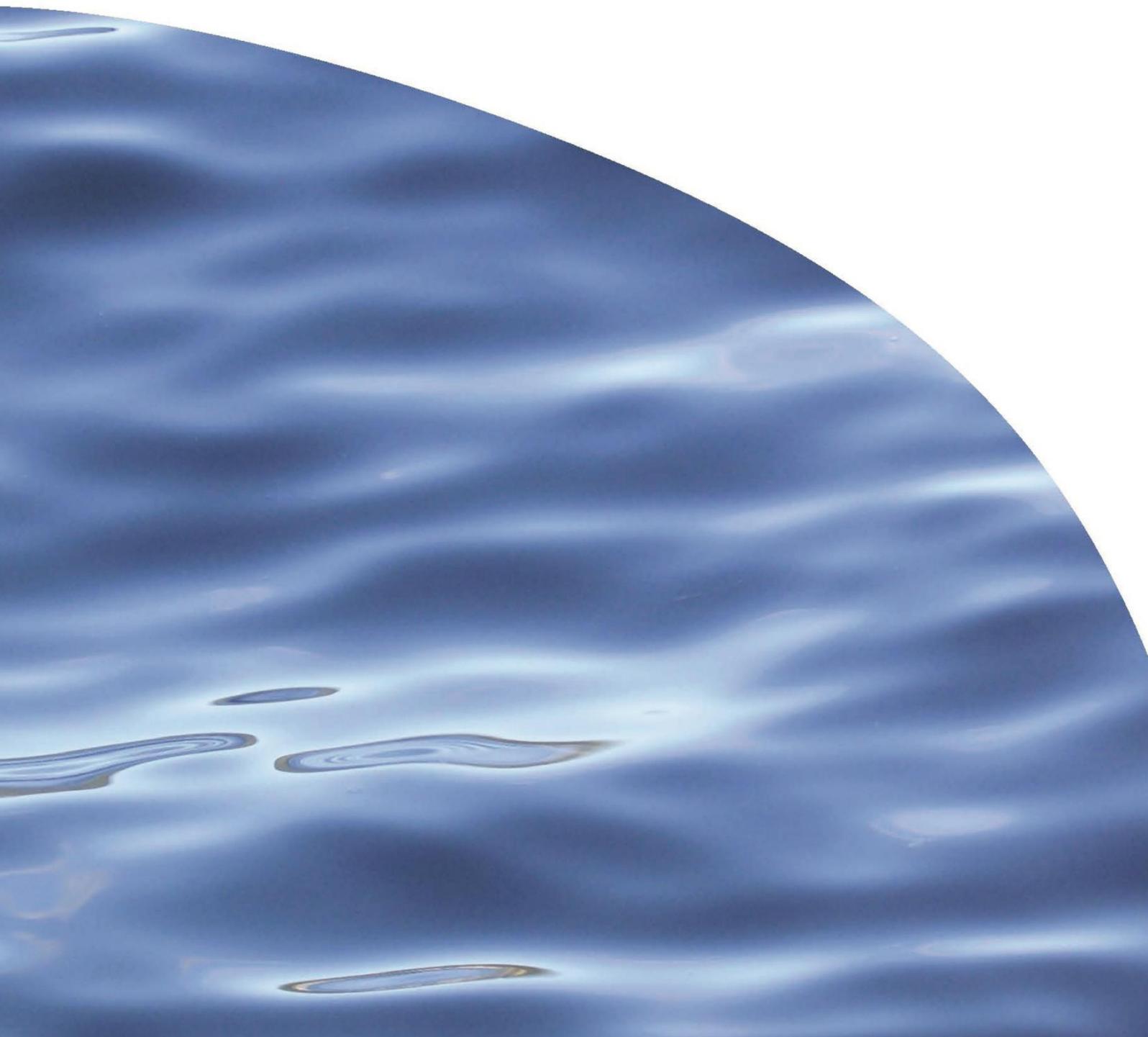




REPORT NO. 3397

**STAKEHOLDER VIEWS ON REDUCING THE RISK
OF MARINE PEST SPREAD BY RECREATIONAL
BOAT OPERATORS**



STAKEHOLDER VIEWS ON REDUCING THE RISK OF MARINE PEST SPREAD BY RECREATIONAL BOAT OPERATORS

MARK NEWTON

Prepared for Auckland Council

CAWTHRON INSTITUTE
98 Halifax Street East, Nelson 7010 | Private Bag 2, Nelson 7042 | New Zealand
Ph. +64 3 548 2319 | Fax. +64 3 546 9464
www.cawthron.org.nz

REVIEWED BY:
Ian Davidson



APPROVED FOR RELEASE BY:
Patrick Cahill



ISSUE DATE: 07 November 2019

RECOMMENDED CITATION: Newton M 2019. Stakeholder views on reducing the risk of marine pest spread by recreational boat operators. Prepared for Auckland Council. Cawthron Report No. 3397. 44 p. plus appendices.

© COPYRIGHT: This publication must not be reproduced or distributed, electronically or otherwise, in whole or in part without the written permission of the Copyright Holder, which is the party that commissioned the report.

EXECUTIVE SUMMARY

Biofouling on recreational boats can unintentionally spread marine pests and the extent to which operators undertake good biofouling management practices on their vessels affects the level of risk of spreading these pests. Recreational vessel hull biofouling is the main vector of marine pest spread within the Auckland region. The large number of recreational vessels and vessel owners in Auckland—which has the most vessels per capita in the world—makes management, monitoring, enforcement and communications challenging.

In early 2019, Auckland Council commissioned Cawthron Institute to explore the behavioural motivations of recreational boat operators to undertake good biofouling management practices. This report comprises three components:

- A review of social science literature relating to recreational marine biosecurity behaviour change
- A review of Auckland Council's policies, rules and other programmes relating to recreational marine biosecurity risk management, and
- 10 interviews and a focus group with stakeholders of Auckland's recreational boating system.

A literature review of social science studies finds little published research in this area, both globally and within New Zealand.

The Auckland Unitary Plan: Coastal section refers to the opportunity for Auckland Council to focus on behaviour change. Under the Auckland Unitary Plan, a clear policy direction is provided for Auckland Council's management requirements regarding hull cleaning, including detailed rules about where, when, and how hull cleaning should take place. Also included is a directive for Auckland Council to raise awareness of biosecurity management issues. However, there is less clarity over how education and awareness should be advanced by Auckland Council.

This study contributes to addressing this uncertainty through interviews with members of Auckland's recreational boating community to explore factors that contribute to risks of spreading marine pests around the region. Analysis of interview material is based on the Model of Pro-environmental Behaviour which proposes that environmental behaviour is the result of attitudes, habits, and individual and external contextual factors. Our research finds six key factors that are likely inhibiting Auckland's recreational boating community from undertaking good biofouling management practices. These factors fall under three categories: **attitudes**, **individual capabilities** and **external conditions**.

Attitudinal factors that prevent good biofouling management take three main beliefs. These are (1) a fatalist sense that 'the horse has bolted' for marine invasive pests and therefore that management is futile, (2) a lack of awareness of the consequences marine pests pose to the things recreational boaters value, and (3) a limited sense of personal responsibility for the

issue and its management to reduce the risks of invasive pest spread. Crucially, boat owners and other stakeholders do not consider that the impacts of *Sabella spallanzanii* (Mediterranean fanworm) have been nearly as bad as originally suggested, and therefore they have little confidence in warnings of potential damage from new species. **Individual capability factors** include (4) poor time management and planning skills. **External conditions** include (5) haul-out service effectiveness and (6) the costs associated with biofouling maintenance.

Based on these findings, the following recommendations are made to Auckland Council.

To address factors (1), (2) and (3):

- consider recreational boating as a social system comprising boat operators, scientists, haul-out operators, central and local government, boat clubs, marinas, and conservationists, and **encourage a sense of self-responsibility** over marine biosecurity impacts across all relevant members (everyone has a part to play)
- invest in, or support in kind, research into the impacts of marine pests on New Zealand's economy, environment, society, and culture to clearly demonstrate the importance of this issue
- **negate the sense that 'the horse has bolted'** by
 - focusing on pathway management
 - communicating the impacts of current marine pests in an accurate and accessible way
 - implementing rules that require all boat operators to reduce risks
- **invite and support** key members of the recreational biosecurity system to be **behaviour change champions**.

To address factors (4), (5) and (6):

- consider providing or supporting cheaper options for hull cleaning
- negate the perception that good hull maintenance is expensive
- consider working with haul-out operators to develop a code of best practice or another tool to encourage best practice across the industry.

Finally, it is recommended that Auckland Council consider monitoring the effectiveness of the above initiatives through a regular survey of recreational boat operators. This is an often overlooked and crucial component of environmental education and outreach: resources are made available to get the message out, but not for whether the message is influencing awareness and behaviour. Such information allows for informed, adaptive outreach programmes that continually improve on the status quo.

TABLE OF CONTENTS

1. INTRODUCTION	1
2. LITERATURE REVIEW OF SOCIAL SCIENCE UNDERTAKEN TO DATE ON MARINE PEST PREVENTION.....	2
2.1. Introduction.....	2
2.2. Literature review.....	2
2.3. Summary	5
3. RISK MANAGEMENT APPROACHES USED ELSEWHERE IN NEW ZEALAND AND OVERSEAS	6
3.1. Fiordland Marine Regional Pathway Management Plan.....	6
3.2. Regional Coastal Plan: Kermadec and Subantarctic Islands.....	7
3.3. Northland Regional Pest and Marine Pathway Management Plan	8
3.4. Northland's Six or One programme	9
3.5. My Bum's Clean, is Yours?.....	9
3.6. National education programmes.....	10
3.6.1. <i>Marine Biosecurity Porthole</i>	10
3.6.2. <i>Pest and Disease Hotline</i>	10
3.6.3. <i>Clean Boats, Living Seas</i>	11
3.6.4. <i>Marine Pest ID Guide</i>	11
3.6.5. <i>New Zealand's Clean Boating Programme</i>	11
3.7. Clean Marina Programme	11
3.8. Don't Move a Mussel, Arizona, USA.....	12
4. AUCKLAND COUNCIL'S POLICIES, RULES, AND OTHER PROGRAMMES RELATING TO RECREATIONAL MARINE BIOSECURITY MANAGEMENT	13
4.1. Auckland Unitary Plan: Coastal	13
4.1.1. <i>Navigating the Rules guidance document</i>	14
4.2. Auckland Regional Pest Management Plan 2019.....	15
4.3. Clean Below? Good to Go and Marinepests.nz.....	15
4.4. Summary	16
5. METHODS AND THEORY OF BEHAVIOUR CHANGE	17
6. RESULTS	20
6.1. What are the perceived risky behaviours?.....	20
6.1.1. <i>Haul-out cleaning limitations</i>	20
6.1.2. <i>DIY cleaning in natural areas</i>	21
6.1.3. <i>Heavily fouled hulls moving infrequently around the region</i>	21
6.2. Who are the high-risk recreational boat operators?.....	21
6.3. Why do recreational boat operators undertake risky behaviours?	23
6.3.1. <i>Attitudes</i>	23
6.3.2. <i>Beliefs</i>	24
6.3.3. <i>Beliefs about assignment of responsibility to self to mitigate consequences</i>	27
6.4. Individual contextual factors	30
6.5. Contextual domain—shared factors	31
6.5.1. <i>Costs</i>	32
6.5.2. <i>Haul-out effectiveness</i>	33
6.6. Additional results	35

6.7. Summary	35
7. DISCUSSION AND CONCLUSION.....	36
8. RECOMMENDATIONS.....	39
9. REFERENCES	41
10. APPENDICES.....	45

LIST OF FIGURES

Figure 1. The Integrated Model of Pro-environmental Behaviour.....	18
--	----

LIST OF TABLES

Table 1. Permitted activities under the Auckland Council Unitary Plan.....	14
Table 2. Behaviours of concern to stakeholders regarding the risks of spreading marine pests around the Auckland region due to dirty hull or niche areas.	20
Table 3. Description of high-risk recreational Auckland boat operator, as determined by interviewees.	22
Table 4. Beliefs about why recreational boat operators undertake poor biosecurity management behaviours.....	25
Table 5. Assignment of responsibility for the containment of marine pests, as stated by interviewees	28
Table 6. Individual capabilities considered by interviewees as preventing recreational boat operators from undertaking good biofouling management.	31
Table 7. External conditions considered by interviewees as preventing recreational boat operators from undertaking good biofouling management	32
Table 8. Interviewees' ideas for things Auckland Council could do differently to encourage good practice.....	48

LIST OF APPENDICES

Appendix 1. Questionnaire.....	45
Appendix 2. Interviewees' ideas for increasing the uptake of better biosecurity management practices.....	47
Appendix 3. What could Auckland Council do differently to encourage good practice?	48

1. INTRODUCTION

Auckland's marine environment has diverse ecosystems that boast a rich diversity of seabirds, whales, dolphins, fish, and unique underwater habitats. The ecosystems are spread across two coasts with beaches, estuaries and two large harbours (Manukau and Kaipara) along the west coast, and the island-scattered Hauraki Gulf to the east. Auckland is one of the earliest places of settlement in New Zealand, and the landing site of many indigenous waka; it has been the home of a number of iwi for many generations. Auckland is New Zealand's largest city with over 1.6 million people and 200 cultures and the population is continuing to grow. Many of these people have a significant interest in Auckland's marine environment through its use for food gathering, recreation and conservation, as well as supporting profitable maritime, aquaculture and fishery industries.

