2024

EXPLORING BOATERS' INTENTIONS AND AWARENESS TO EXPLAIN WHY SOME ANCHOR ON CORAL REEFS

Caroline Caton
University of Rhode Island, cpcaton13@gmail.com

EXPLORING BOATERS' INTENTIONS AND AWARENESS TO EXPLAIN WHY SOME ANCHOR ON CORAL REEFS

BY

CAROLINE CATON

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

BIOLOGICAL AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF RHODE ISLAND

2024

MASTER OF SCIENCE THESIS

OF

CAROLINE CATON

APPROVED:

Thesis Committee:

Major Professor Graham Forrester

Tracey Dalton

Carlos García-Quijano

David Bidwell

Brenton DeBoef
DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND
2024

ABSTRACT

Coral reefs provide a variety of ecosystem services to humans, but are also degrading due to human activities such as boat anchoring. Understanding why some boaters anchor on coral reef, even when environmentally-responsible alternatives are available, will lead to effective management with substantial environmental benefits. Anchoring on reef could occur intentionally, because boaters prioritize other considerations that outweigh any desire to not anchor on reef, or unintentionally, because they lack true awareness of the bottom type. We conducted structured interviews, informed by the Theory of Planned Behavior, with boaters in the British Virgin Islands to uncover the motivations and awareness underlying their anchoring behavior. Perceived awareness is rarely ground-truthed, so we also snorkeled to observe the bottom type where they anchored as a direct check of their interview response. All respondents displayed a strong aversion to anchoring on reef. The few boats we observed anchored on reef did so unintentionally due to a mismatch between their perceived and actual awareness of the bottom type. Because more anchoring leads to more unintentional anchoring on reef, using a mooring is a potential solution to this problem, so it is important to identify ways to increase the use of moorings. The decision to anchor rather than moor is multifaceted. Our results suggest that boaters who do not trust the moorings are safe to use, do not perceive moorings as easy to pre-book, and prefer less-crowded areas are more likely to anchor. By increasing the proportion of boaters using a mooring, the number of boaters anchoring would decrease, and thus the amount of anchoring on reef would decrease as well.

ACKNOWLEDGMENTS

This project would not have been possible without the support of many individuals. First and foremost, I want to express my deepest gratitude to my advisor, Dr. Graham Forrester, for his professional and personal support throughout this journey. Thank you for agreeing to mentor me, trusting in my ability to conduct a social science project, always challenging me to improve, and ensuring I had the resources I needed to succeed. I also could not have undertaken this without the incredible support of my team of social scientists. Thank you to Dr. Tracey Dalton, Dr. Carlos García-Quijano, and Dr. David Bidwell for your guidance, invaluable advice and feedback, and palpable excitement for the project. Also, thank you to Dr. Melva Treviño Peña for serving as my defense chair and being a key facilitator of my knowledge about and excitement for social science. I am also grateful to the University of Rhode Island and The Nature Conservancy for providing funding for my fieldwork and to Dr. Lianna Jarecki, Mike Harmon, and Linda Forrester, who quite literally kept the ship running during it. Finally, a special thank you to all the boaters who took time out of their vacations to share their perspectives with me.

I would also like to extend thanks to the Preisser lab, who took me in as one of their own and provided helpful feedback, encouragement, and friendship throughout my time at URI. Thank you to my family and friends in Rhode Island and across the country for always rooting for and supporting me. Finally, thank you to Conner for all the time and brainpower you contributed to helping me with this project and for being a shoulder during the emotional rollercoaster of graduate school.

DEDICATION

I dedicate this thesis to my dad, who was my number one fan. Thank you for always supporting my dreams and believing I can do hard things.

PREFACE

The following thesis is written in manuscript format and is prepared for submission to the journal *Ocean and Coastal Management*.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This manuscript is formatted for submission to the journal *Ocean and Coastal Management*.

