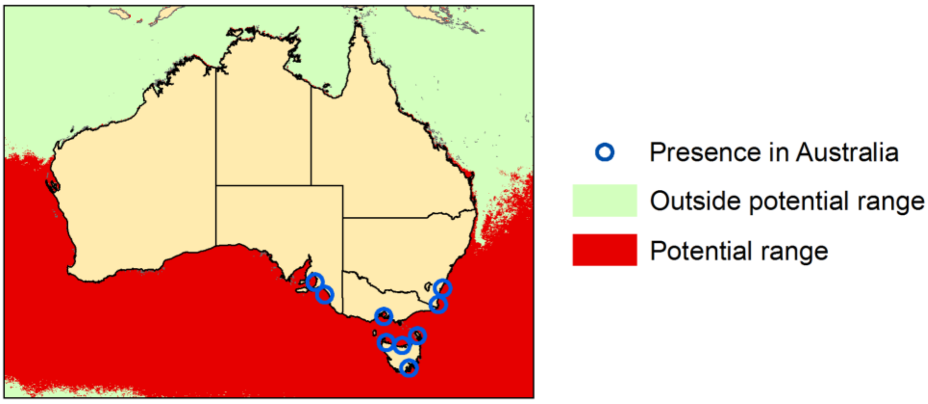
Source: Biofouling Solutions Pty Ltd

Map 1 Known and potential distribution of northern Pacific seastar in Australia



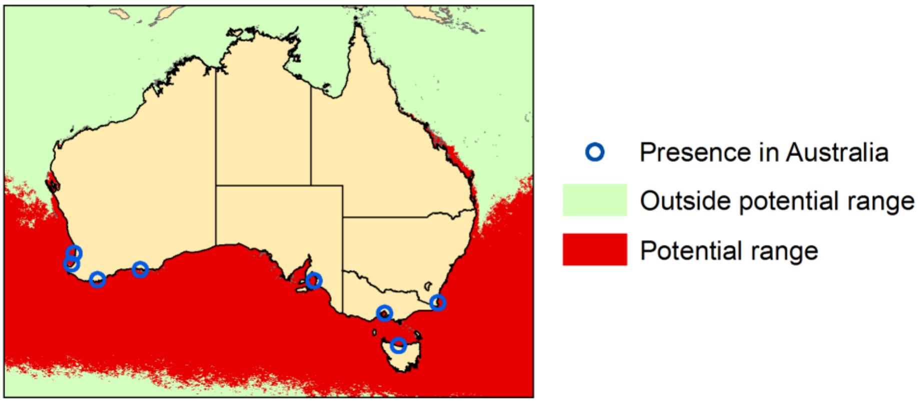
Source: Richmond, Darbyshire & Summerson (2010)

Map 2 Known and potential distribution of European shore crab in Australia



Source: Richmond, Darbyshire & Summerson (2010)

Map 3 Known and potential distribution of European fan worm in Australia



Source: Richmond, Darbyshire & Summerson (2010)

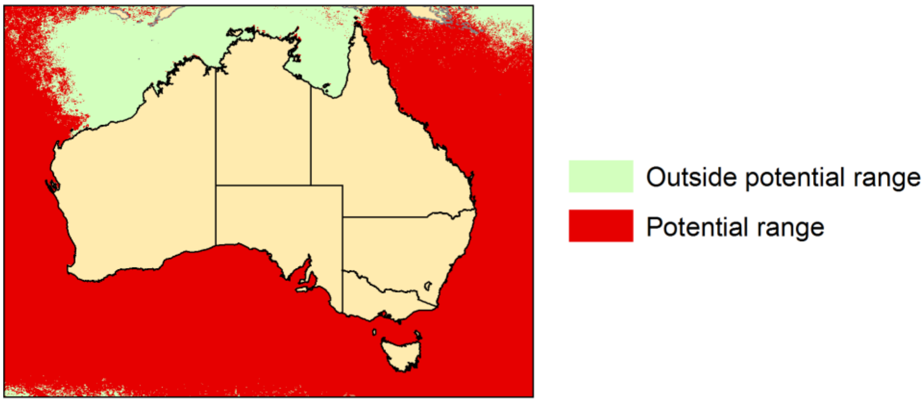
Potential impacts of new marine pests

The impacts of new marine pests on the environment are difficult to predict. Some understanding of potential impacts can be gained from overseas where marine pests have caused environmental, social and economic impacts. These include impacts on native species, the attractiveness of natural environments and coastal recreational activities such as fishing, sailing, boating and scuba diving.

Marine pests that have affected the environment overseas in non-native areas include the Asian clam, Chinese mitten crabs (*Eriocheir sinensis*) and Black-striped mussels (*Mytilopsis sallei*). The Asian clam (*Corbicula fluminea*) was introduced into San Francisco Bay in the 1980s, where it became the dominant species in the northern part of the Bay. In Europe, introduced Chinese mitten crabs (*Eriocheir sinensis*), which burrow into river banks, have caused shore erosion and instability of river banks (Gollasch 2011). Black-striped mussels (*Mytilopsis sallei*), like zebra mussels (*Dreissena polymorpha*) in the United States and Canada, can cause fouling of the environment and aggregate and impact ecosystems (Bax et al. 2002; MESA 2017). Pungent masses of decaying introduced soft-shell clams (*Mya arenaria*) in the Black Sea beaches of Romania have affected the amenity value of tourist resorts (Leppäkoski 1991).

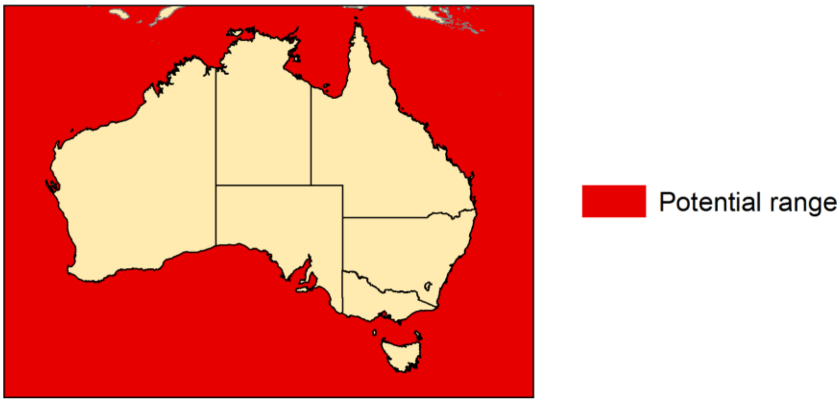
Although examples can be found of the impacts of marine pests overseas, whether their impacts could be similar in the Australian environment is uncertain. Many factors such as differences in climate, availability of food sources, resilience and changes in the natural environment can influence the probability of establishment and intensity of the potential impacts. Cohen & Carlton (1998) estimated that between 1961 and 1995, one new non-native species established in the San Francisco Bay and Delta system every 14 weeks (almost four per year). For potential incursions into Australia, Hewitt (2011) estimated the annual rate of arrivals of NIMS between 3.39 and 4.06 and Lewis (2011) estimated a rate of establishment of 3.0 NIMS incursions per year. A simulated spread (based on surface water temperature) of the potential new marine pests is presented in Map 4, Map 5 and Map 6.

