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Research Article

Marine biofouling on recreational boats on swing moorings and berths

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Abstract

Biofouling on the hulls of recreational boats kept on swing moorings and marina berths poses a risk of transporting invasive species. A survey of 360 boats was undertaken of both mooring types at six sites near Auckland, New Zealand by visual observation from the waterline and underwater video. Both methods showed that the boats on swing moorings had more biofouling than those in berths ($p < 0.001$), and the video found more biofouling than visual observation ($p < 0.001$). A survey of boat owners found that boats on swing moorings moved at lower speeds (a function of different vessel types), making their speed insufficient to dislodge biofouling and potentially increasing their biosecurity risk. Five invasive marine species were known in the study area and the video images suggested that some of these and other invasive marine species were growing on boat hulls. About 8,700 recreational boats may be moored in the region, indicating that they have the potential to disperse invasive marine species beyond their present range.

Key words: introduced species; invasive marine species; New Zealand; non-indigenous marine species; vector

Introduction

The annual economic cost of all invasive species (marine, aquatic and terrestrial) in New Zealand has been estimated at NZ$1.87 billion (MFB 2010). New Zealand's marine environments are (probably) at higher risk to invasive marine species than other countries and they threaten endemic native species with extinction. Although this effect has not yet been demonstrated in the marine environment, more marine species (48%) are endemic to New Zealand than any other country (Costello et al. 2010).

Biofouling on niche areas and boat hulls is the most significant vector for non-indigenous marine species (NIMS) translocations worldwide (Drake and Lodge 2007; Hayden et al. 2009; Bell et al. 2011). The more biofouling present on a boat, the more likely the presence of NIMS (Inglis et al. 2008). Recreational boats pose a high risk of transporting biofouling as they have long lay-up periods, undertake slow and itinerant voyages, are not restricted to ports and frequent in-service maintenance is of marginal benefit to the owner (Floerl et al. 2005; Hilliard and Polglaze 2006; Bell et al. 2011; Murray et al. 2011). The distribution of NIMS by recreational boats is a recognised problem in marine and freshwaters (e.g. Dalton and Cottrell 2013). NIMS can therefore be easily dispersed by these boats, including to remote and relatively untouched coastal environments and marine reserves of high conservation value (e.g. Trenouth and Campbell 2013; Campbell and Hewitt 2013).

Eighty-seven percent of all documented NIMS in New Zealand are likely to have been introduced via biofouling (Cranfield et al. 1998), for example, the kelp *Undaria pinnatifida*, crab *Charybdis japonica*, Mediterranean fan worm *Sabella spallanzanii* and tunicate *Styela clava* in the Auckland region (Hay and Luckens 1987; Kluza et al. 2006; Bell et al. 2011). This region also has the highest number of moored recreational boats in New Zealand (Dodgshun et al. 2007).

Recreational boats are typically moored either in berths (e.g. attached to a pier in a marina) or on swing moorings (attached to an anchored buoy via a rope or chain) (Figure 1; Dodgshun et al. 2007;

Figure 1. Examples of photos of boats on swing moorings (left) and in berths (right).

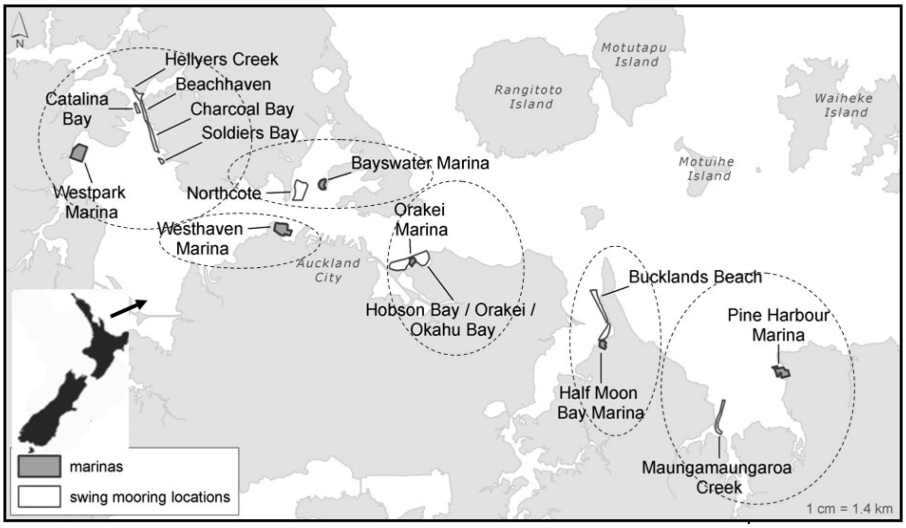


Figure 2. The 6 study sites (circled) and 12 locations (named) surveyed within the Auckland region, New Zealand (inset).

