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Recreational boater views on hull cleanliness: insights from a national survey

Cawthron Report 4113

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REVIEWED BY: Patrick Cahill and Aisling Rayne

APPROVED FOR RELEASE BY: Grant Hopkins

PROJECT NUMBER: 17383/05/500

ISSUE DATE: 12 December 2024

RECOMMENDED CITATION: McCarthy A, Yao R, Newton M, Welsh M, Botero J, Floerl O. 2024. Recreational boater views on hull cleanliness: insights from a national survey. Nelson: Cawthron Institute. Cawthron Report 4113. Prepared for Ministry of Business, Innovation and Employment.

Document no. F-PC21 | Issue no. 2

Recreational boater views on hull cleanliness: insights from a national survey

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Prepared for Ministry of Business, Innovation and Employment

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Glossary

Term	Definition
Antifouling coating	Specialised coatings designed to prevent the accumulation of sessile marine organisms (such as algae and barnacles) on vessel hulls or other submerged artificial surfaces.
Biofouling	The accumulation of sessile organisms including micro-organisms, algae and / or invertebrates on submerged artificial surfaces such as ship hulls, underwater structures or aquaculture equipment.
Discrete choice experiment (DCE)	A quantitative research method used to elicit individuals' preferences by presenting them with a series of simulated choice scenarios. In each scenario, survey participants are asked to select their preferred option from a set of alternatives that vary systematically across multiple attributes. DCEs enable researchers to quantify the relative importance of different attributes and the trade-offs individuals are willing to make among them. This method is widely applied in various fields, including health, economics and environmental studies, to inform policy decisions and resource allocation by understanding preferences and behaviour.
Likert-scale	A type of survey question that measures attitudes or opinions by asking respondents to rate their agreement with statements on a scale, often from 'strongly disagree' to 'strongly agree'.
Invasive species	A subset of NIS (see below) that undergo spread and impact ecological, economic, cultural or spiritual values in non-native ranges.
Mooring	The process of securing a boat or vessel to a fixed point, such as a dock, buoy or anchor, to keep it in place.
Non-indigenous marine species (NIS)	Species that are not native to an area and have been introduced to its waters, with the potential to impact ecosystems.
Perceived behavioural control	Refers to an individual's beliefs about how easy or difficult it is to perform a specific behaviour. In this case, the behaviour of boaters' keeping their hulls reasonably clean at all times.
Subjective norms	The social pressures or expectations perceived by an individual regarding whether they should or should not perform a specific behaviour. In this case, the behaviour of boaters' keeping their hulls reasonably clean at all times.
Theory of planned behaviour (TPB)	A quantitative psychological research method that predicts behaviour based on three factors: attitudes toward the behaviour, subjective norms (social influences) and perceived behavioural control (belief in one's ability to perform the behaviour). Together, these factors shape a person's intention to act.

Contents

Report summary

This research explores recreational boaters' perspectives on hull cleaning. The study aimed to understand what motivates or discourages owners of permanently in-water marine vessels (not trailer boats) from cleaning their hulls; their perceived priorities for improving hull cleaning practices; their level of concern about marine biosecurity; and how much they value certain outcomes of clean hulls, including their willingness to invest further to achieve these benefits.

The Cawthron Institute and Scion developed an online survey, which was distributed with support by the New Zealand Marine Operators Association (NZMOA) and Yachting New Zealand (YNZ). The survey ran from October 2023 to March 2024 and generated 701 usable responses.

Basic information about participants

Regional distribution and boat mooring locations:
Survey responses were broadly geographically consistent with national boat ownership patterns, with the largest participation from Auckland and Northland. Most participants kept their boats at marina berths, and a majority reported sailing between regions.

Boat ownership and usage:
81% of participants owned one boat, typically 10–12 metres long, and the average length of ownership was 11.5 years. The majority used their boats for personal purposes between 31–60 days per year, with very few reporting extensive use beyond 150 days annually.

Antifouling and hull cleaning practices:
Boaters typically antifoul their vessels every 1–3 years, while hull cleaning occurs more frequently. All participants engaged in at least one hull cleaning practice, although a handful clean very infrequently.

Boat cleaning methods, location and compliance:
The majority of boaters cleaned their hulls themselves or hired contractors. Waterblasting was the most popular method out of the water, with dive brushes most commonly used for in-water cleaning. More boaters expressed a preference for accessing haul-out facilities than the number who reported using these facilities. Half of boaters reported cleaning to meet compliance requirements, particularly for regional and marina regulations. This proportion was as high as two-thirds of boaters from Auckland, most of whom aimed to meet regional regulations.

Expenditure and time:
Participants spent an average of $2,755 annually on hull cleaning and antifouling, representing 18% of their total boat maintenance expenses. They devoted 22 hours per year to antifouling and cleaning combined, which also accounted for 18% of the total time they spent on boat maintenance.

Demographics:
Survey respondents were predominantly older (68% over the age of 60), male (87%), of European descent (89%), highly educated and reasonably affluent (39% with a household income over $150K).

What influences boaters to keep their hulls reasonably clean?

Using the theory of planned behaviour (TPB) framework, we explored the attitudes, social influences and perceived control that contribute to shaping boaters' intentions to keep their hulls 'reasonably clean'. Reasonably clean is defined as a mostly clean hull, with minimal biofouling

limited to hard-to-clean areas such as the propeller shaft and keel, that complies with current standards in regions like Auckland. Sixty-nine percent of respondents reported keeping their hull reasonably clean at all times. The remaining 31% maintained hull cleanliness to this standard some of the time or seldom.

Attitudes:
Most boaters agreed that keeping hulls reasonably clean is worthwhile. Benefits such as improved boat efficiency and speed were widely recognised. Conditional willingness to clean was stronger if commercial boaters also fulfilled their responsibilities.

Social influences:
Few social groups strongly influenced the majority of boaters' intentions to keep their hulls reasonably clean. The potential impact of non-indigenous marine species (NIS) on the seafood and aquaculture industry was the most influential factor, shaping the intentions of just under half of respondents. Local authorities and the sailing / boating community also played a role, but their influence was limited to about a third of respondents.

Perceived behavioural control:
Regarding factors affecting boaters' ability to maintain a clean hull, the cost of cleaning was a more prohibitive factor than time taken to clean, particularly among boaters with lower household incomes. Many also reported insufficient cleaning facilities, with dissatisfaction being highest in Auckland. Despite these challenges, nearly two-thirds of boaters agreed that they have clear and sufficient information about hull cleaning in their area, and 82% agreed that haul-out facilities perform well when accessible.

Concerns for spread of marine invasive species:
Most respondents were concerned with the spread of NIS, recognise their impact, and felt that boaters have a responsibility to help prevent their spread. Despite this, nearly half believed that it is too late to effectively contain the spread of NIS.

Intention:
Intention, a key predictor of behaviour, was strong among respondents, with 84% agreeing or strongly agreeing that they are likely to keep their hulls reasonably clean at all times.

Predictors of hull cleaning intention and behaviour:
Multiple regression analysis found a statistically strong relationship between boaters' intentions and their actual behaviour in regard to keeping hulls reasonably clean. The intention question (*'I am likely to keep my hull reasonably clean at all times'*) was the best predictor of whether boaters consistently maintained their hulls to this standard. This suggests that understanding and supporting boaters' intentions can help encourage improved hull maintenance.

When grouping all boaters, three key factors significantly positively influenced their intention to keep hulls reasonably clean: believing it is worthwhile (the strongest predictor of intention), perceiving it as easy to do, and feeling a sense of responsibility to prevent the spread of NIS. Conversely, boaters who viewed hull cleaning as excessively time-consuming were significantly less likely to intend to maintain their hulls. Regional and income variations were also evident. Auckland boaters reported the most influences on their intentions, including the belief that clean hulls improve boat speed, and the influence of local authorities and the sailing community. In contrast, for boaters with household incomes under $100,000, believing that cleaning is worthwhile was the only significant predictor of intention. Higher-income boaters ($100,000+) had multiple predictors, including slight negative associations with being influenced by local authorities or concern for the

spread of NIS, suggesting that they may feel less driven by external pressures or environmental concerns.

Key themes shaping boater motivations:
Factor analysis grouped boaters into four distinct themes that explained their motivations for keeping their hulls reasonably clean:
1. Proactive group – these boaters see hull cleaning as worthwhile, manageable and supported by enough local resources. They feel a sense of responsibility to reduce the spread of NIS and are not deterred by cost, time or rules.
2. Social influence group – this group is primarily shaped by social norms and expectations, with local authorities, marinas and the sailing community shaping their intentions.
3. Lack of access and conditional willingness group – boaters who feel they lack cleaning facilities are more likely to act if other groups, e.g. commercial boaters, do their part too.
4. Lower NIS concern and stronger conditional willingness group – some boaters who are less worried about NIS impacts are only willing to clean if others are also undertaking hull maintenance. Intuitively, this group of boaters are less likely to keep their hulls reasonably clean.

Boater suggestions for supporting clean hulls

Boaters were asked, *'What changes, incentives, or regulations would improve your ability to keep your hull clean?'* Their responses were categorised into nine themes. In order of most frequently mentioned, these themes included:
1. More haul-out facilities and preservation of existing facilities, particularly in underserved areas and for larger vessels.
2. Lower haul-out costs, including reduced council fees, more affordable alternatives and more market competition.
3. Antifouling effectiveness, with suggestions for better eco-friendly products and research innovations to be shared with boaters.
4. DIY and self-cleaning options, such as relaxing restrictions on in-water cleaning, diver-friendly policies and tidal grids.
5. Incentives and rewards, such as discounts or concession cards for responsible boaters.
6. Stricter biosecurity rules for commercial vessels to target perceived inequities.
7. Consistency in regulations to address frustrations with regional differences.
8. Improved marina infrastructure in some areas, including regular cleaning schedules if feasible and displaying of problem species.
9. Better education and awareness, focusing on environmental and boat performance benefits of hull cleaning.

What are the benefits of keeping hulls clean, and would boaters invest further to secure these outcomes?

The discrete choice experiment (DCE) was designed to explore recreational boaters' preferences and willingness to support financial contributions towards improvements in marine ecosystem health, boating efficiency and marine biosecurity policies. The aim was not to assert that boaters are ready to pay more, but rather to identify the outcomes they would prioritise and support through hull cleaning measures, if those investments led to guaranteed improvements.

The DCE results reveal that recreational boaters place the highest value on ecosystem health improvements, followed by boat maintenance and fuel efficiency, and, to a lesser extent, enhanced coordination of marine biosecurity policies. Specifically, the model suggests that, on average, a typical boater would be willing to invest $898–$1,173 per year for measurable ecosystem health improvements, $727 for boat efficiency gains and $400 for more coordinated marine biosecurity policies. Importantly, these values reflect a contingent willingness – one that is dependent on the expectation that the improvements will indeed be realised.

The study's findings also identified three key groups of boaters with distinct priorities: one that is generally supportive of all improvements, another that is focused primarily on ecological benefits, and a third that is largely satisfied with the current state but open to modest gains in boat efficiency. These values, useful in cost-benefit analyses, highlight the importance of engaging boaters and aligning initiatives with their priorities to ensure successful implementation.

Recommendations

1. Overcome pessimism / defeatism
Nearly half of boaters believed it is too late to contain the spread of NIS, despite recognising their responsibility, expressing concern for NIS impacts, and acknowledging the harm they cause. Addressing this mindset could involve positive messaging, success stories, analogies to other environmental challenges and shared responsibility campaigns, which are complemented by regulations and incentives to foster behaviour change. Building on the key predictors of hull cleaning intention – such as fostering a sense of worthwhileness, ease of action and boater responsibility – can further strengthen motivation and promote consistent engagement with biosecurity practices.

2. Leverage boater motivations for targeted campaigns
Engagement strategies could be tailored to different boater groups based on their motivations. Approaches include promoting proactive boaters as ambassadors, designing campaigns that leveraging social norms and expectations for influence, improving access to cleaning facilities for those with conditional willingness, and addressing concerns of lower NIS-awareness groups through education, incentives and regulation.

3. Consider boater suggestions
Boaters offered insights into how hull cleaning practices could be improved, highlighting themes such as increasing access to haul-out facilities, reducing costs, improving antifouling options and allowing more DIY cleaning. Incorporating these perspectives into policy and planning, where feasible, can ensure that interventions are practical, align with current realities and foster greater engagement and compliance.

4. Link hull cleaning behaviour to desired outcomes
Boaters are more likely to support hull cleaning initiatives when they see clear benefits. Campaigns should focus on connecting cleaning behaviours to outcomes that matter to different groups, with a particular focus on engaging the 20% who are least inclined to invest in these efforts by addressing their specific concerns and motivations.

5. Tailor approaches
The survey findings highlight diverse preferences and regional variations among boaters, providing a basis for designing targeted interventions at national and regional levels. Avoiding a one-size-fits-all strategy will be key, as different segments of the boating community have distinct needs and motivations. Future efforts should combine incentives, disincentives and long-term engagement strategies, including two-way communication, to address both boater responsibilities and the role of marinas as key habitats for NIS.

1. Introduction

Boating is the largest recreational activity in Aotearoa New Zealand, with up to 40% of the population participating in some form of boating activity annually.[1] Recreational boating takes place on lakes, rivers and the ocean, and involves the use of kayaks, jet-skis, power boats and sailing boats. The registration of boats is not mandatory in Aotearoa New Zealand; therefore, the exact number of privately owned vessels is unknown. However, a recent study estimated that around 25,000 non-trailered sailing yachts and motor launches are permanently moored in more than 50 coastal marinas and mooring facilities (Hilliam et al. 2024).

All types of vessels, including recreational vessels, can inadvertently facilitate the spread of non-indigenous marine species (NIS) between coastal regions. Several hundred NIS are known to be established in Aotearoa New Zealand's coastal waters, and some of them – such as exotic *Caulerpa* (a marine alga) and the Mediterranean fanworm (*Sabella spallanzanii*) – pose significant risks to the country's ecological, economic, cultural and spiritual values (Tait et al. 2020; Middleton 2023).

Recreational yachts and vessels (hereafter collectively referred to as recreational vessels) can transport marine NIS as biofouling organisms attached to submerged hull surfaces (Floerl et al. 2005), in internal bilge water (Fletcher et al. 2017) and pipework (Cahill et al. 2019), or via entanglement in anchoring gear and other submerged equipment (MPI 2023). Biofouling, which is the accumulation of sessile organisms on submerged surfaces, is a particularly important transport mechanism because it is a natural process that takes place 'automatically' while vessels are stationary (i.e. moored at their homeport during periods of non-use or while anchored at a destination). Biofouling development is a nuisance for boaters, as it reduces a vessel's speed and fuel economy. It also creates a mechanism by which marine NIS can be effectively spread from 'invaded' locations to areas where they previously did not occur. Recent research established that recreational vessels travel between 300+ coastal locations around Aotearoa New Zealand that include high-value environments such as marine reserves, iconic bays and islands, aquaculture farms and areas of cultural significance (Hilliam et al. 2024). This highlights the need for improved biofouling management to protect high-value environments and control NIS spread.

Biofouling development on hulls is primarily prevented via regular hull maintenance, such as the renewal of 'antifouling coatings' (designed to temporarily inhibit biofouling development), or via manual methods such as hull grooming or cleaning. Proactive biosecurity management efforts in Aotearoa New Zealand have focused on the promotion of hull maintenance as a tool for limiting the spread of NIS. However, from a boater's perspective, hull maintenance is not always straightforward or easily undertaken, as it can be costly, not readily available or not a priority. Pathway management initiatives, such as regulatory interventions aimed at achieving hull cleanliness standards, are likely to be most effective if they consider the values and practical concerns of the target population. By aligning interventions with these psychological drivers (e.g. Ajzen 1991), such initiatives can enhance buy-in, reduce pushback and encourage voluntary adherence for sustained behaviour change.

[1] https://nzmarine.co/wp-content/uploads/sites/10/2022/10/NZ-Marine-Industry-Snapshot-2022_A4_02.pdf

While a significant proportion of boaters may already engage in pro-environmental practices, encouraging widespread compliance requires a nuanced approach. Increased regulation could impose untenable financial burdens on some recreational vessel owners. Moreover, recreational vessel movements, while a key pathway for marine NIS, are not the sole contributors, with commercial vessels, aquaculture and the aquarium trade also playing a role (Williams et al. 2013). As recreational boating provides significant social and economic benefits, including enjoyment from leisure activities, tourism and community engagement, biosecurity measures must effectively balance the management of NIS risks with maintaining these 'advantages' emphasised by individuals and communities.

Prior research and campaigns in this space have outlined the importance of involving recreational boaters in biosecurity conversations in Aotearoa New Zealand. A literature review of marine biosecurity behaviour change among boaters identified six main themes of understanding: attitudes, knowledge, education, messaging, current behaviours and behaviour change (Hoffman 2021). The review highlighted that education alone is often insufficient, aligning with broader research indicating that simply providing information to shift attitudes and behaviours (a 'cognitive fix') is rarely effective (Heberlein 2012). Instead, effective behaviour change campaigns for mitigating NIS risks should incorporate various engagement strategies, including addressing the value-action gap, where pro-environmental attitudes do not necessarily lead to action (Cimino and Strecker 2018), or combining moral appeals – such as fostering pride in natural spaces or leveraging guilt – with targeted regulations (van Riper et al. 2019). Trusted community figures can also enhance influence through social pressure (Newton 2019) while balancing positive framing with regulatory measures such as mandatory vessel inspections or fines to improve compliance. Given the mixed results from outreach efforts to date, Hoffman's review concluded that Aotearoa New Zealand campaigns should ideally be tailored to specific populations and locations to address diverse values and responses to NIS risks (Hoffman 2021).

Studies have shown that targeting only the 'worst offenders' does not significantly improve antifouling behaviours. Floerl et al. (2016) instead found that broader strategies, including encouraging modest behavioural changes across a wider boater population, were three times more effective in reducing NIS spread in Aotearoa New Zealand. Research on motivations to reduce hull biofouling among Auckland boaters identified key barriers, such as a sense of futility, cost and logistical constraints (Newton 2019), while a study in Southland recommended community engagement and culturally sensitive messaging to improve long-term adherence (Cepeda-Rios and Matheson 2023). Similarly, a report prepared for Biosecurity New Zealand emphasised the importance of understanding how recreational boaters differ in their commitment to reducing NIS and tailoring messaging to specific user values and concerns (Kantar Public 2023). These findings underscore the importance of understanding boater values, motivations and perspectives to better inform behaviour change interventions across diverse boating communities.

1.1 Aim of the study

This study aims to understand recreational boaters' perceptions of their role in hull maintenance and their contribution to preventing the spread of NIS, while also giving boaters a voice in these discussions. Focusing on moored vessels (those that remain in the water), this study provides insights that will be

valuable to marine biosecurity managers and decision-makers. By examining the challenges and barriers that boaters face, along with factors influencing their hull maintenance practices, the study can inform more effective management strategies.

The specific objectives of this study were to:

- identify challenges, barriers and factors affecting hull maintenance practices and boaters' level of biosecurity concern
- highlight the actions and support that boaters believe would help improve hull maintenance
- understand boaters' preferred outcomes from maintaining clean hulls, such as better vessel efficiency, reduced ecosystem impacts or more consistent regulations
- assess boaters' willingness to invest more in hull maintenance to achieve these outcomes, assuming they are guaranteed.