Map 4 Potential distribution of Chinese mitten crab in Australia



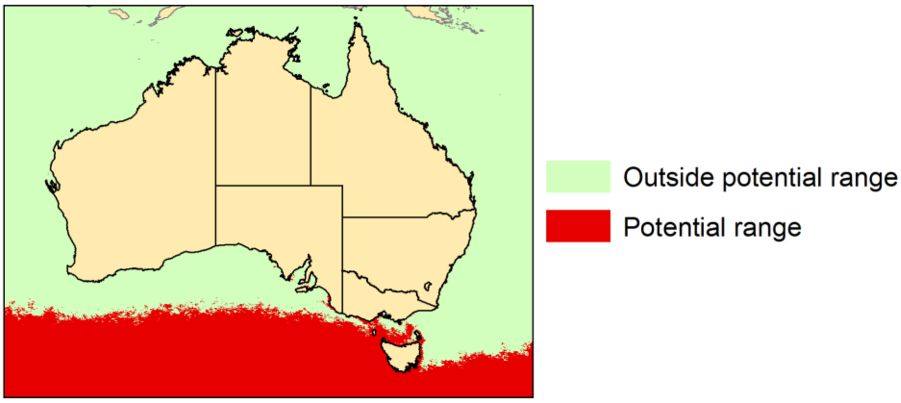
Source: Richmond, Darbyshire & Summerson (2010)

Map 5 Potential distribution of black-striped mussel in Australia



Source: Richmond, Darbyshire & Summerson (2010)

Map 6 Potential distribution of soft-shell clam in Australia



Source: Richmond, Darbyshire & Summerson (2010)

Policy context

A number of initiatives, both domestic and international, have been taken to minimise the risk of marine pest incursions into Australia. On 1 July 2001 Australia introduced mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. The discharge of high-risk ballast water in Australian ports or waters is prohibited. The ballast water requirements were enforceable under the *Quarantine Act 1908* and remain enforceable under the current *Biosecurity Act 2015*, which came into force on 16 June 2016 and replaced the *Quarantine Act 1908*. Amendments were made to the *Biosecurity Act 2015* to strengthen Australia's ability to manage ballast water in ships and implement the IMO Ballast Water Management Convention, which came into force internationally on 8 September 2017. Australia requires Ballast Water Management Systems for vessels entering Australian waters. Under the system, vessels are required to have a ballast water management plan and certificate of compliance (IMO 2017).

Biofouling of vessels remains a management gap and is the most common way for the accidental movement of marine pests. In 2011 the IMO published guidelines for effective implementation of biofouling management plans and record books for vessel operators. These included records of installation and maintenance of fouling control coatings, in-water inspection and cleaning, and considerations about design and construction of vessels. The guidelines recommend that every vessel have a biofouling management plan and a biofouling record book containing detailed information about inspections and biofouling management measures undertaken on the vessel. The guidelines also provide recommendations on general measures to minimise the risks associated with biofouling. The aim of these guidelines is to minimise the risk of transfer of invasive aquatic species and to provide a globally consistent approach to the management of biofouling, but they are not legally enforceable (IMO 2011). To address this issue, international governments have been working to implement the intent of the guidelines through their respective biosecurity regulations. In 2013 the Australian Maritime Safety Authority (AMSA) issued a marine notice to advise vessel owners, operators, ports and marinas of the new IMO Guidelines.

In Australia, a suite of voluntary national biofouling management guidelines was developed for a range of industries and user groups, including Australian commercial vessels operating in Australian waters. These guidelines provide practical maintenance recommendations to help commercial vessel operators manage the level of biofouling on their vessels (AMSA 2015). The guidelines provide instructions on best-practice approaches for the application, maintenance, removal and disposal of anti-fouling coatings and the management of biofouling and invasive aquatic species on vessels and movable structures in Australia and New Zealand.

Currently the department is developing policy to improve regulation of international vessels' biofouling. The proposed requirements would apply to all vessels arriving into Australia and require vessels to manage their biofouling to reduce risk to a low level. This would give effect to the recommendations of the 2015 Review of National Marine Pest Biosecurity and provide consistency with the direction set by the IMO. Implementation of such regulation is intended to reduce the risk of NIMS establishing in Australia and any subsequent impacts of marine pests on the Australian environment and communities.

3 Methods

Stated preferences

Identifying and assessing appropriate management actions to reduce the risk of marine pests from arriving and establishing in Australia can be difficult. The department needs to consider factors such as the different types of prevention methods, the associated likelihood of success, budgetary limitations and the relative benefits and costs of different management actions.

The estimation of the costs of reducing the risk of marine pests and the benefits that this confers on marine industries can be readily estimated using market transaction data. However, little information is available about the potential environmental benefits of these actions. Environmental benefits include prevention of any potential impacts of new marine pests on native species, coastline and adjacent waters such as reduction or loss of native species, loss of amenity value of the coast or recreational use. Assessing these benefits is additionally challenging because most are non-market in nature—that is, people can place value on environmental goods without market transactions taking place. To identify this value to the community, survey-based non-market valuation techniques may be used to estimate the value of the environmental goods. A number of non-market valuation methods are available. These methods can be divided into revealed preference (based on market transaction data of a related good that reveals a preference for the environmental good—for example, the cost of travel incurred to visit a site) and stated preference approaches (where people reporting their preference by stating a value for enjoying the good).

The revealed preference methods predominately measure use values of the environmental goods (such as recreational use value). However, the incidence of marine pests in an area is likely to affect both use and non-use values. Non-use values include:

- existence values—the values that people derive from knowing that these goods exist
- bequest value—the value that people place on passing resources to future generations
- option value—the value that individuals place on the option to use these goods in the future.

Stated preference methods are designed to estimate both use and non-use values. This was considered the appropriate approach for this study. Stated preference methods involve asking people to express their preferences for different environmental outcomes. The most commonly applied stated preference methods are contingent valuation and choice modelling (CM). Both methods are based on a questionnaire where respondents are asked to express their willingness to pay for the change from a current management arrangement to a new arrangement. In a contingent valuation questionnaire, respondents are asked to value a change for a single good. In a CM questionnaire, respondents can be presented with a number of environmental goods and policy options to value.

CM was the preferred technique for this study because of its cost-effectiveness when a number of environmental goods and policy options are considered. CM also addresses many of the biases that can be problematic with other non-market valuation techniques. These biases are well documented (Baker & Ruting 2014).

The CM framework is consistent with the principles of the cost–benefit analysis framework. Therefore, the value estimates derived from CM applications can be directly used in cost–benefit analysis, which allows for a more complete comparison of benefits and costs of different management options. CM has been widely used in environmental valuation studies internationally (Horne, Boxall & Adamowicz 2005; Lundhede et al. 2014; Scheufele et al. 2016; Zhang et al. 2013) and in Australia (Bennett et al. 2015; Rogers & Burton 2017; Rolfe et al. 2004; Scheufele & Bennett 2017). Some studies have also used the CM approach in a biosecurity context (Adams et al. 2011; Carlsson & Kataria 2008; Roberts, Boyer & Lusk 2008).

Using choice modelling to estimate values

CM non-market valuation was used in this study to estimate the environmental value of reducing the risk of marine pests from arriving and establishing in Australia. The CM method was chosen for this study as an established and cost-effective method to value a number of environmental goods and management options.

The CM technique is a survey-based method where respondents are asked a series of choice questions about their preferred options for resource management. In this study each choice question included a number of options for managing marine pest incursions to choose from (Figure 1). The options were described by the outcomes (called attributes):

- number of species protected
- length of coastline and adjacent waters protected
- the chance that outcomes of new policies will occur
- additional annual cost to a household.