Exploring boaters' intentions and awareness to explain why some anchor on coral reefs

Caroline Caton[1] and Graham Forrester[1]

[1] Department of Natural Resources Science, University of Rhode Island, Kingston, RI 02881, USA

Keywords: anchoring, British Virgin Islands, coral reefs, Theory of Planned Behavior, recreational boating

Highlights:

- Anchoring on coral reef is unintentional
- Anchoring on reef occurs because of a lack of actual awareness of the bottom type
- Increased use of moorings instead of anchoring should reduce anchoring on reef
- Increasing actual awareness of bottom type should reduce anchoring on reef

1. INTRODUCTION

Coral reefs are part of a complex social-ecological system because humans rely on these ecosystems for services such as sustenance, protection from erosion and storms, bioprospecting, and tourism (Eddy et al., 2021) but they can also compromise the extent to which reefs provide these services. For example, human benefits from tourism are enhanced by healthy reefs (Dinsdale and Fenton, 2006), but anchoring has been shown to have detrimental impacts on these sensitive marine habitats, including directly injuring coral and lowering invertebrate population density (Dinsdale and Harriott, 2004; Flynn and Forrester, 2019; Forrester et al., 2015; Giglio et al., 2017). This damage is caused by a minority of boaters who anchor on coral reefs, despite having the option to anchor on sand or use a mooring (Forrester, 2020). There is thus a need to understand what causes boaters to perform environmentally-responsible (anchoring on sand or using a mooring) or irresponsible (anchoring on reef) behavior.

There are a variety of frameworks to predict what causes individuals to perform environmentally-responsible behaviors, and the validity of each model depends on the context of the study (Kollmuss and Agyeman, 2002). When determining which framework is most appropriate, it is important to consider both the internal (e.g. awareness, attitudes) and external (e.g. social norms, cost) factors that may serve as motivators (Guagnano et al., 1995; Kollmuss and Agyeman, 2002). Frameworks such as the Theory of Reasoned Action (Fishbein and Ajzen, 1975), the Theory of Planned Behavior (Ajzen, 1991), and others incorporate both internal and external factors. Past research used these frameworks to understand other environmental behaviors, such as

recycling (Guagnano et al., 1995) and fishing waste management (Simmons and Fielding, 2019).

Anchoring on reef may be intentional and other studies have examined anchoring as a planned behavior (Diedrich et al., 2013; Parry-Wilson et al., 2019). Past research in the Mediterranean showed that boaters consider factors such as cost, safety, comfort, crowding, and presence of sensitive marine habitats when choosing locations to visit and whether to anchor or moor there (Diedrich et al., 2013). It is therefore reasonable to propose that boaters may have other concerns that outweigh any desire to not anchor on reef and it is important to understand what these motivations are.

Because properly anchoring requires a level of skill and awareness, anchoring on reef may also occur unintentionally due to boaters' lack of awareness of the bottom type. However, perceived awareness is rarely benchmarked against actual awareness. The only study we could find about anchoring awareness indicated most (76%) boaters in the Mediterranean said they did not know the bottom type on which they were anchored and half (50%) of those anchored were, in fact, on ecologically-sensitive seagrass beds (Lloret et al., 2008). It is thus important to both identify boaters' perceived awareness and directly compare it with their actual awareness by observing their true anchoring behavior.

Management actions to mitigate anchor damage can be taken locally, and common solutions include boater education programs, restricting anchoring on sensitive habitats, and providing moorings as an alternative to anchoring (Beeden et al., 2014; Day, 2002; Francour et al., 2006). These practices have been used in Caribbean locations for decades, but have not prevented extensive damage to reef

habitats. Behavioral solutions are also possible, and understanding boaters' behavioral motivations and incorporating them into future management strategies will further reduce anchor damage and have substantial environmental benefits.

Through this study, we explore boaters' behavioral motivations and anchoring awareness to explain how some boaters anchor on coral reefs. We hypothesize two general reasons for how this occurs. The first is that anchoring on reef is planned because boaters have other concerns that outweigh those about anchoring on reef. These could include several factors, including crowding, the cost of moorings, safety, or lack of concern about the environment (Diedrich et al., 2013). Since this hypothesis assumes anchoring on reef is planned, we used a modified version of the Theory of Planned Behavior (Ajzen, 1991) as a framework to organize specific hypotheses, which are discussed in Section 2.4.1. The second hypothesis is that anchoring on reef is unintentional due to a lack of awareness of the bottom type on which they are anchoring. Boaters may think they are anchored on sand, but actually be anchored on reef.