Piola and Forrest 2009). However, there is a lack of data demonstrating whether a boat's mooring location influences the level of biofouling or potential to be contaminated by NIMS (Floerl 2002; Floerl and Inglis 2003). Boats moored on swing moorings can have higher levels of biofouling if the boats are hard to access and are moored in more exposed, natural environments (Darbyson et al. 2009; Piola and Forrest 2009). Boats berthed in marinas may also have high levels of biofouling if they are close to piers with rich biofouling growth or visiting vessels that are contaminated with NIMS (Floerl 2002; Floerl and Inglis 2003).

The present research used waterline visual assessment and underwater video to assess biofouling levels on boats in berths and on swing-moorings in the Auckland region. In addition, a questionnaire based survey was conducted of boat owners regarding their general boat characteristics, voyage history, maintenance and cleaning history and their knowledge of marine biosecurity. Understanding the nature and extent of biofouling on recreational boats may assist their potential management to mitigate the dispersal of NIMS.

Methods

Biofouling surveys using visual assessment and underwater video were carried out in the summer (February to April) of 2011 in six sites, adjacent to Auckland city (Figure 2). In each site, 60 recreational boats (360 in total) were randomly selected; 30 in berths (i.e. in marinas) and 30 on swing moorings nearby (Table 2).

The level of biofouling on each boat was ranked by the first author using a six-point scale (Floerl et al. 2005, 2008; Table 1) on one side of the boat only. Each boat had identification information recorded, a photo of the waterline taken, and was surveyed by an underwater video camera secured to a manoeuvrable rod (extended 25 cm to create a field of view of 30 cm by 20 cm) from the bow to the stern (including the rudder) on the day of sampling. Water salinity, temperature and wind (by the Beaufort scale) were measured. Later, the underwater video footage was reviewed in the laboratory and still images were taken from the video to determine the level of biofouling and the potential of any NIMS present. Dr Mike Page (a marine biodiversity and biosecurity expert, National Institute of Water and Atmospheric Research (NIWA)) tentatively identified species from the video images. Species nomenclature follows the World Register of Marine Species (Appeltans et al. 2012; Costello et al. 2013).

Questionnaires were created to gather information on: boat characteristics (length, outer hull material and average cruising speed in knots); voyage history (where it had gone since its last antifouling paint application and/or clean, the last 5 locations visited and the maximum period the boat had been moored for extended periods); maintenance history (how often it was used, type of antifouling paint applied, cleaning costs and if there had been any inspections); and knowledge of marine biosecurity (Appendix 1). The questions were derived from the MAF (Ministry of Agriculture and Forestry New Zealand, now the Ministry for Primary Industries, MPI) Yachting Monitoring Survey (Thompson et al. 2009). Questionnaires, participant information sheets and consent forms were administered by face-to-face interviews, mail outs and an online survey (http://www.surveymonkey.com/s/biofoulsurvey) between November 2010 and July 2011. Questionnaires were distributed by a variety of methods to maximise the return rate. Four hundred boat owners with boats on swing moorings were contacted by post (due to the Privacy Act) with the assistance of the Auckland Council Harbour Master. Over 2000 owners of boats in berths were contacted through the marina manager by email, via the marina's website and Facebook page, and by personal contact at the marina.

Statistical analysis of biofouling data

The statistical analysis was carried out in R (Version 2.13.0) and the results were statistically significant when $p < 0.05$. Residuals were examined for heterogeneity of variance and normality.

To test for a difference in the level of fouling between the six sites and mooring type (swing mooring or berth), a two-way analysis of variance (ANOVA) was carried out. Both factors were tested as fixed, not random. To test for significance, a Tukey's post hoc test was carried out. To identify if there was a difference in the distribution of the fouling ranks (0–5) between boats on swing moorings and in berths, a two-way table of counts (Pearson's chi-squared test) was used. Z scores were calculated to identify if there was a significant difference within each fouling rank between boats on swing moorings and in berths.

A paired t-test was used to identify if there was a difference in the level of fouling assessment between the underwater video and waterline visual techniques because the two measurements were not independent (they were made on the same boat). This tested the null hypothesis that the mean difference between the two techniques (visual – video) was equal to 0. A 2-way ANOVA was carried out on the difference between techniques (video – visual) to test whether differences were consistent between sites and mooring type. The six sites and mooring types (swing mooring or berth) were treated as fixed, not random. A 2-way ANOVA was carried out to test for differences between boat type (launch or yacht) and sites. Few launches were surveyed on swing moorings therefore this statistical analysis was restricted to boats in marinas.