The behaviour of recreational boat operators can create marine biosecurity risks to Auckland's coastal ecosystems. Recreational boats can transport marine pest species from international and domestic maritime ports and transport hubs (Floerl & Inglis 2003; Davidson et al. 2010; Ferrario et al. 2017). The main mechanisms of recreational biofouling risk are fouling of the hull and niche areas, bilge water, and gear (Sinner et al. 2013). Three key reasons underly these risks.

First, recreational boats are particularly susceptible to fouling accumulation due to:

- typical speeds slower than the speed (around 10 knots) required to dislodge fouling from hulls (Coutts et al. 2010; Forrest 2018)
- reduced effectiveness of anti-foul coats owing to extended periods spent idle on swing arms or moorings
- variable standard of anti-foul application
- some hull cleaning practices that reduce the efficacy and longevity of anti-foul.

Second, recreational vessels often travel from international transport hubs such as Auckland—where pests are introduced to New Zealand—directly to isolated locations of high ecological and amenity value (Forrest 2018). Third, the large number of recreational vessels and vessel owners in Auckland—which has the most vessels per capita in the world—makes management, monitoring, enforcement and communications challenging.

Good management of biofouling from recreational boats is essential to prevent the spread of marine pests. This study provides a better understanding of the behavioural motivations of recreational boat operators that contribute to the introduction and spread of marine pests within the Auckland region.

2. LITERATURE REVIEW OF SOCIAL SCIENCE UNDERTAKEN TO DATE ON MARINE PEST PREVENTION

2.1. Introduction

This section presents a literature review of articles relating to marine biosecurity behaviour change for recreational boat operators. The aim is to establish what is known about marine biosecurity behaviour change to inform development of an interview schedule for Auckland's recreational boat operators and stakeholders. A literature search was conducted in Google Scholar using a combination of the terms 'recreational boat*', 'marine', 'biosecurity', 'behaviour¹ change', 'foul', and 'hull'. Web searches were suspended at the 100th result to consistently limit the searches while allowing enough scope to effectively capture the most relevant literature (Collaboration for Environmental Evidence 2013). The citation lists of relevant articles were also searched for additional relevant articles. On top of this, Auckland Council provided references to 14 documents from their research literature database.

2.2. Literature review

Noting the lack of research on the effectiveness of strategies to change risky biosecurity management behaviours, Floerl et al. (2016) modelled the efficacy of management campaigns that aim to reduce the spread of invasive biofouling organisms by improving antifouling behaviour of boaters. Specifically, they examined three factors shaping the effectiveness of campaigns: (1) the proportion of the vessel population targeted, (2) the amount of change in behaviour made by individual boaters, and (3) the rate of uptake of the measure by the targeted population. A key finding was that strategies that target only the 'worst offenders' cause relatively little reduction in the spread of marine pests, as the proportion of worst offenders among recreational boaters is relatively small, and because other boaters pose some biosecurity risk too. The greatest reduction in biosecurity risk was achieved when a larger proportion of the recreational boating population was targeted with mitigation measures specifically aimed at transition points where relatively small changes in behaviour can lead to critical reductions in risk. The take-home message is that high rates of uptake across the recreational boating population are required for campaigns to be effective at reducing risk.

Many social science studies on marine pest prevention have investigated the effectiveness of education campaigns. Studies show that marine biosecurity messages are more likely to be positively received and increase public awareness when delivered in person by someone trusted (Sharp et al. 2011), and when messages are couched in terms that relate to the values of the target population. For

¹ And American spelling 'behavior'.

example, Verbrugge et al. (2013) found that marine pests are of little concern to the general public unless they are perceived as posing threats to human health or the local economy. Funk et al. (2013) found that policies are more likely to be accepted amongst recreational users if they are perceived to benefit social and economic values. Trenouth and Campbell (2013) found that high self-rated awareness of marine pests corresponded with willingness to support management interventions to prevent or control the spread of marine pests. Campbell et al. (2017) explored the feasibility of recreational boat operators self-managing marine biosecurity by encouraging them to detect, monitor and report sightings of marine pests. The study found that, while recreational boat operators may self-declare a high level of knowledge of marine pests, this did not correspond with their actual ability to identify those same marine pests.

A behaviour change study by Stenekes et al. (2018) used a national survey of 1,585 Australian recreational boat owners, co-owners, and crew about their boat maintenance practices. The purpose was to inform a national communication approach to reducing the risk of marine pest translocation due to recreational boat biofouling. The study, based on the social marketing framework of McKenzie Mohr (2011), found that the greatest overall behaviour change benefits for marine pest management would arise from promoting behaviours in the following order

- cleaning the boat before moving it to another location (i.e. clean-and-go)
- anti-fouling coating applied to the boat hull including the niche areas
- biofouling waste captured and disposed of after cleaning the boat.

While Stenekes' study provides many relevant insights to behaviour change study design, caution is recommended before applying the findings to Auckland's situation. Other studies have shown the importance of designing behaviour change interventions specifically for a community. In a study of the impact of educational outreach on recreational boat operators' perceptions of marine pests and their management, Sharp et al. (2017) observed different perceptions between survey respondents at two study locations some 50 km apart, highlighting that the effectiveness of educational programmes can differ between recreational user communities.

Social norms have also been observed to affect recreational biosecurity risk reduction behaviour in New Zealand. Rench et al. (2018) conducted a survey of passengers aboard a ferry to pest-free islands to assess the efficacy of the Treasure Islands Campaign in the Hauraki Gulf to educate visitors about terrestrial island biosecurity issues. While the results are not yet fully published, the survey uncovered anecdotal evidence from passenger behaviour upon disembarking the ferry. The researcher noted that:

Passengers would visually check their shoes for obvious debris. If they looked clean, they would not brush them. Large groups of

friends were less compliant with brushing their shoes if a few people just visually checked them. Approaching one member of the group was often enough to convince everyone to brush their shoes as friends would encourage each other to be compliant (Rench et al. 2018, p 6).

Another study examined how stakeholder social networks could aid collaborative efforts to manage marine pests and identify potential roles for communities in sustainable management of marine pests. Omondiagbe et al. (2017) focused on communication networks as part of collaborative stakeholder efforts at marine pest management in the Hauraki Gulf Marine Park, New Zealand. By identifying key stakeholders and analysing their communication network structure, the study proposed ways that influential stakeholders could initiate and strengthen collaborations that might lead to collective marine pest management action.

The sense of a lack of control over invasive aquatic pests has been posited as another possible reason for recreational boat operators' risky biosecurity behaviour (Prinbeck et al. 2011). Self-efficacy and perceived behavioural control has long been considered a fundamental determinant of whether or not people choose to engage in a behaviour (Ajzen 1985, 1991; Bandura 1997). In a study of behavioural determinants affecting the spread of invasive species in Oregon, USA, Prinbeck et al. (2011) found that people considered the fight against invasive species to be a losing battle; that there are too many unknowns about the control of invasive pests for efforts to be effective; and that the management tasks asked of recreational boat operators were too difficult.

Arnold (2004) reviewed literature on public attitudes towards marine issues in New Zealand. The review includes 14 research papers undertaken by DOC and other local and central government agencies within and beyond New Zealand. While the study did not directly address marine pests, some key findings of the review are that

...the views of indigenous stakeholders on marine management may differ from those of the general populace... and that the public is concerned about marine pollution, presumably because it is often visible and is a threat that exists near the shore... [and that] much recent marine research has focused on the threats posed by over-fishing and the collateral damage that certain fishing methods cause on marine habitats in both coastal and deep-sea environments (Arnold 2004, p 23).

Some reasons for poor biofouling management practices have been identified in an annual survey of recreational boat operators in the north of the South Island (Forrest 2018). The survey, conducted annually since 2016, involves a level of hull biofouling assessment at marinas in this region. When present, boat owners are asked

questions about their vessel maintenance habits and home port. During the summer of 2017/18, 232 boat operators were asked questions as part of the survey. Anecdotal information about the reasons for poor biofouling management practices was also provided by some interviewees. The main reason provided was a lack of capacity at haul-out facilities in the 'Top of the South', which meant that many boat operators employ the risky practice of scrubbing submerged surfaces (and potentially removing marine pests) while they are moored or anchored in high-value areas outside of ports or marinas (Forrest 2018).

Finally, many of the recreational boating and marine biosecurity studies (that include a social science aspect) collect basic hull husbandry and boat movement information from boat operators and combine it with ecological information to assess risk. For example, Martínez-Laiz et al. (2019) assessed the potential of recreational boat operators as vectors of marine pests in the Mediterranean Sea. Many other studies have used the boater questionnaire developed by Floerl and Inglis (2005). These studies surveyed the level of fouling of recreational vessels, which was then linked with information asked of boat operators (such as vessel type and length, date and type of antifouling paint application, and in-water cleaning schedule). For example, Ashton et al. (2014) used a boater questionnaire to assess marine biosecurity risks posed by small boats (recreational and fishing) travelling long distances north into Alaskan coastal waters. Zabin et al. (2014) used the boater survey to assess the risk of small vessels transferring species to and from a major commercial hub in San Francisco Bay, California. Murray et al. (2013) compared the efficacy of two common fouling assessment tools available to marine biosecurity managers: a dockside level of fouling assessment and a behavioural questionnaire model. The study found that the behavioural questionnaire was a more reliable predictor of macrofouling than the dockside survey.

2.3. Summary

Relatively few studies have explored human behavioural aspects of marine biosecurity management. A majority of studies in this field have occurred outside of New Zealand and, crucially, do not explore biofouling management behaviour through a behaviour change lens. The literature lacks New Zealand-based studies that assess the motivations and determinants of recreational boat operators' behaviours to reduce the risk of spreading invasive pests between marine areas.

3. RISK MANAGEMENT APPROACHES USED ELSEWHERE IN NEW ZEALAND AND OVERSEAS

3.1. Fiordland Marine Regional Pathway Management Plan

The Fiordland Marine Regional Pathway Management Plan (FMRPMP), established in April 2017 under the Biosecurity Act 1993, aims to minimise the risk of marine pests being transported into the Fiordland Marine Area (FMA) by targeting vessels and gear (Environment Southland 2017). The FMRPMP takes a pathways approach to exclude or limit the spread of pest species such as *Undaria pinnatifida* and *Styela clava* to Fiordland's highly valued marine ecosystems. The plan was developed and is implemented by a partnership group consisting of Environment Southland, Fiordland Marine Guardians, Ministry for Primary Industries, Department of Conservation and Ngāi Tahu.

Prior to the development of the FMRPMP, only voluntary measures (such as the provision of marine biosecurity information and biofouling management infrastructure such as boat cleaning stations) were in place to reduce the risks of marine pests entering or moving within Fiordland. The ineffectiveness of the voluntary approach, coupled with the high value of the Fiordland marine area and evidence that risk reduction could be achieved more cost-effectively through pathways approaches (Sinner et al. 2009), led to the implementation of the FMRPMP (Environment Southland 2016). The FMRPMP employs a mix of voluntary, assisted, and enforced measures. These include

- requiring the owner or person in charge of a vessel entering or operating within one nautical mile of the landward boundary of the FMA to hold a Fiordland Clean Vessel Pass to assist with vessel operator knowledge and identifying higher-risk vessels
- standards for clean hull, clean gear, residual seawater, and bilge water procedures
- a communications plan to ensure that owners or persons in charge of vessels entering within one nautical mile of the landward boundary of the FMA understand the rules and the reasons for them
- monthly hull inspections at Bluff to assist with vessel operator knowledge and identifying high-risk vessels
- a compliance and enforcement programme to ensure that non-compliant vessels are identified and corrective action taken.