2. METHODS

2.1. Study location

The British Virgin Islands (BVI) are an ideal location to investigate anchoring behavior. They are one of the most popular sailing destinations, as the calm seas and mild weather are conducive for sailors of all skill levels, and the islands are close together, so dozens of bays are easily accessible through a short sail (Fig. S2). Yacht tourism is thus a key contributor to the BVI economy (Everitt, 2007), with more than 30 charter companies and 1100-1500 charter yachts operating in BVI waters (CharterWorld, 2024; Forrester, 2020). Other types of boats, including small fishing boats and large mega-yachts, also operate in the BVI, but most boats are intermediate-sized power and sailing vessels associated with the charter and tourism industries. Similarly, most boaters in the BVI can be categorized into one of three operator types: 1) bareboaters, who are charterers who rent a boat and captain it themselves; 2) charter captains, who are professionals employed by charter companies to operate the boat for those renting it; and 3) private boat owners, who both own the boat and operate it themselves.

Past research also identified boat anchoring as a significant contributor to coral reef decline, despite a system of moorings and regulations against anchoring on reef (Flynn and Forrester, 2019; Forrester et al., 2015). There are several types of moorings across the BVI. A private company, BoatyBall, provides a system of reservable moorings ($55/night), first-come-first-serve moorings ($30-40/night), and day-use-only moorings (donation-based) (BoatyBall, 2024). The reservable moorings are available to book on a cellular app that requires internet access. Moorings open for reservation at 7 a.m. each day and are only available to book for that day. The BVI

National Parks Trust also maintains day-use-only moorings at popular dive and snorkel sites that are free to use after purchasing a permit (BVI National Parks Trust, 2024). Finally, there are privately-owned moorings that are provided by businesses, private owners, or private islands (typically $30-40/night). A comprehensive list of all moorings in the BVI does not exist, but these represent the main categories of moorings present there. Additionally, it is free to anchor in the BVI, but anchoring is prohibited in some areas (Virgin Islands Fisheries Regulations, 2003).

We propose that boaters' anchoring behavior can be described as a three-step process and it is important to understand their motivations at each of these steps. First, boaters choose a bay or anchorage in which to secure their vessel. Most boaters in the BVI are on a multi-day itinerary, so the bays they select to visit can affect, or be affected by, their intent to anchor or moor. The most discernible reason for this is that some bays have no moorings. There are also 20 bays designated as marine protected areas (MPAs) where anchoring is prohibited (Virgin Islands Fisheries Regulations, 2003). After choosing a bay, boaters must decide whether to anchor or moor. The options to secure vessels in the BVI are anchoring, mooring, or docking at a marina, but at the vast majority of locations, anchoring and mooring are the existing alternatives. Finally, if they decide to anchor, they must decide on which substrate they will anchor.

2.2. Questionnaire design

There were three main components to the sampling approach. The first was face-to-face, structured interviews to identify boaters' anchoring and mooring motivations,

perceptions of the bottom type, and perceived awareness. The second was online questionnaires to supplement these in-person interviews and increase the sample size. The third was a direct observation of the seabed habitat for those who were anchored during the in-person interviews. This served as a mechanism to ground-truth these boaters' perceived awareness of where they anchored against their actual awareness.

Interview questions were informed by the Theory of Planned Behavior (TPB). This framework, initially described by Ajzen (1991) as a framework for predicting behavior by examining the factors that influence behavioral intent, has been used successfully to predict behavioral intent for other environmentally-responsible behaviors (de Leeuw et al., 2015; García Mejías et al., 2021; Han et al., 2010). Here, questions were asked about core TPB factors, including attitude towards behavior (as defined by (Zemore and Ajzen, 2014), subjective norms (as defined by Maichum et al., 2016), perceived behavioral control (as defined by Maichum et al., 2016), actual behavioral control (as defined by Ajzen, 1991), and behavioral intentions (as defined by Maichum et al., 2016). Question types included five-item Likert scales, multiple choice, and open-ended questions. Likert scale questions were rated from 1 to 5, and, unless stated otherwise, 1 represented "strongly disagree" and 5 represented "strongly agree." The full set of interview questions can be found in Appendix 2.

To test the clarity of the questions, a pilot study was conducted with 58 boaters in the United States Virgin Islands from 31 May 2023 – 9 June 2023. Revisions were made after the pilot study to streamline the interview process and improve the clarity and informativeness of the questions. A final review of the new set of questions was given by two colleagues who have extensive experience with yachting in the BVI.