The options differ in the quantities of attributes (called levels), including 'the number of species protected (0–6)', 'kilometres of coastline and adjacent waters protected (250–1,500)', 'percentage chance that outcomes of new policies will occur (20 per cent–80 per cent)' and 'additional annual cost to a household' expressed in dollar terms ($20–$200). These options were compared to no new policies involving no additional protection of species or coastline and adjacent waters. The attributes and their levels were chosen based on a literature search of marine pest impacts overseas and consultations with scientists and biosecurity specialists. The relevance of the attributes was determined through expert consultation and tested with the public during a series of focus groups discussions held in Melbourne, Sydney, Brisbane, Wollongong and Wagga Wagga.

The environmental attributes (species protected, coastline and adjacent waters protected) were identified as the main environmental attributes that marine pests affect in the environment in Australia and overseas. These attributes were relevant to the respondents and were clearly understood by focus group participants. The attribute 'number of species protected' represents the number of species protected from being threatened by marine pests. Focus group participants' understanding of threatened species was consistent with those defined by the *Environment Protection and Biodiversity Conservation Act 1999*. The attribute 'kilometres of coastline and adjacent waters protected' represented the number of kilometres of coastline and adjacent waters protected from any negative impact that new marine pests pose to these areas. Whether examples of environmental impacts of marine pests overseas are comparable in the Australian context is uncertain. Many factors such as differences in climate, availability of food sources or resilience and changes in the natural environment influences the probability of establishment and intensity of the potential impacts. The effectiveness of new biofouling management practices is also uncertain. To reflect these uncertainties the attribute 'percentage chance that outcomes of new policies will occur' was incorporated into the choice questions. This attribute was presented to respondents as the percentage probability that the combined two outcomes (number of native species protected and kilometres of coastline and adjacent water protected) will occur under each of the options presented.

In choosing between alternative future policy options, respondents made trade-offs between the cost to them (additional annual cost to a household), different levels of the environmental outcomes (species protected and coastline and adjacent waters protected) and the probabilities of those environmental improvements being achieved (chance that outcomes of new policies will occur). The environmental attributes and the probability attribute are mutually dependent and cannot be interpreted separately. For example, an option presented to a respondent might provide higher environmental outcomes than another but the probability of achieving those outcomes could be lower. Therefore, the respondent may choose an option with lower environmental outcomes that has a higher probability of achieving those outcomes. This means that respondents' choices between alternative future management options depend on both the chance that the outcomes of new policy will occur and the environmental outcomes (number of species protected, length of coastline and adjacent waters protected).

Format of the choice modelling questionnaire

The format of the questionnaire followed a standard CM questionnaire format. The introduction page of the questionnaire explained the purpose of the survey, provided assurance of the confidentiality and provided contact details for the researchers. The questionnaire then included brief background information about marine pests and their impacts on the environment (Appendix C). Alternative policy actions were described, together with potential consequences of continuing the current and alternative management actions. The information was supported by photographs and maps. It was explained in the questionnaire that the new policy requirements considered may include one of or a combination of these actions:

- more frequent inspections of ships and boats by the Department of Agriculture and Water Resources before entering Australian ports
- more frequent application of coatings/paint
- more regular cleaning and using new technology to clean boats and ships
- treatment of ballast water on every voyage
- using new technology to treat ballast water in more boats and ships.

The questionnaire included five choice questions, each containing three options and having all the attributes but with varying levels of each attribute (Figure 1). A baseline option (Option A) representing the status quo (no new policy) was included in each choice question. The choices were made between the status quo option and two different proposed new management options (new policies). By making choices between these alternative management options respondents traded-off different attributes against each other. Based on respondent's choices, the relative values of each attribute to the Australian community could be estimated.

A monetary attribute (additional annual cost to a household) is required in choice modelling experiments to allow respondents to make trade-offs between the monetary value of the chosen option and the benefit received through that option. It was explained to respondents that the cost of the new policy would be paid for by additional regulatory costs imposed on the shipping industry and boat owners (all types of boats coming from overseas ports), and that these costs would ultimately be passed on to households in the form of higher prices for imported goods and goods made in Australia using imported products.

The questionnaire also included some socio-demographic questions that were used in a screening process to ensure that a representative sample of the Australian community was obtained for the study. At the end of the questionnaire respondents were asked additional questions to check the consequentiality, credibility and clarity of the information presented.

Figure 1 Example of choice question

Option	Additional cost to YOUR household	Outcomes		Chance that outcomes of new policies will occur	CHOICE Tick ONE
		Species protected	Coastline and adjacent waters protected		
Option A (no new policies)	$0 per year	0 species protected	0 km protected	Not applicable	☐
Option B (new policies)	$20 per year	4 species protected	1,500 km protected	50% chance	☐
Option C (new policies)	$50 per year	6 species protected	1,000 km protected	80% chance	☐

The questionnaire's design is important in any CM study. To obtain reliable results from the CM experiment, the questionnaire needs to be relevant to the policy and to the respondents. That is, the respondents need to feel their answers will be taken into consideration by policymakers. The scenarios presented in the questionnaire, attributes and their levels must be relevant to the respondents and in-line with the environmental variables predicted as relevant by scientists who are familiar with the issue being modelled. Moreover, the questionnaire needs to be objective, factual and the information presented must be clear and sufficient. This was tested during the focus groups.

The CM questionnaire was designed following a literature search and consultations with experts, including scientists, policymakers, economists and marine biosecurity experts. Focus group sessions were used to determine the type of information that should be included in the final CM questionnaire and how best to present information to respondents. At each focus group session an experienced facilitator guided a discussion with 10 to 12 participants, after which participants were asked to complete a preliminary questionnaire. The questionnaire was tested in the sessions to check whether the information presented was appropriate and to observe whether the issue was communicated clearly.

The focus groups were heterogeneous in terms of participants' occupation, background, age and gender in order to obtain a representative sample. Participants provided a diversity of perceptions and opinions and helped verify the appropriateness of the attributes presented in the questionnaire, and their levels, the presentation of the status quo situation and alternative options.

The focus group sessions were held in March 2017 in five locations (two in each location), giving a total of 10 sessions. Sessions were held in three metropolitan cities—Sydney, Melbourne and Brisbane—and in two regional areas—Wagga Wagga and Wollongong. Wollongong was chosen to provide a representation of the views of population from a coastal regional area and Wagga Wagga from communities located inland.

The focus groups found that the information provided in the questionnaire was believable, well-balanced, appropriately structured, factual, presented in a clear and concise manner and the language used was appropriate. Respondents found the questionnaire informative and the issue presented important. During the focus groups respondents were asked to discuss the choice questions presented to them in the questionnaire, attributes and their levels. Participants agreed that the choice of the attributes for the questionnaire were appropriate, the scenarios were believable and that all of the attributes were important. The levels of the attributes presented in the questionnaire seemed reasonable to participants.

4 Results

Survey

An online CM survey of Australian residents was conducted in May and June 2017 by a private service provider. The respondents were randomly selected from the general public. In total, 2,808 responses were obtained from around Australia. People over 18 years old were asked to complete the questionnaire on behalf of the whole household.

The ABS Census 2011 was used to form a framework for distribution of the sample to obtain a representative sample of the population. The sample distribution was designed based on the distribution of the households across all capital cities (Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart, Darwin and Canberra) and regional parts of Australia (regional New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, the Northern Territory and the Australian Capital Territory) and across gender and age groups. A comparison of the socio-economic characteristics of the sub-samples with ABS population data was undertaken to determine representativeness of the sample. The comparison (using a chi-square test) found no significant differences in the distribution of gender, age, tertiary education and household income between the samples and the ABS population data (Appendix B).