A non-parametric correlation (Spearman's rho) was carried out to test for differences between the mean level of fouling in each sampling location and the cost to moor a boat per day.

Statistical analysis of questionnaire data

Independent sample t-tests were used to identify significant differences in boats' average cruising speed, mooring charges, maximum period a boat had been laid up in a location other than its home in the last 2 years and maintenance and cleaning fees between boats on swing moorings and in berths.

Table 1. The system to score biofouling on recreational boats based on Floerl et al. (2005, 2008).

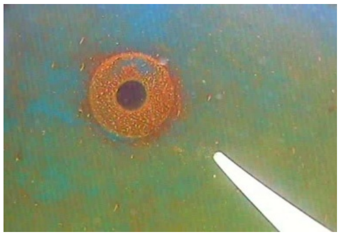
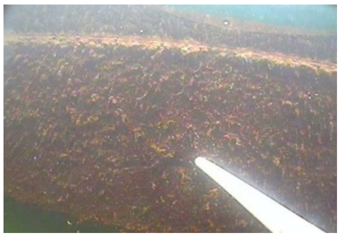
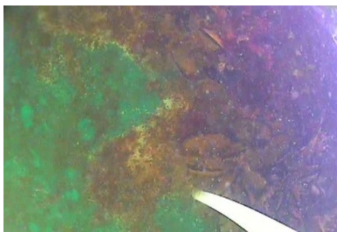
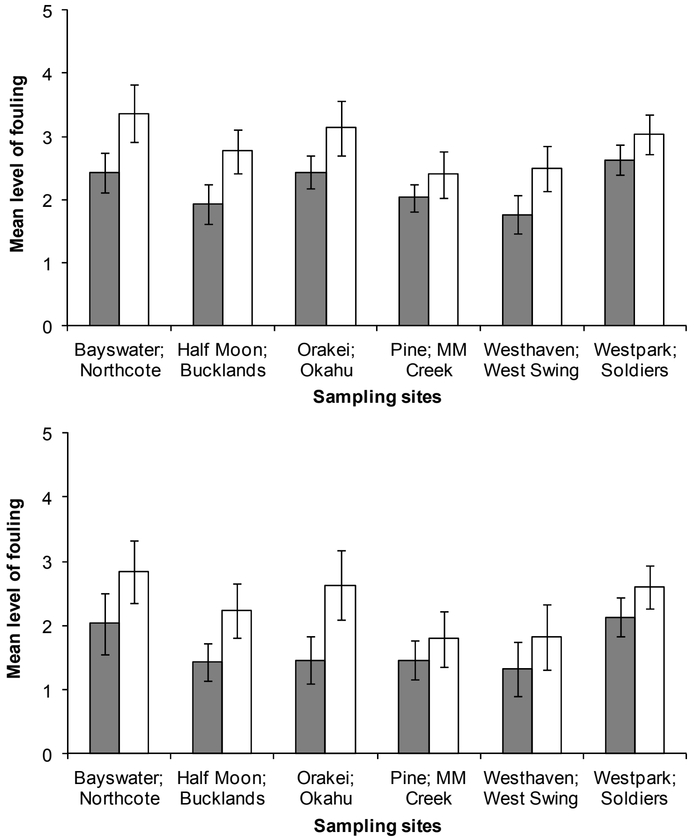
Rank	Description	Waterline	Underwater
0	No visible biofouling. Hull entirely clean, absolutely no biofilm on any submerged parts of the hull. No biofouling cover via a visual and underwater camera estimate.		
1	Slime biofouling only. Submerged hull areas partially or entirely covered in biofilm, but no macrofouling present. No biofouling cover via a visual and underwater camera estimate.		
2	Light biofouling. Hull covered in biofilm and 1-2 very small patches of macrofouling with only one taxon (for example, diatom or filamentous algae). Biofouling less than 2 cm thick. Using visual and underwater camera estimates, around 1-5% of visible submerged surfaces are covered.		
3	Considerable biofouling. Presence of biofilm and macrofouling patchy but clearly visible and comprised of either one single or several different taxa (for example, hard encrusting animals, algal tufts and/or mobile amphipods). Using visual and underwater camera estimates, around 6-15% of visible submerged surfaces are covered.		
4	Extensive biofouling. Presence of biofilm and abundant biofouling assemblages consisting of more than one taxon (for example, mussels, seaweed, sponges, crabs and/or seastars). Using visual and underwater camera estimates, around 16-40% of visible submerged surfaces are covered.		
5	Very heavy biofouling. Diverse assemblages covering most of visible hull surfaces. Using visual and underwater camera estimates, around 41-100% of visible submerged surfaces are covered.		