2.3. Sampling strategy

Face-to-face, structured interviews using a questionnaire (Bernard, 2017) were conducted with 74 boat operators in 16 bays and anchorages around the BVI from 25 October – 3 November 2023 (Figure S2). To obtain a sample representative of boater preferences, our sample of bays included sites with and without moorings, as well as both popular and secluded areas. Interviews were conducted across all days of the week and during daylight hours, approximately 8 a.m. to 6 p.m. In each bay or anchorage, the interviewer used a small, inflatable boat to approach vessels and request an interview. All secured boats were approached unless they had already been interviewed in a different location. All boaters approached agreed to be interviewed, except five boaters who were actively preparing to depart the bay. Boats within a bay were approached in haphazard order, to reduce the likelihood of boats at anchor feeling targeted. Additionally, the interviewer wore University of Rhode Island clothing to assure the boaters that this was a research study. After explaining the purpose of the study and obtaining consent, the interviewer read the boat operator each question and recorded their quantitative and qualitative responses on paper. Interviews were conducted in English and, on average, lasted about 10 minutes.

On-water interviews were supplemented by structured interviews on land and online questionnaires. Nine boat operators were approached opportunistically during the field trip (from 24 October – 4 November 2023) while their boat was docked or at a marina. An additional 47 responses were obtained through a Qualtrics questionnaire posted from 16 November 2023 - 27 November 2023 on a public Facebook page (BVI

Charter Chat) with over 35,000 members at the time of posting. On-land and online respondents were asked the original interview questions and instructed to answer based on their most recent anchoring or mooring experience. As these groups were not approached on the water, they could not be ground-truthed. While these different sampling strategies (on water, on land, and electronic) could result in different responses to questions, no formal comparisons between groups were made due to the small sample size of each group. However, the data across these three groups were compared visually and no obvious differences were identified.

2.4. Why do some boaters anchor on coral reefs?

2.4.1. Hypothesis 1: Anchoring on coral reef is a planned behavior

Because the TPB is limited in scope, extensions are commonly added to increase its explanatory power (Gautam, 2020; Ha et al., 2021; Maichum et al., 2016; Panwanitdumrong and Chen, 2021; Simmons and Fielding, 2019; Xu et al., 2020). Two extensions were added for this study. The first was an environmental concern factor preceding attitude towards behavior, as past work suggests that concern for the environment can influence attitudes and behavioral intention (Maichum et al., 2016). Because anchoring on coral reef has significant, negative environmental impacts, we predicted boaters with higher levels of concern for the environment would be less likely to anchor on reef. The second extension was perceived awareness of BVI-specific information relevant to anchoring. Past research on pro-environmental behaviors in marine recreation found individuals with more specific knowledge of and experience in the location and activity were more likely to support environmentally-

responsible behaviors (Ha et al., 2021). This factor was added in our study to account for the potential effects of local knowledge and experience in BVI waters on boaters' attitudes and perceived behavioral control. BVI residents, captains of crewed yachts, and private boat owners were predicted to be more familiar with BVI waters, and thus have more negative attitudes towards anchoring on reef, and more positive attitudes towards the environmentally-responsible anchoring alternative. These groups were also predicted to be more knowledgeable of proper anchoring practices, and thus have higher perceived control over their behavior to avoid reef when anchoring. Similarly, boaters who received a detailed briefing from the charter company, as well as those with a higher perceived awareness of BVI-specific regulations and the BVI environment, were predicted to have more negative attitudes towards anchoring on reef, and more positive attitudes towards anchoring on sand.

2.4.2. Hypothesis 2: Anchoring on coral reef is unintentional due to a lack of awareness

To address the hypothesis that anchoring on reef could be unintentional due to lack of awareness of the bottom type, we also asked two questions about boaters' perceived awareness of the bottom type. One question asked about the seabed habitat on which they anchored, while the other specifically asked if they thought they were anchored on reef. To ground-truth boaters' perceptions of their anchoring location an observer snorkeled to identify the bottom type under the anchor and chain of each boat at anchor. Each anchored boat was classified based on whether its anchor and adjoining anchor chain contacted primarily (1) sand, (2) seagrass, (3) coral reef, or (3) substrata of other composition. This judgement included both the substratum

underlaying the anchor and chain at the time of observation, plus the area plausibly affected by the chain and anchor with changing wind direction. This allowed for a direct comparison of boaters' perceived and actual awareness of the bottom type. The snorkeler worked independently from the interviewer and, because the presence of snorkelers is routine at most sites sampled, we consider it unlikely that boaters were aware of the snorkeler's intent.