Boat operators may obtain a Fiordland Clean Vessel Pass by visiting Environment Southland's website, or by post, email, or in person at Environment Southland's office. The Fiordland Clean Vessel Pass requires boat operators to sign a declaration that they understand their obligations under the FMRPMP. The information collected from

these applications enables council monitoring officers to more easily identify compliant and non-compliant vessels departing Invercargill.

Former Environment Southland staff member, Shaun Cunningham (now Cawthron), who helped design and implement the FMRPMP, offered his thoughts on the effectiveness of the plan. Overall, Mr Cunningham considers the scheme a great improvement on that which existed before in terms of risk reduction in the Fiordland marine area. Boat operators visiting the FMA are largely compliant with the rules, and the public awareness campaign has helped to increase acceptance among the target population. Mr Cunningham noted an initial period of approximately a year when compliance remained low. During this time, boat operators were sometimes found without a Clean Vessel Pass, or with non-compliant levels of hull fouling. Mr Cunningham posits a number of potential reasons for this, including

- the time it took for word of the new FMRPMP requirements to spread amongst the boating community
- the lack of hull maintenance facilities (e.g. haul-out yards) in Southland
- the high cost of hull maintenance services in Southland
- a low level of awareness amongst owners of syndicate boats, i.e. boats with multiple owners who infrequently travel to Fiordland, and charter boats with frequently changing skippers—many of whom may not be *au fait* with the rules.

In response to these behavioural barriers, Environment Southland with other local authorities and the maritime community are taking steps to improve adherence to the FMRPMP. These include:

- increasing the capacity of hull maintenance facilities in the region
- reducing the cost of hull maintenance facilities in the region
- increasing compliance and engagement, and publishing instances of non-compliance (e.g. lack of a Clean Vessel Pass, or having a fouled hull inside the FMA) via local news media² (Shaun Cunningham, 2019, pers. comm.)

3.2. Regional Coastal Plan: Kermadec and Subantarctic Islands

The Regional Coastal Plan: Kermadec and Subantarctic Islands (DoC 2017) aims to provide for the sustainable management of the coastal marine areas of the Kermadec and Subantarctic islands. The Ministry of Conservation is required to prepare a regional coastal plan for offshore islands under the RMA 1991. The Regional Coastal Plan: Kermadec and Subantarctic Islands, which became operative in 2017, establishes a framework comprising objectives, policies and rules that enables

² While Environment Southland only publishes the non-compliance details in general terms (i.e. they do not 'name and shame' non-compliant boaties) they observed a marked increase in Clean Vessel Pass applications immediately followed publication.

assessment of whether activities in the Kermadec and Subantarctic islands marine areas should be permitted or not.

The highly valued and remote Kermadec and Subantarctic islands face a range of management challenges. Marine biosecurity and oil spills are two key threats, while the islands' remoteness makes emergency response challenging—particularly in rough seas and/or bad weather.

The comprehensive plan contains rules relating to a wide range of terrestrial and marine activities. Rules relating to recreational boating stipulate that boats travelling to within 1 km of the islands must have a clean hull and niche areas (not more than a slime layer). Boat operators wishing to travel within 1 km must obtain and submit to the Department of Conservation a hull inspection form from an approved inspector and provide evidence of an effective anti-fouling system.

3.3. Northland Regional Pest and Marine Pathway Management Plan

Northland's Regional Pest and Marine Pathway Management Plan (Northland Regional Council 2017) is the primary mechanism to manage terrestrial and marine pests in the Northland region. The plan is operative under the Biosecurity Act 1993 and is a combination of a Pest Plan and Marine Pathway Plan. The aim of the *Marine Pathway Plan* is to prevent the introduction of new marine pests into Northland and slow the spread of established marine pests within the region.

The Marine Pathway Plan contains a number of voluntary and mandatory measures to meet its objectives. Mandatory requirements are that

1. the owner or person in charge of a craft entering Northland must ensure that fouling on the hull and niche areas of the craft does not exceed 'light fouling'
2. the owner or person in charge of a craft moving from one designated 'place'³ and entering a separate designated 'place' in Northland must ensure that fouling on the hull and niche areas of the craft does not exceed 'light fouling'.

Voluntary measures include a declaration of an anti-foul application that meets the manufacturer's instructions. Northland Council also provides advocacy and education under the Marine Pathway Plan.

The Marine Pathway Plan does not apply to international vessels. Instead, the responsibility for border biosecurity is that of MPI under the Craft Risk Management Standard (New Zealand Government 2014).

³ Note that Northland Council designates certain coastal areas as 'designated places' under the *Marine Pathway Plan*. These places are demarcated based on known marine pest risks of that place, common vessel movements and anchorages, and the proximity of haulout or cleaning facilities.

3.4. Northland's Six or One programme

Six or One is a marina-led initiative that originated in Northland, and has been adopted by other marinas over time. The aim is to prevent the introduction and spread of invasive pests between marinas. Under the initiative, marinas require that all vessels visiting a participating Northland marina have been hauled out and cleaned within the last month or antifouled within the last six months. Vessel operators must provide proof in the form of receipts for haul-out and/or paint receipts.

3.5. My Bum's Clean, is Yours?

In 2013 the Bay of Plenty Regional Council (BoPRC) initiated the *My Bum's Clean, is Yours?* campaign. The social marketing campaign consisted of a number of methods to educate and engage with recreational boat operators including signboards at boat ramps, online educational resources, surveillance, engaging with marina owners and talking to recreational boat operators at boat shows and fishing events. They also provided promotional materials such as branded hats, t-shirts and fliers.

According to BoPRC Biosecurity Officer, Hamish Lass, the campaign was successful at encouraging better recreational boater behaviour for marine biosecurity. At the start of the campaign, BoPRC collected level of fouling (LOF) data for recreational boat hulls. The LOF is used to assess biofouling on the wetted surface of a vessel. The scale ranges from 1–5, where one is very light fouling (slime layer) and 5 is heavy fouling (Floerl et al. 2005). Over the course of the program, monitoring showed that the LOF decreased on average across the boating population—from above 4 at the start of the campaign, to below 3 at the end of the campaign (Lass 2019).

Mr Lass worked on the campaign and considers that, while the messaging was “a bit crass”, it generally found favour within the community by employing terminology⁴ and a sense of humour familiar to boat operators (Lass 2019). Lass considers that when recreational boat operators were approached by BoPRC staff during inspections, most boat owners were approachable, interested, and welcomed the information provided. Boat owners generally recognised and accepted the benefits of a clean hull (including greater speed and efficiency), as well as the reduced biosecurity risks and environmental benefits brought about by good hull hygiene management practices.

However, the campaign encountered ongoing difficulties with a small subset of the community. These were the owners of boats that were infrequently used, generally parked on moorings or swing arms, of low monetary value, and that travelled at low speeds (Lass 2019). Subsequently, the *My Bum's Clean, is Yours?* campaign was discontinued as BoPRC felt that it was time for a fresh approach. They further wanted

⁴ Recreational boat operators sometimes colloquially refer to a boat hull as a bum.

to remain in line with neighbouring regions in the top of the North Island, and so adopted the *Clean Below, Good to Go!* campaign in its place (Lass 2019, Section 4.3).

3.6. National education programmes

Education and advocacy are key tools for managing marine biosecurity in New Zealand. Information and education campaigns are employed internationally, nationally, and locally within the Auckland region. Education campaigns attempt to increase public awareness of marine pests, their impacts, and the actions people may take to reduce risks.

The Ministry for Primary Industries (MPI) provides educational resources for recreational boat operators about the risks of marine biosecurity. Educational resources advise boat operators on many aspects of biosecurity management, including:

- good hull hygiene maintenance
- not transferring live bait between regions
- cleaning before travelling between locations
- reporting unwanted organisms to MPI.⁵

Initiatives under this campaign include advertising in specialist boating media and websites, meetings with boat clubs, provision of roving advisors in marinas, and a water-resistant guide to marine biosecurity which describes the potential impacts of harmful marine organisms and the importance of good vessel hygiene.

3.6.1. Marine Biosecurity Porthole

The Marine Biosecurity Porthole is an online portal that provides access to surveillance and other New Zealand marine pest records. It is the result of a collaboration between MPI and NIWA. The Porthole plays an important role in distributing information about current knowledge on marine pests in New Zealand.

3.6.2. Pest and Disease Hotline

Voluntary education campaigns often provide mechanisms through which members of the public can contribute to surveillance and reporting of suspected marine pests. In New Zealand, this occurs at a national scale through MPI's Pest and Disease Hotline.⁶ Auckland Council also provides information to recreational boat operators on

⁵ <https://www.mpi.govt.nz/travel-and-recreation/outdoor-activities/boating-and-watersports/cleaning-boats/>

⁶ <https://www.mpi.govt.nz/protection-and-response/finding-and-reporting-pests-and-diseases/report-a-pest-or-disease/>

their website.⁷ The Top of the North Marine Biosecurity Partnership developed the *Clean Below? Good to Go* brand (see Section 4.3) that provides information to recreational boat operators.

3.6.3. Clean Boats, Living Seas

The Clean Boats, Living Seas programme is an awareness-raising campaign administered by MPI. The programme provides information through a variety of channels. A waterproof brochure that can be used by recreational boaters to identify key marine pest species is distributed via boat shows, yacht clubs, and marinas. Other information provided through the programme includes hull cleaning methods, anti-foul application, and tips for checking boat hulls and gear (MPI 2013). While the programme has ended, much of the information, including the brochure, is still available on MPI's website.⁸

3.6.4. Marine Pest ID Guide

The Marine Pest ID Guide provides information to vessel operators in New Zealand about how to identify and report marine pest species. The guide includes information about marine pest species already established in New Zealand, as well as species that have not yet arrived but have caused problems overseas. For each species, key features, spatial distribution, and the habitat where it is likely to be found are described, along with some of its impacts. As well as online information, a semi-waterproof hardcopy guide that vessel operators may take on the water summarises the important information. This guide was revised in May 2019.

3.6.5. New Zealand's Clean Boating Programme

MPI partners with the New Zealand Marina Owners Association through New Zealand's Clean Boating Programme to provide guidance for the voluntary management of marine biosecurity risks by recreational vessel operators in New Zealand. New Zealand's Clean Boating Programme provides boat operators with educational materials to help them play their part in improving their environmental performance (New Zealand Marina Operators Association n.d.).

3.7. Clean Marina Programme

The Clean Marina Programme is an industry-led programme developed by the New Zealand Marina Operators Association which promotes sustainable environmental initiatives to protect coastal and inland marine waters. Under the programme, marinas can apply to become a certified clean marina by meeting a suite of criteria. If an audit

⁷ <https://www.aucklandcouncil.govt.nz/environment/plants-animals/pests-weeds/Pages/prevent-pests-from-spreading.aspx>

⁸ <https://www.mpi.govt.nz/travel-and-recreation/outdoor-activities/boating-and-watersports/cleaning-boats/>

finds that a marina consistently meets best management practices, the marina can use the Clean Marina Programme brand for their own marketing and branding. The programme encourages marina operators, boatyards, contractors and recreational boaters to do their part to protect coastal and inland water quality by engaging in environmentally sound Best Management Practices. These include, for example, regular boat engine inspection and maintenance, proper waste disposal and reduction of discharge. Eleven New Zealand marinas have been awarded a clean marina status, as reported on the Clean Marina Programme website.⁹ While the Clean Marina Programme focuses on water quality, elements of the programme may provide learnings to help reduce marinas' significant role in the spread of marine pests via recreational vectors (Ferrario et al. 2017).

3.8. Don't Move a Mussel, Arizona, USA

Public information campaigns are commonly employed nationally and internationally to control the spread of marine pests through voluntary means. As an international example, in Arizona, USA, the 'Don't Move a Mussel' campaign encouraged recreational boat operators to prevent the spread of quagga mussels and zebra mussels by advising them to clean, check, and dry trailered watercraft between waterbodies. The measures were made compulsory in 2009.¹⁰

⁹ <http://www.cleanmarinas.org.nz/>

¹⁰ <https://www.azgfd.com/fishing/invasivespecies/quaggamussels/>

4. AUCKLAND COUNCIL'S POLICIES, RULES, AND OTHER PROGRAMMES RELATING TO RECREATIONAL MARINE BIOSECURITY MANAGEMENT

This section reviews the relevant policies, rules, and other programmes in Auckland that relate to recreational marine biosecurity management. Specifically, this section will identify aspects of Auckland's recreational marine biosecurity management system that may provide opportunity to reduce the risk of marine pest spread.

4.1. Auckland Unitary Plan: Coastal

The Auckland Unitary Plan: Coastal has as its objectives to (1) minimise the risk or spread of harmful aquatic organisms from vessel biofouling, and (2) minimise the spread or introduction of harmful aquatic organisms from in-water cleaning of vessels near the shores of Hauraki Gulf Marine Park islands which have conservation status.