Before the main survey was undertaken, two pre-tests were conducted with 200 responses. During the pre-testing the respondents could provide comments and suggestions to help improve the questionnaire. The pre-testing showed that a majority of respondents found the questionnaire easy to complete. The respondents found the issue important and the topic presented interesting. The pre-testing process identified no major issues.

In total 2,808 respondents completed the main survey. The estimated response rate was around 16 per cent, which is typical for general public surveys. From the main survey 192 protest responses were identified. These were excluded from the analysis, under the assumption that respondents who disagree with the survey mechanism give invalid responses. The analysis of the data showed that excluding protest responses made no significant difference to the analysis and the results. The results also showed that over 90 per cent of the respondents believed that the results will be taken into consideration by policymakers. The survey was easy to understand by most of the respondents (98 per cent).

Community views about marine pests

The results showed that over 40 per cent of the respondents were aware of marine pests prior to answering the questionnaire. Other respondents appreciated the information provided, which is shown in the comments provided:

- ‘Great to inform public on issue we are not given much information about.’
- ‘Interesting survey lots of information I did not know.’
- ‘Opened up my eyes on marine threats and how they get here.’
- ‘Thank you for informing me of marine pests. I am now going to find out more about it as a result of my participation.’
- ‘I was unaware of the pests that are in our oceans can do so much damage.’

- ‘A very interesting survey and makes you think.’
- ‘Thanks for bringing this important environmental issue to my attention. It is not something that I would have thought about.’
- ‘Most people do not realise the threats in the sea unless they have some involvement. There should be more surveys to make people aware. Boats, particularly recreational ones, should have more checks.’

Some other comments from the respondents of the survey indicated that the protection of marine environment from the impact of marine pests was important, for example:

- ‘I think it is significant and crucial that we protect the indigenous Australian wildlife from non-native species that are detrimental to their survival and the surrounding environment.’
- ‘I believe we need to protect our waters from marine pests.’
- ‘Anything that can be done to protect our seas around Australia is a good thing.’
- ‘It is very important we look after our marine environment, and stop these pests entering our waters at once, no matter the cost.’
- ‘A great and urgently needed important survey.’
- ‘Extremely interesting survey and very necessary.’

The public also appreciated to be consulted on this matter:

- ‘The subject is critically important and I'm glad to be consulted about it.’
- ‘Thank you for asking our opinion on this most serious issue.’
- ‘Great to see the public is involved with these important decisions.’
- ‘I think this survey is very important, I'm glad I was able to participate.’
- ‘Very interesting survey. Good to see community engagement on these issues.’

The public expressed that they would like the government to act on this issue effectively:

- ‘Fantastic the Department of Agriculture and Water Resources is doing something about this.’
- ‘Very interesting and I just hope something will be done.’
- ‘Hope that these policies happen. We need our marine environment to be protected.’
- ‘The government should implement all these policies regardless of the cost to safe guard and protect our marine life.’

Most of the comments from respondents were positive but some were negative. The majority of the negative comments related to scepticism some respondents had to the government undertaking these actions.

It was explained in the questionnaire that the cost of the new policy would be paid for by the shipping industry and boat owners and that these costs would ultimately be passed on to households in the form of higher prices for imported goods. However, some respondents thought the cost of these policies would involve higher taxes and expressed their concerns:

- ‘Most citizens of Australia would not be happy with an increase in tax, especially how much it could increase it. It is very hard to keep both the population and the wellbeing of Australia in balance.’

- 'I understand that protecting marine life and environment is important however government should also cover some of the cost. Living cost is increasing every year and government has already gain a lot of taxes from the citizen so it should be their responsibility to cover most of the cost.'

Some respondents expressed their concerns about any potential adverse impact on the natural environment of the new management methods for biofouling and ballast water treatments. Currently the Department of Agriculture and Water Resources is looking at this issue and a separate study has been conducted by ABARES to investigate treatments of ballast water and its impact on port water quality (Summerson et al. 2017). Lewis (2010) discusses potential implications of impacts of anti-fouling coatings on the environment.

Non-market Valuation Results

Data from the 2017 survey respondents were modelled using conditional logit (CL) and panel error component (EC) model specifications. These specifications are suited to analysing data collected through choice experiments and have been extensively used by choice modelling practitioners to estimate non-market values. The resultant models proved robust across a range of diagnostic tests and the estimated parameters were highly significant, confirming the reliable fit of the model specification to the data collected (Appendix A).

Results indicate the extent to which the Australian community values marine species, coastline and adjacent waters. Analysis of the characteristics of the respondents reveals that respondents who were aware of marine pests before answering the questionnaire preferred management scenarios that provided higher levels of protection in terms of number of species and area of coastline. This was the case also for respondents who used the marine environment for recreation and who had lived or currently live in a coastal area (Appendix A). Poe, Severance-Lossin & Welsh (1994) test was conducted to identify any significant differences in values between different communities. The annual household values obtained from capital cities and regional areas were compared and no significant differences were found.

Table 3 Annual household values at 1 per cent probability of the attributes occurring

Region	100 km of coastal area and adjacent waters protected	One native species protected
Australia	$0.074 (0.066 ~ 0.082)	$0.326 (0.294 ~ 0.358)
Capital cities	$0.076 (0.066 ~ 0.087)	$0.341 (0.300 ~ 0.382)
Regional	$0.070 (0.065 ~ 0.084)	$0.300 (0.246 ~ 0.351)

Note: 95% confidence intervals in brackets.

Table 3 shows the estimated values for 1 percent probability of the outcome occurring at the 95 per cent confidence level, indicating a 95 per cent chance that the true value for the mean value of household willingness to pay lies within the range presented. It was assumed in the study that the expected values are linear in both the scale of environmental outcomes and the probabilities that characterise the chance of the outcome occurring. These values are generated by the model output and should be extrapolated to more realistic probabilities (20% to 80%) and number of species (0 to 6) and length of the coastline (250km to 1500km) which is within the probable range. Therefore, the willingness to pay for a 1 per cent chance of the outcome occurring were extrapolated to match the chances presented in the survey. Table 4 presents the CM results for 20 per cent, 50 per cent and 80 per cent probability of a policy intervention achieving the outcome of one native species and 250 kilometres of coastline protected. At the 20 per cent probability that policy interventions will lead to these outcomes, households would on average be willing to pay $6.52 per year for one native species protected and $3.70 per year to protect 250 kilometres of coastline and adjacent waters from marine pests.

Table 4 Annual household values for the prevention of marine pest impacts

Probability of success	250 km of coastal area and adjacent waters protected	One native species protected
20%	$3.70	$6.52
50%	$9.25	$16.29
80%	$14.80	$26.07

The values estimated for an Australian household were used to extrapolate the household values to the Australian population using the Australian Bureau of Statistics census data (ABS census 2011) (Table 5). A lower estimate is calculated on the assumption that 16 per cent of Australian households (1.3 million of 8.4 million households) have the same average value as the survey sample, based on the survey response rate of 16 percent. Without a knowledge about preferences of non-respondents a conservative approach is to assume that non-respondents place zero value on these policy options. This is in line with standard practice in choice modelling experiments (for example see Baker & Ruting 2014, Bennett et al. 2008, Breeze et al. 2014 and Windle & Rolfe 2014). The estimate is considered very conservative, as it assumes 84 per cent of households that have not responded to the survey place zero value on this issue. This conservative approach was adopted in this study to establish a lower estimate because it is unknown what proportion of non-respondents have a positive and/or different value without a comprehensive survey of non-respondents. Non-respondents may have a different value than respondents for a number of reasons. For example, decisions to participate in the survey may be correlated with a pro-environment disposition whereas decisions not to participate in the survey might be correlated with a view that the environment is highly resistant and does not need protection.