Figure 3. The mean level of biofouling assessed by video (upper panel) and visually (lower panel) for boats in berths (shaded, n = 180) and on swing moorings (clear, n = 180) across all sites. Error bars depict 95% confidence intervals.



A chi-squared test was used to identify: significant differences in the boat owners' perceived condition of their boat exterior; the boat's movements from its home mooring location; the date antifouling paint was last applied and what type of antifouling paint was used; and actions taken if an unusual looking marine organism were found.

Results

Biofouling

Whether estimated by video or visual methods, the mean level of biofouling on boats on swing moorings was significantly higher than those in berths: i.e. biofouling rank of (a) 2.9 ± 0.16 (95% CL) for swing moorings and 2.3 ± 0.19 for berths by video; and (b) 2.2 ± 0.12 and 1.6 ± 0.15 by visual observation, respectively (Figure 3). Significantly more boats on swing moorings had a biofouling rank of 4 ($z = 3.43$, $p <0.001$) and 5 ($z = 4.84$, $p <0.05$) compared to those in berths (Figure 4). In contrast, there were significantly more boats with a biofouling rank of 1 in berths than on swing moorings ($z = 3.9$, $p <0.001$). Although both video and visual techniques showed the same pattern of biofouling across boats, they were significantly different (paired t-test. $t_{359} = 13.38$, $p < 0.001$) (Figure 5).

Biofouling levels varied significantly between sites (2-way ANOVA, $F = 8.10$, d.f. = 5, $p < 0.001$): Bayswater - Northcote had significantly more than Half Moon - Bucklands (post-hoc Tukey's honestly significant difference test: $p < 0.02$), which in turn had more than Pine - MM Creek, and Westhaven - West Swing sites ($p < 0.01$ respectively). The Orakei - Okahu site had significantly more biofouling than Pine - MM Creek site ($p < 0.05$) and the Westhaven - West Swing site ($p < 0.01$). The Westpark - Soldiers site had significantly higher levels of biofouling than the Pine - MM Creek and Westhaven – West Swing sites ($p < 0.01$). However, there was no interaction between site and mooring type (2-way ANOVA, $F = 0.93$, d.f. = 5, $p = 0.46$), so the difference between mooring types was consistent at all sites.

Figure 4. The distribution of biofouling on boats averaged across all sites with boats in berths and on swing moorings. A star indicates a significant difference of p < 0.001 and a diamond indicates a significant difference of p < 0.05 between boats in berths (shaded, n = 180) and on swing moorings (clear, n = 180) within each level of biofouling.

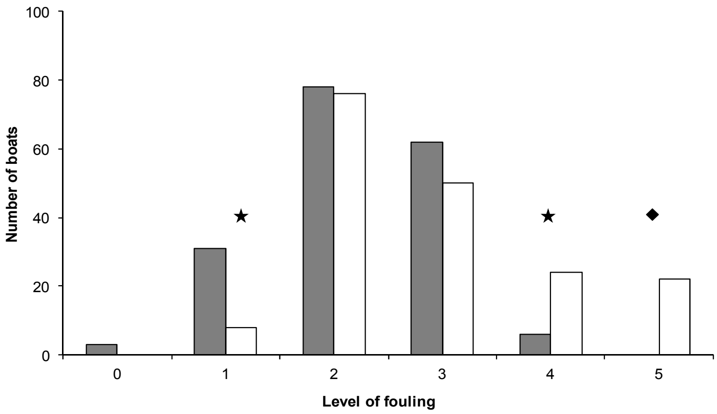
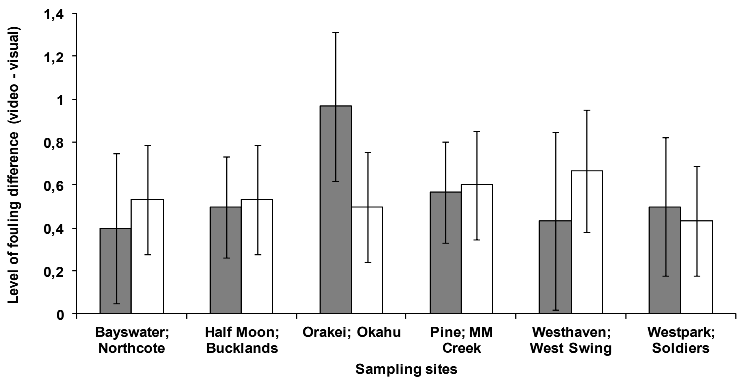


Figure 5. Difference (video – visual) in the mean level of biofouling between video and visual technique across all sites with boats in berths (shaded, n = 180) and on swing moorings (clear, n = 180). Error bars depict 95% confidence intervals.