To address (1)—minimise the risk or spread of harmful aquatic organisms from vessel biofouling—the Unitary Plan policy focuses on raising awareness amongst the recreational boating community. Policy F2.13.3. (1) states:

Raise awareness among the boating community, particularly for vessels arriving from outside New Zealand or Auckland, of the importance of maintaining clean hulls to reduce risk of introducing or spreading harmful aquatic organisms from biofouling on vessel hulls and niche areas, and particularly during boat maintenance activities and from the passive discharge of organisms from macrofouling.

Movement controls are deferred to the Biosecurity Act 1993:

Movement controls for the management of biofouling on vessels can be addressed through the Biosecurity Act 1993. It has mechanisms to manage the hull state of vessels arriving from overseas through the Craft Risk Management Standard and between regions through Pest and Pathway Plan provisions in the Act.

To address (2)—minimise the spread or introduction of harmful aquatic organisms from in-water cleaning of vessels near the shores of Hauraki Gulf Marine Park islands which have conservation status—the unitary plan contains rules that allow for the removal of microfouling from vessels but place progressively stricter controls on vessels with higher levels of hull bio-fouling (Table 1). Boat operators may be fined up to \$750 for an unmaintained hull, or if hull cleaning is undertaken in a way or in a location that could result in the spread of marine pests.

Table 1. Permitted activities under the Auckland Council Unitary Plan.

TABLE A: PERMITTED ACTIVITIES		TABLE B: STANDARDS APPLICABLE TO PERMITTED ACTIVITIES	
ACTIVITY	STANDARDS	NO.	REQUIRED STANDARD
Cleaning of a vessel with micro-fouling	1, 2, 4, 6	1	Gentle non-abrasive cleaning techniques must be used.
Small scale manual cleaning (up to 5% of the hull surface area, including niche areas)	2, 3, 4, 6	2	The cleaning method must not compromise the existing anti-fouling coating system.
Cleaning of a vessel with macro-fouling from within Auckland	2, 4, 6	3	Cleaning technologies should capture debris greater than 50 micrometres in diameter. All captured debris must be collected and disposed of appropriately.
Cleaning of a vessel with macro-fouling of domestic origin (that is less than extensive to very heavy macro-fouling) following a risk assessment that determined a relative biosecurity risk of negligible or low	2, 4, 6	4	If unusual or suspected harmful aquatic organisms (or species designated as pests in the relevant pest management plan prepared under the Biosecurity Act) are found, the vessel owner or operator must take the following steps: (a) all cleaning must cease; (b) the Council must be immediately notified; (c) cleaning may not recommence until notified by Council to do so.
Cleaning of a vessel with macro-fouling of domestic origin that is: - More than low biosecurity risk, - Or has not had a risk assessment, - Or has extensive to very heavy macro-fouling	2, 3, 4, 6	5	The discharge or escape of hull bio-fouling organisms or debris onto the foreshore, seabed or into the water must be collected as far as practicable and removed from the coastal marine area.
Cleaning of a vessel with macro-fouling of international origin	2, 3, 4, 6	6	The anti-fouling coating on the hull and niche areas to be cleaned must not have exceeded its planned service life as specified by the manufacturer.
Treatment methods that render bio-fouling organisms non-viable	2, 5, 6		

4.1.1. Navigating the Rules guidance document

Auckland Council provides guidance to recreational boat operators on the hull cleaning rules through the *Navigating the Rules* guidance document (Auckland Council 2019). The document provides guidance on where, when, and how to clean hulls in Auckland without falling foul of the rules in the Unitary Plan.

4.2. Auckland Regional Pest Management Plan 2019

The Auckland Regional Pest Management Plan 2019-2029 (RPMP) (Auckland Council 2019) enables Auckland Council to exercise the relevant powers under the Biosecurity Act 1993, and to provide a framework to manage or eradicate specified organisms in the region. The RPMP indicates Auckland Council will develop a Marine Pest Pathway Management Plan. Auckland Council are at the time of writing undertaking an options analysis for potential rules for a Marine Pest Pathway Management Plan in collaboration with neighbouring regions, seeking to align consistent rules for the upper North Island regions (Northland, Auckland, Waikato and Bay of Plenty Toi Moana), with support from Biosecurity New Zealand (Auckland Council 2019). Marine pests are also managed by the Ministry for Primary Industries under the Biosecurity Act 1993.

4.3. Clean Below? Good to Go and Marinepests.nz

Clean Below? Good to Go is a brand that encourages recreational boat operators to check and clean their hulls before travelling between locations in the top of the North Island. The brand was developed by the Top of the North Marine Biosecurity Partnership composed of Auckland Council, Northland, Waikato, Bay of Plenty Toi Moana, and Hawke's Bay regional councils, Gisborne District Council, and the Ministry for Primary Industries. This campaign has now been adopted by a number of other local government agencies and marinas across the country and is openly available pending brand guideline adherence.

The Top of the North also developed a website called marinepests.nz that provides a range of information to recreational boat operators including:

- marine pest species of the top of the North
- good vessel biofouling management practices
- locations of haul-out, hardstand and dry-dock facilities
- links to the rules in various regions in the top of the North
- links to the rules of marinas.¹¹

Development of *Clean Below? Good to Go* was informed by two focus group workshops with members of the boating community. Each workshop was attended by seven boat owners or operators. Workshop participants were male, had different biofouling management practices, and had boats of at least 25 ft that are permanently in the water, travel between regions and can carry marine pests on their hulls. Findings from the workshops were that:

- *Clean Below? Good to Go* was the most preferred of three alternative options:

¹¹ <https://marinepests.nz/>

- There was resistance to identifying a clean boat with a flag—a transom sticker was preferred.
- There was support for a self-declared and policed ‘warrant of cleanliness’ and associated text message reminder for when the next warrant is due (as for car warrant of fitness).

4.4. Summary

The aim of this section was to identify aspects of Auckland’s recreational marine biosecurity risk management system that may provide opportunity to reduce the risk of marine pest spread. To assess this, the section reviewed the regulatory and voluntary initiatives employed by Auckland Council or in the Auckland region. Auckland Council’s marine biosecurity management efforts comprise regulatory, policy, social marketing, and educational initiatives to reduce the risks of marine pest spread via recreational boat vectors. Few, if any, national and international efforts match or surpass Auckland Council’s, making Auckland one of a small group of world leaders in this field. However, while the Unitary Plan provides detailed rules about where, when, and how hull cleaning should take place, further information about how education and awareness could be advanced (and measured) by Auckland Council is required in order to realise the full potential of the Unitary Plan.

Whereas the marine pathway management plans of Northland and Fiordland provide detailed rules and systems for biofouling management and vessel movements within those regions, including movement to and from designated high value areas, such a regulatory tool is not available to Auckland Council. The outcomes may be that Auckland Council’s regulatory tools are different to those that other councils deem necessary to reduce the risks of marine pest spread in their regions, and this possibly creates confusion for recreational boat operators who travel to Auckland from neighbouring regions.

Section 3 also presented other initiatives from New Zealand. While the success of initiatives is difficult to appraise given that few program evaluations exist, observations by staff involved with program implementation suggest encouraging outcomes from Fiordland’s marine pathway management plan, and the *My Bum’s Clean, is Yours?* and *Clean Below, Good to Go* social marketing campaigns.

For Auckland Council to continually improve recreational marine biosecurity risk management, new tools may be required—particularly to raise awareness among the boating community about the need to reduce the risks of marine pest spread (as required by Policy F2.13.3 of the Unitary Plan). For new tools to be effective at changing behaviour, it is important that their development responds to the behavioural motivations of Auckland’s recreational boat operators. The next section details the methods this study employed to elicit insights on this behaviour from Auckland’s recreational boat operators and other stakeholders.

5. METHODS AND THEORY OF BEHAVIOUR CHANGE

In July 2019, 10 interviews and a focus group of four people were conducted with recreational boat operators and stakeholders associated with recreational marine biosecurity in Auckland. Interviewees and focus group participants were identified by Auckland Council staff and subsequent snowball sampling¹². They included two marina managers, five recreational boat operators, one central government marine biosecurity staff member, one regional council marine biosecurity staff member, one haul-out yard operator, two scientists, one boat club chairperson and a representative of the New Zealand Marina Operators Association. The aim of the interviews was to identify the behavioural impediments that prevent good biosecurity management practices.

Behaviour change is a field of social science that aims to understand and explain why people engage in the behaviours they do, and what it might take to change those behaviours. Many behaviour change theories propose different psychological, behavioural and environmental factors as the key determinants of behaviour. The Theory of Reasoned Action (Fishbein & Ajzen 1975; Ajzen & Fishbein 1980) proposes that people consider the consequences of a behaviour and are influenced by social norms and pre-existing attitudes which drive behavioural intentions. The Theory of Planned Behaviour (Ajzen 1985) builds on the Theory of Reasoned Action by adding perceptions of behavioural control as a key factor in determining behaviour. Self-efficacy (Bandura 1982; Bandura 1997), the belief of an individual that they possess the ability to perform a challenging or difficult task, is both a theory in its own right and contributes to other theories. Social Learning Theory (Bandura 1977) posits that new behaviours are acquired by observing and imitating others. Social Cognitive Theory (Bandura 1986) proposes that behaviour is the outcome of a complex and shifting interaction of person, environment, and behavioural observation, emphasising social influence and behavioural reinforcement, be it positive or negative.

This project employs the Integrated Model of Pro-environmental Behaviour (Wilson & Dowlatabadi 2007) that proposes two overarching domains, the personal and the contextual, that drive pro-environmental decisions or behaviour (Figure 1). The personal domain includes two key determinants of a decision or behaviour—attitudes and habits—with attitudes being the result of values, beliefs and norms. The contextual domain includes both the personal capabilities of individuals, and also external conditions such as regulations, market forces, available technologies and so on (Figure 1). An interview schedule that sought to identify the factors preventing good marine biosecurity behaviour was developed in conjunction with Auckland Council staff. The interview schedule contained questions that explored the values, beliefs, norms, attitudes, habits, and contextual factors in relation to recreational boaters' biosecurity management practices (Appendix 1).

¹² Snowball sampling is technique where research participants recruit other participants for a study.

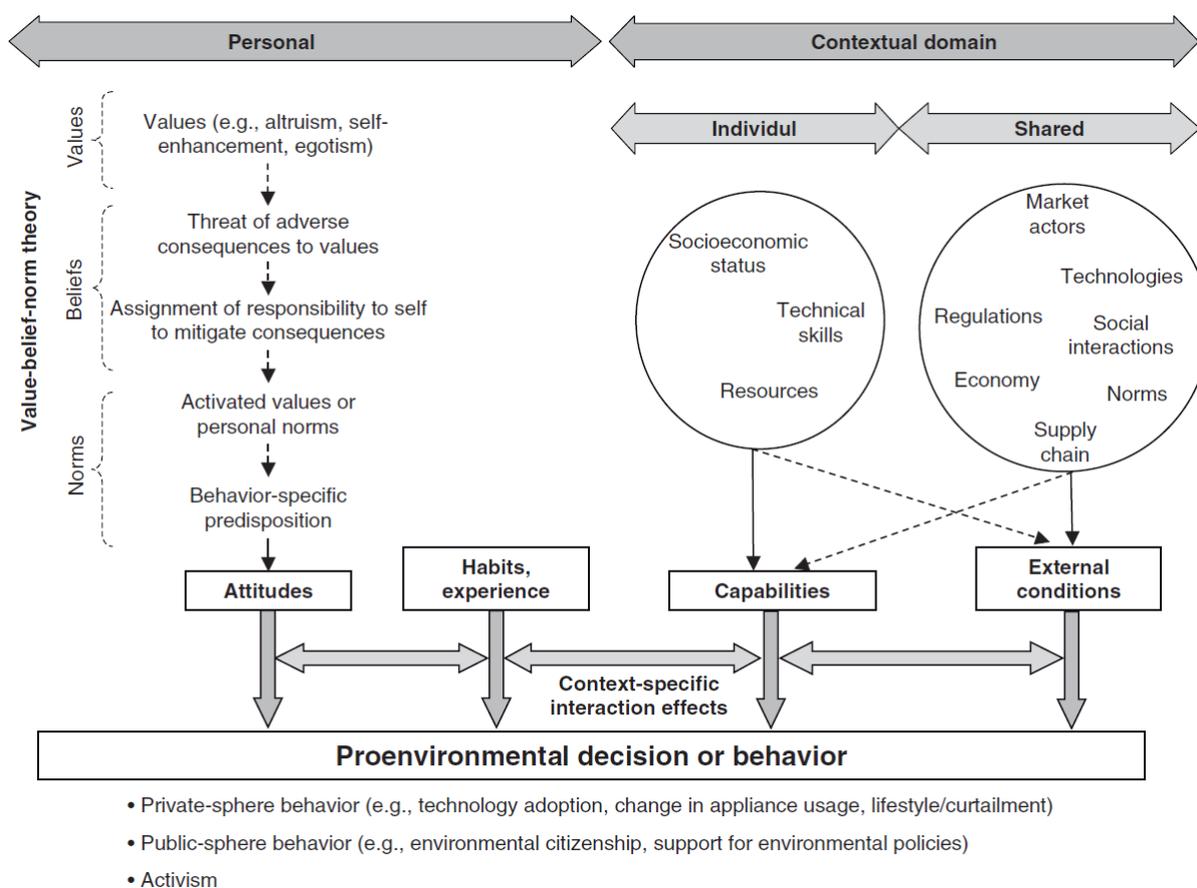


Figure 1. The Integrated Model of Pro-environmental Behaviour. (Wilson & Dowlatabadi (2007) p 183, adapted from Stern 2000). The diagram shows how attitudes, habits, individual capabilities and external conditions interact to determine pro-environmental decisions or behaviours. Further, it shows the factors that comprise those elements of a decision or behaviour. For example, attitudes are composed of values, beliefs and norms.