Morrison (2000) argues that potential respondents who are interested but too busy to undertake a survey would be likely to have similar preferences to respondents. Therefore, in line with Morrison (2000), some studies extrapolate the values to the response rate and 32 percent of non-respondents. Following this approach, this study calculates an upper estimate based on 16 per cent of respondents and 32 per cent of non-respondents (43 per cent of Australian households 3.6 million households). An alternative would be to assume the average value form the survey sample is representative of the Australian population as a whole. This approach would imply a higher total value, and is not adopted here for two reasons. First, extrapolating to the whole population might overstate true willingness to pay, given uncertainties about the attitudes and values of non-respondents (Breeze et al. 2014). Second, there is a well demonstrated scale effect where a survey assesses the value of a specific instance of a larger set of similar cases. For example, a survey to value the perceived benefits of a new national park will typically find a higher valuation when it is the sole focus, rather than being presented as one of a number of potential parks.

Given the difficulty and complexity of adjusting results for scale effects an adjustment for scale effects has not been undertaken for this study. This is an area of ongoing research (e.g. Mazur and Bennett, 2009, Spencer-Cotton, A, Burton, M & Kragt, M, E 2016, Xu, S, Liua,Y, Wanga, X & Zhang, G, 2017).

Table 5 Australian population annual values ($AU million)

	250 km of coastal area and adjacent waters protected		One native species protected	
Probability	**Lower estimate**	**Upper estimate**	**Lower estimate**	**Upper estimate**
20%	$4.99	$13.36	$8.78	$23.53
50%	$12.47	$33.41	$21.95	$58.82
80%	$19.94	$53.45	$35.12	$94.11

When more species or area are expected to be protected as a result of the management actions, the values are extrapolated accordingly by the number of species or area of coastline protected. The study assumes that values are linier with respect to both number of species and area protected. Figure 2 reports results where the number of species protected ranges from one to four and Figure 3 where coastline protected ranges from 250 km to 1,500 km. In making such extrapolations decision-makers and scientists need to consider relevant scenarios and possibilities of achieving the expected outcomes of number of species and area of coastline protected through active management of marine pest risks and the probability that management will be successful in achieving the stated outcomes. Extrapolation outside the ranges of the attributes (species, coastline length and probability) presented to respondents is not appropriate.

Figure 2 Australian annual values for species protected

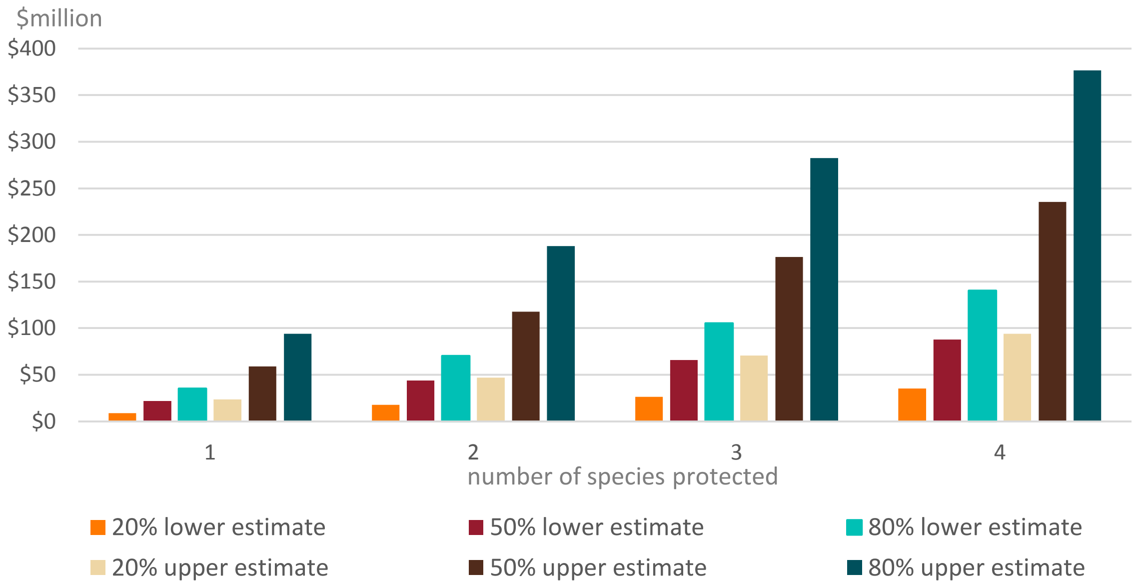
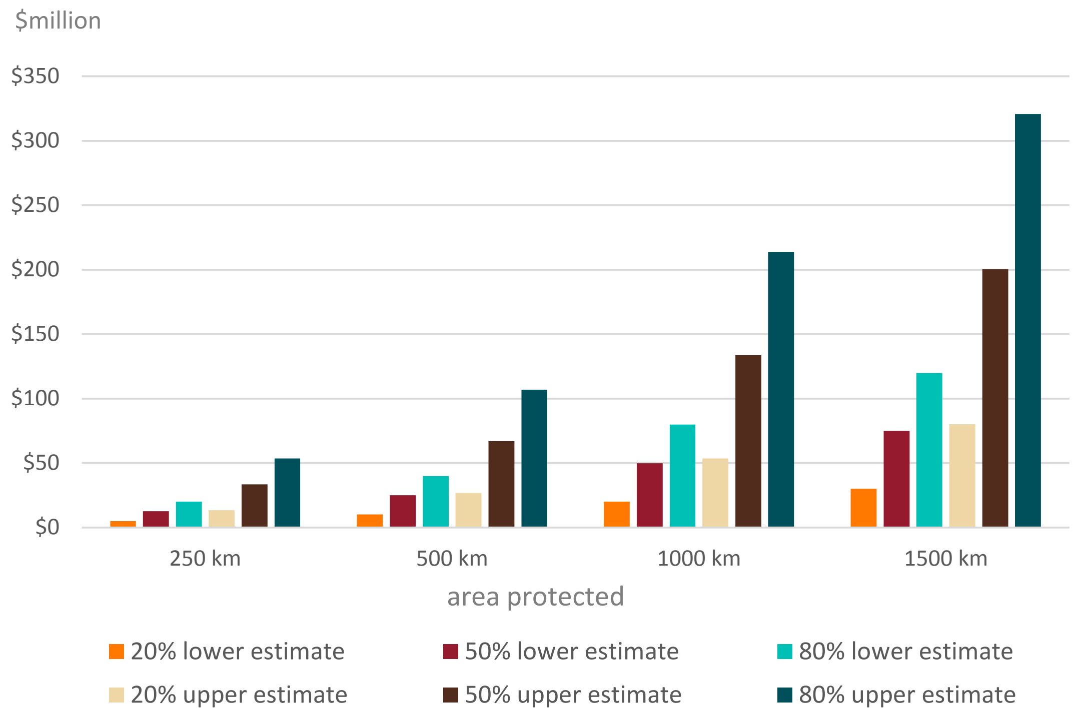


Figure 3 Australian annual values for coastline and adjacent waters protected



The benefits that the Australian community holds for prevention and avoided environmental damage from the impact of new marine pests can be directly compared with the costs of prevention at a given probability of success. Cost benefit analysis holds that policy action is worthwhile where the benefits outweigh the costs. In comparison to a previous study conducted by PwC (2011) that has estimated the net present value of implementation of a national approach to biofouling at $146 million to $225 million (in 2016–17 dollars) over a 10-year period (on average $14.6 million to $22.5 million per year), the environmental benefits are likely to be higher than the cost of prevention. However, more recent estimates of the costs are required and each case should be assessed on its merits. The cost estimated by PwC do not include deadweight losses associated with taxes or revenue collection. The values estimated in this study reflect the values placed on potential benefits of marine pest prevention and do not reflect any likely costs of policy that addresses the risks inherent in marine pests. In choosing between alternative policy options, policymakers can identify the management action that provides the highest net social benefit. The values obtained from this study represent the value of the environmental benefits of a reduction in risk of marine pest incursions in Australia's water and can be compared against the cost of alternative policies to reduce the risk of new marine pest incursions into Australia.