On swing moorings, there were more yachts (93%) than launches surveyed; in berths, there were more launches (56%) than yachts, which reflected yacht and launch distribution by mooring type (Figure 6). Because there were so few launches surveyed on swing moorings, the analysis of the effect of boat type was restricted to marinas. For boats in marinas, there was no significant difference in the level of biofouling between boat type (2-way ANOVA, d.f. = 5, F = 1.03, p = 0.31). Neither was there any correlation between the boat length (range 7 – 25 m) and biofouling on boats in berths (Spearman's r^2 <0.01). Boat length was not measured on swing moorings.

There was little variation in salinity (29.5 – 33.4 ppt), temperature (21.0 – 24.6 °C) and wind (Beaufort scale 1–5 indicating 5–25 km h^{-1} winds) when sampling, and these parameters were not correlated with the levels of biofouling (2-way ANOVA, d.f. = 1, F = 0.17, p = 0.68).

It was not the intention of the present study to detect NIMS. However, the video images from 8 boats in five locations had suspected NIMS, namely the tunicates *Botrylloides leachii*, *Styela canopus*, *Ascidiella aspersa*, *Styela plicata*, and *Botryllus schlosseri,* and fan worm *S. spallanzanii* (Table 3).

Boat use

There were 150 questionnaire respondents, mostly male (95%), and 75% (112) were owners of boats moored in berths. Boats were used mainly (93% of time) in the summer but more than half (58%) were used at least once a month; with no significant difference across the mooring types (χ^2_3 = 6.89, p = 0.76).

There was a negative correlation (Spearman's rho = -6.7, p < 0.05) between the level of biofouling and the cost to moor a boat. Owners of boats on swing moorings spent less on mooring charges (92% spent less than $1000) than those in berths (87% spent between $2000–10000) annually ($t_{145}$ = 6.14, p < 0.001).

Average cruising speed ranged from 4 to 15 knots for boats on swing moorings, but up to 25

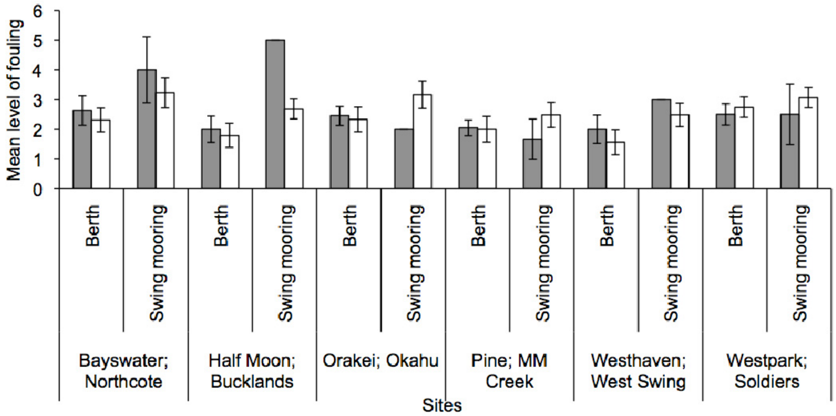


Figure 6. The mean level of biofouling across sites by mooring and boat type (launch (shaded) or yacht (clear)). Error bars depict 95% confidence intervals. Columns with no error bars indicate only one boat within that boat type.

knots for boats in berths. The latter (predominantly launches) thus had a significantly higher average boat cruising speed than boats on swing moorings (predominantly yachts) (t_{142} = 3.78, p < 0.001).

There was no difference in the distance boats of both mooring types travelled (χ^2_3 = 4.93, d.f. = 1, p = 0.18) (Figure 7). Only 7% travelled internationally. The majority (54%) did not travel more than 30 km from their home location, with Waiheke Island being the most common destination (Figure 8). When boats travelled to different areas in the last 2 years, most (56%) were moored for 1–9 days, but up to 10% over 10 months, although there was no difference in the length of stay between boats on swing moorings and in berths (t_{148} = -0.64, d.f. = 1, p = 0.52).