Interviews followed a semi-structured qualitative format after the method of King (2018). The focus group was also structured to follow King’s group interview method. To identify interviewees’ and focus group participants’ values in relation to marine biosecurity, the following question was asked, with follow-up questions seeking clarification or elaboration where necessary:

- Does marine biosecurity concern you at all? Why?

To assess beliefs about the threat of adverse consequences to values, interviewees were asked:

- What are the most concerning impacts of marine pests?
- How much risk do marine pests pose to the things you are concerned about? (Minor, low, moderate, significant, severe, catastrophic).

To assess beliefs about the assignment of personal responsibility to mitigate consequences:

- Whose responsibility is the management of marine biosecurity?

To assess boat operators' habits, the following questions were asked:

- What methods do you use to clean your hull?
- Have your methods changed over time?

These last two questions were only asked of recreational boat operators.

6. RESULTS

6.1. What are the perceived risky behaviours?

Interviewees and focus group participants were asked ‘what are the behaviours of recreational boaties that you think carry the highest risk in relation to marine biosecurity in the Auckland region?’ This elicited eight perceived risky behaviours (Table 2). Some of these are behaviours undertaken by recreational boat operators, while others are performed by haul-out operators and paint sellers. The most frequently cited risky behaviours are haul-out cleaning limitations (cited by 5 people), people doing their own hull cleaning in natural areas (5), and boat operators who do infrequent trips with a fouled or heavily fouled hull (5). These are briefly discussed in turn, below.

Table 2. Behaviours of concern to stakeholders regarding the risks of spreading marine pests around the Auckland region due to dirty hull or niche areas. The numbers in brackets refer to the number of interviewees, while the numbers in the columns refer to the number of interviewees who stated a particular behaviour of concern.

Behaviour of concern	Scientist (2)	Conservationist (1)	Commercial diver (1)	Marina manager (2)	Haulout operator (1)	Recreational boat operator (4)	Recreational boat club representative (1)	Total (15)
Haulout cleaning limitations keel niche areas and patches	1		1		1	2		5
DIY inwater cleaning in natural areas	1	1		1		2		5
Low frequency trips but dirty hull	2	1				1	1	5
Abandoned or unmaintained vessels	1	1				1	1	4
Risk coming from out of the region				1		2		3
Deliberate disregard			1					1
High frequency trips but relatively clean hull	1							1
Incorrect antifoul application and maintenance	1							1

6.1.1. Haul-out cleaning limitations

Regarding the limitations of haul-out facilities, concerns focused chiefly around the inability of many haul-out operations to clean and anti-foul the bottom of the keel,

niche areas, and the patches of the hull underneath the blocks or straps. This behaviour is covered further in Section 6.5.2 below.

6.1.2. DIY cleaning in natural areas

Another behaviour of concern was boat operators doing their own cleaning in natural areas instead of at haul-out facilities. This included in-water cleaning, cleaning in estuaries at low tide, or adjacent to public piles. The following is a conversation between two recreational boat operators and a marina manager.

That's the other thing, public piles or in Mahurangi there's some piles that people just tie up and wash off so that is... Sarah, recreational boat operator.¹³

These piles like these posts are just stuck in the mud and there's a set of them in Smokehouse Bay at Barrier. People go over there for Christmas holidays and they have got a bit of spare time and they tie up to them and the tide goes out and they clean the bottom of their boat and float it off again. That's been done for generations. Paul, marina manager.

And it continues to be done. Sean, recreational boat operator.

6.1.3. Heavily fouled hulls moving infrequently around the region

Boat operators that have a fouled hull and take infrequent trips around the region was another group whose behaviour was of significant concern. These boats may be parked on swing moorings instead of in marinas, and the operators are not concerned with speed. This issue was cited as concerning by five interviewees.

People that don't look after or monitor their hull and probably fair-weather boaties, they might decide at Easter that they're going to take their boat from here and go out to Great Barrier and if they've got some juvenile fanworms on the bottom, I guess that's a real risk. David, marina manager.

6.2. Who are the high-risk recreational boat operators?

Interviewees were asked 'can you describe the recreational boat operators that pose the greatest risks to Auckland marine biosecurity?' Answers to this question are relevant in that they provide some indication to Auckland Council about who to target behaviour change efforts towards for increased effectiveness. Interviewees were not

¹³ Note that these are not the real names of interviewees. Real names are withheld in order to protect anonymity.

given any prompts; the types of boat operators described below emerged from coding of responses.

Interviewees considered high risk recreational boat operators to be those who do not undertake regular hull maintenance (cited by 8 people), seldom use their boat (5), are over 50-60 years old (5), park their boat on a mooring or swing arm (3), are male (3), do not have much money to allocate to hull maintenance (2), may not hold environmental values (1), and who may live on their boat (1) (Table 3). Most interviewees considered that these boat operators are the minority, and that the majority try to do the right thing. For example,

It's a particular type, if you've got a yacht and you want to go quick and don't want any drag then they want to keep their boat hull nice and clean. It's the ones that sit around on swing moorings that aren't worth much money, that do sort of grumble when you talk to them, ...I don't want to pay \$1,000 to get my boat hull cleaned when I'm just going from one side of the harbour to the other. So it's probably I would say 90% of people are receptive and the other 10%, it's too hard or costs are too high related to the value of their boat so they are less receptive.
Hamish, Regional Council staff.

Table 3. Description of high-risk recreational Auckland boat operator, as determined by interviewees.

Description of high risk boat operator	Scientist (2)	Conservationist (1)	Council staff (1)	Commercial diver (1)	Marina manager (1)	Recreational manager (2)	Recreational boat operator (4)	Central Govt (1)	Marina Operators Assoc (1)	Total (15)
Does not undertake regular hull maintenance	1	1	1	1	1	1	1	1	1	8
Seldom uses boat	1	1				1	1	1		5
Over 50-60 years old			1	1	1	1			1	5
Parks boat on swing arm or mooring	1	1						1		3
Male		1		1	1					3
Do not have much money for boat maintenance			1					1		2
Does not value environment		1								1
Live on boat								1		1

The point was made that the risk does not lie solely with those recreational boat operators described above, but also rests with the wider recreational boating population of Auckland. Even where recreational boat operators implement good

practices for biofouling management on their vessels, some risk will always remain (in the absence of completely clean boats) due to the high number of boats and trips made within the region:

There are different ways that [recreational boat vectors] can be risky and it's hard to say which one is riskier. So, you can have a highly fouled boat... it goes to other places like outside the region and it stays there for a long time. The longer you stay the more opportunities you create in theory for your fouling to reproduce or to colonise that new destination environment. So, you can take one very long trip that's risky. But equally it could also be some boaters don't stay very long but they go very frequently so they have these repeat voyages and that creates other types of opportunities. It's the amount and rate of biological material delivered to a recipient environment. It's either a lot in one go or smaller amounts multiple times. Both can be a risk. Alex, scientist.

6.3. Why do recreational boat operators undertake risky behaviours?

Interviewees and focus group participants were asked about the reasons people undertake the behaviours stated above. The main question was 'Why do recreational boat operators undertake [risky] behaviours?'. Follow-up questions were asked where elaboration and clarification were necessary. Answers to these questions are presented below.

6.3.1. Attitudes

According to the Model of Pro-environmental Behaviour, attitudes are composed of values, beliefs about threats to values, assignment of responsibility to self, activated values, or personal norms, which contributes to a behaviour-specific predisposition.

Some respondents considered negative attitudes to be an important factor preventing good biosecurity management behaviour amongst recreational boat operators. Those interviewees talked about the need for attitude change to encourage behaviour change. An example of the attitudes that interviewees encountered in their dealings with high risk boat operators is:

it's kind of an age thing too... 'like I've had a boat for 40 years, don't tell me how to tie it up or put my life jacket on. I'll do what I'll like!' It's that that's wrong and it'll be no different to people cleaning their bottom. No different: 'Don't you bloody come here tell me what I should be doing!' David, boat club chair.

A recreational boat operator (who admits to moving his fouled boat on occasion) also considers attitudes an important factor of risky biofouling behaviour. That boater is optimistic about the possibility of changing attitudes, likening the challenge to attitude change achieved in other environmental issues:

You can change people's attitudes. I feel guilty if I go up north and I haven't cleaned the boat, I do. But just like everybody used to throw their beer bottles over the side of the boat... you never see that anymore and that's a change in moral attitude. Michael, recreational boater.

Given the attitudes stated above, a number of beliefs considered by the Model of Pro-environmental Behaviour as important for the composition of attitudes are presented in the sub-sections, below.

6.3.2. Beliefs

This study identified a total of ten beliefs explaining why recreational boaters undertake risky marine biosecurity management practices (Table 4). The two most commonly cited beliefs were a fatalist sense that the containment of marine pests is futile ('the horse has bolted', 10 out of 15 interviewees) and that people are not convinced that marine pests pose a threat to the region.

Table 4. Beliefs about why recreational boat operators undertake poor biosecurity management behaviours.

Belief												
	Scientist (2)	Conservationist (1)	Council staff (1)	Commercial diver (1)	Marina manager (1)	Haulout operator (2)	Recreational boat operator (1)	Recreational boat operator (4)	Recreational boat club representative (1)	Central Govt (1)	Marina Operators Assoc (1)	Total (15)
"The horse has bolted"	1	1	2		3	1	1	1	1			10
Not convinced that invasive marine pests pose a threat to the region		1	1		3	1			1			7
International risk is not managed effectively					3							3
Its someone elses fault			1					1				2
Going fast is not important	1							1				2
I am clean but in fact I am not actually clean	1		1									2
Other issues more important			1	1								2
People think fanworm is beautiful			1									1
The risk of spreading pests is very low				1								1

The horse has bolted

Ten of the 15 interviewees said that they believe the attempt at containing marine pests in Auckland is futile, or they have spoken with recreational boaters who believe this. Generally, this belief is about species already present in the Auckland region, such as *S. spallanzanii*:

The fanworm, in my opinion, forget about it. The horse has bolted. I think we were just too late. While we've got all the regulatory bodies faffing about, that's when they should have been onto it and, unfortunately, we can't do anything now. Craig, marina manager.

...about things like the fanworm and Undaria and so on... it seems to me it's quite a difficult one to tackle unless you tackle it at source and you nip it...it sounds to me as if you have a pest and it gets away on you, well you're pretty much wasting your time trying to recover from...the horse has bolted. Riley, conservationist.

Not all who noted this belief actually believed it themselves but had instead talked with recreational boaters who did. For example, a commercial diver who frequently converses with recreational boaters while undertaking hull inspections noted:

the biggest misconception we come across is that it's a waste of time... that you're never going to beat it. James, commercial diver.

Insufficient evidence of the threats posed by marine pests

Several questions were asked to identify peoples' values in relation to marine biosecurity, and beliefs about threats to those values. Questions included:

- Does marine biosecurity concern you at all? Why?
- What are the most concerning impacts of marine pests?
- How much risk do marine pests pose to the things you are concerned about?

Follow-up questions sought clarification or elaboration where necessary.