2.5. Why do some boaters anchor rather than moor?

If anchoring on reef is unintentional, then it is important to understand why some boaters choose to anchor, rather than use the alternative of mooring. For that reason, we also asked questions addressing boaters' anchoring and mooring motivations. This set of questions was also inspired by the TPB and was designed to discover how attitudes, perceived behavioral control, and perceived awareness influenced both anchoring and mooring. The questions were informed by past literature that suggested safety, comfort, crowding, cost, and environmental concern can influence boaters decisions to anchor or moor (Diedrich et al., 2013). As in section 2.4.1, environmental concern and BVI-specific perceived awareness were added as extensions to the TPB in this model. As hypothesized previously, BVI residents, captains of crewed yachts, and private residents were expected to be more familiar with BVI waters than non-residents and bareboat captains, and therefore be more likely to anchor. Because anchoring and mooring are the only two options in most bays, some responses about anchoring are interpreted here as being informative towards mooring, and vice versa.

2.6. How does bay choice influence boaters' decision to anchor vs. moor?

Because most boaters in the BVI are on a multi-day itinerary, the bays they select to visit can affect, or be affected by, their intent to anchor or use a mooring. To understand this, boaters were asked how important a variety of factors were in their decision to choose a bay in which to secure their vessel (e.g. cost, crowding, availability of moorings, etc.). Importance was rated on a scale from 1 to 5, with 1 being "not at all important" and 5 being "very important." Because anchoring in some bays is prohibited (Virgin Islands Fisheries Regulations, 2003), questions about perceived awareness of anchoring regulations were also asked (e.g., presence of no-anchoring zones and perceived knowledge of those locations).

2.7. Data analysis

Pathways predicted to be influential were set up as hypotheses prior to data collection (Fig. S3, Fig S4, Table S1, Table S2). Models developed using the TPB are often fit to data using structural equation models. The small sample size of this study provided too few observations per model parameter to properly fit a statistical model to these pathways. As a descriptive guide, Mann-Whitney *U*-tests, Kruskal-Wallis *H*-tests, Chi-square tests, and Pearson correlations were used as appropriate to test the association between pairs of variables specified in each hypothesis. Non-parametric tests were used because most questions used a Likert scale (Allen and Seaman, 2007). IBM SPSS 28.0 was used for all analyses. Qualitative responses were inductively coded to identify patterns in open-ended responses (Kirner and Mills, 2019). Additionally, several questions were not included in statistical analyses due to

inconsistent interpretations by respondents or overlapping information with other questions. These are noted in Table S3.

3. RESULTS

3.1. Sample characteristics

A total of 130 responses were obtained (74 on water, 47 electronic, 9 on land) (Fig. S2). Respondent demographics and boat information are shown in Table 1. The majority of respondents were male (82%) bareboaters (61%) who did not reside in the BVI (75%), with an average of 29 years of boating experience. Most were operating powerboats (55%) with an average length of 13 meters (42 feet), suggesting this sample is representative of the typical boat types found in the BVI. Mooring (79%) was more common than anchoring.

Table 1. Sample characteristics. Sample size is given after each item. The sample size for "seabed where anchored" is the number of boaters who were observed to be anchored during on-water interviews.

Item	Classification	Count	Percentage	Mean	Std. Dev.
Boat type (n = 130)	*Sailboat*	58	45		
	Powerboat	72	55		
Boat length (m) (n = 130)				13	3
Boat secured by (n = 130)	*Anchoring*	27	21		
	Mooring	103	79		
Boat operation (n = 130)	*Private owner*	24	18		
	Charter captain	27	21		
	Bareboat	79	61		
Country of primary residence (n = 130)	*BVI*	20	15		
	Non-BVI	98	75		
	No response	12	10		
Gender (n = 130)	*Male*	106	82		
	Female	19	15		
	No response	5	3		
Years of boating experience (n = 125)				29	17
Age (years) (n = 106)				48	15
Seabed where anchored (n = 14)	*On reef*	3	21		
	Not on reef	11	79		

3.2. Why do some boaters anchor on coral reefs?

3.2.1. Hypothesis 1: Anchoring on coral reef is a planned behavior

Planning to anchor on coral reef was extremely rare. 100% of respondents disagreed or strongly disagreed they intended to anchor on reef that day and 98% strongly disagreed they intend to in the future ($\overline{x}$ = 1.02, SD = 0.20). This suggests that, while the TPB was useful in informing question design, it is insufficient in explaining anchoring behavior (Fig. 1).