Boat cleaning

The majority of questionnaire respondents (79%) personally carried out general boat maintenance and cleaning on their boat and did this about every 6 months. All the owners of boats on swing moorings cleaned their boat themselves. The majority of boat owners cleaned their boats out of the water but 24% cleaned it in the water. Owners of boats on swing moorings applied antifouling paint significantly more (once every year) than those in berths (every 2 years) (χ^2_3 = 14.42, p = 0.002). Thirty-seven percent of all respondents had applied antifouling paint within the last 6–12 months. Although there were different types of antifouling paint (for example, conventional, ablative and self-polishing), there was no significant difference in the type of antifouling paint applied to any of the boats regardless of mooring type (χ^2_7 = 9.40, p < 0.23).

It appeared that the majority of owners of boats on all moorings applied antifouling paint frequently. Respondents considered that the removal of biofouling and the use of antifouling paints were essential but most (86%) were motivated by the impact on speed and fuel economy. The owners of boats on swing moorings thought their boats were in good condition while the owners of boats in berths thought their boats were in excellent condition (χ^2_3 = 17.13, p < 0.001). Owners of boats on swing moorings spent significantly less on their boat maintenance and cleaning charges annually than owners of boats in berths (unequal variances were assumed t_{106} = 4.11, p < 0.001).

Most respondents (86%) had received information about the importance of boat cleaning to prevent the spread of NIMS, but they had not changed their cleaning routine. Many (78%) mentioned that they would not change their cleaning routine because they already maintained their boats in a way that would prevent the spread of NIMS. When asked what they would do if they came across something unusual looking when cleaning their boats, the majority of respondents (79%) said they would report it to MAF, the closest marina, or the cleaning contractor.

Number of boats

We estimated that there were about 8,700 recreational boats in the Auckland region, comprised of 3,600 on swing moorings (Bruce Goff, Auckland Council Harbour Master, personal communication, 2012) and 5,100 boats in berths (estimation from the number of boats in marinas); excluding boats held on land.

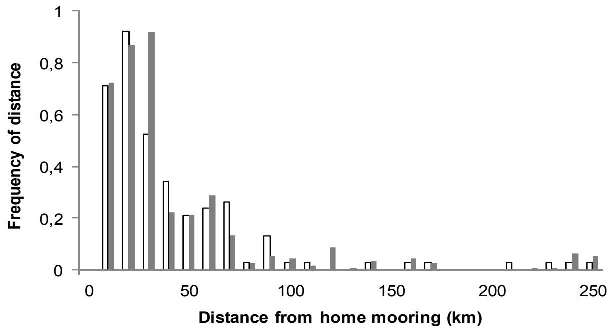


Figure 7. Frequency of distances (km) and number of travel locations from the home mooring in the last 2 years on berths (shaded) and swing moorings (clear).

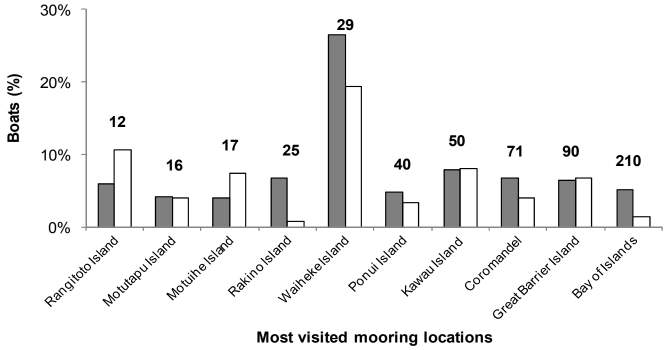


Figure 8. The locations most visited by boats from berths (shaded) and swing moorings (clear), ordered by distance from the study area (shown in km above each bar).

Table 2. Number and % of boats surveyed on swing moorings and in berths in each location.

Site	Location	Total number of boats on swing moorings	% of boats surveyed from each swing mooring location	Total number of boats in berths	% of boats surveyed from each berth location (marina)
A	Bayswater			415	7
	Northcote	186	16		
B	Half Moon			513	6
	Bucklands	182	16		
C	Orakei			179	17
	Okahu	295	10		
D	Pine			556	5
	MM Creek	55	55		
E	Westhaven			1189	3
	West Swing	52	58		
F	Westpark			592	5
	Soldiers	116	26		
TOTAL		886	20	3444	5

Discussion

Both visual and video methods found that boats on swing moorings had significantly higher levels of biofouling than those in berths. Although the video found more biofouling, both methods were suitable to identify biofouling on recreational boats.