Seven of the interviewees considered that there is insufficient scientific evidence of the threats marine pests pose. Interviewees had observed the invasive pests arriving in the region, had heard warnings from central and local government about their potential impacts, but were not aware of any actual impacts beyond a change in visual amenity—which was considered a positive impact by one interviewee:

There seems to be quite a lot of misunderstanding about what does fanworm do. Is it going to be as catastrophic as government and council are telling these boaties? I think a lot of people scratch their heads because Styela clava, some of these pests... it was like real doom and gloom when they arrived and has there really been... could you put a figure... like a monetary figure on the cost of it arriving? Has it really reduced the aquaculture's profits? All of these things that everyone says, "oh it's going to be bad for all of these reasons", there should be some truthing to that. There should be some post-arrival research ten years down the track from Styela clava. What actually did it do? I think it's important to tell the whole story. James, commercial diver.

Who is going to convince me that I've got to do this? I'm not talking about me, personally, I'm talking about for boaties in general. I think it's up to [scientists] to show us that it is worth the time.... I'd be much more comfortable about rolling up my sleeves and getting wholeheartedly behind it if I knew we were going to do some good. That's because... maybe it's the scientists that should be solving the questions. Do the things die if you scrape them off and let them drop on the bottom or do they live? If you scrape them off on the piles when the tide goes out, do

they die or live?... That's a scientific question that has to be answered.
Michael, recreational boater.

The case of *S. spallanzanii* highlights the challenges for those tasked with education on marine biosecurity issues. Much of the dubiousness around management of marine pests draws from scepticism regarding the validity of original warnings when the species first arrived in New Zealand.

I think there's some fundamental issues that I now see after being in the industry for 30 years. Considering for example Mediterranean fanworm is still a pest and I don't know that it is, it's almost everywhere. Then if you take a second look at it and you say right, it's been here 20 years or 18/19 years since we were first warned about it during the America's Cup and it's arrived and objectively, while I'm passionate about the planned space I'm going right, it's arrived in Auckland and what's happened? Actually nothing. It's populated and it's taken over a pile that used to have something else on it but no one has actually gone right, that recommendation we made 20 years ago based upon some population outbreak in some distant land, an island somewhere... But on reflection, has it lived the same way here? Do they kill off anything? No one has actually done that research to say what has happened. So, what happens is naturally from a long-term person like me, I go well are we getting these definitions of what is a pest correct or are they just a new species that actually are just a new species? Because someone at a conference 20 years ago mentioned that it smothered a mussel farm in the eastern Mediterranean, did it actually happen here or is it too early to say or don't we know? And actually, we need to check in again on those things in my opinion to actually ratify the decision. Dan, Marina Operators Association

As far as I'm aware the Mediterranean fanworm hasn't yet been proved to have any particularly detrimental effects. So, so far it looks like a storm in a teacup unless they do some good science around it. As a creature that filters, well we need them. Will it compete with the aquaculture industry? Well they should know that because it already will be. Riley, conservationist.

I'd say the majority of people... are probably either unaware or not fully aware of why they should do this. Sam, central government.

6.3.3. Beliefs about assignment of responsibility to self to mitigate consequences

Interviewees were asked who they consider carries the responsibility for reducing the risks of recreational boat operators spreading invasive pests around the Auckland region. Responsible parties identified by interviewees included “everyone”,

recreational boat operators, Auckland Council, central government, marina operators, recreational boat operators, and boat supply retailers. Many people conceptualised marine biosecurity as an interconnected system comprising many stakeholders, all of whom carry unique responsibilities to reduce the risk of marine pest spread around the region. For example, boat supply retailers could reduce the risks of marine pests by giving customers good advice on products such as anti-foul paint. Marinas were identified as having a responsibility to keep their structures clean to reduce the risk of fouling moored boats:

A lot of it is awareness and that awareness has to fall onto local government to control it. Make people aware. I've seen habits actually change over the last three years where people are taking more responsibility to it all. David, marina manager.

Table 5. Assignment of responsibility for the containment of marine pests, as stated by interviewees

Responsible party	Scientist (2)	Conservationist (1)	Commercial diver (1)	Marina manager (2)	Haulout operator (1)	Recreational boat operator (4)	Total (15)
Everyone	2	1	1	1	1		6
Auckland Council				1		3	4
Government				1		1	2
Marina operators	1			1			2
Boat operators		1		1			2
Boat supply retailer	1						1
Scientists						1	1

Of the six stakeholder groups that were asked this question, five placed responsibility on “everyone”. While not all interviewees defined exactly who they meant by “everyone”, some quotes provide explanation:

It's got to be everybody. It's got to be otherwise it's not going to work. You can't have one group that's going "yeah we're onto it" and the other one is going "nah". That's what I find when we go to the Marina Operators Association meetings. We've got Tauranga that has got the Waikato University marine guys diving through there weekly or every two weeks. Every boat that comes in that they know of that's outside of the area gets checked and their moorings and everything are being

checked, that's fantastic because they're utilising students and things to help eradicate, keep an eye on it. But what are [haul-out operators] doing? And for marinas too—we haven't got that much [S. spallanzanii] here but it's starting. There should be a cleaning schedule. Simone, haul-out operator.

I do think that is not just the boaters, I do think that it's also the people who sell stuff to the boaters and the people who clean the boats – they are an important part of the puzzle because if the boaters trust if I buy your stuff or if you clean my boat or maintain it, if they trust them it's all hunky dory. I'm like an A boater you know? But if it's not like that, then it's also that the groups of people who service the boating community who might need to be considered where there might be some gains to be made. Does the guy in the paint shop sell you antifouling because it's on special or because it's the antifouling that you need for the way you travel or don't travel with your boat? Do people buy antifouling because their best mate said this works really well or do they buy it because it's the cheapest or on special or whatever? That sort of thing. Do cleaning facility providers really, ...do they know how to adequately clean boats or also to maybe warn boaters that this is all I could do for you but don't expect your coating is going to perform for much longer, that sort of thing. There might be areas in the entire landscape that could be strengthened, that are not the boaters themselves but also the people who work on the boats, I think. At least it's worth looking into. Alex, scientist.

Recreational boat operators were the only interviewees who did not vest responsibility for the containment of marine pests with recreational boat operators. When asked the question 'Where does the responsibility lie for preventing that spread of marine pests into and around the Auckland region lie?' recreational boaters instead suggested that responsibility for education, awareness and compliance lies with Auckland Council (3), and education with central government (1) and scientists (1).

Marinas were also identified by two interviewees (scientist and marina manager) as holding a degree of responsibility for recreational boat operators' risks of spreading marine pests. The responsibility of marinas related to fouled marina structures is described below:

Marinas are some of the most heavily fouled areas in a coastal marine area for pests just in terms of the nature of the hard structures and that and the fact that no one is cleaning or managing the pests that grow on and around the structures. So, the likelihood of obviously those propagules colonising on boats is pretty high once you stop antifouling. That's not actually the fault of the boat owners, it's just that they're

exposed to a high level of risk because of the fact they keep it in the marina. I think that should be addressed. Jules, scientist.

Additionally, while the central government staff member was not asked this question directly, that interviewee anticipated the question and offered how they thought recreational boaters would answer. That is, the reason for their fouled hull is not their fault, but someone else's. The following quote is based on their experience of regularly engaging with recreational boat operators that have been found with heavily fouled hulls:

You hear the "same ol' same ol'" and it's a bit frustrating. I think the key ones are blaming someone else—and there's a range of someone else's—from MPI to the marina... to "it's everywhere" to "the horse has bolted". The other excuse is the old antifouling paint: "why did we move to this new stuff? The old stuff worked really well!" Have you heard that one? Sam, central government.

6.4. Individual contextual factors

The Model of Pro-environmental Behaviour proposes that contextual factors can also account for peoples' environmental behaviour. Contextual factors may relate to individual capabilities, such as technical skills or socioeconomic status, or they may relate to external conditions, such as technologies or regulations. These are presented in turn below.

The most cited individual contextual factor was lack of time management and planning. Other factors are that boat operators may cut corners during maintenance, or that recreational boat operators do not realise their hull is fouled because the fouling is out of sight in a niche area.

Table 6. Individual capabilities considered by interviewees as preventing recreational boat operators from undertaking good biofouling management.

Individual capability	Scientist (2)	Conservationist (1)	Commercial diver (1)	Marina manager (1)	Haulout operator (2)	Recreational boat operator (1)	Central Govt (1)	Total (15)
Lack of time or poor planning	2	1			1		1	5
Cutting corners during maintenance					1	1		2
Doing the right thing but fouling is out of sight	1		1					2

Lack of time management and planning

Time management and planning related to some recreational boat operators' tendency to leave hull cleaning to the last minute—often at a busy time of the year for haul-out operators. In mid-late December, haul-out yards are particularly busy cleaning boats in preparation for the summer season. Boat owners that leave it too late may miss out and then face the choice of either setting off with a dirty hull, or not going at all.

6.5. Contextual domain—shared factors

There were three frequently-cited, shared contextual factors that interviewees considered contributed to poor biofouling management behaviours by recreational boat operators. These were 1) cost, 2) haul-out effectiveness, and 3) issues with anti-foul paint (Table 7). These are discussed in turn, below. Other factors include a perceived lack of appropriate hull maintenance facilities, national legislation and regional rules, the inherent disincentive for boat operators to report instances of fouling on their hulls, and the belief that regulators should focus on international risks.

Table 7. External conditions considered by interviewees as preventing recreational boat operators from undertaking good biofouling management

External condition	Scientist (2)	Conservationist (1)	Council staff (1)	Commercial diver (1)	Marina manager (2)	Haulout operator (1)	Recreational boat operator (4)	Central govt (1)	Marina Operators Assoc (1)	Total (15)
Cost issues	2	1		1	1		2	1		8
Haulout wash effectiveness	1			1	1	1	3			7
Antifoul paint	1				1	3	1			6
Lack of facilities				1		2				3
National legislation and regional rules		1						1		2
Disincentive to report or address		1								1
Need to focus on international risk				1						1

6.5.1. Costs

Costs were most frequently identified as the primary impediment to recreational boaters undertaking good biofouling management practices. Costs primarily related to haul-out fees, anti-foul paints and other items involved with hull maintenance, and labour. Some recreational boat operators considered haul-out fees expensive compared to what they used to pay for alternative cleaning methods, such as paying a commercial diver. There was some dubiousness about whether hull maintenance costs are an external behavioural inhibitor, or a belief that boat operators hold:

I know it's imposing regulations but I'm sorry, if you're fortunate enough to be in the socioeconomic bracket of having a large boat in a marina, suck it up. You do also have a responsibility. And I am particularly keen on that because spending my life out at the Noises, all you see are these people who think they have rights to come out to extract, there's never any thought about putting back or the consequences of their actions... Quite honestly if it was my way I'd have boating licenses and in order to get your license you have to be aware of the regulations, whether those are fishing regulations or whether they are regulations to do with biosecurity and complying with them. If you don't then you get fined. It's the same that you can't afford it, well I'm sorry if you can afford \$50k plus on your boat, then you can afford a license. Riley, conservationist.

While that dubiousness exists and may be true for many, as for any population there will be those on the margins for whom costs are an issue. An MPI staff member with experience in dealing with boat owners with fouled hulls notes that:

Some live on their boats in marinas and some live on their boats either near the city or right out in remote locations and some of those people living on boats are doing it for a reason – they don't have any money and it's the cheapest way to do it is to be in a remote area, on a mooring and just live on your boat. They're the ones that aren't going to be moving around much but they probably do from time to time, so that's the problem, their hulls will be heavily fouled, they'll be unwilling to clean their vessels regularly because they don't have any money. Sam, central government.

6.5.2. Haul-out effectiveness

Haul-out effectiveness related to the ability of haul-out operators to clean niche areas. The issue of haul-out operator effectiveness was raised by a haul-out operator:

What happens is it's along the keel where the blocks are sitting a lot of the time, so you lift them and they do their patches but it's only 20 minutes before they go back in the water, so even the people that have had their antifouls within that six months potentially would still be carrying. Simone, haul-out operator.

That haul-out operator also noted that there are different levels of attention to detail between staff within a single haul-out operation, as well as between haul-out operations:

I do feel that if people are coming to have a wash somewhere, that there should be a criteria that is put out either by Northland or by somebody, that is met by [haul-out operators]... If that means that we have charge more or we have to figure out a different practice, well so be it. There's no real "right this is how it should be, make sure you do around your bow thrusters and check your live tanks and your intakes and things". I feel like if there was a checklist and a criteria and... there's a little certificate or something that you then give to the owner. Ticked, ticked, yes, you've got it and that's across the board, then it makes sense. But if everybody is just doing something different and some things aren't getting washed and some are, it's a mess! Simone, haul-out operator.