2. Survey design and implementation

2.1 Methodology for survey design

To design the survey, we first solicited research objectives through conversations with end-user partners of the Marine Biosecurity Toolbox programme (www.biosecurity-toolbox.org.nz/), including Auckland Council, Northland Regional Council, Marlborough District Council and the Ministry for Primary Industries (MPI). These conversations helped define the survey's scope, which focused on understanding what motivates or discourages recreational boat owners to keep their hulls clean and identifying the broader values they prioritise when deciding on hull maintenance.

To address the survey's scope, we adopted a combined approach using behaviour change and economic methods. Drawing on existing literature, particularly the study by Börger and Hattam (2017), we integrated these approaches to elicit insights. Focus groups with recreational boaters in Nelson and Whangarei, along with interviews with Auckland-based recreational boat owners, helped to understand the perspectives of boaters to develop and refine the survey questions. A pre-test was conducted with 20 boaters, and feedback was used to adjust the survey for clarity. Input from the New Zealand Marina Operators Association (NZMOA) and Yachting NZ (YNZ) ensured relevance and facilitated a broad distribution to recreational boaters. The final version of the survey is included as Appendix 1 in this report, with sections and questions as shown in Table 1.

Ethics approval (CAW-ETH-210818) was obtained for the focus groups, pilot testing and the actual survey. Participants were informed on the welcome page of the survey that individual responses would be anonymised, and that aggregated responses would be summarised in this report.

Table 1. Topics in survey and number of questions for each topic.

Section	Number of questions
Welcome page and consent	1
Section A: General questions – boat location, cleaning and antifouling frequency, money and time expenditure, years boating, etc.	26
Section B1: Perspectives on maintaining a reasonably clean hull – attitudes, subjective norms and perceived behavioural control (theory of planned behaviour)	23
Section B2: Level of concern for introduced marine organisms	3
Section B3: What would help you maintain a clean hull?	1
Section C: Discrete choice experiment	10
Section D: Demographics	7

2.2 Theory of planned behaviour

The theory of planned behaviour (TPB) is a psychological framework used to predict and understand human behaviour by examining three key components: attitudes, subjective norms and perceived behavioural control (Ajzen 1991). Attitudes reflect an individual's positive or negative evaluation of performing the behaviour. Subjective norms involve the perceived social pressure to engage or not engage in the behaviour. Perceived behavioural control relates to an individual's belief in their ability to perform the behaviour, considering any facilitating or constraining factors. Together, these components influence an individual's intention to engage in a specific behaviour, which is a strong predictor of their actual behaviour (Figure 1).

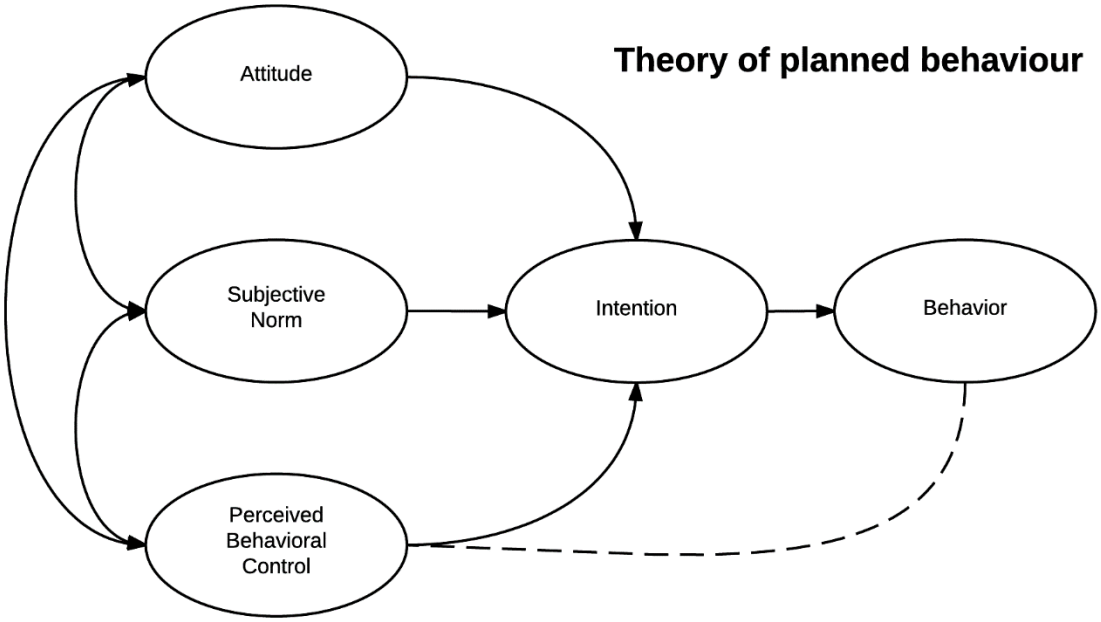


Figure 1. Diagram of the theory of planned behaviour, illustrating how attitudes, subjective norms and perceived behavioural control influence intention, which in turn affects behaviour.

We developed a series of Likert-scale questions to measure each TPB component in the context of recreational boaters' behaviour of keeping their boat hulls *'reasonably clean at all times'*. This was defined as a mostly clean hull, with minimal biofouling limited to areas that are typically hard to clean (e.g. propeller shaft and keel), consistent with Level 2 on the level of fouling (LoF) scale[2] (Figure 2). This standard aligns with the strictest hull cleanliness regulations in Aotearoa New Zealand, such as those applied in Auckland.

[2] https://www.nrc.govt.nz/media/igbn3s0s/level-of-fouling-lof-guidance-and-schematics-cawthron.pdf

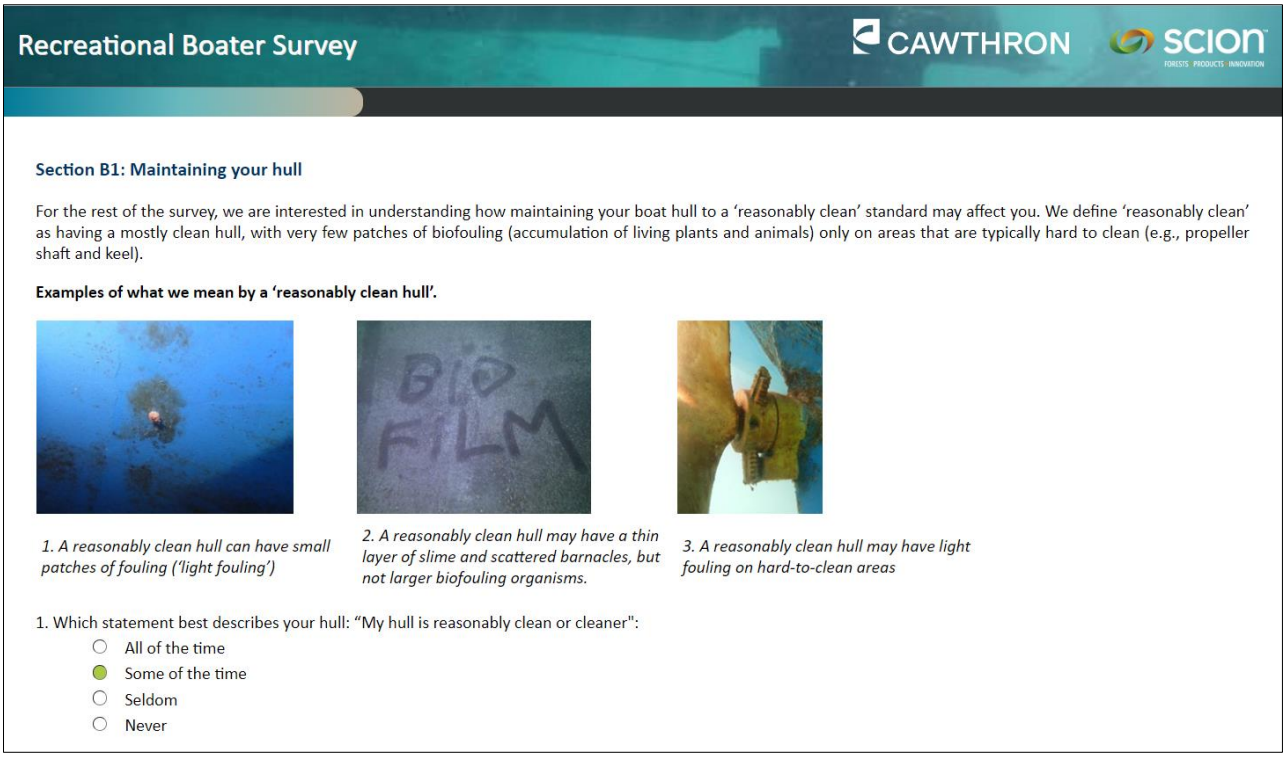


Figure 2. Definition of a 'reasonably clean' hull as presented to survey respondents, with visual examples of acceptable levels of biofouling.

The survey included eight questions assessing attitudes, eight questions evaluating perceived behavioural control, six questions focused on subjective norms, and one question measuring the intention to keep the hull 'reasonably clean' at all times. The intention question specifically asked respondents to indicate their likelihood of maintaining a clean hull based on this predefined standard.

Multiple regression analysis, a standard statistical method used in TPB research, was employed to analyse the TPB data. We used this method to identify the relative contribution of each TPB component (attitudes, subjective norms and perceived behavioural control) in predicting behavioural intention to keep hulls '*reasonably clean at all times*'. This approach allowed us to determine which specific beliefs and perceptions most strongly influenced recreational boaters' intentions. Given that questions included a 'don't know' option, we opted for a pairwise deletion model to allow us to maximise the use of available data. Additionally, we included the three invasive species concern questions in the regression model to assess their additional impact on predicting behavioural intentions.

We also used factor analysis as a tool to identify patterns within large sets of data. In this study, we used factor analysis to group related survey questions (variables) about boaters' attitudes, subjective norms and perceived behavioural control over hull cleanliness. This helped us identify key themes in how boaters think and behave regarding hull maintenance. We included only those variables (questions) with loading values of ±0.4 or higher, as these represented stronger relationships between the survey questions and each identified factor (Guadagnoli and Velicer 1988), ensuring that only meaningful patterns were included. After identifying these themes, or 'factors', we reviewed the questions within

each theme to create clear descriptions that captured the distinct ways different groups of boaters view hull cleanliness.

2.3 Discrete choice experiment

A discrete choice experiment (DCE) is an established survey-based method used to evaluate preferences for different options by presenting individuals with a series of hypothetical scenarios (McFadden 1972; Ben-Akiva and Lerman 1985; Hess and Daly 2024). It is particularly useful in understanding decision-making when multiple attributes are involved, as it allows researchers to quantify the trade-offs people are willing to make between competing factors. In this study, the DCE was used to understand recreational boat owners' preferences regarding four key attributes: marine ecosystem health, boat maintenance and fuel costs, marine biosecurity policies and the annual cost of hull cleaning (Figure 3).

Attribute		Status quo	Level 1	Level 2	Level 3
Marine ecosystem health		Declining by 10%	Stable	Increasing by 10%	
Boat maintenance & fuel cost		Increasing by 20%	Increasing by 10%	0% increase	
NZ marine biosecurity policies		Different across 16 NZ regions	Improved coordination	One set of rules for all regions	
Annual cost of hull maintenance ($)		Current cost	Cost increase by 5%	Cost increase by 10%	Cost increase by 15%

Figure 3. The four attributes identified for the choice experiment.

These attributes and their levels were developed through a literature review, focus group discussions and consultations with experts. Each attribute had multiple levels, with the status quo level representing current conditions, while improvement levels were derived based on literature and field expert input. The DCE design comprised 36 choice scenarios, distributed across six blocks, resulting in six distinct versions of the survey. Each respondent was presented with six choice scenarios, each containing three options: the status quo and two alternative options, which varied in terms of the attribute levels. Respondents were asked to choose their preferred option in each scenario, with the goal of assessing how they weighed costs, environmental benefits, boat efficiency benefits and policy options (Figure 4).

Figure 4. An example of the choice situation presented in the online survey.

To analyse individual preferences, we employed a mixed logit model to account for heterogeneity among respondents. Additionally, latent class logit models were used to identify distinct groups of respondents with similar preferences. A Bayesian D-efficient design (Scarpa and Rose 2008) was used to generate the simulated choice scenarios (non-status quo options), minimising potential biases in the data. To mitigate ordering bias, we randomised the order of attributes and the placement of options for each respondent in the online survey.

2.4 Survey implementation

To maximise the pool of potential respondents, YNZ and NZMOA circulated a link to the online survey to their members. They also promoted the survey through advertisements in their newsletters, social media channels and listservs. In addition, our research team directly contacted managers and secretaries of 45 regional yachting clubs across Aotearoa New Zealand, focusing on regions south of Auckland, to encourage participation. Cawthron Institute and Scion further supported the survey by advertising it on their social media platforms, aiming to engage a broader audience of recreational boaters.

To incentivise participation, respondents who completed the survey were entered into a draw to win one of five $250 gift cards, with a total prize pool of $1,250. Winners could choose between a Bunnings or New World gift card.

The survey was launched in October 2023 and remained open until March 2024.

2.5 Usable responses

Data were reviewed to remove duplicates and invalid responses. Nine responses were identified as duplicates, where the same individual retook the survey, as indicated by matching IP addresses and / or matching names. An additional 42 responses were excluded for not meeting the minimum threshold of questions answered required for valid analysis.

This left a total of 715 valid survey responses. Of these, 14 participants selected the 'trailer boat' option, which directed them to the end of the survey, and they were not included in the analysis. This resulted in a final pool of 701 usable responses, with 619 participants completing section B (theory of planned behaviour) and 574 participants completing section C (discrete choice experiment) (Table 2).

Table 2. Breakdown of usable survey responses.

Detail of survey responses	Number of responses
Trailer boat users – removed from analysis	14
Total number of usable responses	701
Usable responses completing section B – theory of planned behaviour	621
Usable responses completing section C – discrete choice experiment	574

3. Basic information about participants

3.1 Regional distribution and boat mooring locations

The Auckland and Northland regions had the highest proportions of participants, with 336 (48%) and 172 (25%) of the 701 total participants, respectively. Wellington was the next largest hub with 43 responses, while Waikato and Bay of Plenty had 27 and 18 participants, respectively. In the South Island, responses mostly came from the top of the South Island, with Nelson, Marlborough and Tasman collectively contributing 73 responses, accounting for 10% of all participants. Participation for the rest of the South Island was very limited beyond Canterbury, which had 19 responses. Six participants did not specify their location (Figure 5). The geographic distribution of survey responses is broadly consistent with the national distribution of boat ownership, as described in Hilliam et al. (2024).

Regarding where boaters kept their most frequently used boat, 71% of participants kept them at marina berths, 27% on moorings and the remaining 2% in various locations, including jetties, wharves, river estuaries or anchored at sea. Additionally, 72% of participants reported sailing or motoring their boats between regions (Figure 5).

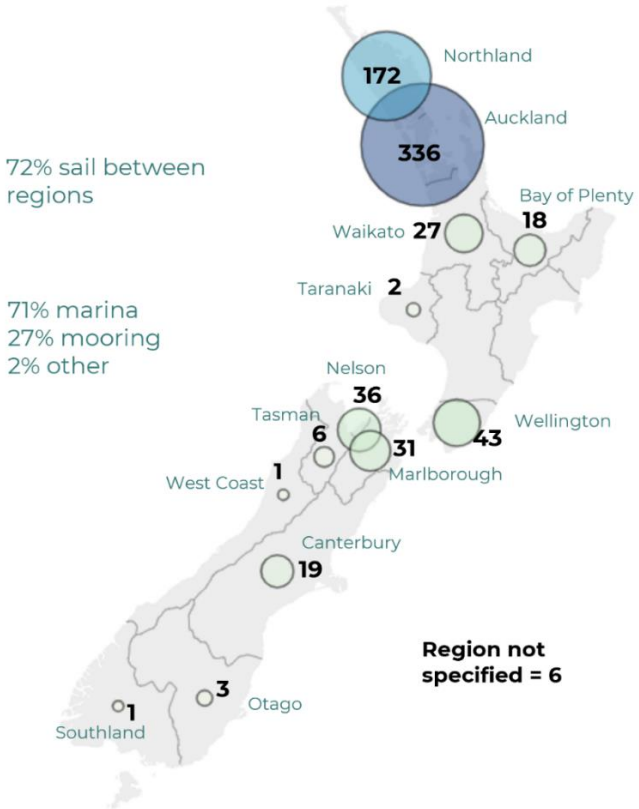


Figure 5. Distribution of locations where participants keep their boats by region in Aotearoa New Zealand (n = 701).

3.2 Boat ownership and usage

Boat ownership and length

The majority of participants (81%) owned one boat, while 13.6% owned two boats. Ownership of three boats was less common at 3.1%, and very few participants owned four or more boats (2.3% in total).

Survey respondents on average owned their most frequently used vessel for 11.5 years (mean value), with ownership durations ranging from 0 to 80 years. The highest frequency of ownership was within the 0- to 5-year range, with 288 participants (41%), followed by 154 participants (22%) owning boats for between 6 and 10 years, and 100 participants (14%) in the 11- to 15-year range. Ownership decreased steadily beyond 15 years, with only a small number of participants reporting ownership beyond 20 years. Very few participants had owned their boats for more than 50 years, and just one participant had owned a boat for 80 years.

Boat lengths ranged from 6 to 48 metres, with an average length of 11.8 metres. Over half of the boaters (51%) owned vessels measuring between 10 and 12 metres.

Boat usage and activity

The majority of participants used their boats between 0 and 60 days per year, with the highest number of respondents falling in the 31- to 60-day range. Usage decreased significantly beyond 90 days per year, with only a small number of participants using their boats more than 150 days annually. Four percent of participants reported using their boats extensively, i.e. over 330 days per year (Figure 6).

The vast majority of participants (96%) used their boats for personal purposes, with commercial and hire use each representing less than 1% of the total. Other uses, including categories such as racing and living aboard, accounted for a small remaining portion of responses. Notably, participants who lived aboard their boats were the primary group using their vessels for more than 300 days per year.

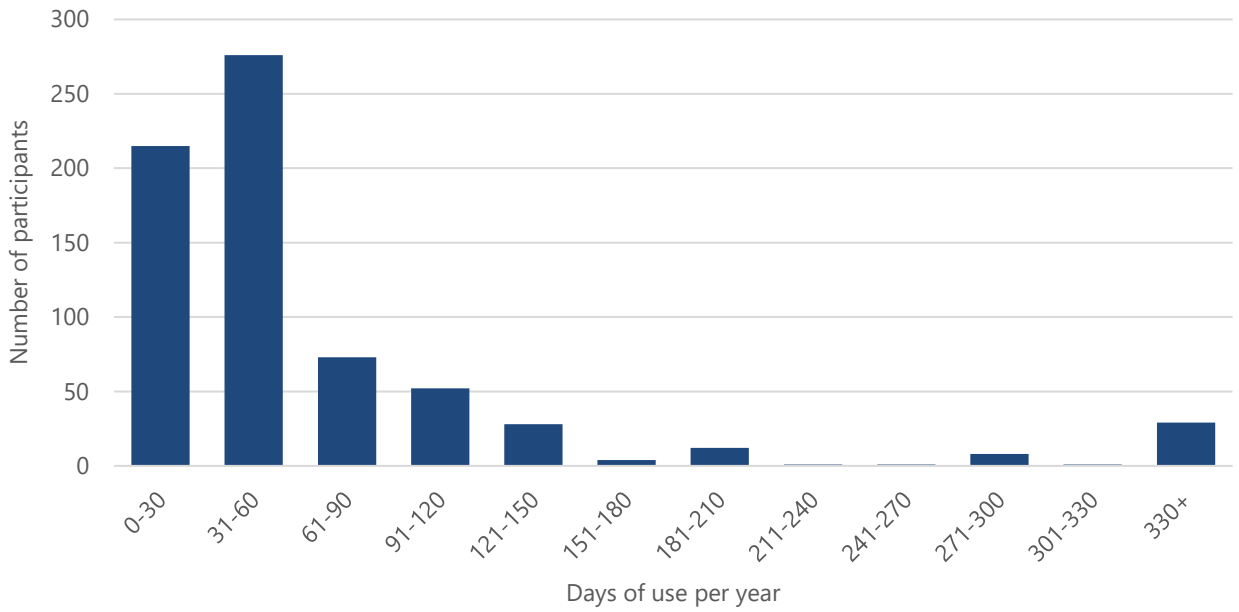


Figure 6. Participant distribution by days of boat use per year (n = 701).