Significantly more boats on swing moorings had a biofouling rank of 4 and 5 compared to boats in berths. Thus, on average, boats on swing moorings were more likely to be fouled by NIMS (Inglis et al. 2008). However, a survey of the species composition of biofouling would be required to confirm this. Contaminants from boat paints and high turbidity may limit NIMS growth in marinas or facilitate them by limiting natural competitors (Bax et al. 2002; Floerl and Inglis 2003; Davidson et al. 2010; Johnston et al. 2011).

Table 3. Species identified from the still images obtained from the video on boats on swing moorings and in berths.

Location	Species found	Images
Bayswater (berth)	Possibly *Botrylloides leachii*	
Bucklands (swing mooring)	Possibly *Styela canopus* and *Ascidia aspersa*	
Okahu (swing mooring)	*Styela plicata*, possibly *Botryllus schlosseri*	
MM Creek (swing mooring)	Possibly Botryllid tunicate	
Westhaven (berth)	Possibly *S. plicata* (left), *S. spallanzanii* (right).	 

On the other hand, studies in Australia have proposed that in enclosed marinas the marina's act as stepping stones for NIMS through a combination of low flushing rates (retaining propagules) and changes in temperature and salinity to induce spawning (Apte et al. 2000; Ashton et al. 2006; Floerl and Inglis 2003; Glasby et al. 2007; Minchin and Gollasch 2003).

Although mooring a boat in a marina berth is considerably more expensive for boat owners than on a swing mooring and the latter spent less on boat maintenance, antifouling paints were applied more often to boats on swing moorings. Antifouling paint was applied more frequently on boats on swing moorings suggesting antifouling paints are less effective on these vessels (potentially due to greater fouling growth or greater water flow (to wear off the antifouling paint)). These results could be due to survey bias as those who cleaned their boats and/or applied antifouling paint were possibly more likely to have returned the survey.

The risk of spreading species depends largely on the movements of the highly fouled boats (Ashton et al. 2006). Boats on swing moorings travelled at slower cruising speeds (4–15 knots) than boats in berths. If a boat moves at a speed less than 14 knots to get to their destination, the biofouling species are unlikely to become dislodged during travel (Coutts et al. 2010). However, because more yachts were on swing moorings (93%) and more launches were in berths (56%), the slow speed of a yacht could allow for greater levels of biofouling to persist, despite more frequent antifouling. Thus, not only do boats on swing moorings generally have more biofouling, their speed may be insufficient to dislodge biofouling.

Eight boats in five locations were found with NIMS present. The invasive crab *C. japonica*, fan worm *S. spallanzanii*, and kelp *Undaria pinnatifida* have been previously reported from all locations except Pine - MM Creek (MAF et al. 2011). The invasive tunicate *S. clava* and oyster *Crassostrea gigas* have been reported from Westhaven - West Swing and Westpark - Soldiers locations, and *C. gigas* at Bayswater - Northcote (MAF 2011). Our observations from video suggested several invasive tunicates may also have been present in at least three swing mooring and two berth locations (Table 3), but this requires confirmation by the collection of specimens. Thus, the Auckland marinas have a range of invasive species that may attach to boat hulls and be dispersed regionally, particularly to Waiheke Island because it is the most popular destination.

Many questionnaire respondents noted that they would report an unusual looking marine species to MAF or the closest marina and had received brochures that compared the native with invasive species, but would struggle to identify species. Thus, while public reporting should be encouraged and can be helpful, confirmation of species identification by professionals is essential (Crall et al. 2010). The present study indicated that visual observation of boats from the waterline can identify boats that pose a biosecurity risk (i.e. biofouling rank >2), but that physical samples of specimens would be required to confirm the presence of particular species.

The owners of boats on swing moorings cleaned their boats themselves (with water blasting the most common method), even though many boats were difficult to reach due to their location. Some were cleaned in the water, even though this activity is prohibited without a permit. In addition to public information about the need to prevent the spread of invasive species, additional incentives to encourage boat cleaning could be considered, perhaps in conjunction with boat safety inspections.

Given the fact that there are at least 8,700 boats in the Auckland region, even if only 5–20% of boats have biofouling levels >2, hundreds of boats may already be transporting invasive species within the region. This redistribution of alien species on recreational boats may be typical of the situation in many countries (e.g. Europe, Katsanevakis et al. 2013, Ashton et al. 2006).

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Supplementary material

The following supplementary material is available for this article:

Appendix 1. Risk factors for biofouling of recreational boats moored on swing moorings and in berths.

Date: ………………………………..