The issue was also raised by James, a commercial diver, who said the issue created such increased risks that there is a need for consistency across the industry:

...haul-out facilities don't seem to have a code of practice, I could be totally wrong but there's a lack of quality control and I think that's quite...that's to do with any new environmental effort always have a lag time on things like businesses picking up what they should be doing. So [the boat operators] think it's all good, we've had a lift and wash without

looking at it through biosecurity eyes and... an understanding of the biology of some of these organisms. They're approaching it from an antifoul and fuel reduction perspective, all the reasons you get a haul-out but not looking at it through a lens of biosecurity frame. James, commercial diver.

The outcome is that boat operators who think they are doing the correct thing, are actually carrying an elevated level of risk of spreading marine pests around the region.

It just so happens that there is always some residual risk that is difficult to manage but I do think that some people aren't aware fully of that residual risk. They think if my boat has come out and it got blasted and anti-fouled, it's good to go for 12-18 months, don't have to worry about it. But we've seen a lot of boats with less than 12 months anti-fouling coating where there was stuff on some areas that weren't well protected. Alex, scientist.

A related concern raised by a scientist is of the level of understanding of anti-foul paint selection, application, and maintenance.

antifouling paints are designed to be on vessels that move at least on a regular basis. They're not designed to be on a vessel that hardly ever gets used so if you put a good antifouling coating on but you use your vessel less than you should or than you intend to, that coating won't protect you as long as you think it would. Some people then say oh you know, "give it a waterblast and it will rejuvenate it and get rid of the fouling". That then brings out the coating which hasn't actually had that much of its lifetime used up yet. But then when you do that you blast away the fouling with the coating underneath, you're actually ending up with a hull that is really compromised in terms of fouling protection and I think there's a lot of boat owners and possibly also applicators or haul-out operators, who...if you're a haul-out operator they just say what do you want? If you say give it a good blast and get rid of the fouling, it's only half a year old – they just say alright, they crank it up until the fouling is gone and that's the end of their problem. They don't say (they might not even know) "look mate, that boat is going to accumulate fouling a lot faster now and you better think twice before you go off far away and do your next regatta to the Bay of Islands or whatever. Alex, scientist.

6.6. Additional results

Some additional results that do not fit within the Model of Pro-environmental Behaviour, but that may be of interest to Auckland Council, are provided in Appendices 2 and 3.

6.7. Summary

The Model of Pro-environmental Behaviour proposes that people must believe that their values are threatened by an environmental problem (such as marine pests) such that they then assign responsibility to themselves to mitigate the problem. Several beliefs appear to prevent them assigning responsibility to themselves. Chiefly, these are:

1. that people are not aware of the threats marine pests pose to their values or the things they value
2. recreational boat operators do not assign responsibility to themselves over the issue and its management to reduce the risks of invasive pest spread
3. a fatalist sense that 'the horse has bolted' for marine invasive pests and therefore that management is futile.

An individual contextual factor is that many recreational boat operators lack a general understanding of biosecurity risks, and sometimes lack the planning and organisational skills to undertake biofouling management before departure. Shared contextual factors relate to the costs of biofouling maintenance, and the effectiveness of haul-out operations.

7. DISCUSSION AND CONCLUSION

Under the Unitary Plan, Auckland Council is given by the Resource Management Act a duty of care to raise awareness among the boating community of the importance of maintaining clean hulls to reduce the risk of introducing or spreading harmful aquatic organisms from biofouling. This study identified several opportunities for the Auckland Council to advance this effort. Specifically, the research proposes six key factors that are likely inhibiting Auckland's recreational boating community from undertaking good biofouling management practices. These include **attitudes**, **individual capabilities**, and **external conditions**. Habits may also play a part.

Attitudinal factors that contribute to preventing good behaviours to manage marine invasive pests appear to be influenced by three beliefs. These are (1) people are not aware of the consequences marine pests pose to their values or the things they value, (2) that recreational boat operators do not assign responsibility to themselves over marine biosecurity management to reduce the risks of invasive pest spread, and (3) a fatalist sense that 'the horse has bolted' for marine invasive pests and therefore that management is futile. **Individual capability factors** include (4) poor time management and planning skills. **External conditions** include (5) haul-out effectiveness and (6) the costs associated with biofouling maintenance.

The study found that recreational boat operators often do not ascribe responsibility for the management and impacts of marine biosecurity to themselves. From a behaviour change point of view, this is an important finding. The Model of Pro-environmental Behaviour suggests ascription of responsibility to self is a key factor in undertaking pro-environmental behaviour. Overturning the belief that responsibility over recreational marine biosecurity management lies with someone else is therefore an important avenue for increasing behaviour change.

That said, the interviews also revealed several aspects of the recreational marine biosecurity system perpetuated by non-boaters that contribute to increased risk. Some of these aspects include

- the effectiveness of haul-out operators' service in removing fouling from niche areas
- marina operators and the management of fouled marina structures
- costs of haul-out services
- the possibility that questionable technical advice is provided to recreational boat operators by non-boating members of the recreational biosecurity system
- the lack of scientific studies on the impacts of introduced pests
- the lack of knowledge about marine biosecurity impacts held by trusted 'champions' within the recreational boating community.

Responsibility for these risks does not lie with recreational boat operators, but with other relevant members of the recreational marine biosecurity system. As this study found, other members generally did ascribe some degree of self-responsibility for improving marine biosecurity management, which is encouraging.

However, in some cases people did not know how to reduce those risks. Recreational boat operators often turn to marina managers, boat club leaders, and haul-out operators for advice on biofouling-related topics, but often people in those positions are not sufficiently informed themselves to provide relevant information. This presents a behaviour change opportunity. People are more likely to learn from trusted people within their community, and there is a willingness on behalf of those people to 'do the right thing' and provide relevant information. Education initiatives could target these people to be champions of information and advice.

This study found a consistent desire among interviewees for evidence of the environmental, economic, and social impacts of marine pests. A brief search, conducted by the author, of New Zealand based marine pest impact research found three published studies that may provide a starting point for communicating the impacts of marine pests.¹⁴ These are a review of the ecological effects of *U. pinnatifida* in Australasia (South et al. 2017), a forecast of the cumulative economic impacts of two invasive biofouling species (*S. clava* and *S. spallanzanii*) on New Zealand green-lipped mussel *Perna canaliculus* aquaculture (Soliman & Inglis 2018), and a study by Forrest and Atalah (2017) of the impacts of blue mussels on New Zealand's green-lipped mussel aquaculture industry. Internationally, Davidson and colleagues (Davidson et al. 2015; Ojaveer et al. 2015) have studied the economic, environmental, and social impacts of marine pests.

The issue of high costs preventing hull cleaning and maintenance could be addressed in one of two ways. The conceptual framework of this study considers costs to be an external contextual factor affecting recreational boat operators' hull hygiene maintenance behaviour. One way to negate this factor is to provide cheaper options such as a *Drive-in Boatwash*[®] (Cunningham & Davidson 2019) and/or to subsidise maintenance activities. A difficulty for Auckland Council would be the perception amongst Auckland ratepayers that public funds are being allocated to people wealthy enough to afford a recreational vessel. However, there is another way of thinking about the issue of costs when considered through the lens of alternative behaviour change theories. While costs will genuinely be an impediment to good marine biosecurity management practices for some boat operators on the economic margins, for other boat operators, costs will only be *perceived* as preventative of good practices. Indeed, other behaviour change models such as the Theory of Planned Behaviour (Ajzen 1985) would define costs as a psychological perception rather than

¹⁴ However, given the apparent low number of impact studies, further studies would likely be required in order to communicate compelling arguments of the impacts of marine pests.

an external contextual factor. According to that theory, beliefs about costs contribute to the formation of positive or negative attitudes towards a behaviour, which then manifest as an intention to undertake the behaviour or not.

Overturning the recurring sense amongst members of Auckland's recreational boating system that 'the horse has bolted' could result in an increased willingness to implement best practice behaviours. A Marine Pest Pathway Management Plan currently under consideration by Auckland Council (Auckland Council 2019) may go some way to overcoming the effect of this perception on behaviour. The perception of futility appears to relate to certain species such as *S. spallanzanii*, yet it may contribute to negative attitudes towards marine biosecurity management in general and actually undermine pathway-based management. While it may be valid to consider it too late to contain the spread of some established marine pests, that perception need not influence marine biosecurity management behaviours that would prevent the introduction of marine pests that have not yet arrived, or further spread those that have. The Council's policy is rightly aimed at preventing the next horses from bolting as well. This study therefore suggests a reorientation in the way risks and solutions are communicated to recreational boat operators. A Marine Pest Pathway Management Plan is designed to prevent marine pests from reaching new areas, rather than responding to certain pest species. This approach forms the basis of many international and national vector management approaches (e.g. ballast water management), which attempt to prevent the process of marine pest spread rather than species-led management. If the rules of a marine pathway plan were to mirror those of Northland's, it would address another concern raised by interviewees; that is, the confusion of operating under multiple rules when travelling from Auckland to neighbouring regions.

8. RECOMMENDATIONS

To recap, this study finds attitudinal factors that prevent good biofouling management take three main beliefs. These are (1) a fatalist sense that ‘the horse has bolted’ for marine invasive pests and therefore that management is futile, (2) a lack of awareness of the consequences marine pests pose to boaters’ values or the things they value, and (3) a limited sense of personal responsibility for the issue and its management to reduce the risks of invasive marine pest spread. Crucially, boat owners and other stakeholders do not consider that the impacts of marine pest species such as *S. spallanzanii*, *U. pinnatifida* and *S. clava* have been nearly as bad as they were originally made out to be, and therefore they do not believe the warnings of potential damage from new species. Individual capability factors include (4) poor time management and planning skills. External conditions include (5) haul-out service effectiveness and (6) the costs associated with biofouling maintenance.

Based on these findings, the following recommendations are made to Auckland Council. To address factors (1), (2), and (3):

- Consider recreational boating as a social system comprising boat operators, scientists, haul-out operators, central and local government, boat clubs, marinas, and conservationists, and **encourage a sense of self-responsibility** over marine biosecurity impacts across all relevant members (everyone has a part to play)
- Invest in, or support in kind, research into the impacts of marine pests on New Zealand’s economy, environment, society, and culture
- **Negate the sense that ‘the horse has bolted’** by
 - Focusing on pathways management
 - Communicating the impacts of current marine pests, as well as the results of species-specific research projects undertaken to date
 - Implementing rules that require all boat operators to reduce risks
- **Invite and support** key members of the recreational boating community to be **behaviour change champions**

To address factors (4), (5) and (6):

- consider providing or supporting cheaper options for hull cleaning, and/or
- negating the perception that good hull maintenance is expensive
- consider working with haul-out operators to develop a code of best practice or another such tool to encourage best practice across the industry.

Finally, it is recommended that Auckland Council consider monitoring the effectiveness of the above initiatives through a regular survey of recreational boat operators, such as the Recreational Boat User Survey (Auckland Council 2017) which could be used as a baseline. This is an often overlooked and crucial component of environmental education and outreach: resources are made available to get the

message out, but not for whether the message is influencing awareness and behaviour.

9. REFERENCES

- Ajzen I 1985. From intentions to actions: In: Kuhl J, Beckmann J (eds) *Action Control*. SSSP Springer Series in Social Psychology. Springer, Berlin, Heidelberg.
- Ajzen I 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50(2): 179-211.
- Ajzen I, Fishbein M 1980. *Understanding attitudes and predicting social behaviour*.
- Arnold AC 2004. A review of public attitudes towards marine issues within and beyond New Zealand, DOC Science Internal Series 170. Wellington, Department of Conservation.
- Ashton G, Davidson I, Ruiz G 2014. Transient small boats as a long-distance coastal vector for dispersal of biofouling organisms. *Estuaries and Coasts* 37(6): 1572-1581.
- Auckland Council 2017. *Recreational boat user survey*. Auckland, Auckland Council.
- Auckland Council 2019. *Mahere ā-Rohe Whakahaere Kaupapa Koiora Orotā mō Tāmaki Makaurau 2019-2029*. Auckland Regional Pest Management Plan 2019-2029. Auckland, Auckland Council.
- Auckland Council n.d. *Navigating the rules: Doing your bit to stop invasive marine pest species*. Auckland, Auckland Council
- A review of public attitudes towards marine issues within and beyond New Zealand, Prentice Hall; Toronto: Prentice-Hall of Canada.
- Bandura A 1982. Self-efficacy mechanism in human agency. *American Psychologist* 37(2).
- Bandura A 1986. *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, New Jersey: Prentice-Hall. 617 p.
- Bandura A 1997. *Self-efficacy: the exercise of control*. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co.
- Campbell ML, Bryant DE, Hewitt CL 2017. Biosecurity messages are lost in translation to citizens: Implications for devolving management to citizens. *PLoS One* 12(4): e0175439.
- Coutts AD, Piola RF, Hewitt CL, Connell SD, Gardner JP 2010. Effect of vessel voyage speed on survival of biofouling organisms: implications for translocation of non-indigenous marine species. *Biofouling* 26(1): 1-13.
- Cunningham S, Davidson I 2019. *Evaluation of the Drive-In Boatwash® In-water cleaning system*. Prepared for Auckland Council. Cawthron Report No. 3353. 17 p. plus appendix.