3.3 Antifouling and hull cleaning practices

For the purposes of this survey, we differentiated between antifouling and other forms of physical hull cleaning. Most boaters reported antifouling their vessels every 1 to 3 years, with 37.2% doing so every 2 to 3 years and 29.6% annually. Notably, 16 of the 29 respondents who selected 'other' for antifouling indicated they used Coppercoat®, which (according to them) prevents biofouling for up to 10 years, explaining their reduced antifouling frequency (Table 3).

While 5.8% of respondents indicated they never physically clean their hulls, all of them did apply antifouling, with most applying it yearly. There were no participants who simultaneously neglected both antifouling and hull cleaning, highlighting a widespread commitment to at least one maintenance practice.

In contrast to antifouling, hull cleaning occurred more frequently, with 27.3% of respondents cleaning every 6 months and 24.6% every 3 months. Additionally, many of the 100 individuals who selected 'other' for hull cleaning reported doing so more frequently than the listed options – every 2 months, monthly, fortnightly or as needed. This suggests that while antifouling tends to follow a more predictable, longer-term schedule, many boaters adopt flexible and frequent cleaning routines to maintain hull cleanliness.

Table 3. Frequency of antifouling and hull cleaning practices among survey participants.

Frequency	Antifouling	% of total	Hull cleaning	% of total
Never	4	0.6	40	5.8
Every 5 years or more	8	1.2	2	0.3
Every 3 to 5 years	27	3.9	5	0.7
Every 2 to 3 years	255	37.2	16	2.3
Every 18 months	155	22.6	10	1.5
Yearly	203	29.6	154	22.4
Every 6 months	4	0.6	187	27.3
Every 3 months	0	0.0	169	24.6
Don't know	1	0.1	3	0.4
Other	29	4.2	100	14.6
Total	**686**	**100**	**686**	**100**

3.4 Boat cleaning methods, location and compliance

The majority of respondents (39.4%) cleaned their hulls themselves, while 35.4% hired a contractor. A smaller proportion use a combination of methods, including 12.5% who alternated between themselves and a contractor, 2.5% who cleaned with friends, and 10.1% who used various combinations involving family, crew and contractors (Table 4).

Table 4. Distribution of who usually cleans the recreational boat hulls owned by the survey participants (n = 672).

Who usually cleans your hull?	Number of responses	% of total
Myself	265	39.4
Contractor	238	35.4
Myself + contractor	84	12.5
Myself + friends	17	2.5
Other combinations (myself, friends, family, contractor, crew)	68	10.1
Total	**672**	**100**

Table 5 represents the cleaning methods used by recreational boaters, both when the boat was out of the water (e.g. haul-out) and in the water. When the boat was out of the water, the most common method was waterblasting (53.1%), followed by a combination of waterblasting and sanding (18.5%). Various other combinations of methods were reported in the remaining responses, including the use of brushes, wipes and sand.

For in-water cleaning, 15.5% of boaters used a dive brush, while 14.4% reported not cleaning in water, likely indicating reliance on haul-out facilities. Nearly 40% of those who cleaned in water opted for a single method, such as a dive brush, dive wipe or surface brush. Various other combinations of surface and dive tools were described by the remaining boaters.

Table 5. Distribution of cleaning methods used by recreational boaters when the boat is out of the water (e.g. haul-out) and when the boat is in the water, based on survey responses (n = 672).

Cleaning method out of water	Number of responses	% of total
Waterblast	357	53.1
Waterblast + sand	124	18.5
Waterblast + sand + brush	31	4.6
Waterblast + brush	31	4.6
Waterblast + wipe + sand + brush	24	3.6
Other combinations of these methods	105	15.6
Total	**672**	**100**
Cleaning method in water	**Number of responses**	**% of total**
Dive brush	104	15.5
None	97	14.4
Dive wipe	85	12.6
Surface brush	70	10.4
Surface brush + dive brush	49	7.3
Surface wipe + dive wipe	34	5.1
Dive brush + dive wipe	27	4.0
Surface brush + surface wipe + dive brush + dive wipe	24	3.6
Surface wipe	23	3.4
Other combinations of these methods	159	23.7
Total	**672**	**100**

While most boaters frequently cleaned their hulls at haul-out facilities (348 respondents), an even greater number reported that they would prefer to use haul-out facilities more often than they currently do (419 respondents). In-water cleaning was the second most common method (283 respondents), but fewer boaters actually preferred this method (184 respondents). While tidal grids were only frequently used by 21 respondents, this method was selected as most preferred by 50 respondents. Tidal inlets and other locations (including floating docks) were rarely used or preferred. These results suggest a preference for haul-out facilities over other cleaning locations, despite many boaters still cleaning in the water (Figure 7).

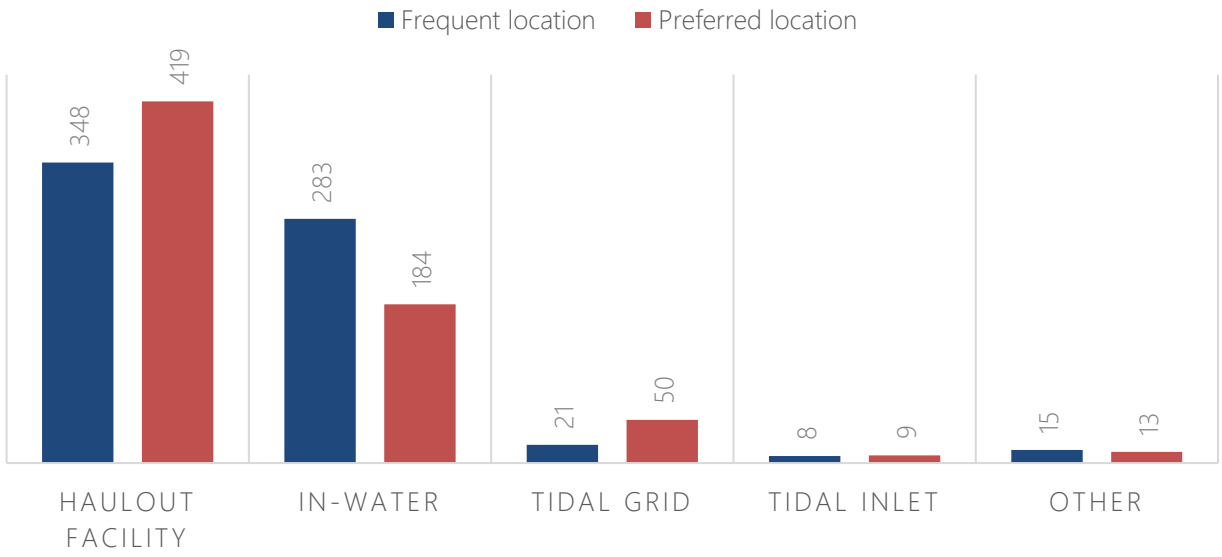


Figure 7. Most common cleaning locations in comparison to most preferred cleaning locations (n = 675).

A close analysis of the haul-out facility responses showed that the greatest percentage increase in preference for these facilities was in Waikato (44% rise, from 9 to13 respondents), followed by Northland (39% rise, from 60 to 83 respondents) and Auckland (20% rise, from 167 to 201 respondents). These results indicate a growing preference for haul-out facilities in these regions compared to the current number of boaters who frequently use them (Table 6).

Table 6. Breakdown of the percentage change by region of those who most commonly use haul-out facilities vs those who most prefer to use haul-out facilities. Only regions with 10 or more responses were included.

Region	Frequent haul-out	Prefer haul-out	% change
Waikato	9	13	44.4
Northland	60	83	38.3
Auckland	167	201	20.4
Bay of Plenty	12	14	16.7
Marlborough	22	25	13.6
Wellington	33	34	3.0
Nelson	25	25	0.0
Canterbury	12	11	-8.3

When boaters were asked if they had their boat specifically cleaned to meet rules or regulatory requirements in the past 12 months, almost half (46.9%) responded with *'no'*. Those who answered *'yes'* had their boats cleaned for regional regulations (23%), local marina regulations (14%) or a combination of the two (10%). Other reasons included cleaning as a requirement for entry into Aotearoa New

Zealand (< 2%) (Table 7). For the two regions with most respondents (Auckland and Northland), those who reported cleaning for compliance in Auckland did so 62% of the time for regional regulations versus 32% of the time to meet marina rules. In comparison, respondents from Northland showed a more balanced distribution, with 49% cleaning for marina compliance.

Table 7. Number of survey respondents who cleaned to meet compliance in the last 12 months.

Cleaned due to compliance?	Number of responses	% of total
'No'	315	46.9
'Yes': Regional regulations	155	23.1
'Yes': Marina regulations	94	14.0
'Yes': Regional + marina regulations	70	10.4
Don't know	16	2.4
Other	11	1.6

3.5 Expenditure and time

On average, respondents spent approximately $2,755 annually on hull cleaning, including antifouling and other cleaning methods, $6,439 on standard boat maintenance and $6,266 on mooring fees. These costs amount to around $15,460 per year per boat owner, with cleaning and antifouling making up 18% of the total annual expenses (Figure 8). This finding highlights that maintaining hull cleanliness is a significant financial commitment for boat owners.

In terms of time, participants devoted an average of 103 hours per year to boat maintenance, with 13 hours spent on antifouling and 9 hours on hull cleaning. Maintenance accounted for 83% of the total labour hours, while antifouling and cleaning together represented 18%, aligning with their proportional share of the total cost.

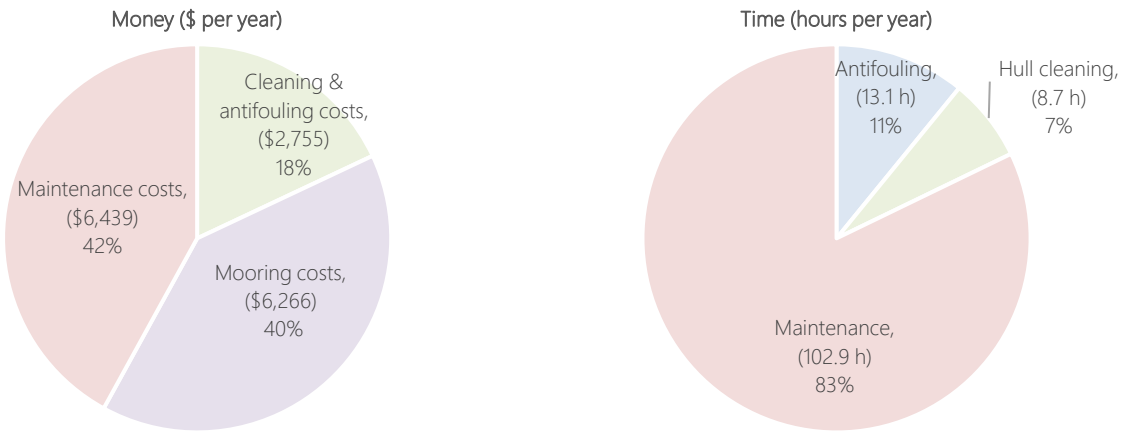


Figure 8. Average annual expenditure and time boaters allocate to maintenance, mooring, antifouling and cleaning (n = 686).

3.6 Demographics

Survey respondents were predominantly older, male and highly educated, although we cannot necessarily extrapolate this finding out to the boating community as a whole. Most participants were over the age of 60, with 56% aged between 60 and 74, compared to just 20% of the general Aotearoa New Zealand population in that range. Young boaters (under 40) accounted for less than 5% of the survey sample (Table 8). The vast majority of survey participants were male (87%), with female participants accounting for only 10% and the remaining participants choosing not to disclose their gender.

Respondents were predominantly European (89%), with limited representation from Māori (2.5%), Pacific peoples (0.8%), and other ethnicities (7.8%), reflecting less diversity than the national population. Respondents were typically highly educated, with 66% holding an undergraduate university degree or higher, and relatively affluent, with 40% reporting annual household incomes above $150,000 (Table 8).

Additionally, 83% of respondents were members of a boating association or club, and 75% report that they have a family history of sailing or boating.

Table 8. Demographic profile of survey respondents compared to the 2023 New Zealand census.

	Recreational boaters (% of survey sample)	2023 NZ Census (% of NZ population)
Age category		
20–29	0.8	17.3
30–39	3.8	19.2
40–49	10.5	16.5
50–59	17.3	16.7
60–69	37.9	14.7
70–79	26.7	10.1
80+	3.0	5.3
Total	**100.0**	**100.0**
Ethnicity		
NZ European	88.9	59.1
Māori	2.5	15.5
Pacific	0.8	7.7
Other	7.8	17.7
Total	**100.0**	**100.0**
Highest educational attainment		
None	1.4	
High school	9.8	
Trades / Diploma	23.1	
University graduate	30.5	
Honours	19.1	
Master / PhD	16.1	
Total	**100.0**	
Annual household income		
$20,000 or less	1.9	
$20,001–$30,000	3.7	
$30,001–$50,000	11.1	
$50,001–$70,000	11.4	
$70,001–$100,000	16.0	
$100,001–$150,000	16.7	
$150,001 or more	39.2	
Total	**100.0**	

4. What influences boaters to keep their hulls 'reasonably clean'?

The results presented in this section focus on the behaviour of boaters keeping their hulls '*reasonably clean at all times*'. The definition of *'reasonably clean'* used in this study is defined in Section 2.2.

This section is structured as follows:

1. We provide an overview of boater attitudes associated with keeping their hulls reasonably clean, social expectations (who influences their intention to clean their hulls), perceived behavioural control (the factors that affect their ability to keep their hulls reasonably clean at all times) and their level of concern for NIS.
2. We examine which factors statistically predict boaters' intentions to keep hulls reasonably clean.
3. We present responses to an open-ended question asking boaters what changes, incentives, rules or actions could help them maintain a reasonably clean hull.

At the outset, we asked boaters how often they keep their hulls 'reasonably clean or cleaner' across four frequency options: 'all of the time', 'some of the time', 'seldom', and 'never'. The majority of respondents (69%) reported keeping their hulls clean 'all of the time', while 28% maintained hull

cleanliness 'some of the time'. Only 3% indicated that they 'seldom' keep their hulls clean, and no respondents selected 'never' for this question (Figure 9).

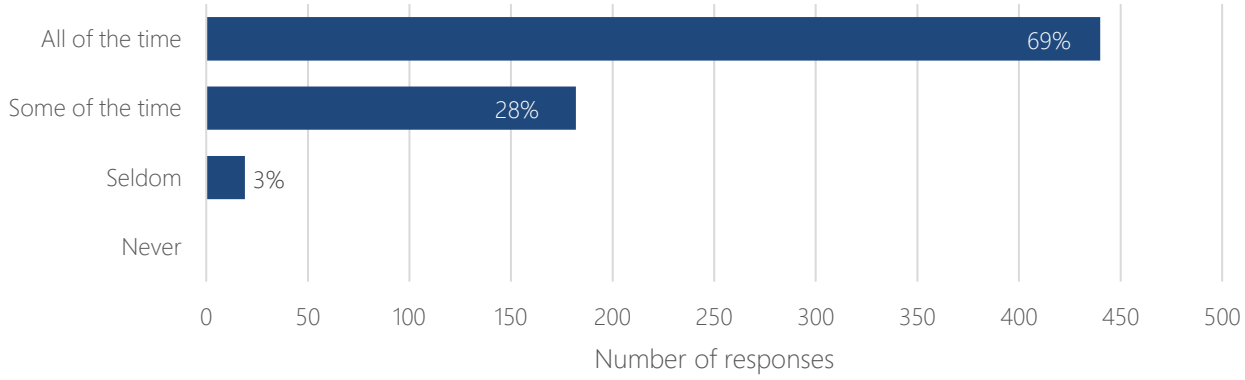


Figure 9. Self-reported frequency of keeping hulls 'reasonably clean or cleaner' across all boaters (n = 641).

Regional breakdowns showed similar trends, with Auckland, Wellington, Bay of Plenty and Tasman regions having the highest percentage of boaters (above 70%) keeping their hulls reasonably clean or cleaner. Slightly larger proportions of boaters from Marlborough, Northland and Waikato responded with 'some of the time'. There were very few responses from boaters from the Tasman, Otago, Southland, Taranaki and West Coast regions (Table 9).

Table 9. Regional breakdown of self-reported frequency of keeping hulls 'reasonably clean or cleaner' (n = 641).

Region	All of the time	%	Some of the time	%	Seldom	%	Never	%	Total
Auckland	226	72.0	81	25.8	7	2.2	0	0.0	**314**
Northland	91	61.1	52	34.9	6	4.0	0	0.0	**149**
Wellington	30	76.9	9	23.1	0	0.0	0	0.0	**39**
Nelson	23	67.6	10	29.4	1	2.9	0	0.0	**34**
Marlborough	17	60.7	11	39.3	0	0.0	0	0.0	**28**
Waikato	14	58.3	8	33.3	2	8.3	0	0.0	**24**
Bay of Plenty	14	82.4	3	17.6	0	0.0	0	0.0	**17**
Canterbury	10	62.5	4	25.0	2	12.5	0	0.0	**16**
Other	8	100.0	0	0.0	0	0.0	0	0.0	**8**
Tasman	5	83.3	1	16.7	0	0.0	0	0.0	**6**
Otago	1	33.3	2	66.7	0	0.0	0	0.0	**3**
Southland	0	0.0	1	100.0	0	0.0	0	0.0	**1**
Taranaki	1	100.0	0	0.0	0	0.0	0	0.0	**1**
West Coast	0	0.0	0	0.0	1	100.0	0	0.0	**1**
Total	**440**		**182**		**19**		**0**		**641**

4.1 Attitudes, social pressures and control factors

In this section, we present responses to a series of Likert-scale questions designed to assess boaters' attitudes towards keeping their hulls reasonably clean, the social expectations that influence their behaviour and the factors affecting their perceived control over maintaining hull cleanliness. For clarity, the figures presented exclude 'don't know' responses, although these percentages are available in Appendix 2. The proportion of 'don't know' responses was very small for each question, accounting for less than 2% of all responses.

Attitudes

Almost half of respondents agreed or strongly agreed that maintaining their hulls to a reasonably clean standard at all times was pleasant, while a quarter disagreed or strongly disagreed (Figure 10). In comparison, the vast majority of boaters thought that keeping their hulls clean was worthwhile work. This indicates that despite it not being pleasant work for some, respondents almost unanimously consider it a worthwhile task.

Slightly more boaters disagreed than agreed with the statement, '*I dislike rules and regulations to encourage cleaning*', and this sentiment remained reasonably consistent across regions. The next two statements explore conditional willingness to clean, with boaters showing slightly more emphasis on their willingness to clean if commercial boaters did their part too, in comparison to other recreational boaters. Nearly 40% of respondents expressed no strong opinion either way. Few boaters disagreed with these statements, highlighting a general openness to shared responsibility. Almost all boaters agreed that keeping their hulls reasonably clean at all times improves boat efficiency and boat speed.