5 Conclusion

This study was designed to assist the Department of Agriculture and Water Resources in analysing policy interventions that reduce the chance of marine pests arriving and establishing in Australia. The prevention of entry of marine pests may be the most practical and effective management method because marine pests are costly and often impossible to eradicate once they establish. The study revealed that the Australian public values policy that protects the Australian environment from the potential impacts of new marine pests, especially policies that have a high chance of successfully minimising new marine pest incursions. The study presents estimates that indicate the Australian community places a substantial monetary value on environmental benefits (willingness to pay) to prevent new marine pests establishing.

For this study a CM survey was applied to identify the community's attitudes and preferences and the value placed on protecting the environment from new marine pests. The study involved a large-scale survey of the public across Australia and indicated that the public values the protection of the Australian environment from the potential impact of new marine pests. The results show that those management scenarios that provide higher environmental benefits and a higher likelihood of effectiveness of the prevention measures are preferred. The results indicate that individual households sampled in this study were on average willing to pay $16.3 per year to protect one species and $9.3 per 250 km of coastal area and adjacent waters protected if there is a 50 per cent chance that the outcome will occur. When extrapolated to the Australian population, the willingness to pay to prevent potential environmental impacts, ranges between an annual value of $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 per cent chance that the outcome will occur.

The results from this study can be used in a benefit–cost analysis of policy interventions that prevent the incursion of marine pests into Australian waters. The environmental benefits estimated in this study form only part of the total benefits from effective policy that prevents new marine pest incursions. Benefits in the form of avoided losses to industries need also to be included but have not been estimated in this study. Although benefits arise from policies that reduce the chance of future incursions, policymakers should choose management actions that are likely to provide the highest net benefit. Management actions should be considered on the basis of the environmental outcomes they can generate and the relative likelihood of achieving these outcomes and the cost to achieve these outcomes.

Appendix A. Results of the choice models

The survey data obtained were analysed using conditional logit (CL) and error component (EC) models. Table A1 sets out the modelling results. The pseudo R2 for the EC model indicate a good model fit. The ASC was positive and significant, which implies that respondents systematically preferred the change options over the status quo. The signs of the model parameters are in accordance with a priori expectations. All parameter coefficients have positive signs value, which indicates that those scenarios resulting in higher amounts of marine pest prevention are preferred. The cost coefficient was significant and negative. The environmental parameters (species and coastline) were interacted with the attribute that represents the chance of the outcomes occurring. Therefore, the probability of a respondent choosing an improvement in environmental qualities was conditional on the chance of these outcomes occurring. Parameters were estimated for length of coastline and adjacent waters protected conditional on the chance of this outcome occurring (Chance* Coastline and adjacent waters protected) and for native species protected conditional on the chance of this outcome occurring (Chance* Species protected). To test for preference heterogeneity, a conditional logit (CL) model including characteristics of the respondents was estimated (CL with interactions). The results show that respondents who were aware about marine pests before answering the survey prefer management scenarios that provide higher levels of outcomes (Table A1). Similarly, respondents who use the marine environment for recreation and who had lived or currently live in a coastal area preferred the change options.

Table A1 Results of the choice models

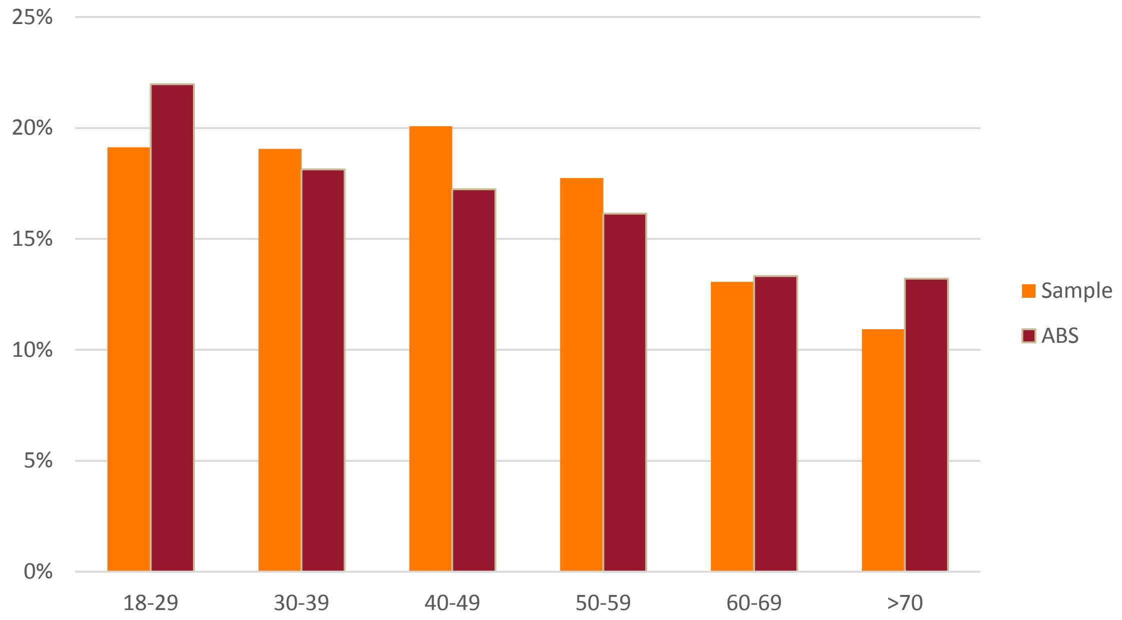
Explanatory variables	CL attributes only	CL with interactions	EC attributes only	EC with interactions
Cost to household	-.01038***(.00026)	-.01048***(.00026)	-.01160***(.00023)	-.01161***(.00023)
Chance*100km of coastline and adjacent waters protected	.000647***(.000036)	.000650***(.000036)	.000859***(.000038)	.000856***(.000038)
Chance* a species protected	.00265***(.00014)	.00268***(.00014)	.00378***(.00014)	.00377***(.00014)
ASC	.91548***(.05503)	.41631***(.06102)	2.57533***(.13195)	1.51236***(.14898)
ASC*aware about marine pests		.37816***(.05208)		.68915*** (.17321)
ASC*use marine environment for recreation		.56208***(.05747)		1.11669***(.18827)
ASC* lived or currently live in a coastal area		.41562***(.05222)		.76052***(.17454)
SigmaE01			-3.40396***(.10727)	3.31987***(.10349)
Pseudo R2	0.1596	0.1726	.3305	.3341
D.F.O	4	7	5	8
Log likelihood	-11297.13896	-11118.24641	-9620.22545	-9568.26714
Observations	13080	13080	13080	13080

Note: ***, **, * Significance at 1%, 5%, 10% level. The 95 per cent confidence intervals in brackets calculated using a bootstrapping procedure (Krinsky & Robb 1986).