- Davidson AD, Hewitt CL, Kashian DR 2015. Understanding acceptable level of risk: incorporating the economic cost of under-managing invasive species. *PLoS One* 10(11): e0141958.
- Davidson IC, Zabin CJ, Chang AL, Brown CW, Sytsma MD, Ruiz GM 2010. Recreational boats as potential vectors of marine organisms at an invasion hotspot. *Aquatic Biology* 11(2): 179-191.
- DoC (Department of Conservation) 2017. Regional Coastal Plan: Kermadec and Subantarctic Islands. Wellington, Department of Conservation.
- Environment Southland 2016. Proposal for a Fiordland Marine Regional Pathway Management Plan under the Biosecurity Act 1993. Invercargill, Environment Southland.
- Environment Southland 2017. Fiordland marine regional pathway management plan. Invercargill, Environment Southland.
- Ferrario J, Caronni S, Occhipinti-Ambrogi A, Marchini A 2017. Role of commercial harbours and recreational marinas in the spread of non-indigenous fouling species. *Biofouling* 33(8): 651-660.
- Fishbein M, Ajzen I 1975. Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA, Addison-Wesley.
- Floerl O, Inglis GJ 2003. Potential for the introduction and spread of marine pests by private yachts. In: Godwin LS (ed) Hull fouling as a mechanism for marine invasive species introductions: Proceedings of a workshop on current issues and potential management strategies. Honolulu, HI. Pp. 22-28.
- Floerl O, Inglis GJ 2005. Starting the invasion pathway: the interaction between source populations and human transport vectors. *Biological Invasions* 7(4): 589-606.
- Floerl O, Inglis GJ, Hayden BJ 2005. A risk-based predictive tool to prevent accidental introductions of nonindigenous marine species. *Environmental Management* 35(6): 765-778.
- Floerl O, Inglis GJ, Dietrich J 2016. Incorporating human behaviour into the risk–release relationship for invasion vectors: why targeting only the worst offenders can fail to reduce spread. *Journal of Applied Ecology* 53(3): 742-750.
- Forrest B 2017. Vessel hard-stand survey and biofouling risk factors. Top of the South Marine Biosecurity Partnership Technical Report 2017/02 Nelson, Marine Biologic.
- Forrest B 2018. Regional recreational vessel fouling and marine pest survey 2017/18. Top of the South Marine Biosecurity Partnership Technical Report 2018/01. Nelson, Marine Biologic.

- Forrest BM, Atalah J 2017. Significant impact from blue mussel *Mytilus galloprovincialis* biofouling on aquaculture production of green-lipped mussels in New Zealand. *Aquaculture Environment Interactions* 9: 115-126.
- Funk JL, Matzek V, Bernhardt M, Johnson D 2013. Broadening the case for invasive species management to include impacts on ecosystem services. *BioScience* 64(1): 58-63.
- King N, Horrocks C, Brooks J 2018. *Interviews in qualitative research, second edition*. London, SAGE Publications Limited.
- Lass H 2019. Personal communication. 7 May 2019.
- Martínez-Laiz G, Ulman A, Ros M, Marchini A 2019. Is recreational boating a potential vector for non-indigenous peracarid crustaceans in the Mediterranean Sea? A combined biological and social approach. *Marine Pollution Bulletin* 140: 403-415.
- McKenzie-Mohr D 2011. *Fostering sustainable behavior: An introduction to community-based social marketing*. Gabriola Island, BC, Canada, New Society Pub.
- MPI 2013. *Clean boats - living seas*. Brochure. Wellington, Ministry for Primary Industries
- Murray CC, Therriault TW, Pakhomov E 2013. What lies beneath? An evaluation of rapid assessment tools for management of hull fouling. *Environmental Management* 52(2): 374-384.
- New Zealand Government 2014. *Craft risk management standard: Biofouling on vessels arriving to New Zealand*. Wellington, New Zealand: Ministry of Primary Industries.
- New Zealand Marina Operators Association n.d. *New Zealand's clean boating programme*. Available at www.cleanboating.org.nz.
- Northland Regional Council 2017. *Northland Regional Pest and Marine Pathway Management Plan*. Whangarei, Northland Regional Council.
- Ojaveer H, Galil BS, Campbell ML, Carlton JT, Canning-Clode J, Cook EJ, Davidson AD, Hewitt CL, Jelmert A, Marchini A 2015. Classification of non-indigenous species based on their impacts: considerations for application in marine management. *PLoS Biology* 13(4): e1002130.
- Omondigbe HA, Towns DR, Wood JK, Bollard-Breen B 2017. Stakeholders and social networks identify potential roles of communities in sustainable management of invasive species. *Biological Invasions* 19(10): 3037-3049.
- Prinbeck G, Lach D, Chan S 2011. Exploring stakeholders' attitudes and beliefs regarding behaviors that prevent the spread of invasive species. *Environmental Education Research* 17(3): 341-352.

- Rench K, Andrews P, Fraser D 2018. Dissemination of biosecurity information for passengers travelling to pest-free islands in the Hauraki Gulf. Preliminary report. Unitec Institute of Technology Department: Environmental And Animal Sciences for Auckland Council. Auckland, New Zealand
- Sharp RL, Larson LR, Green GT 2011. Factors influencing public preferences for invasive alien species management. *Biological Conservation* 144(8): 2097-2104.
- Sharp RL, Cleckner LB, DePillo S 2017. The impact of on-site educational outreach on recreational users' perceptions of aquatic invasive species and their management. *Environmental Education Research* 23(8): 1200-1210.
- Sinner J, Roberts B, Piola R 2009. Pride of the south: risk analysis for marine biosecurity in Fiordland. [2009 Conference, August 27-28, 2009, Nelson, New Zealand](#) 97162, New Zealand Agricultural and Resource Economics Society.
- Sinner J, Forrest B, Newton M, Hopkins G, Inglis G, Woods C, Morrissey D 2013. Managing the domestic spread of harmful marine organisms, Part B: Statutory framework and analysis of options. Prepared for Ministry for Primary Industries (MPI) Preparedness and Partnerships Directorate. Cawthron Report No. 2442. 72 p. plus appendix.
- Soliman T, Inglis GJ 2018. Forecasting the economic impacts of two biofouling invaders on aquaculture production of green-lipped mussels *Perna canaliculus* in New Zealand. *Aquaculture Environment Interactions* 10: 1-12.
- South PM, Floerl O, Forrest BM, Thomsen MS 2017. A review of three decades of research on the invasive kelp *Undaria pinnatifida* in Australasia: An assessment of its success, impacts and status as one of the world's worst invaders. *Marine Environmental Research* 131: 243-257.
- Stenekes N, Kancans R, Binks B 2018. Recreational boat operators' self-management of biofouling in Australia. ABARES technical report prepared for the Aquatics and Marine Pests Unit, DAWR, Canberra, July. CC BY 4.0.
- Stern PC 2000. New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues* 56: 407-424.
- Trenouth AL, Campbell ML 2013. Perceptions of ecological risk associated with introduced marine species in marine protected areas. *Management of Biological Invasions* 4(1): 7-24.
- Verbrugge LN, Van den Born RJ, Lenders HR 2013. Exploring public perception of non-native species from a visions of nature perspective. *Environmental Management* 52(6): 1562-1573.
- Wilson C, Dowlatabadi H 2007. Models of decision making and residential energy use. *Annual Review of Environment and Resources*. 32: 169-203.

10. APPENDICES

Appendix 1. Questionnaire

1. How would you describe your role in relation to recreational boating? E.g. Recreational boat owner, marina operator, scientist, haulout operator etc
2. How long have you been a [answer to 1] _____?
3. What does the term marine biosecurity mean to you?
4. Could you tell me a bit about what you do in relation to marine biosecurity?
5. Does marine biosecurity concern you at all? Why? What are the most concerning impacts of invasive marine pests?
6. How much risk do invasive marine pests pose to the things you are concerned about? Minor, low, moderate, significant, severe, catastrophic
 - a. Why?
7. What are the behaviours recreational boaties do that you think carry the highest risk in relation to marine biosecurity in the Auckland region? Please list in order of importance.
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
8. Why do you think people do those things? Prompts may include
 - i. Values
 - ii. Attitudes
 - iii. Beliefs
 1. Norms
 2. Awareness of consequences
 3. Responsibility
 4. Knowledge
 - f. Habits
 - g. Capabilities (technical skills, socio economic status, resources)

- h. External (regulations, economy, market actors, technologies, social interactions, norms)
9. Can you describe the recreational boat operators that pose the greatest risks to Auckland marine biosecurity? _____
10. What do you think would make recreational boat operators more likely to undertake better biosecurity management practices? E.g. regulation, information and education, provision of better/cheaper facilities, other.
11. Are you aware of any Auckland Council initiatives aimed at recreational marine biosecurity?
12. What could Auckland Council do differently to encourage good marine biosecurity management practices?
13. What do you think are the barriers to engaging with boat operators about marine biosecurity issues?
- a. How could these barriers be negated?
14. Have you heard of the “Clean below, good to go!” campaign? Y/N
15. Do you think the “Clean below, good to go!” campaign is effective at reducing recreational marine biosecurity risks? Y/N
- b. Why? _____
- c. What, if anything, could be changed to get better results?

16. Are you aware of any other successful marine biosecurity programmes that could be relevant to the Auckland context to reduce marine biosecurity risks from recreational boat operators? Y/N
- d. If yes, please describe _____
17. Is there anything you would like to add?

Appendix 2. Interviewees' ideas for increasing the uptake of better biosecurity management practices.

Interviewees were asked “What do you think would make recreational boat operators more likely to undertake better biosecurity management practices?” The results are presented, below, in Table A1.1.

Table A1.1. Interviewees' ideas for increasing the uptake of better biosecurity management practices.

Idea for greater uptake of good biofouling behaviour	Scientists (2)	Conservationist (1)	Commercial diver (1)	Marina manager (2)	Haulout operator (1)	Recreational boat operator (1)	Recreational boat club representative (4)	Marina Operators Assoc (1)	Total (15)
Increase education for recreational boaters	1	1	1	1			1	1	6
Floating inwater cleaning facilities		1				2			3
Independently verified cleaning certification for haulout operators	1		1		1				3
Implementation of hull cleaning standards for haulout operators	1		1		1				3
Dive shop salesperson education and information in shops	1				1				2
Implement a recreational boat licence system like for cars		1					1		2
Culture change within boating community			1				1		2
Cleaning schedule for marinas		1			1				2
Check all boats that arrive in port					1	1			2
Anti foul sales person education	1								1
GPS tracking device						1			1
Case studies and or stories of impacts of marine pests							1		1
GPS tagged app to locate instances of invasive pests				1					1

Appendix 3. What could Auckland Council do differently to encourage good practice?

Interviewees' were asked: "what could Auckland Council do differently to encourage good practice?" The results are presented, below, in Table 8.

Table 8. Interviewees' ideas for things Auckland Council could do differently to encourage good practice.

Ideas that Auckland Council could enact	Scientist (2)	Conservationist (1)	Council staff (1)	Commercial diver (1)	Marina manager (2)	Haulout operator (2)	Recreational boat operator (1)	Recreational boat operator (4)	Central govt (1)	Marina Operators Assoc (1)	Total (15)
Provide cheaper options for cleaning or make it easier	1	1					1	1			4
Research the impacts of fanworm and tell those stories	1		1				1		1		4
Increase compliance monitoring effort		1	1				1	1			4
Increase international arrival haulout capacity						3					3
Subsidise the costs associated with recreational biofouling management					3						3
Address the risks associated with swing arm and mooring boat owners				1	2						3
Educate marina operators about impacts of marine pests		1					1		1		3
Demarcate marine areas by value and ocean currents	1		1								2
Raise awareness and knowledge to improve entire maintenance of vessels	1		1								2
Discourage inwater cleaning	1										1
Manage for pests that arent here yet	1										1
Implement a marina accreditation scheme		1									1
Who to target							1				1
Clear cohesive messaging of rules that align with other regions				1							1