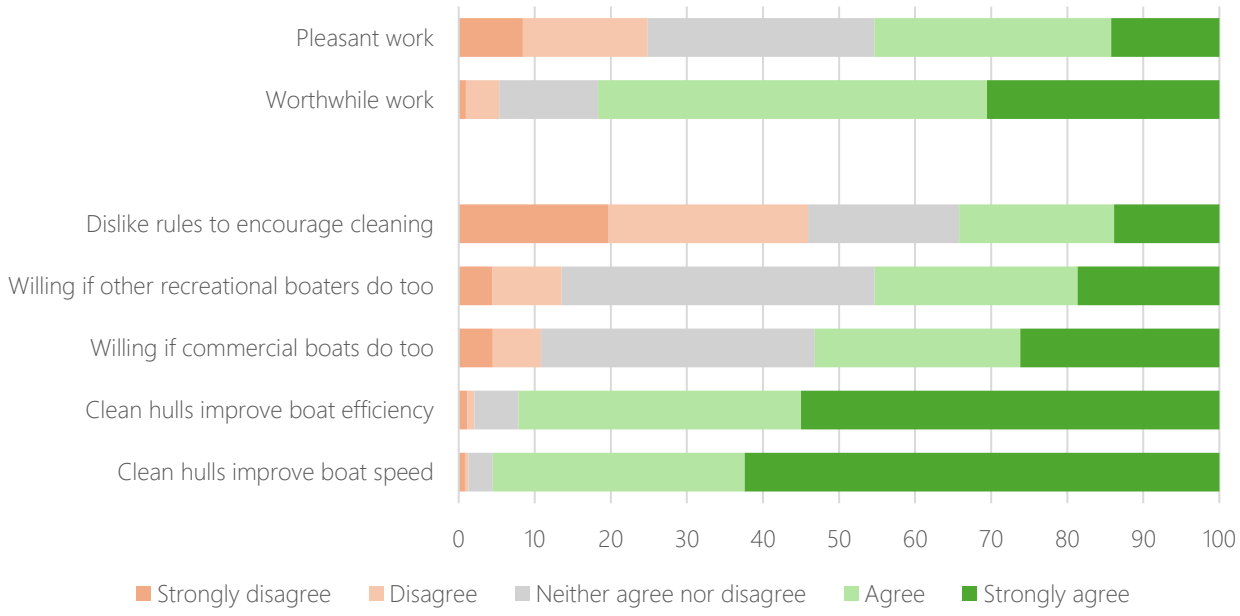


Figure 10. Responses to statements about attitudes associated with maintaining a reasonably clean hull at all times.

Who influences boaters' intentions to clean their hulls?

Regarding social expectations (also known as 'subjective norms'), few groups had a strong influence on boaters' intentions to keep their hulls reasonably clean. Local hapū / iwi had the least influence, likely reflecting the fact that only 2.5% of the survey respondents identified as Māori. Local authorities influenced about a third of respondents, as did the sailing / boating community, indicating some level of influence from both peers and regulatory bodies.

The potential impacts to the aquaculture and seafood industry emerged as the most influential factor, with nearly half of boaters agreeing that it shapes their intentions to clean their hulls (Figure 11). This sentiment was most pronounced for boaters in Auckland (150 agree vs 75 disagree), Marlborough (16 agree vs six disagree), and Bay of Plenty (11 agree vs two disagree).

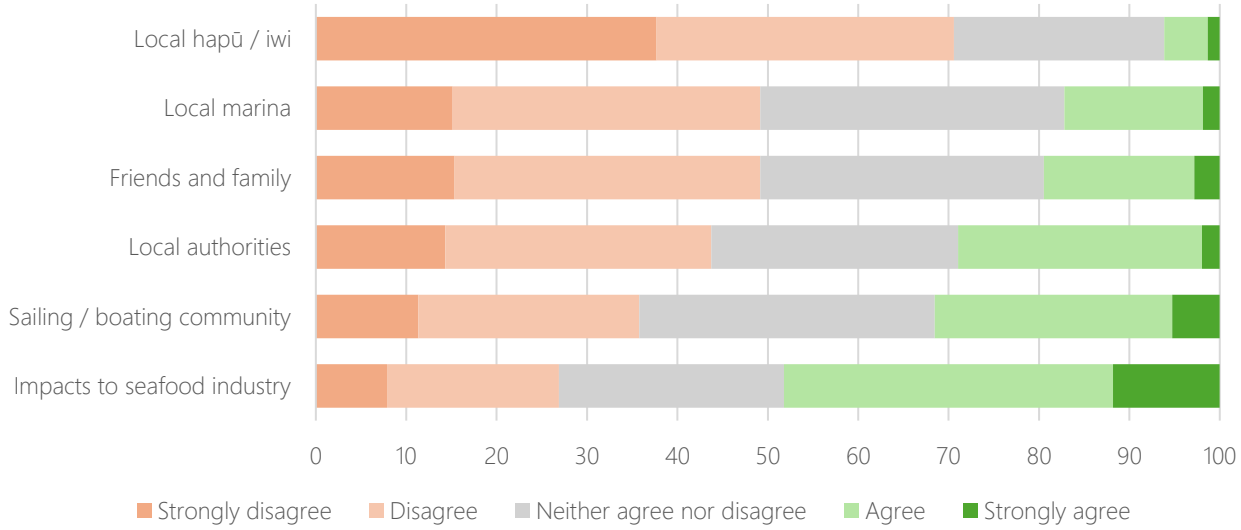


Figure 11. Responses to statements about the influence of societal groups on boaters' intentions to keep their hulls reasonably clean.

What factors affect boaters' abilities to maintain a clean hull?

These factors relate to boaters' beliefs about how easy or difficult it is to keep their hulls reasonably clean at all times (also known as perceived behavioural control). Almost twice as many boaters disagreed than agreed with the statement that keeping their hulls reasonably clean is excessively time-consuming. In comparison, slightly more boaters agreed than disagreed with the idea that maintaining their hull is excessively costly. This suggests that cost plays more of a prohibitive role than time in relation to maintaining hulls to a reasonably clean standard (Figure 12). When separating boaters by income bracket, those with household incomes below $100k were more likely to agree that hull cleaning is excessively costly (44%) compared to those who disagreed (35%). For higher-income earners (over $100k), a smaller percentage (30%) agreed with the cost being excessive, while 38% disagreed.

More than half of boaters disagreed that they have sufficient cleaning facilities in their area. The disparity was largest for respondents in Auckland, with 60% of boaters disagreeing that the cleaning facilities were sufficient versus 31% who perceived the facilities as adequate. Northland, Waikato and Nelson regions had slightly higher proportions of boaters who believed that the cleaning facilities were not sufficient compared to those that responded positively. In contrast, in Wellington, Bay of Plenty and Marlborough, more than twice as many boaters believed that they had sufficient cleaning facilities compared to those who disagreed.

A fairly even spread of boaters agreed and disagreed that keeping their hulls reasonably clean is easy work, suggesting that more than a third of respondents find the task difficult. Interestingly, more boaters believe that it is too late to contain the spread of marine invasive species than those who do not. This may suggest a sense of resignation or perceived futility – almost as though '*the horse has already bolted*' – among nearly half of the respondents. A slightly higher proportion of boaters believe that it is easy to access haul-out facilities than those who do not. The majority of boaters felt that they had clear information in their area about where and how to clean their hulls, and that haul-out operators can clean their hulls to a reasonable standard when they are accessible.

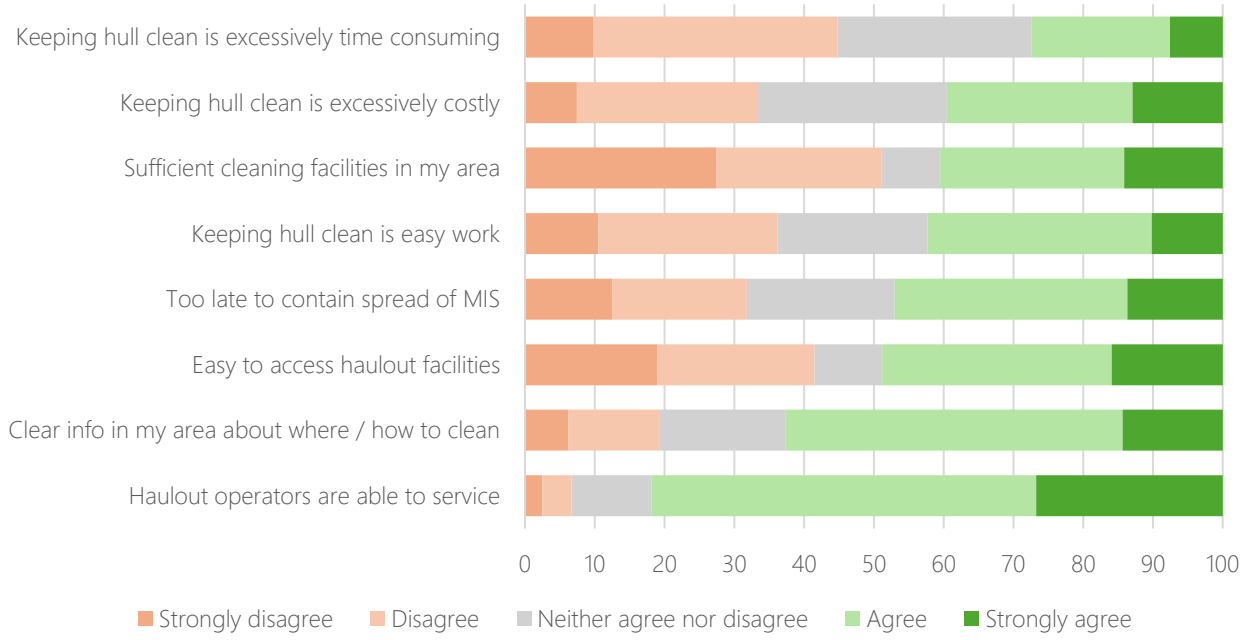


Figure 12. Responses to statements about the factors that affect boaters' ability to keep their hulls reasonably clean at all times.

Concerns for spread of marine invasive species

The results indicate that boaters almost unanimously agree that NIS cause negative impacts to marine areas, express concern about the spread of NIS, and feel a sense of responsibility to help prevent the spread of NIS by keeping their hulls reasonably clean. Despite this strong sense of awareness and responsibility, almost half of boaters agreed that it is too late to contain the spread of NIS (Figure 13).

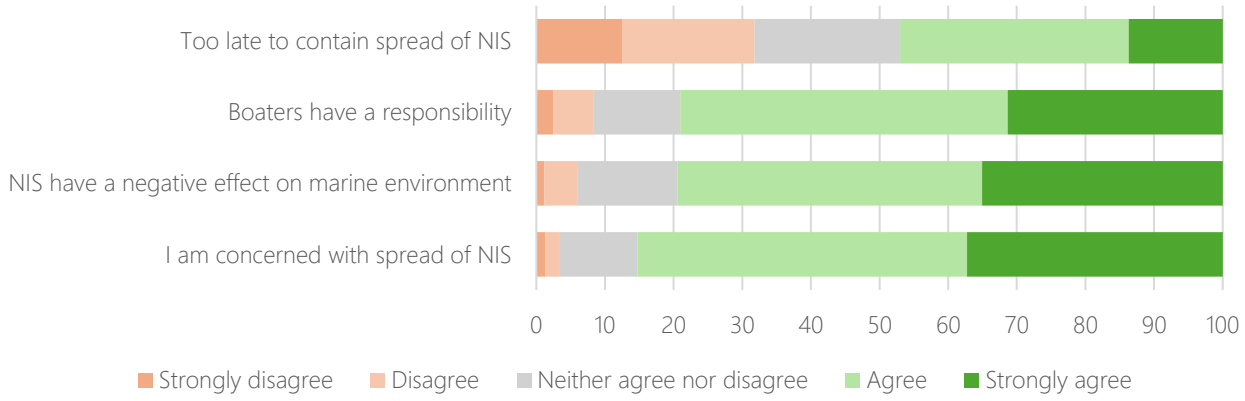


Figure 13. Responses to statements about boaters' levels of concern for the spread of non-indigenous marine species (NIS).

Intention

The intention question is the strongest predictor of actual behaviour (Ajzen 1991). In response to the statement, *'I am likely to keep my hull reasonably clean at all times'*, around 84% of boaters either agreed or strongly agreed, indicating a high level of intention to engage in this behaviour (Figure 14).

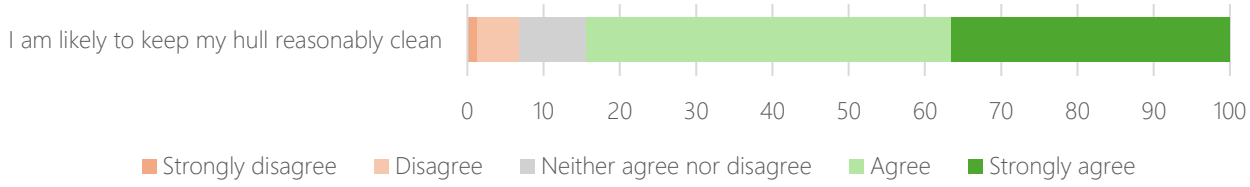


Figure 14. Responses to the intention question statement, *'I am likely to keep my hull reasonably clean'*.

4.2 Predictors of hull cleaning intentions

Predictors of hull maintenance intentions: multiple regression results

The multiple regression analysis helped identify which variables (attitudes, perceived control, subjective norms, etc.) most significantly influence recreational boaters' intention to *'keep their hulls reasonably clean at all times'*, with notable differences across regions and income groups. Age was not included in the analysis, as there were too few younger participants to allow for meaningful cross-age comparisons.

To validate the use of intention as a key factor in predicting behaviour, we also ran the analysis using the behaviour question *('My hull is reasonably clean or cleaner … all of the time, some of the time, seldom, never'*) as the outcome being predicted (see Appendix 3). This revealed a statistically strong positive relationship between intention and behaviour for all boaters when grouped, and across all regions except Northland, where significance bordered on the threshold. The intention question *('I am likely to keep my hull reasonably clean at all times'*) emerged as the strongest predictor of actual behaviour among all the variables. These findings suggest that understanding and supporting boaters' intentions can help encourage cleaner hull maintenance.

Overall findings

For the full dataset, four variables emerged as significant predictors of intention. Boaters were more likely to maintain clean hulls if they believed it was worthwhile work ($b^* = 0.41$, $p < 0.001$) and easy work ($b^* = 0.19$, $p < 0.001$). Additionally, the perception that boaters have a responsibility to prevent the spread of marine invasive species positively influenced intention ($b^* = 0.11$, $p = 0.01$). Furthermore, the negative coefficient for 'excessively time-consuming' ($b^* = -0.16$, $p < 0.001$) suggests that boaters who disagree – those who do not find cleaning too time-consuming – are more likely to maintain a clean hull (Table 10).

Regional insights

The regional analysis grouped responses from Auckland and Northland separately, with all other regions combined into broader categories due to smaller sample sizes. Auckland had the largest number of significant predictors, aligning closely with the results for all boaters, but with additional influences such as the belief that clean hulls improve boat speed and the influence of local authorities and the sailing community. The influence of local authorities is perhaps unsurprising given Auckland's fouling standards (LoF2) for all recreational boaters. 'Worthwhile work' was the strongest predictor of intention across most regions, indicating that attitude plays a significant role in the likelihood that boaters will keep their hulls reasonably clean at all times.

In Northland, the importance of boat efficiency ($b^* = 0.25$, $p = 0.02$) and whether adequate cleaning facilities were available ($b^* = 0.19$, $p = 0.04$) also emerged as predictors of intention, suggesting a stronger focus on practical factors and efficiency-related benefits.

For boaters in the rest of the North Island, worthwhileness ($b^* = 0.56$, $p < 0.001$) and easiness ($b^* = 0.29$, $p = 0.02$) were the only significant predictors. Interestingly, the South Island had no

significant predictors, indicating fewer clear motivational patterns in that region – possibly a result of grouping respondents from across broad regions.

Income-based differences

Income brackets revealed distinct differences in predictors. For boaters with a household income below $100,000, the only significant predictor was the belief that cleaning is worthwhile work ($b^* = 0.50$, $p < 0.001$). In contrast, those with household incomes over $100,000 had nine predictors, including 'worthwhile work'. Interestingly, this group displayed slight negative associations with being influenced by local authorities ($b^* = -0.14$, $p = 0.02$) and concern for the spread of NIS ($b^* = -0.18$, $p = 0.02$), suggesting that some higher-income boaters may feel less driven by external pressures or environmental concerns.

Table 10. Results of multiple regression analysis showing standardised coefficients (b*) and p-values for predictors of boaters' intention to maintain a 'reasonably clean hull at all times'. The analysis is presented for the full dataset (all boaters) as well as by region and income bracket. Significant predictors ($p < 0.05$) are highlighted in red. Variables are grouped by their component: A (attitudes), PBC (perceived behavioural control), SN (subjective norms), and IC (invasive species concern).

		All boaters		Auckland		Northland		Rest of North Island		South Island		Income <100k		Income >100k	
Component	**Variable**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**
A	**Willing if commercial boats do too**	-0.03	0.46	0.01	0.85	-0.14	0.14	0.14	0.40	-0.13	0.34	-0.07	0.51	-0.08	0.21
A	**Clean hulls improve boat efficiency**	0.01	0.76	-0.07	0.20	0.25	0.02	0.06	0.62	0.16	0.19	-0.05	0.52	0.06	0.26
A	**Dislike rules to encourage cleaning**	0.05	0.15	0.09	0.06	-0.01	0.89	0.07	0.64	0.04	0.77	0.12	0.06	0.03	0.64
A	**Clean hulls improve boat speed**	0.07	0.10	0.12	0.04	-0.11	0.27	-0.14	0.34	0.17	0.16	0.06	0.41	0.10	0.10
A	**Willing if rec boaters do too**	0.07	0.10	0.07	0.25	0.06	0.53	-0.20	0.28	0.19	0.17	0.03	0.81	0.19	0.00
A	**Pleasant work**	0.02	0.64	-0.02	0.61	0.05	0.45	0.01	0.95	0.20	0.10	-0.02	0.79	0.04	0.42
A	**Worthwhile work**	0.41	0.00	0.42	0.00	0.49	0.00	0.56	0.00	0.14	0.20	0.50	0.00	0.28	0.00
PBC	**Keeping hull clean is easy**	0.19	0.00	0.25	0.00	0.15	0.05	0.29	0.02	0.06	0.66	0.12	0.11	0.27	0.00
PBC	**Excessively time-consuming**	-0.16	0.00	-0.16	0.01	-0.08	0.39	-0.05	0.79	-0.23	0.11	-0.12	0.15	-0.14	0.05
PBC	**Excessively costly**	-0.06	0.16	-0.01	0.81	-0.15	0.10	-0.22	0.15	0.04	0.80	-0.12	0.11	0.01	0.94
PBC	**Too late to contain spread of NIS**	0.05	0.14	0.08	0.09	0.04	0.59	0.13	0.31	0.02	0.85	0.03	0.64	0.15	0.01
PBC	**Haul-out operators able to service**	-0.01	0.80	-0.01	0.85	0.05	0.48	-0.06	0.59	-0.05	0.70	0.04	0.55	-0.05	0.30
PBC	**Adequate cleaning facilities in area**	0.00	0.93	-0.05	0.40	0.19	0.04	-0.05	0.81	0.06	0.77	0.07	0.44	-0.05	0.55
PBC	**Clear info in my area**	0.00	0.97	0.03	0.52	-0.11	0.13	-0.17	0.27	0.02	0.90	-0.07	0.32	0.06	0.33
PBC	**Easy to access haul-out facilities**	0.00	0.95	-0.01	0.83	-0.16	0.07	0.24	0.21	0.07	0.72	-0.05	0.55	0.02	0.79
SN	**Influenced by local marina**	0.06	0.12	0.06	0.27	0.15	0.08	0.04	0.77	-0.16	0.34	-0.02	0.74	0.15	0.02
SN	**Influenced by friends & family**	-0.03	0.43	-0.07	0.24	0.03	0.72	-0.28	0.11	0.11	0.41	0.05	0.56	-0.09	0.14
SN	**Influenced by hapū/iwi**	-0.03	0.37	-0.01	0.79	-0.05	0.52	0.12	0.31	-0.13	0.37	-0.06	0.35	-0.01	0.83
SN	**Influenced by seafood industry**	0.01	0.79	-0.02	0.70	-0.01	0.86	0.09	0.46	0.16	0.16	0.04	0.56	-0.02	0.66
SN	**Influenced by local authorities**	-0.05	0.18	-0.11	0.03	0.02	0.78	0.00	1.00	0.16	0.42	0.04	0.62	-0.14	0.02
SN	**Influenced by sailing community**	0.07	0.07	0.14	0.02	-0.02	0.82	0.14	0.36	0.04	0.76	0.04	0.62	0.04	0.51
IC	**NIS has negative effects**	0.02	0.66	-0.03	0.67	0.09	0.42	-0.10	0.45	0.08	0.56	-0.09	0.25	0.18	0.02
IC	**Boaters have a responsibility**	0.11	0.01	0.16	0.01	0.01	0.94	0.03	0.84	0.16	0.32	0.13	0.14	0.23	0.00
IC	**I am concerned with spread of NIS**	-0.02	0.64	0.06	0.36	-0.06	0.55	0.08	0.58	-0.05	0.75	0.07	0.37	-0.18	0.02
	Valid responses	n = 552		n = 278		n = 138		n = 62		n = 76		n = 168		n = 219	

Unpacking boater motivations: themes from factor analysis

Using factor analysis, we identified a smaller set of underlying factors that explain most of the variation among the 24 questions (variables) included in this section. Factor analysis helped reduce the complexity of the data by grouping correlated variables into factors, each representing a specific theme or pattern of thought.