Appendix B. Socio-demographic characteristics of the respondents

The comparison of the age distribution between the ABS data and the sample is shown in Figure 4.

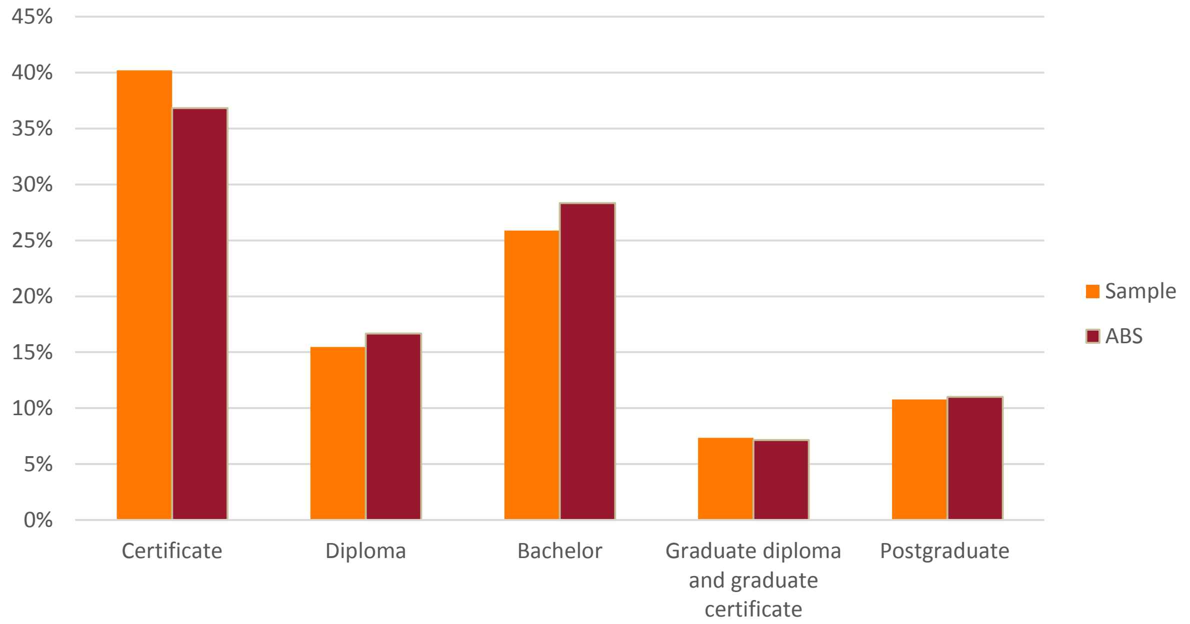
Figure 4 Comparison of age distribution of survey respondents with ABS population data



Source: ABS (2016a)

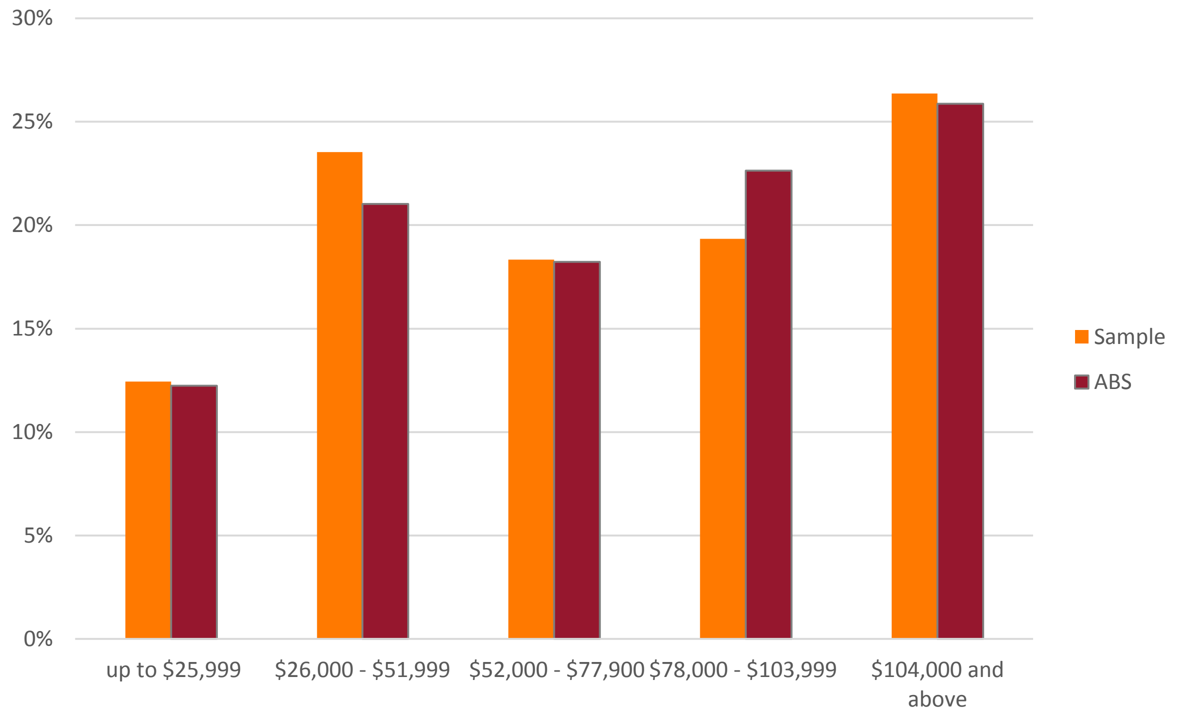
The difference in distribution of tertiary education between the respondents and the ABS population data (Figure 5) was not statistically significant. However, most of the respondents had tertiary education (93 per cent), which is significantly higher than the national data (63 per cent). Only one person per household could complete the questionnaire on behalf of the whole household so education of other household members was not captured. A comparison between the distributions of household incomes also shows no significant differences between the sample and the population data (Figure 6).

Figure 5 Comparison of tertiary education levels of survey respondents with ABS population data



Source: ABS (2016b)

Figure 6 Comparison of household income distribution of survey respondents with ABS population data



Source: ABS (2015)

Appendix C. Questionnaire example

Dear respondent,

Thanks for participating in this survey. The Australian Government is looking at some new policy options to reduce the chance of marine pests from arriving and establishing in Australia. Marine pests are plants or animals that are not native to Australia.

This survey is to find out your views on these options. Your answers are important and will assist the Government in developing new policies.

This survey is funded by the Australian Government and undertaken by the Australian Bureau of Agricultural and Resource Economics and Sciences.

You have been chosen at random to be part of the survey.

The survey will take about 15 minutes to complete and is entirely voluntary. You do not need to know anything about marine pests to complete the survey. Some background information is provided.

While information collected in this survey may be reported in research publications, individual responses will remain confidential and anonymous.

All information collected during this research will be securely stored. For more information about our obligations under the Privacy Act please visit http://www.agriculture.gov.au/about/privacy

If you have any enquiries or concerns about participating in this survey please contact Dr Kasia Mazur by e-mail: Kasia.Mazur@agriculture.gov.au

Yours sincerely,
Dr Kasia Mazur
Principal Economist
Australian Bureau of Agricultural and Resource Economics and Sciences
Department of Agriculture and Water Resources
Canberra ACT 2601 Australia

About this survey

This survey is about marine pests in Australia. There are four parts to the survey:

Part 1. About you – a few questions about you to make sure we have a representative sample of the Australian population.