NOTE: This survey can be completed online http://www.surveymonkey.com/s/biofoulsurvey

Section one – General information

1. What is your name? Note: All individual survey results and personal information is confidential and will be accessible only to the researcher.

……………………………………………………………………….

2. What are your contact details?
Telephone: (Cell phone) ………………………..

(Home phone) ……………………….

Email address: ……………………………………………….

3. Where is your boats primary mooring location?

……………………………………………………………………….

4. What is your boats swing mooring number (swing mooring boat owners) OR marina berth number (marina boat owners)?

……………………………………………………………………….

5. What is the name of your boat?

……………………………………………………………………….

6. What is the length of your boat (approximate value in metres)?

……………………………………………………………………….

7. What is your boat's outer hull made from? Tick the box/boxes that apply.

☐ Steel
☐ Wood
☐ Fibreglass
☐ Aluminium
☐ Concrete
☐ Ferro-cement
☐ Other – please specify: ……………………………………..

8. What is your boat's average ocean cruising speed (knots)?

…………………………………………………………………….

9. How would you describe the general condition of your boats exterior? Tick the one box that applies.

☐ Excellent
☐ Good
☐ Average
☐ Very Poor/Poor

10. How often do you use your boat? Tick the one box that applies.

☐ More than once a month
☐ At least every month
☐ At least every 3 months
☐ Less than once a year

11. In which season would you most use your boat? Tick the one box that applies.

☐ Summer
☐ Spring
☐ Autumn
☐ Winter

12. What are your approximate mooring charges ($) annually? Note: This is how much it costs to moor your boat its current location; it excludes maintenance and cleaning charges.

…………………………………………………………………….

Section two – Voyage history

13. Please supply the details of your boats last five mooring locations in the last 2 years:

……………………………………………………………………………..........…………………………………

14. Does your boat travel overseas? Tick the one box that applies.

☐ Yes
☐ No

15. Since your boats most recent antifouling paint application and clean, which different harbours has this boat visited?

a) Number of harbours visited (e.g. 1, 5, 10): ………………………………

b) Location of harbours visited: ………………………………………

16. What was the maximum period (in days and/or months) that your boat was moored in one location (other than its home location) in the last 2 years?

Days: ………….

Months: ………….

Section three – Maintenance history

17. Do you personally maintain and clean your boat?

☐ Yes
☐ No

18. How often is the following maintenance carried out on your boat? Please select the frequency for each question.

Maintenance type		Frequency							
		1		2		3		4	
a)	Removal of slime, weeds, shells (biofouling)	Every 6 months		Once every year		Once every 3 years		Never	
b)	Antifouling paint application	Once every year		Once every 2 years		Once every 3 years		Never	
c)	General repairs	Ongoing		Every 6 months		Once every year		Seldom	

19. How have slime/weeds/shells been removed from your boat previously? Tick all the boxes that apply.

☐ Water blasting
☐ Scrubbing
☐ Brushing
☐ Other – please specify: ……………………………………..

20. Your boat is cleaned: (Tick the one box that applies)

☐ In the water
☐ Out of the water

21. What brand of antifoul paint was used last? Tick the one box that applies.

☐ Altex (e.g. No. 5)
☐ Coppercoat
☐ International (e.g. Micron extra, Micron 66, Ultra)
☐ Wet & Forget War Paint
☐ Trilux
☐ Alkitex (e.g. Sea Horse)
☐ Don't know
☐ Other – please specify: ……………………………………..

22. When was this boat's current antifouling paint last applied (dd/mm/yyyy)?

Date: ……/……/…………

23. What are your approximate boat maintenance and cleaning charges ($) annually? Note: this excludes any mooring charges.

………………………………………………………………………………

24. On a scale of 1 to 5 where 1 is 'don't care' and 5 is 'essential', what is your general attitude toward antifouling? Please put an X on the line.

1 (don't care) 2 3 4 5 (essential)

25. What are the reasons for your score on Question 26?

………………………………………………………………………………………

………..……………………………………..…………………………………………

Section four – Knowledge of marine biosecurity

26. Have you ever received information about the importance of boat cleaning to prevent spreading marine pests?

☐ Yes
☐ No

27. Have you changed your boat maintenance routine in light of learning more about the damage marine pests can cause?

☐ Yes
☐ No

28. What would you do if you came across something unusual looking to you when cleaning your boat?

☐ Take no action
☐ Report it to the Ministry of Agriculture and Forestry, the closest marina, or the cleaning contractor
☐ Try to dispose of it
☐ Other – please specify: ………………………………………..

29. Are there any other comments you would like to add?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

Thank you for your time