In this case, four distinct factors emerged, indicating their importance in explaining the variance in responses. Table 11 shows all the variables that strongly relate to each of the four factors and the positive or negative association of each variable to that factor. By examining the variables and their corresponding loading values for each factor, we developed conceptual themes for each factor that reveal insights into how boaters perceive and approach hull maintenance.

Factor 1: Proactive group

This factor captures a broad spectrum of variables (14 of the 24) and represents a highly motivated group of boaters. By examining the size and direction of the loading values for each variable, we see that these boaters believe that maintaining reasonably clean hulls at all times is both worthwhile and manageable. They feel that they have sufficient access to facilities and information to support their efforts. They do not view regulatory measures negatively and disagree with the idea that hull cleaning is excessively costly or time-consuming, or that it is too late to control the spread of marine invasive species. They are also motivated by a sense of responsibility and are influenced by potential effects of NIS on the environment including the aquaculture and seafood industry (Table 11).

Factor 2: Social influence group

This factor revolves exclusively around social influence – the extent to which others influence a boater's intention to maintain a reasonably clean hull – from five key societal groups. The strongest influence comes from local authorities, followed by local marinas, members of the sailing community, and friends and family. Local hapū / iwi exert the least influence, although still contribute to shaping intentions. This factor highlights the importance of social norms and expectations in shaping boater behaviour (Table 11).

Factor 3: Lack of access and conditional willingness group

This factor describes a sub-set of boaters who feel that they lack access to sufficient cleaning facilities, haul-out services or information regarding how and where to clean their boats in their area. Their willingness to keep their boat hulls reasonably clean at all times is somewhat conditional, depending on whether commercial boaters and other recreational boaters also keep their hulls clean (Table 11).

Factor 4: Lower NIS concern and strong conditional willingness group

This factor reflects a group of boaters whose willingness to maintain reasonably clean hulls at all times is more strongly conditional on the actions of others, specifically whether commercial or recreational boaters also keep their hulls clean. They also tend to disagree with the idea that NIS are causing significant environmental and social-economic impacts and are less concerned with the spread of NIS (Table 11). Intuitively, this group is less likely to keep their hulls reasonably clean at all times than the other groups.

Table 11. Factor loadings (pattern matrix) of four factors with eigenvalues > 1, derived from 25 variables related to boater behaviour, attitudes, social norms and control factors. Variables are grouped by TPB coding: A (attitudes), PBC (perceived behavioural control), SN (subjective norms), and IC (invasive species concern). Positive and negative loading values indicate the strength and direction of each variable's contribution to the corresponding factor. Only loading values above ±0.4 are displayed.

TPB coding	Variable (question)	Factor 1	Factor 2	Factor 3	Factor 4
A	I would be willing to keep my hull reasonably clean at all times if commercial boats keep their hulls reasonably clean too			0.440	0.481
A	Keeping my hull reasonably clean at all times would improve my fuel efficiency				
A	I dislike the idea of using rules and regulations to encourage boaters to keep their boat hulls reasonably clean at all times	-0.485			
A	Keeping my hull reasonably clean at all times would improve my boat speed				
A	I would be willing to keep my hull reasonably clean at all times if other recreational boat owners keep their hulls reasonably clean too			0.407	0.475
A	Maintaining my hull to a reasonably clean standard at all times would be pleasant work	0.440			
A	Maintaining my hull to a reasonably clean standard at all times would be worthwhile work	0.625			
PBC	It is already too late to contain the spread of introduced marine organisms within New Zealand	-0.409			
PBC	It would be easy for me to keep my hull reasonably clean at all times	0.560			
PBC	Maintaining my hull to a reasonably clean standard at all times would be excessively time-consuming	-0.588			
PBC	Maintaining my hull to a reasonably clean standard at all times would be excessively costly	-0.478			
Intention	I am likely to keep my hull reasonably clean at all times	0.5971			
PBC	Haul-out facility operators are able to clean my hull to a reasonably clean standard				
PBC	There are sufficient cleaning facilities in my area for keeping my hull clean	0.471		-0.562	
PBC	I have access to sufficient and clear information describing where and how I can clean my hull	0.443		-0.406	
PBC	I can easily access a haul-out facility when I need to clean my hull	0.456		-0.523	
SN	People who work at my marina influence my intentions to keep my hull clean		0.547		
SN	My friends and family influence my intentions to keep my hull clean		0.494		
SN	Local iwi or hapū influence my intentions to keep my hull clean		0.474		
SN	Potential impacts to the aquaculture and fishing industry influence my intentions to keep my hull clean	0.418			
SN	Local authorities influence my intentions to keep my hull clean		0.591		
SN	Members of the sailing community influence my intentions to keep my hull clean		0.540		
IC	Introduced marine organisms are causing negative environmental, cultural, social and / or economic impacts in New Zealand marine areas right now	0.558			-0.403
IC	Recreational boaters have a responsibility to maintain a reasonably clean hull at all times to prevent the spread of introduced marine organisms	0.734			
IC	The spread of introduced marine organisms is of concern to me	0.586			-0.427

4.3 Boater suggestions for supporting clean hulls

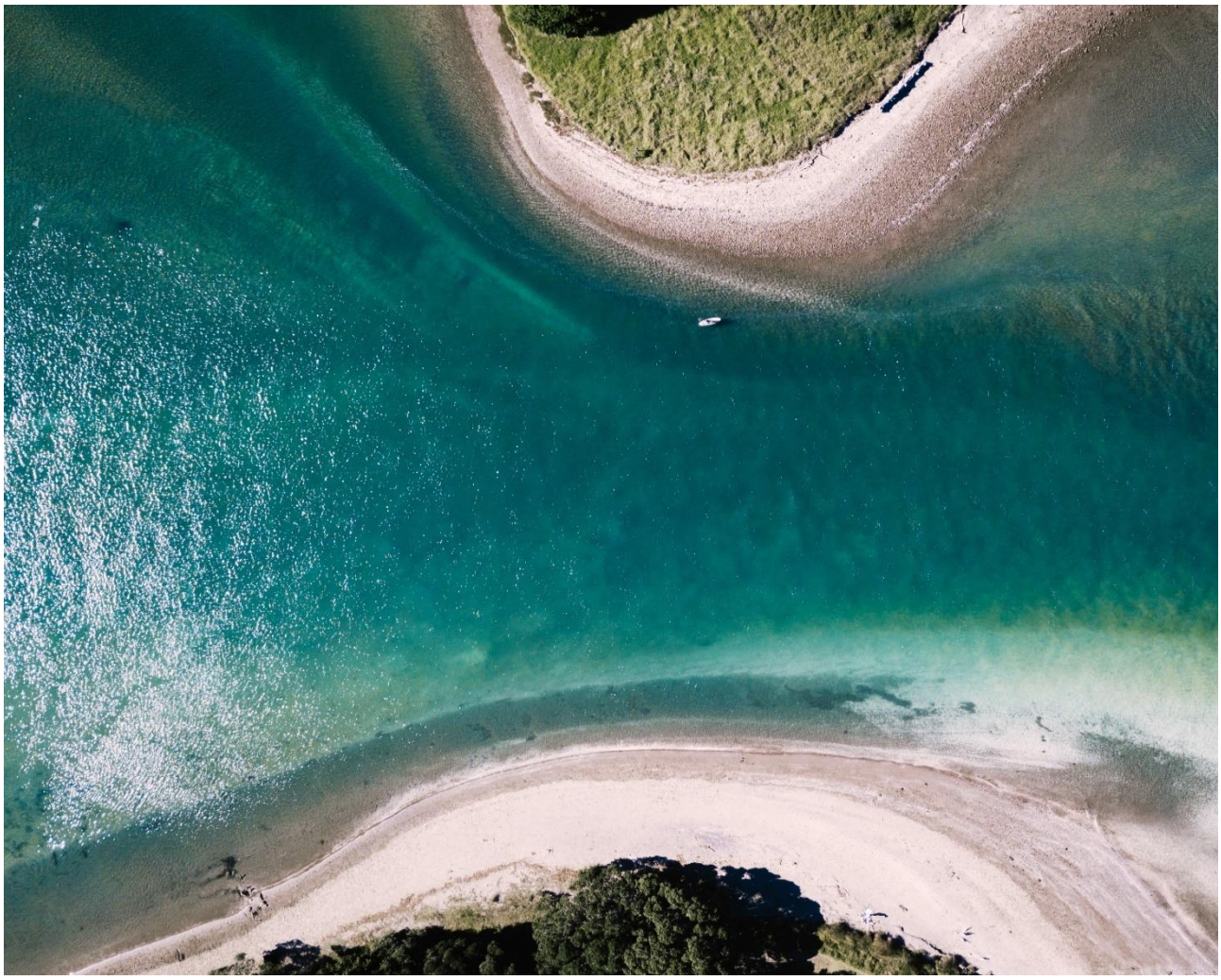
We received 444 written responses to the question, *'What changes, incentives or regulations would improve your ability to keep your hull clean?'*. We categorised these responses by themes in order of most frequently mentioned (Table 12).

Table 12. Overview of themes, common points and suggestions from recreational boaters regarding ways to improve their ability to keep their hulls clean.

Theme	Common points	Suggestions
1. More haul-out facilities	Many boaters cited the shortage of haul-out facilities, especially in Auckland and other busy regions, and the closure of some facilities due to urban development as a barrier to hull maintenance.	Increase the number of haul-out facilities, particularly in underserved areas. Protect existing facilities from closure. Include facilities in larger hubs that can cater to multihulls and wider boats.
2. High costs of haul-out services	The high cost of hauling out and cleaning boats was frequently mentioned as a disincentive to regular hull maintenance.	Introduce more competitive pricing options, and lower regional council fees to moored crafts. Offer lower-cost, quick haul-out and clean options. Encourage competition in the market.
3. Antifouling effectiveness	Many boaters feel current antifouling products are less effective, particularly since regulations restricted the use of stronger chemicals.	Support research into more effective, environmentally friendly alternatives. Keep the public aware of research and technology advances in this space.
4. DIY and self-cleaning options	Explore safer, more flexible self-cleaning methods, such as in-water cleaning, to meet boater needs.	Relax restrictions on in-water cleaning for light fouling and locally derived fouling (e.g. boats that have not moved since last clean), using acceptable methods or non-biocidal coatings that have lower contamination risks. Allow more flexible self-cleaning options in marinas, implement diver-friendly policies and increase the number of tidal cleaning grids in certain locations.
5. Incentives and rewards	Incentives or rewards to complement existing rules and regulations may motivate boaters to keep their hulls clean.	Offer discounts for second haul-out services within the year or implement concession cards for multiple cleanings. Implement reward / discount systems for responsible boaters and clean hull certifications.
6. Biosecurity management for commercial vessels	There was a perception from some that biosecurity regulations target recreational boaters, while commercial vessels are seen as larger culprits.	Enforce stricter biosecurity checks and cleaning requirements on domestic commercial vessels (noting that international commercial ships already undergo Craft Risk Management Standards upon entry).
7. Consistency in rules	Some boaters were frustrated with varying regional regulations, making it difficult to understand or comply with hull cleaning requirements.	Standardise biosecurity rules nationwide to create consistency and avoid confusion. Ensure communication is clear and accessible to all boaters.

Theme	Common points	Suggestions
8. Marina infrastructure	Some boaters highlighted opportunities for marinas to enhance infrastructure cleanliness or signage in some areas, which would help reduce the likelihood of rapid re-colonisation of hulls following cleaning.	Encourage marinas to adopt regular cleaning schedules for pontoons and other structures in some areas, if feasible. Support biosecurity compliance through clear signage and communication and displaying problem species information at marinas to raise awareness.
9. Education and awareness	Some boaters noted a lack of clear communication or education on biosecurity risks and hull cleaning regulations.	Improve education on biosecurity through clubs, marinas and coastguard communications. Promote environmental and performance benefits of clean hulls and compliance with regulations.

5. Preferences and trade-offs: how boaters value ecological health, efficiency and biosecurity policies



The discrete choice experiment (DCE) investigated boaters' willingness to contribute financially toward various outcomes, while acknowledging the need to balance this with practical realities they face. These findings reflect values and trade-offs boaters are willing to consider, highlighting a shared opportunity for all stakeholders – boaters, decision-makers and the commercial sector – to collaborate for improved outcomes. We may interpret these results as a willingness to further invest in hull cleanliness *when clear benefits and guarantees of those outcomes are established*, while also recognising the financial concerns that boaters may already navigate.

We analysed DCE data from 574 respondents using the error components mixed logit model (EC model), as detailed in Appendix 4. Of the three outcomes that boaters were asked to choose from – namely, improved marine ecosystem health, reduced boat maintenance and fuel costs and better consistency in regional biosecurity policies – improved ecosystem health was, on average, the most valued.

Based on the EC model, we calculated how much boaters were willing to pay (WTP) for these improvements (Figure 15). The data show that a recreational boater, on average, was willing to pay an additional $898 per year for a basic improvement in ecosystem health (Level 1) and approximately $1,173 per year for the highest level of improvement (Level 2). The median WTP of $1,018 for Level 2 was the highest across all attributes, but responses varied widely, indicating a wide range of individual opinions.

The second most valued outcome was better boat maintenance and fuel efficiency. A typical boater was willing to pay an additional $727 per year for a basic improvement in this area. For improved biosecurity policies, boaters were willing to spend an extra $400 per year, for either one national policy or better coordination between regions.

The willingness to pay values presented above represents the benefits that recreational boaters attribute to *guaranteed* improvements in ecosystem health, boat efficiency and biosecurity policies. These estimates can be used in cost-benefit analyses to account for the non-market values associated with maintaining clean hulls in decision-making processes. They also indicate the relative importance of these attributes to boaters. However, these values should not be interpreted as direct monetary estimates for charging recreational boaters the stated amounts; boaters were asked to select their preferred option from a range of valuation scenarios, and boaters typically chose improved conditions alongside an increase in their current hull cleaning expenses. Implementing these WTP estimates in policy would require collaboration with economists who are experienced in effectively applying these estimated non-market values, and further consultation and engagement with boaters would also be needed.

Overall, these results suggest that on average, boaters are not fully satisfied with the status quo and would support investing in initiatives that lead to guaranteed improvements in marine environmental outcomes, boating efficiency and more streamlined marine biosecurity policies. Therefore, engaging boaters in the development of such initiatives would be beneficial to ensure their perspectives are considered and to increase support for practical, effective solutions.

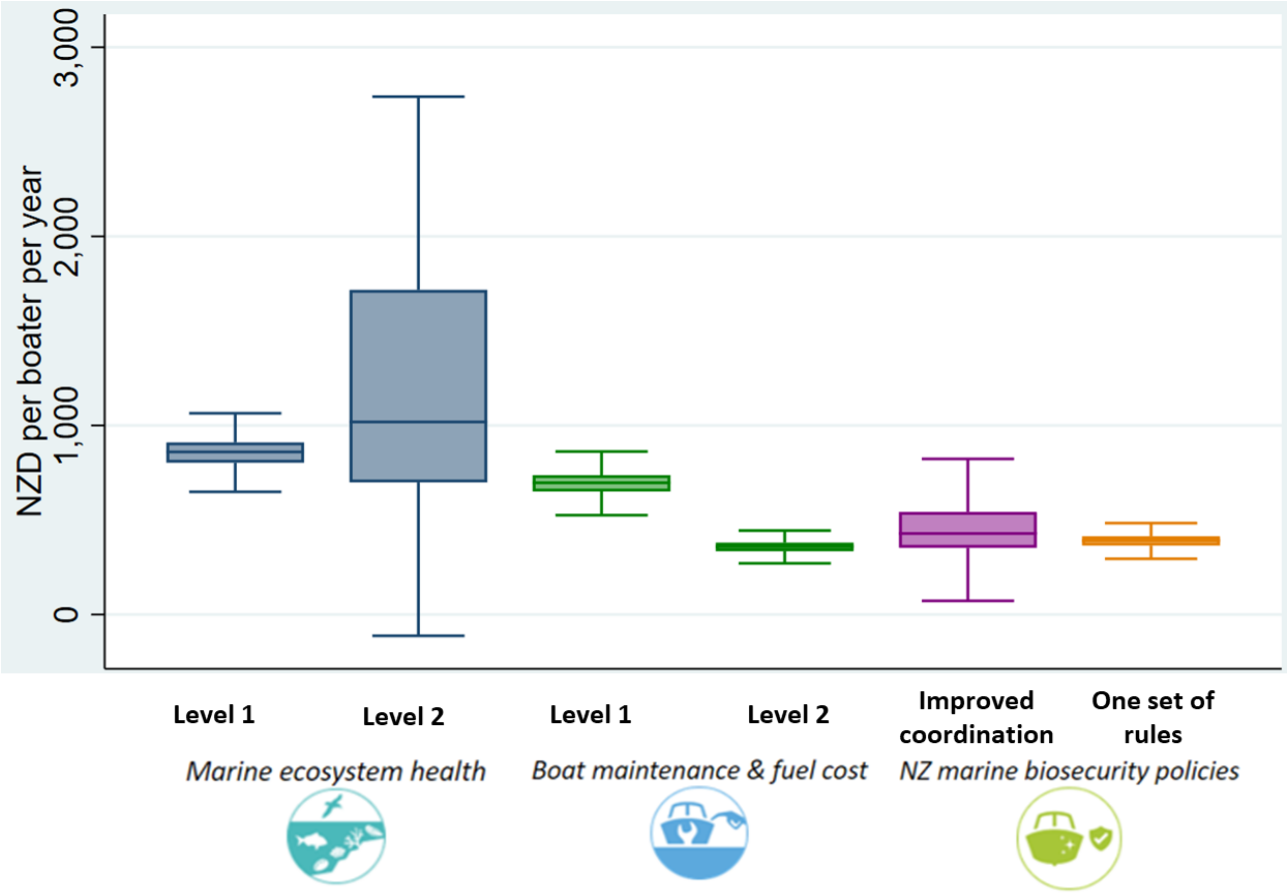


Figure 15. Summary of individual specific willingness to pay among recreational boat owners (n = 574) for improved outcomes. For simplicity, outliers have been excluded from the box plot.