Part 2. About Marine Pests – information about marine pests, their impacts and ways of reducing the chance of marine pests arriving and establishing in Australia.

Part 3. Your choices – we ask you to make some choices between alternative future options to reduce the chance of marine pests arriving and establishing in Australia

Part 4. Finally – a few more questions about you.

Part 2. About Marine Pests

This part of the questionnaire provides some background information about marine pests.

It also sets out some policies the government is looking to introduce to reduce the chance of marine pests from arriving and establishing in Australia. Please take some time read this important information carefully.

Marine pests are plants and animals not native to Australia. There are already over 15 marine pests in Australia. Marine pests are costly to control and almost impossible to eradicate once they establish.

Marine pests **mostly** come to Australia by:

- **bio-fouling** (attaching to boat and ship parts) - currently boats and ships voluntarily manage the risk of bio-fouling

Photo source: Bayview Slipway Marine Services

- **ballast water** (water carried by ships for stability) - currently all ships and boats must manage their ballast water

Photo source: United States Coast Guard

IN AUSTRALIA

Examples of marine pests that have already established in Australia

Northern Pacific Seastar

Photo source: Biofouling Solutions Pty Ltd

European Shore Crab

Photo source: Julian Black, (licensed under Creative Commons)

European Fan Worm

Photo source: John Polglaze

Impacts

Northern Pacific Seastar

- eats native species and threatens the existence of some native species
- competes with native species for food and space

European Shore Crab

- eats native species
- competes with native species for food and space

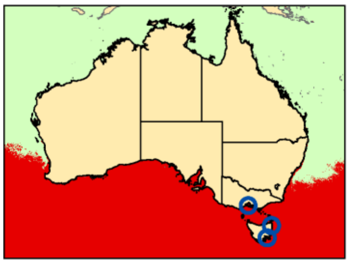
European Fan Worm

- forms dense colonies and overgrows native species
- competes with native species for food and space

Description

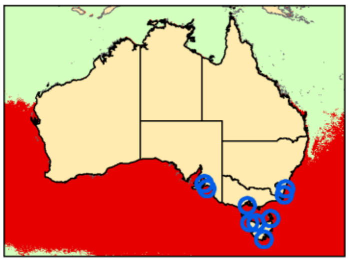
Northern Pacific Seastar

- prefers soft sediment, artificial structures and rocky reefs
- animal can be up to 50 cm



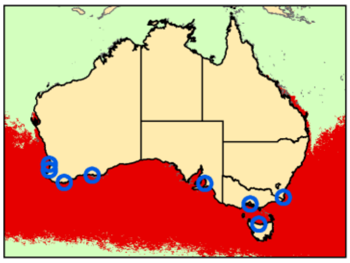
European Shore Crab

- prefers bays/estuaries but found in all types of shores up to 60m depth
- shell up to 7 cm



European Fan Worm

- attaches to hard surfaces, artificial structures, rocks, shells and seagrass
- tubes up to 40 cm



presence in Australia

potential maximum spread

unlikely to establish

NOT IN AUSTRALIA

<u>Examples</u> of potential marine pests that <u>could</u> establish in Australia in the future

Chinese Mitten Crabs

Photo source: Stephan Gollasch, GoConsult

Black-Striped Mussels

Photo source: CSIRO, (licensed under Creative Commons)

Soft-Shell Clams

Photo source: Liam O'Brien, (licensed under Creative Commons)

Impacts

Chinese Mitten Crabs

- would burrow into the banks of estuaries causing erosion and instability
- would eat native species
- would compete with native species for food and space

Black-Striped Mussels

- would harm water quality
- would form dense clusters fouling marine infrastructure
- would compete with native species for food and space

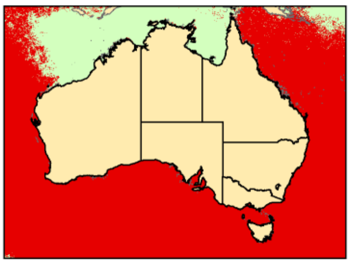
Soft-Shell Clams

- would turn sandy beaches into shell gravel
- would form large populations that die and decay along the shoreline causing a smell
- would compete with native species for food and space

Description

Chinese Mitten Crabs

- shell up to 8 cm
- native to East Asia and established in Europe and United States

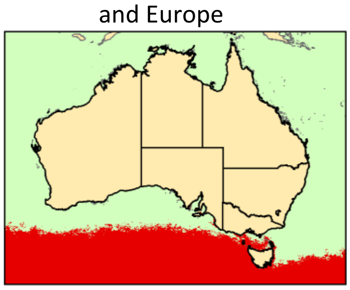


Black-Striped Mussels

- fast growing small animal (2.5 cm)
- native to Caribbean Sea and now widespread in Eastern Asia

Soft-Shell Clams

- grows up to 15 cm
- native to east coast of North America and now widespread on the west coast of North America and Europe



potential maximum spread

unlikely to establish

What could be done

The Government is looking at new policy options to reduce the chance of marine pests arriving and establishing in Australia. New policy options would involve any or a combination of the following additional requirements:

1. More frequent inspections of ships and boats **before** entering Australian ports by the Department of Agriculture and Water Resources;
2. More frequent application of coatings/paint;
3. More regular cleaning and using new technology to clean boats and ships;
4. Treatment of ballast water on every voyage;
5. Using new technology to treat ballast water in more boats and ships.

The outcomes of the new policy options would depend on which of these additional requirements are introduced and how they are combined.

To enter Australia waters, all boats and ships coming from overseas ports would need to comply with these additional requirements in order to be granted entry to Australia. The new policies would be enforced by the Department of Agriculture and Water Resources.

Where the money would come from

The introduction of new policy options to reduce the chance of marine pests arriving and establishing in Australia would cost money.

Different policies would have different costs.

The cost of any new policy option would be paid by the shipping industry and boat owners (all types of boats coming from overseas ports).

Those extra costs would be passed on to you in the form of higher prices for imported goods and goods made in Australia using imported products.

Part 3. Your choices

In this part of the survey we want to know your opinion of potential new policy options to reduce the chance of marine pests arriving and establishing in Australia.

In the next five (5) questions, we are going to ask you to choose between three (3) alternative policy options.

Option A does NOT involve any new policies or costs to your household. In each question, you always have the opportunity to choose Option A.

The other two policy options would introduce new policies and involve additional costs for you.

Policy outcomes

Each policy option is described by their predicted outcomes:

- **Number of native species protected from new marine pests.**
- **Length of coastline and adjacent waters protected from new marine pests.**

Note that under Option A, with **no** new policies:

  - **None** of six (6) native species threatened by new marine pests would be protected.
  - **None** of 1,500km of coastline and adjacent water threatened by new marine pests would be protected.

New policy options also vary by:

- **Chance that the predicted outcomes will occur – for example, for a particular new policy option, the chance of its predicted outcomes occurring may be 80%. That means there is a 20 % chance that the Option A outcomes (with no new policies) will occur.**
- **Additional cost to your household – the amount your household has to pay each year in higher prices of goods to get the predicted outcomes.**

Some of the new policy outcomes may seem strange. This is because different combinations of policies can lead to different outcomes.

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