The LC model allowed us to categorise boaters into groups based on how they selected their preferred option from among the three choices presented in each of the six choice situations in the experiment. Results show three distinct groups (or classes) of boaters (Table 13):

Class 1, the largest group, makes up 56% of respondents (321 boaters). These boaters are generally supportive of change and willing to invest in hull cleaning activities to achieve all three outcomes: better marine ecosystem health, improved boat efficiency and streamlined biosecurity policies across Aotearoa New Zealand.

Class 2 accounts for 24% of respondents. This group is primarily focused on improving marine ecosystem health. They are willing to pay more for hull cleaning if it results in measurable ecological improvements, especially moving from a basic to a higher level of improvement. Interestingly, the coefficient for additional cleaning cost is positive and borderline significant, suggesting that this group is highly invested in achieving these outcomes. They likely see the added cost as a worthwhile investment, believing the benefits outweigh the expense.

Class 3 comprises 20% of respondents (114 boaters). This group is generally satisfied with the status quo, as indicated by the significant positive status quo coefficient. They do not demonstrate support for improvements in marine ecological health and seemingly oppose the notion of paying more for one set of biosecurity policies across Aotearoa New Zealand. However, they are open to further investing in hull cleaning for small improvements in boating efficiency (Level 1).

These insights highlight the varying preferences and priorities among different groups of boaters. The success of future initiatives will depend on addressing the different preferences within the boating community. By engaging boaters and aligning strategies with their motivations – whether those are environmental health, boat efficiency or maintaining the status quo – managers can improve the chances of initiative success.

Table 13. Estimates from the latent class logit models. Respondents to the survey fall into three 'classes' (C1– C3) that have different values and preferences. Parameters that significantly influence people in classes 1–3 are marked in red (n = 574).

Parameter	*C1 – Broadly supportive of change*			*C2 – Invested in improving ecosystem health*			*C3 – Pro status quo and boat efficiency*		
	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value
Utility									
Status quo	-0.904	0.164	< 0.001	-27.022	106.900	1.000	2.165	0.409	<0.001
Ecohealth improvement L1	1.179	0.116	< 0.001	4.149	1.822	0.023	0.180	0.360	0.618
Ecohealth improvement L2	0.825	0.107	< 0.001	6.281	2.808	0.025	-0.352	0.312	0.260
Boat efficiency L1	1.045	0.108	< 0.001	-0.710	1.565	0.650	0.863	0.348	0.013
Boat efficiency L2	0.438	0.090	< 0.001	-0.508	0.867	0.558	-0.161	0.348	0.643
Biosec rules: Improved regional coordination	0.700	0.125	< 0.001	4.299	3.320	0.195	0.121	0.321	0.707
Biosec rules: One set of rules for NZ	0.603	0.087	< 0.001	1.856	1.376	0.178	-0.726	0.362	0.045
Additional cost	-0.001	0.000	< 0.001	0.002	0.001	0.074	0.000	0.000	0.701
Class probability	0.56	(56% of boaters)		0.24	(24% of boaters)		0.2	(20% of boaters)	
Number of respondents by class	321			139			114		
Log likelihood at max	-2286								
McFadden Pseudo R-squared	0.379								
Akaike information criterion (AIC/N)	1.882								
Number of choice observations	3354								
Total number of respondents	574								

6. Conclusions and recommendations

This study is the first in Aotearoa New Zealand to employ a combination of behavioural and economic methods to understand how recreational boaters think about hull maintenance and what outcomes they prioritise. By examining boater motivations, challenges and willingness to invest, we gained a deeper understanding of the factors that influence hull maintenance behaviours and the broader outcomes boaters seek.

Our study presents three key contributions that can help inform marine biosecurity and environmental management, while also giving voice to recreational boaters to help support planning, infrastructure and services that align with the needs and priorities of boaters. The three contributions (factors that influence hull cleanliness, boater suggestions and support for certain outcomes) are summarised below.

1. What influences boaters to keep their hulls reasonably clean?

Most boaters agreed that keeping their hulls reasonably clean is worthwhile, even though few found the task 'pleasant', with benefits such as improved boat efficiency and speed being widely recognised. Few societal groups strongly influenced the majority of boaters' intentions to keep their hulls reasonably clean. However, the potential impacts of NIS on the seafood and aquaculture industry shaped the intentions of almost half of all boaters, while local authorities and members of the sailing / boating community influenced about one-third of respondents. The cost of hull cleaning was a bigger barrier than the time spent on the task, especially for those with household incomes under $100,000. Many also reported a lack of adequate cleaning facilities in their area, with dissatisfaction highest in Auckland. Despite these challenges, nearly two-thirds of boaters agreed they have clear and sufficient information about hull cleaning in their area, and almost all agreed that haul-out facilities perform well when they are able to access them. Interestingly, while most respondents acknowledged the impact of NIS, expressed concern about their spread and agreed that boaters have a responsibility to help prevent it, nearly half believed it is too late to effectively contain their spread. This suggests a sense of pessimism or defeatism about the effectiveness of current NIS containment efforts or the role of boaters in helping prevent their spread.

Through multiple regression analysis, we found that key predictors of hull cleaning intention included whether boaters believed it was worthwhile (the strongest predictor), whether they found it easy and whether they felt that boaters had a responsibility for helping prevent the spread of NIS. This suggests that boaters' attitudes toward cleaning and their sense of responsibility are significant factors – and could be key areas to focus on for improving cleaning behaviour.

Factor analysis revealed four distinct themes explaining boaters' motivations for keeping their hulls reasonably clean:

- *Proactive group* – these boaters see hull cleaning as worthwhile, manageable and supported by sufficient local resources. They feel a strong sense of responsibility to reduce the spread of NIS and are not deterred by cost, time or regulations.
- *Social influence group* – this group is primarily influenced by social norms and expectations, with local authorities, marinas and the broader sailing community shaping their intentions.

- *Lack of access and conditional willingness group* – boaters who feel they lack adequate cleaning facilities are more likely to act if others, such as commercial boaters, also contribute to the effort.
- *Lower NIS concern and stronger conditional willingness group* – Some boaters, who are less concerned about the impacts of NIS, are only willing to clean if others do as well. Intuitively, this group is less likely to keep their hulls reasonably clean.

By understanding these underlying themes in boater motivations, targeted interventions can be designed to address specific barriers, enhance compliance and foster behaviours that support effective marine biosecurity practices.

2. What are boater suggestions for improved hull cleanliness?

Boaters provided a range of suggestions and insights on what changes, incentives or regulations could improve their ability to keep their hulls reasonably clean at all times. The top five most frequently mentioned themes were:

- more haul-out facilities and preservation of existing facilities, particularly in underserved areas and for larger vessels
- lower haul-out costs, including reduced council fees, more affordable alternatives and more market competition
- antifouling effectiveness, with calls for better eco-friendly products and research innovations to be shared with boaters
- DIY and self-cleaning options, such as relaxing restrictions on in-water cleaning, diver-friendly policies and tidal grids
- incentives and rewards, such as discounts or concession cards for responsible boaters.

3. What are the benefits of keeping hulls clean, and would boaters invest further to secure these outcomes?

The results of the DCE suggest that the average recreational boater is more likely to support hull cleaning initiatives when they see clear benefits, with the highest value placed on improvements to ecosystem health, followed by better boat maintenance and efficiency, and, to a lesser extent, more coordinated marine biosecurity policies. These findings reflect preferences and trade-offs, with boater support contingent on guaranteed outcomes. The analysis also identified three main classes (groups) of boaters based on their priorities:

- *Broadly supportive of change* – this group is generally supportive of change and are willing to invest further in hull cleaning activities to achieve all three outcomes – improvements in marine ecosystem health, boat efficiency and more coordinated marine biosecurity rules and policies – provided they are guaranteed. They represent the largest group, comprising 56% of respondents.
- *Ecosystem-focused* – this group is highly primarily motivated by improving marine ecosystem health. They account for 24% of respondents.
- *Status quo-oriented* – This group is mostly satisfied with the current situation but is open to supporting cleaning initiatives that lead to small improvements in boat efficiency. Although they represent the smallest group, accounting for about 20% of respondents, they are the most likely

to resist additional hull cleaning requirements, possibly due to concerns about financial burdens or scepticism about the connection between increased hull cleaning and the promised outcomes.

These results present an opportunity to tailor engagement campaigns to the status quo-oriented group and to better understand the link between hull cleaning efforts and desired outcomes.

Recommendations

Building on these findings, we propose targeted strategies to address key challenges, leverage boater motivations and align interventions with the diverse needs of the recreational boating community.

1. Overcome pessimism / defeatism

The results indicate that nearly half of boaters believe it is too late to contain the spread of NIS. However, this belief contrasts with their strong sense of boater responsibility, concern about NIS impacts and acknowledgement of the harm they cause. Positive messaging and sharing success stories of pathway management or eradication efforts to inspire hope and action could help to shift this defeatist mindset. Analogies, such as managing climate change, reducing landfill waste or controlling invasive species such as wilding pines or rats, can help illustrate the fallacy of inaction – emphasising that while the *'horse may have bolted'* in certain instances, significant progress can still be made by preventing further spread. The value of such containment efforts could be emphasised by communicating the current, often limited, distribution of certain pests and the consequences of not intervening.

It is important to frame these efforts as a shared responsibility, involving recreational boaters, the commercial and private sector, marinas, central and local government, and the public, rather than placing the burden solely on one group. This collective approach aligns with boaters' conditional willingness to act if others contribute. Furthermore, building on the key predictors of hull cleaning intention identified in this study – such as fostering a sense of worthwhileness, ease of action and boater responsibility – could strengthen motivation and encourage more consistent engagement with biosecurity practices.

In line with recommendations from other studies, messaging to overcome defeatism could also focus on the secondary benefits of hull cleaning, such as improving gear longevity and fuel efficiency, to further motivate engagement (Kantar Public 2023). Moreover, strategies could include inviting trusted, well-informed members of the boating community and providing them with tools to act as 'champions' of information and advice to help induce behaviour change (Newton 2019). Finally, the most effective tools for eliciting meaningful change are likely to include a mixture of 'carrot and stick' approaches (Floerl et al. 2016), incentives to encourage compliance, as well as pairing rules to regulate worst offenders alongside engagement campaigns to overcome defeatism.

2. Leverage boater motivations for targeted campaigns

For the groups identified in the factor analysis, we propose engagement strategies to encourage behaviour that supports marine biosecurity by drawing on our understanding of each group's motivations.

- *Proactive group*: Build on their positive attitudes by promoting members of this group as role models or ambassadors for best practices in marine biosecurity. Recognise their efforts and provide tools to help them share knowledge and inspire others. Identify and support 'champions of change', i.e. trusted, well-informed individuals within this group.
- *Social influence group*: Design campaigns that leverage social norms and peer influence, such as marina-based recognition programmes and endorsements from influential sailing clubs or local authorities. Campaigns and interventions that draw on social influence and social acceptability can be used extensively for community outreach, health, advertising and public relations campaigns.
- *Lack of access and conditional willingness group*: Prioritise improving access to cleaning facilities in underserved areas. Emphasise shared responsibility by highlighting efforts such as the stringent biofouling requirements for international commercial vessels entering Aotearoa New Zealand, ensuring recreational boaters do not feel solely burdened.
- *Lower NIS concern and strong conditional willingness group*: Raise awareness about the tangible impacts of NIS on marine ecosystems and boat efficiency. Counter defeatist attitudes by showing how their actions can help prevent further spread. Highlight the importance of collective action and address their conditional willingness, while reinforcing the need for regulation compliance.

3. Consider boater suggestions

Boater insights and suggestions provide valuable perspectives on how they perceive the improvements that can be made to help support their ability to maintain a clean hull. These suggestions reflect boaters' understanding of key areas for action, including themes such as increasing access to haul-out facilities, reducing costs, improving antifouling effectiveness, allowing more DIY cleaning options and offering incentives for responsible practices.

Understanding boater perspectives is essential for evaluating which of these suggestions can be realistically actioned and how they align with current policies and practical considerations. Incorporating their input into decision-making ensures that interventions are not only effective but also resonate with the boating community, fostering greater engagement and compliance.

4. Link hull cleaning behaviour to desired outcomes

The findings suggest that boaters, on average, are open to investing further in hull cleanliness if the benefits – e.g. improved ecosystem health, greater boat efficiency and better policy coordination – are guaranteed. However, achieving these outcomes may not be straightforward, as factors beyond hull cleanliness also contribute to results such as improved ecosystem health. If higher investment approaches are pursued, policymakers will need to clearly communicate what can realistically be achieved. The success of future coordinated hull cleaning initiatives will partly depend on addressing the diverse preferences and priorities within the boating community.

Future studies could help to understand the broader range of outcomes that boaters truly value. While environmental health, boat efficiency and policy consistency were used in this study, other priorities, such as the ability to fish in productive waters or sail to islands without restrictions, may also resonate strongly. Linking hull cleaning behaviours to these diverse and meaningful outcomes can make initiatives more relevant and compelling for boaters.

It will be important to design campaigns that engage and influence the status quo-oriented group, which comprised about 20% of boaters who were least likely to invest in further hull cleaning activities for the outcomes listed in this study. This could be achieved by connecting hull cleaning behaviours to outcomes they genuinely care about and adopting targeted strategies. These strategies could emphasise secondary benefits and deliver awareness campaigns that incorporate longer-term engagement about the risks NIS pose to the outcomes they value most.

5. Tailor approaches

The findings of this study are too extensive to summarise fully in this report. While some overarching patterns emerged, there were also regional and other variations in how boaters responded. Avoiding a one-size-fits-all strategy will be key, as different segments of the boating community have distinct needs and motivations. The information gathered through this survey can form the basis for designing future interventions and campaigns at both national and regional levels. It provides insight into which approaches may work well for certain segments of the boating population and identifies opportunities to develop and trial strategies that could achieve broader uptake.

Future efforts may involve a combination of incentives and disincentives, addressing not only boaters' responsibilities but also the role of marinas and mooring facilities, which often serve as key habitats for marine NIS. Awareness-raising and behaviour change campaigns will remain important but should be supported by long-term engagement strategies, including two-way communication, to encourage sustained action (Cepeda-Rios and Matheson 2023). These findings offer a starting point for managers to develop tailored and practical approaches that reflect the diverse needs and motivations within the boating community.

7. Acknowledgements

The authors would like to thank the recreational boaters who participated in this survey, gifting their time and knowledge to help researchers, the public and relevant agencies better understand their perspectives and needs. Special thanks also to the boaters who participated in the focus groups, and to Northland Regional Council for hosting one of these sessions.

This research was undertaken as part of the Marine Biosecurity Toolbox Programme. We are grateful to the programme partners who provided valuable input into the survey's conceptualisation, including Auckland Council, Northland Regional Council, Marlborough District Council, Biosecurity New Zealand and the Top of the South Marine Biosecurity Partnership.

We also appreciate the support of NZMOA, Yachting New Zealand and Zoe Hawkins for reviewing the survey and assisting with its distribution through their networks.

Finally, we thank the Ministry of Business, Innovation and Employment for funding this work.

8. Appendices

Appendix 1. Survey questions

The following 18 pages contain screenshots of the online survey questions.

We value your opinion!

This survey is part of a research programme funded by the Ministry of Business, Innovation and Employment. The survey was developed by researchers based at Scion and the Cawthron Institute with support from Yachting New Zealand (YNZ) and the New Zealand Marina Operators Association (NZMOA).

What is the survey about?

As a boat owner, you have probably heard the message about maintaining a clean hull to stop introduced marine organisms from spreading. We want to know more about what motivates you, what obstacles you face, and about all of the considerations that guide your decisions.

The findings will assist government agencies, and the boating and marina industries in developing approaches to limit the spread of introduced marine organisms on the hulls of vessels and to overcome some of the challenges that make it more difficult.
Our aim is to ensure that decision-makers hear the opinions of boat owners like you.

The survey should take approximately 20 minutes to complete.

Who should answer the survey?

The survey is for recreational boat owners of permanently moored recreational yachts, boats and launches (not trailer boats) domiciled in New Zealand.

Do I have to answer?

No, your participation is entirely voluntary. You may choose not to participate and may stop at any time.

What's in it for me?

By completing the entire survey, you will have the chance to win one of five $250 gift cards!

Privacy

We will not ask you for any personally identifying information during the survey and your answers will not be traceable to you.

Who can I contact with questions or concerns?

If you have any questions or would like to contact the research team about the survey, please email rec.vessels@cawthron.org.nz. Thank you.

The Survey Team
Cawthron Institute
98 Halifax Street East
Nelson

☐ I confirm that I have read the information above, and I consent to participate in this research.

Next

Section A: General questions page 1

1. Do you own or part own a boat that is permanently moored in the water?

- ◉ Yes, a sailing yacht
- ○ Yes, a motor launch
- ○ No, I only own a trailered vessel(s)
- ○ No, I do not own a boat

2. How many boats do you own? ____

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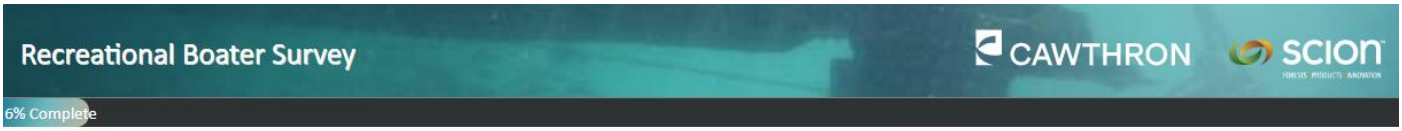

Section A: General questions page 2

If you own more than one boat permanently moored in the water, answer questions in this section referring to the boat that you most frequently use.

3. Approximately how many days per year do you use your boat? ☐

4. How long have you owned your boat? ☐ years

5. What is the length of your boat? ☐ metres

6. In which region is your boat usually moored? (Tick one)

- ○ Northland
- ○ Auckland
- ○ Waikato
- ○ Bay of Plenty
- ○ Taranaki
- ○ Gisborne
- ○ Hawke's Bay
- ○ Manawatu-Wanganui
- ○ Wellington
- ○ Marlborough
- ○ Nelson
- ○ Tasman
- ○ Canterbury
- ○ West Coast
- ○ Otago
- ○ Southland
- ○ Other Please specify
- ○ Other Please specify

7. Where do you usually keep your boat?

- ○ Marina berth
- ○ Mooring
- ○ On land
- ○ Freshwater body (river or lake)
- ○ Other Please specify

8. What are the main uses of your boat? (Tick all that apply)

- ☐ Personal / recreational use
- ☐ For hire / charter
- ☐ Other commercial use
- ☐ Other Please specify

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Recreational Boater Survey

11% Complete

Section A: General questions page 3

These questions are all about your most frequently-used boat.

9. Approximately how often do you apply antifouling paint to your boat?

- ○ Never
- ○ Every five years or more
- ○ Every three to five years
- ○ Every two to three years
- ○ Every 18 months
- ○ Yearly
- ○ Every six months
- ○ Every three months
- ○ Don't know
- ○ Other Please specify

10. On average, how many hours do you personally spend each year on antifouling the hull of your boat? Please exclude any hours of paid labour

hours

11. Aside from antifouling, approximately how often is the hull of your boat cleaned?

- ○ Never
- ○ Every five years or more
- ○ Every three to five years
- ○ Every two to three years
- ○ Every 18 months
- ○ Yearly
- ○ Every six months
- ○ Every three months
- ○ Don't know
- ○ Other Please specify

12. On average, approximately how many hours are spent cleaning the hull of your boat (excluding antifouling) each year?

hours

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Recreational Boater Survey

CAWTHRON SCION

16% Complete

Section A: General questions page 4

These questions are all about cleaning of your most frequently-used boat.

12. Who usually cleans your hull? (Tick all that apply)
- ☐ Myself
- ☐ Contractor (e.g. haul-out operator, diver etc)
- ☐ Family member
- ☐ Friend
- ☐ Other Please specify

13. What is your most *frequent* location for cleaning your hull?
- ○ In-water
- ○ Haul-out facility
- ○ Tidal grid
- ○ Tidal inlet or beach
- ○ Other Please specify

14. What is your most *preferred* location for cleaning your hull?)
- ○ In-water
- ○ Haul-out facility
- ○ Tidal grid
- ○ Tidal inlet or beach
- ○ Other Please specify

15. How is your boat hull usually cleaned when *hauled out*? Tick all that apply.
- ☐ Water blasting
- ☐ Wipe off
- ☐ Sanding
- ☐ Brushing
- ☐ Unsure
- ☐ It is not cleaned when hauled out
- ☐ Other Please specify

16. How is your boat hull usually cleaned when *in the water*? Tick all that apply.
- ☐ Surface (waterline) brushing
- ☐ Surface (waterline) wipe off
- ☐ Surface (waterline) scrubbing/scraping
- ☐ In-water (snorkel or diver) brushing
- ☐ In-water (snorkel or diver) wipe off
- ☐ Unsure
- ☐ It is not cleaned in the water
- ☐ Other Please specify

17. Have you had your boat specifically cleaned to meet rules or regulatory requirements in the past 12 months? (Tick all that apply)
- ☐ Yes, to meet marina rules
- ☐ Yes, to meet regional regulations
- ☐ No
- ☐ Don't know
- ☐ Yes, to meet other legal directives (e.g. MPI directive) Please specify

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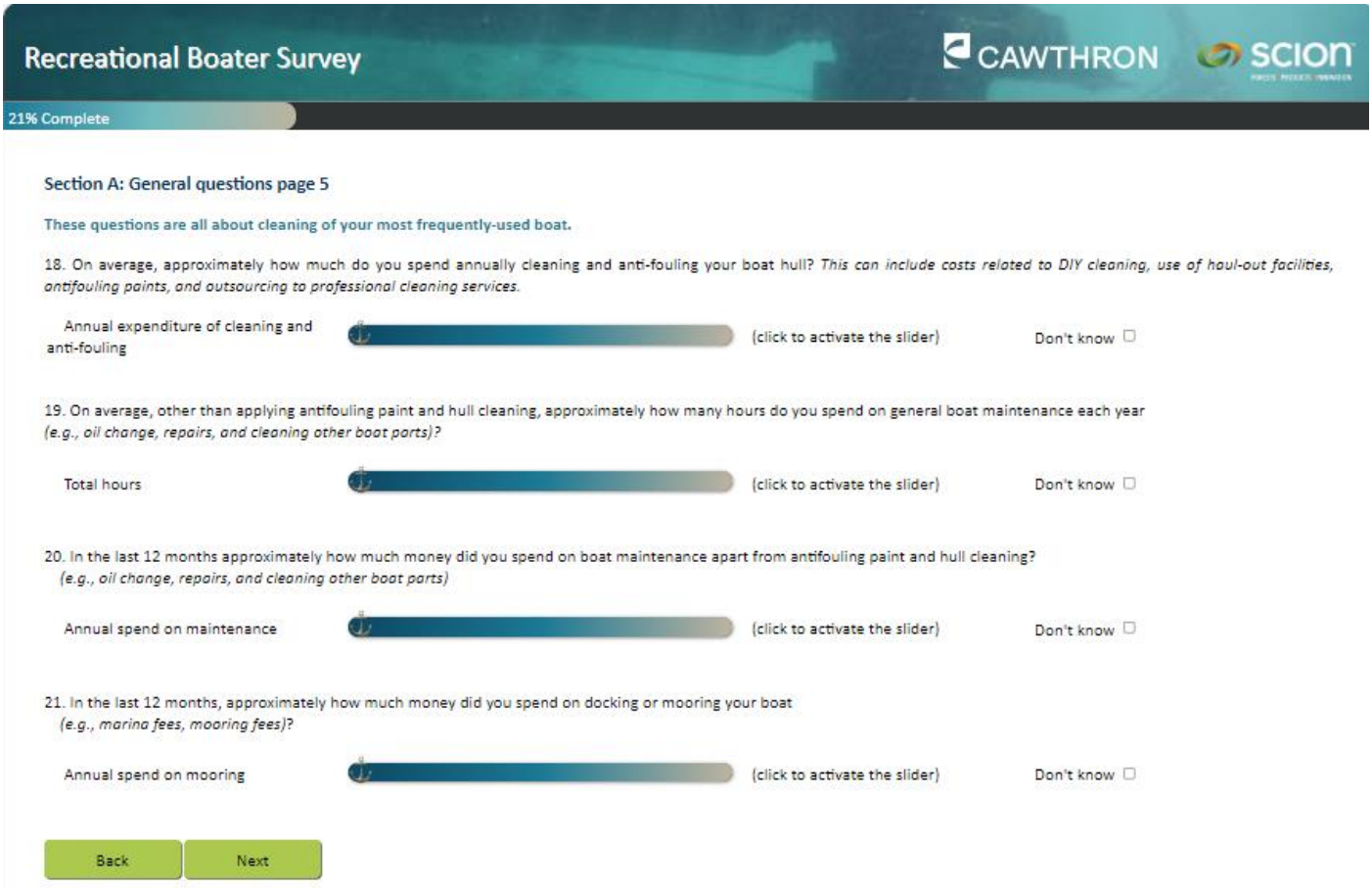
Recreational Boater Survey
CAWTHRON
SCION
21% Complete
Section A: General questions page 5
These questions are all about cleaning of your most frequently-used boat.
18. On average, approximately how much do you spend annually cleaning and anti-fouling your boat hull? This can include costs related to DIY cleaning, use of haul-out facilities, antifouling paints, and outsourcing to professional cleaning services.
Annual expenditure of cleaning and anti-fouling
(click to activate the slider)
Don't know
19. On average, other than applying antifouling paint and hull cleaning, approximately how many hours do you spend on general boat maintenance each year (e.g., oil change, repairs, and cleaning other boat parts)?
Total hours
(click to activate the slider)
Don't know
20. In the last 12 months approximately how much money did you spend on boat maintenance apart from antifouling paint and hull cleaning? (e.g., oil change, repairs, and cleaning other boat parts)
Annual spend on maintenance
(click to activate the slider)
Don't know
21. In the last 12 months, approximately how much money did you spend on docking or mooring your boat (e.g., marina fees, mooring fees)?
Annual spend on mooring
(click to activate the slider)
Don't know
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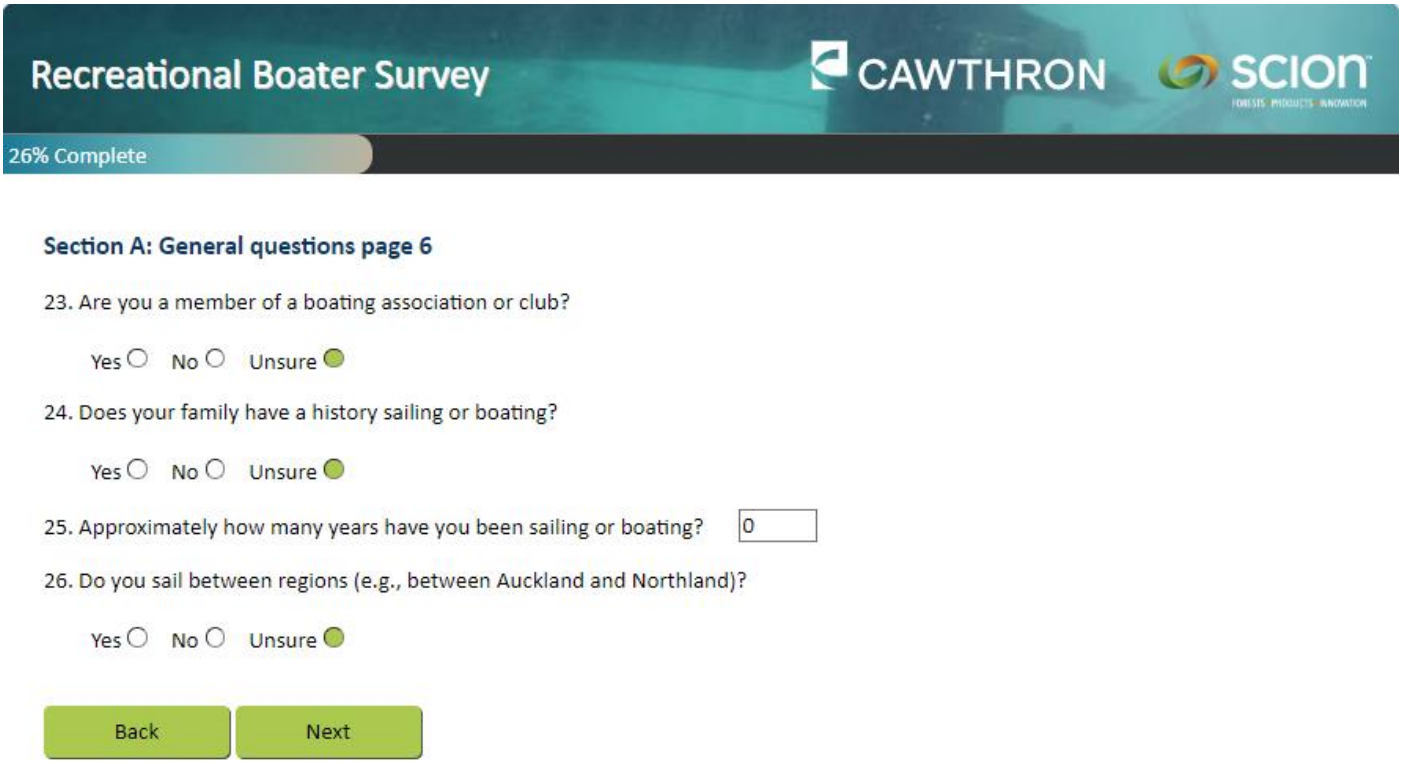
Recreational Boater Survey
CAWTHRON
SCION
26% Complete
Section A: General questions page 6
23. Are you a member of a boating association or club?
Yes
No
Unsure
24. Does your family have a history sailing or boating?
Yes
No
Unsure
25. Approximately how many years have you been sailing or boating?
0
26. Do you sail between regions (e.g., between Auckland and Northland)?
Yes
No
Unsure
Back
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Recreational Boater Survey

CAWTHRON SCION

Section B1: Maintaining your hull

For the rest of the survey, we are interested in understanding how maintaining your boat hull to a 'reasonably clean' standard may affect you. We define 'reasonably clean' as having a mostly clean hull, with very few patches of biofouling (accumulation of living plants and animals) only on areas that are typically hard to clean (e.g., propeller shaft and keel).

Examples of what we mean by a 'reasonably clean hull'.

1. A reasonably clean hull can have small patches of fouling ('light fouling')

2. A reasonably clean hull may have a thin layer of slime and scattered barnacles, but not larger biofouling organisms.

3. A reasonably clean hull may have light fouling on hard-to-clean areas

1. Which statement best describes your hull: "My hull is reasonably clean or cleaner":

- ○ All of the time
- ○ Some of the time
- ○ Seldom
- ○ Never

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We are interested in your level of agreement or disagreement with the following statements relating to maintaining your boat hull to a 'reasonably clean' standard at all times.

Please score your level of agreement/disagreement with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know/NA
1. Keeping my hull reasonably clean at all times would improve my fuel efficiency	○	○	○	○	○	○
2. It is already too late to contain the spread of introduced marine organisms within New Zealand	○	○	○	○	○	○
3. Keeping my hull reasonably clean at all times would improve my boat speed	○	○	○	○	○	○
4. I would be willing to keep my hull reasonably clean at all times if commercial boats keep their hulls reasonably clean too	○	○	○	○	○	○
5. I would be willing to keep my hull reasonably clean at all times if other recreational boat owners keep their hulls reasonably clean too	○	○	○	○	○	○
6. I dislike the idea of using rules and regulations to encourage boaters to keep their boat hulls reasonably clean at all times	○	○	○	○	○	○

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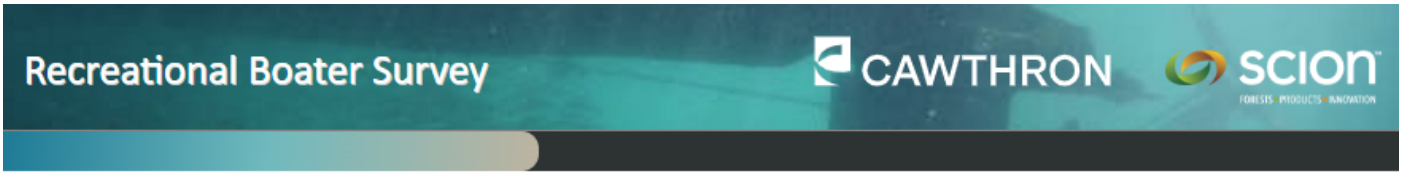

Next, we are interested in understanding potential barriers to maintaining your boat hull to a 'reasonably clean' standard at all times.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know/NA
9. Maintaining my hull to a reasonably clean standard at all times would be excessively time-consuming	○	○	○	○	○	○
10. Maintaining my hull to a reasonably clean standard at all times would be *"worthwhile"*	○	○	○	○	○	○
11. Maintaining my hull to a reasonably clean standard at all times would be *"pleasant"*	○	○	○	○	○	○
12. It would be easy for me to keep my hull reasonably clean at all times	○	○	○	○	○	○
13. Maintaining my hull to a reasonably clean standard at all times would be excessively costly	○	○	○	○	○	○
14. I am likely to keep my hull reasonably clean at all times	○	○	○	○	○	○

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For this section, we are interested in understanding whether there are suitable facilities available to maintain your boat hull to a 'reasonably clean' standard at all times.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know/NA
15. Haul-out facility operators are able to clean my hull to a reasonably clean standard	○	○	○	○	○	○
16. I can easily access a haul-out facility when I need to clean my hull	○	○	○	○	○	○
17. There are sufficient cleaning facilities in my area for keeping my hull clean	○	○	○	○	○	○
18. I have access to sufficient and clear information describing where and how I can clean my hull	○	○	○	○	○	○

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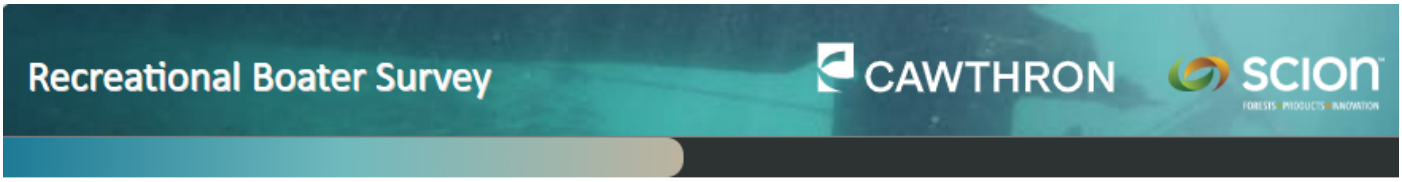

Next, we are interested in understanding who influences your decision to maintain your boat hull to a "reasonably clean" standard at all times.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know/NA
19. People who work at my marina influence my intentions to keep my hull clean	○	○	○	○	○	○
20. Local authorities influence my intentions to keep my hull clean	○	○	○	○	○	○
21. Potential impacts to the aquaculture and fishing industry influence my intentions to keep my hull clean	○	○	○	○	○	○
22. My friends and family influence my intentions to keep my hull clean	○	○	○	○	○	○
23. Members of the sailing community influence my intentions to keep my hull clean	○	○	○	○	○	○
24. Local iwi or hapū influence my intentions to keep my hull clean	○	○	○	○	○	○

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Section B2: Environmental concern

Please score your level of agreement/disagreement with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know/NA
1. Recreational boaters have a responsibility to maintain a reasonably clean hull at all times to prevent the spread of introduced marine organisms	○	○	○	○	○	○
2. Introduced marine organisms are causing negative environmental, cultural, social, and/or economic impacts in New Zealand marine areas right now	○	○	○	○	○	○
3. The spread of introduced marine organisms is of concern to me	○	○	○	○	○	○

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Section B3: What would help?

What changes, incentives or regulations would improve your ability to keep your hull clean?

You are two-thirds of the way through! In the upcoming final section, you'll be presented with six choice situations designed to explore which broader values you prioritise when deciding whether to keep your hull clean. By completing this section, you will go into the draw to win one of five $250 prizes.

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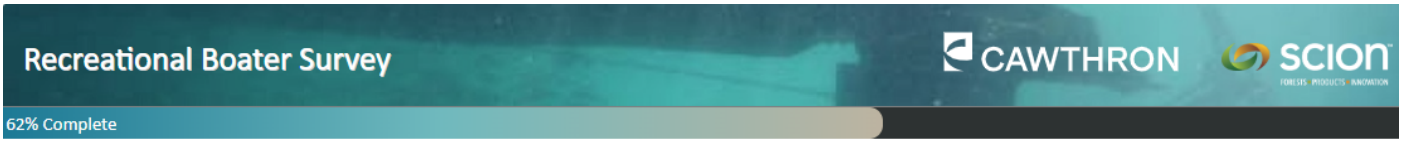

Section C1: Choice experiment

Owning a boat enables individuals to explore the marine environment and enjoy its beauty. However, boat owners also face several challenges, such as hull upkeep and compliance with regulations set by local councils. To gain deeper insights into the decisions made by boat owners, we want to understand how you prioritise different factors relating to hull cleanliness. Previous studies indicated four key factors that govern people's decisions regarding hull maintenance. These factors include consistency of regulations, marine ecosystem health, financial considerations, and boat efficiency. Please read the description of each factor below. On the following pages you will be asked to choose between several scenarios relating to these factors.

Attribute	Attribute description
Marine ecosystem health	Introduced marine organisms can harm the ecology of coastal marine environments, and affect taonga and seafood species. This, in turn, affects activities like diving, snorkeling, shoreline exploration, and recreational seafood collection. Currently New Zealand's coastal health is **declining**, but a reduction in the spread of introduced organisms can help prevent the decline.
NZ marine biosecurity policies	Currently, New Zealand regions have varying marine biosecurity policies regarding hull cleanliness. Some regions enforce specific rules, while others do not. Due to disparities in introduced marine organism populations across these regions, these policy differences may lead to confusion and can make adhering to best practices challenging for boat owners traveling to different parts of New Zealand by boat.
Boat maintenance & fuel cost	Biofouling organisms (e.g., Mediterranean fanworm) can **increase** your boat maintenance cost and fuel consumption. They may affect your boat by: - clogging the motor, pipes, or propellers - increasing drag and, therefore, fuel costs.
Annual cost of hull maintenance ($/year)	Money must be spent to maintain a boat hull. These costs include fees for professional hull cleaning, or the cost of materials and equipment to clean yourself. It also includes the cost of antifouling paint and application. This attribute pertains to the amount of money you spend to maintain your hull at a "reasonable" level of cleanliness. **Investing more money** may lead to greater boat efficiency, improvements in marine ecosystem health, and increased seafood abundance. Please note that the cost of hull cleaning here is different from the cost spent on general boat maintenance and repair.

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Recreational Boater Survey

CAWTHRON SCION

65% Complete

Choice Situation 1 of 6

In this section, we will provide you with a total of six 'Choice Situations' – one for each new page. In each Choice Situation, you must choose your preferred scenario. Once you've completed one, move on to the next page and 'don't look back'.

In Choice Situation 1 below, we present three scenarios: the status quo and two alternatives. The status quo represents your current cost of hull maintenance and the current situation resulting from introduced marine species (for example, a 10% decline in marine ecosystem health). The other two scenarios offer alternatives (for example, a 10% improvement in ecosystem health), but achieving them would require an increase in the cost of hull maintenance (for example, through new technology and more frequent cleaning). We would like to know which of these three scenarios you would choose for the next five years (2024 to 2029). Please note that it is entirely acceptable to choose the status quo option.

Which option (column) would you vote for?

Attribute	Status Quo	Option 1A	Option 1B
Marine ecosystem health 	Declining by 10%	Improving by 10%	Declining by 10%
NZ marine biosecurity policies 	Different rules in each NZ region	Different rules in each NZ region	Improved coordination between regions policies vary based on risk
Boat maintenance & fuel cost 	Increasing by 20%	Stable neither increasing nor decreasing	Increasing by 20%
Annual cost of hull maintenance ($/year) 	Current cost (average $2,000 per year)	Cost increase by 10% (extra $200 per year)	Cost increase by 5% (extra $100 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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Choice Situation 2 of 6

In Choice Situation 2 below, we provide three more scenarios (the status quo and two alternatives), but we have slightly tweaked the two alternatives. Remember that the status quo represents your current cost of hull maintenance and what is currently occurring because of introduced marine species. We want to know which of the three scenarios below you would choose for the next five years (2024 to 2029). Note that it is perfectly ok to choose the status quo option.
Once you've chosen, move on to the next page and don't look back!

Which scenario (column) would you vote for?

Attribute	Status Quo	Option 2A	Option 2B
Marine ecosystem health 	Declining by 10%	Stable neither declining nor improving	Declining by 10%
NZ marine biosecurity policies 	Different rules in each NZ region	Improved coordination between regions policies vary based on risk	One set of rules across all NZ region
Boat maintenance & fuel cost 	Increasing by 20%	Increasing by 20%	Increasing by 10%
Annual cost of hull maintenance ($/year) 	Current cost (average $2,000 per year)	Cost increase by 5% (extra $100 per year)	Cost increase by 10% (extra $200 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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Choice Situation 3 of 6

In Choice Situation 3 below, we provide three more scenarios (the status quo and two alternatives). We want to know which of the three scenarios below you would choose for the next five years (2024 to 2029).

Which scenario (column) would you vote for?

Attribute	Status Quo	Option 3A	Option 3B
Marine ecosystem health 	Declining by 10%	Stable neither declining nor improving	Improving by 10%
NZ marine biosecurity policies 	Different rules in each NZ region	Improved coordination between regions policies vary based on risk	One set of rules across all NZ region
Boat maintenance & fuel cost 	Increasing by 20%	Increasing by 10%	Stable neither increasing nor decreasing
Annual cost of hull maintenance ($/year) 	Current cost (average $2,000 per year)	Cost increase by 10% (extra $200 per year)	Cost increase by 5% (extra $100 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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Recreational Boater Survey

CAWTHRON SCION

74% Complete

Choice Situation 4 of 6

In Choice Situation 4 below, we provide three more scenarios (the status quo and two alternatives). We want to know which of the three scenarios below you would choose for the next five years (2024 to 2029).

Which scenario (column) would you vote for?

Attribute	Status Quo	Option 4A	Option 4B
Marine ecosystem health 	Declining by 10%	Stable neither declining nor improving	Improving by 10%
NZ marine biosecurity policies 	Different rules in each NZ region	One set of rules across all NZ region	Improved coordination between regions policies vary based on risk
Boat maintenance & fuel cost 	Increasing by 20%	Increasing by 10%	Increasing by 20%
Annual cost of hull maintenance ($/year) 	Current cost (average $2,000 per year)	Cost increase by 5% (extra $100 per year)	Cost increase by 15% (extra $300 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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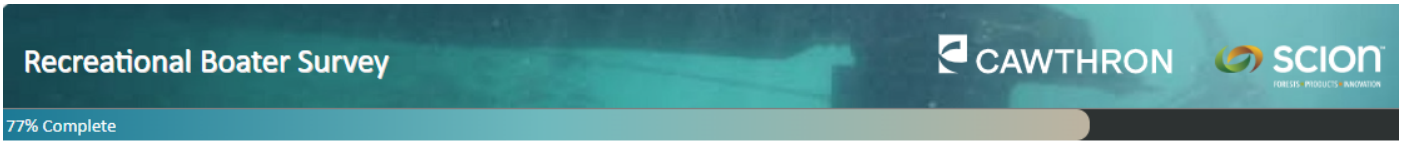

Choice Situation 5 of 6

In Choice Situation 5 below, we provide three more scenarios (the status quo and two alternatives). We want to know which of the three scenarios below you would choose for the next five years (2024 to 2029).

Which scenario (column) would you vote for?

Attribute	Status Quo	Option 5A	Option 5B
Marine ecosystem health	Declining by 10%	Improving by 10%	Stable neither declining nor improving
NZ marine biosecurity policies	Different rules in each NZ region	One set of rules across all NZ region	Improved coordination between regions policies vary based on risk
Boat maintenance & fuel cost	Increasing by 20%	Increasing by 20%	Increasing by 10%
Annual cost of hull maintenance ($/year)	Current cost (average $2,000 per year)	Cost increase by 5% (extra $100 per year)	Cost increase by 15% (extra $300 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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Recreational Boater Survey

80% Complete

Choice Situation 6 of 6

In Choice Situation 6 below, we provide three more scenarios (the status quo and two alternatives). We want to know which of the three scenarios below you would choose for the next five years (2024 to 2029).

Which scenario (column) would you vote for?

Attribute	Status Quo	Option 6A	Option 6B
Marine ecosystem health 	Declining by 10%	Declining by 10%	Improving by 10%
NZ marine biosecurity policies 	Different rules in each NZ region	Improved coordination between regions policies vary based on risk	One set of rules across all NZ region
Boat maintenance & fuel cost 	Increasing by 20%	Increasing by 20%	Increasing by 10%
Annual cost of hull maintenance ($/year) 	Current cost (average $2,000 per year)	Cost increase by 5% (extra $100 per year)	Cost increase by 10% (extra $200 per year)
I would vote for (choose one)	No Change ○	Option A ○	Option B ○

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Recreational Boater Survey

83% Complete

Some follow-on questions regarding your choices

1a. Were there any attributes in the choice experiment that you ignored when choosing which option to vote for? If so, which? (tick all that apply)

- ☐ I did not ignore any attributes
- ☐ NZ hull cleanliness policies
- ☐ Annual cost of cleaning
- ☐ Boat maintenance & fuel cost
- ☐ Marine ecosystem health

2. Are there any other attributes that we did not include in the choice situations that you think should be considered?

3. Would you be willing to attend free training on new methods and technologies (e.g., antifouling with longer lasting effectiveness) to help you keep your hull clean?

Yes ○ No ○

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Section D: Demographic information (1 of 2)

You've arrived at the very last bit!

The remaining questions ask for information about yourself to help us ensure we hear from a wide range of people. Answering these questions is voluntary and the information you provide will not be attributed to you, personally.

1. Which age group do you belong to?

- ○ Under 20 years
- ○ 20 - 24 years
- ○ 25 - 29 years
- ○ 30 - 34 years
- ○ 35 - 39 years
- ○ 40 - 44 years
- ○ 45 - 49 years
- ○ 50 - 54 years
- ○ 55 - 59 years
- ○ 60 - 64 years
- ○ 65 - 69 years
- ○ 70 - 74 years
- ○ 75 - 79 years
- ○ 80 years or more
- ○ I prefer not to disclose

2. What is your gender?

- ○ Male
- ○ Female
- ○ Another gender
- ○ I prefer not to disclose

3. Which race/ethnicity best describes you (you may choose more than one)

- ☐ New Zealand European
- ☐ Māori
- ☐ Pacific Islander
- ☐ Chinese
- ☐ Indian
- ☐ Other
- ☐ I prefer not to disclose

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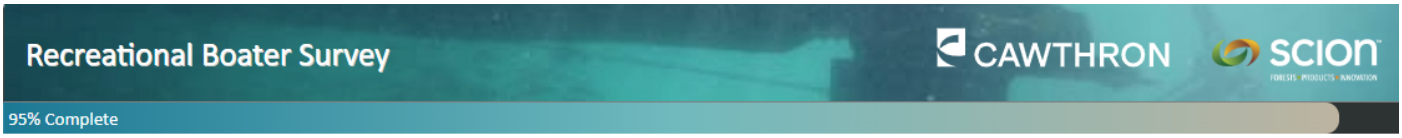

Section D: Demographic information (2 of 2)

4. What is your highest form of qualification?

- ○ No qualification
- ○ Secondary/High School
- ○ Trades certificate/Post-school diploma
- ○ Tertiary/Undergraduate/University Degree
- ○ Post Graduate Certificate or Diploma/Honours Degree
- ○ Masters degree/PhD
- ○ I prefer not to disclose
- ○ Other Please specify

5. Approximately, what is your annual household income?

- ○ $20,000 or less
- ○ $20,001 - $30,000
- ○ $30,001 - $50,000
- ○ $50,001 - $70,000
- ○ $70,001 - $100,000
- ○ $100,001 - $150,000
- ○ $150,001 or more
- ○ I prefer not to disclose

6. Is there anything else you would like to add?

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Prize draw

Please provide your contact details to go into the draw to win one of five $250 gift vouchers! We will not use your identity or personal information in any way, other than for making contact with you should you win one of the gift vouchers.

Name:
Email:
Phone:

Submit entry

Appendix 2. TPB tables including the 'don't know' responses

Table A2.1. Complete list of questions from the theory of planned behaviour, with corresponding percentages of boaters who agreed or disagreed with each question, including the percentage of don't know' responses, which accounted for less than 2% of all responses.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't know
Intention	**I intend to keep my hull reasonably clean at all times**	1%	5%	9%	48%	36%	0%
A	**Willing if commercial boats do too**	4%	6%	35%	26%	25%	4%
A	**Clean hulls improve boat efficiency**	1%	1%	6%	37%	55%	1%
A	**Dislike rules to encourage cleaning**	19%	26%	20%	20%	14%	2%
A	**Clean hulls improve boat speed**	1%	0%	3%	33%	62%	0%
A	**Willing if rec boaters do too**	4%	9%	40%	26%	18%	3%
A	**Pleasant work**	8%	16%	29%	30%	14%	3%
A	**Worthwhile work**	1%	4%	13%	51%	30%	0%
PBC	**Keeping hull clean is easy**	10%	26%	21%	32%	10%	1%
PBC	**Excessively time-consuming**	10%	35%	28%	20%	8%	0%
PBC	**Excessively costly**	7%	26%	27%	26%	13%	0%
PBC	**Too late to contain spread of NIS**	12%	18%	20%	31%	13%	6%
PBC	**Haul-out operators able to service**	2%	4%	11%	53%	26%	3%
PBC	**Adequate cleaning facilities in area**	27%	24%	8%	26%	14%	1%
PBC	**Clear info in my area**	6%	13%	18%	48%	14%	1%
PBC	**Easy to access haul-out facilities**	19%	22%	10%	33%	16%	1%
SN	**Influenced by local marina**	14%	32%	32%	15%	2%	5%
SN	**Influenced by friends & family**	15%	33%	31%	16%	3%	2%
SN	**Influenced by hapū/iwi**	37%	32%	23%	5%	1%	3%
SN	**Influenced by seafood industry**	8%	19%	25%	36%	12%	2%
SN	**Influenced by local authorities**	14%	29%	27%	26%	2%	2%
SN	**Influenced by sailing community**	11%	24%	32%	26%	5%	2%
IC	**NIS has negative effects**	1%	5%	14%	42%	33%	4%
IC	**Boaters have a responsibility**	2%	6%	13%	47%	31%	1%
IC	**I am concerned with spread of NIS**	1%	2%	11%	48%	37%	0%

Appendix 3. Predictors of hull cleaning behaviour

We used the behaviour question, *'My hull is reasonably clean or cleaner … all of the time, some of the time, seldom, never'*, as the dependent variable in the analysis. Eight factors emerged as predictors of behaviour, but the intention question consistently stood out as the strongest and most significant predictor among all boaters (when grouped) and across all regions, except Northland, where significance was marginal. These results suggest that the intention question, '*I am likely to keep my hull reasonably clean at all times*', is a reliable indicator of actual hull cleaning behaviour.

Table A3.1. Results of multiple regression analysis showing standardised coefficients (b*) and p-values for predictors of whether boaters kept their hulls reasonably clean or cleaner. The analysis is presented for the full dataset (all boaters) as well as by region and income bracket. Significant predictors ($p < 0.05$) are highlighted in red. Variables are grouped by their component: A (attitudes), PBC (perceived behavioural control), SN (subjective norms), and IC (invasive species concern).

		All boaters		Auckland		Northland		Rest of North Island		South Island	
Component	**Variable**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**	**b***	**p-value**
Intention	**Likely to keep my hull clean at all times**	0.48	0.00	0.52	0.00	0.12	0.09	0.81	0.00	0.46	0.01
A	**Willing if commercial boats do too**	0.09	0.08	0.15	0.06	0.12	0.69	0.02	0.89	0.02	0.91
A	**Clean hulls improve boat efficiency**	0.04	0.36	-0.01	0.90	0.14	0.56	0.03	0.82	0.20	0.21
A	**Dislike rules to encourage cleaning**	-0.02	0.72	0.04	0.52	0.09	0.02	0.12	0.45	0.04	0.80
A	**Clean hulls improve boat speed**	0.06	0.23	0.10	0.15	0.13	0.99	0.01	0.94	0.10	0.52
A	**Willing if rec boaters do too**	-0.12	0.03	-0.20	0.01	0.13	0.95	0.05	0.79	0.00	0.99
A	**Pleasant work**	-0.05	0.25	-0.11	0.08	0.09	0.48	-0.02	0.83	-0.11	0.45
A	**Worthwhile work**	0.02	0.66	0.06	0.46	0.13	0.44	-0.10	0.52	0.03	0.81
PBC	**Keeping hull clean is easy**	0.00	0.93	0.03	0.72	0.10	0.61	-0.20	0.13	0.07	0.65
PBC	**Excessively time-consuming**	-0.12	0.02	-0.10	0.15	0.12	0.01	0.20	0.24	-0.13	0.45
PBC	**Excessively costly**	-0.05	0.26	-0.03	0.66	0.11	0.37	-0.16	0.28	0.00	0.98
PBC	**Too late to contain spread of NIS**	-0.03	0.39	-0.01	0.81	0.11	0.20	-0.25	0.04	-0.03	0.81
PBC	**Haul-out operators able to service**	0.08	0.05	0.10	0.08	0.09	0.11	0.16	0.16	0.21	0.14
PBC	**Adequate cleaning facilities in area**	-0.07	0.25	0.00	0.97	0.12	0.98	-0.20	0.33	0.10	0.65
PBC	**Clear info in my area**	0.01	0.82	0.01	0.92	0.09	0.80	0.15	0.32	-0.14	0.38
PBC	**Easy to access haul-out facilities**	0.04	0.51	0.00	0.98	0.11	0.58	0.12	0.54	-0.19	0.41
SN	**Influenced by local marina**	-0.05	0.32	-0.07	0.30	0.11	0.02	-0.17	0.25	-0.15	0.43

		All boaters		Auckland		Northland		Rest of North Island		South Island	
Component	Variable	b*	p-value	b*	p-value	b*	p-value	b*	p-value	b*	p-value
SN	Influenced by friends & family	-0.02	0.70	-0.01	0.90	0.11	0.69	0.16	0.33	-0.09	0.54
SN	Influenced by hapū / iwi	-0.07	0.09	0.02	0.74	0.10	0.58	-0.21	0.10	-0.26	0.11
SN	Influenced by seafood industry	0.01	0.90	0.02	0.80	0.10	0.96	-0.04	0.76	0.00	0.97
SN	Influenced by local authorities	0.01	0.80	0.07	0.25	0.11	0.19	-0.02	0.88	0.20	0.36
SN	Influenced by sailing community	-0.03	0.47	-0.08	0.30	0.11	0.18	-0.08	0.63	-0.02	0.89
IC	NIS has negative effects	-0.09	0.07	-0.21	0.01	0.14	0.57	0.09	0.52	-0.14	0.36
IC	Boaters have a responsibility	0.00	0.93	0.04	0.59	0.12	0.11	0.17	0.26	0.01	0.97
IC	I am concerned with spread of NIS	-0.04	0.40	-0.03	0.66	0.13	0.83	-0.20	0.19	0.08	0.65

Appendix 4. Estimates from mixed logit model

To develop the final EC logit model, we tested multiple model specifications. Initial runs involved examining each attribute level for heterogeneity or variability in respondent preferences, using a lower number of Halton draws (e.g. 100). More refined model specifications were then tested with 500 draws, while the final model utilised 2,000 Halton draws.

The final specification demonstrated robustness across various diagnostic tests, with all estimated parameters being highly significant. The model achieved a high McFadden Pseudo R^2 value of 0.364, indicating a strong fit to the observed data (as shown in Table 6). The statistically significant coefficient for the error components (σm) indicates a positive correlation between the two designed options, which was accounted for in the estimation process.

Table A4.1. Estimates from the mixed logit model used for calculating individual specific WTP.

Variable	Coefficient	Standard error	t-statistic	p-value
Mean				
Ecological health improvement 1	1.327	0.108	12.27	< 0.001
Ecological health improvement 2 [RP]	1.726	0.103	16.7	< 0.001
Boat efficiency improvement 1	1.075	0.104	10.3	< 0.001
Boat efficiency improvement 2	0.554	0.090	6.13	< 0.001
Biosecurity rules: Improved regional coordination [RP]	0.669	0.123	5.46	< 0.001
Biosecurity rules: One set of rules	0.603	0.082	7.36	< 0.001
Additional cleaning cost [RP]	-0.002	0.000	-9.73	< 0.001
Current condition or status quo				< 0.001
Standard deviation of random parameter				
Ecological health improvement 2	2.938	0.265	11.08	< 0.001
Biosecurity rules: Improved regional coordination	1.706	0.337	5.06	< 0.001
Additional cleaning cost	0.002	0.000	9.73	< 0.001
Error component (σm)	5.364	0.435	12.33	< 0.001
Log-simulated likelihood at max	-2,344			
Macfadden Pseudo-R2	0.364			
Number of respondents	574			
Number of choice observations	3,354			
Number of Halton draws	2,000			

[RP] Indicates that the utility coefficient is specified as *random parameter*, while the remaining utility coefficients are specified as *fixed*.

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