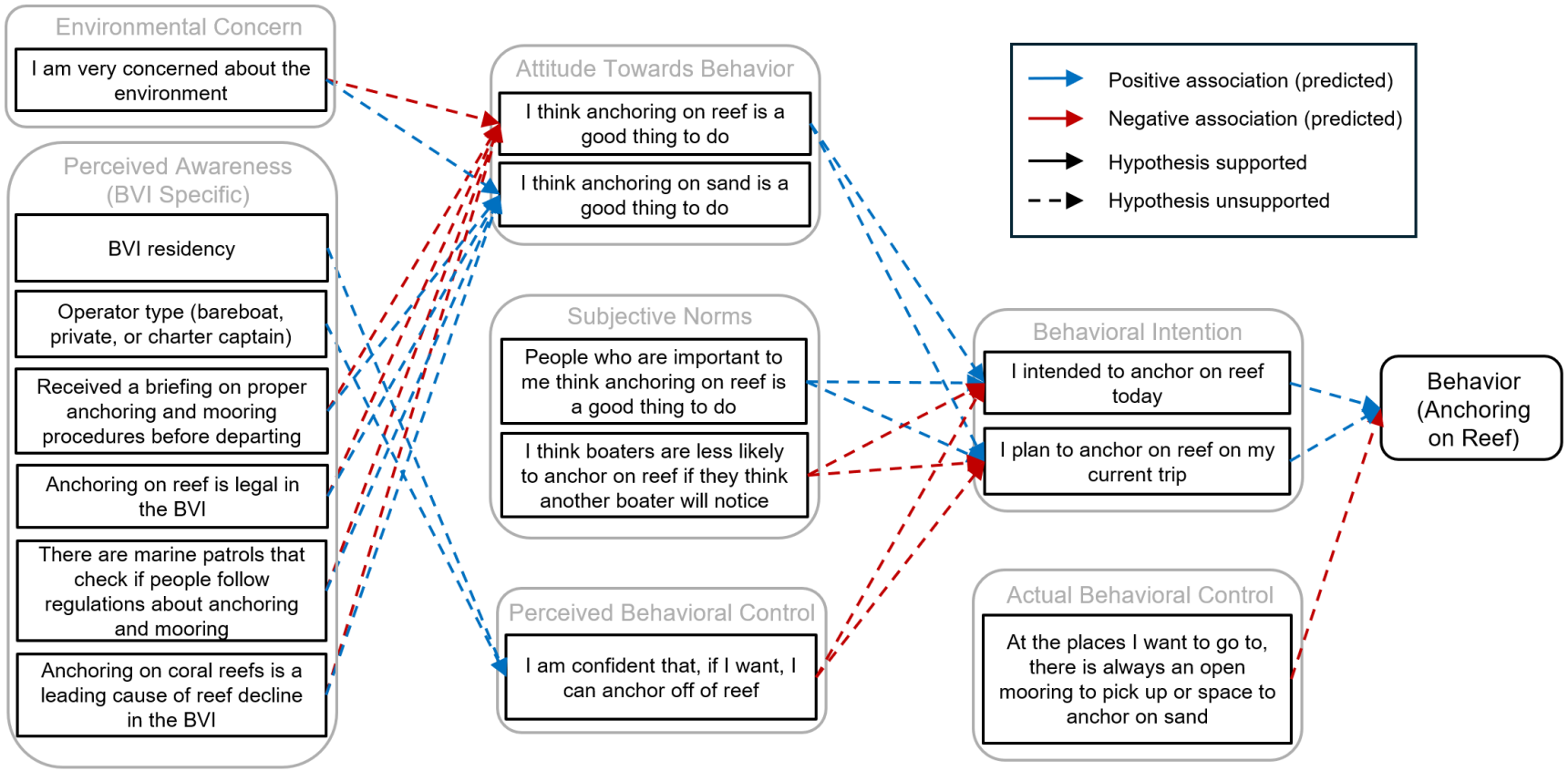
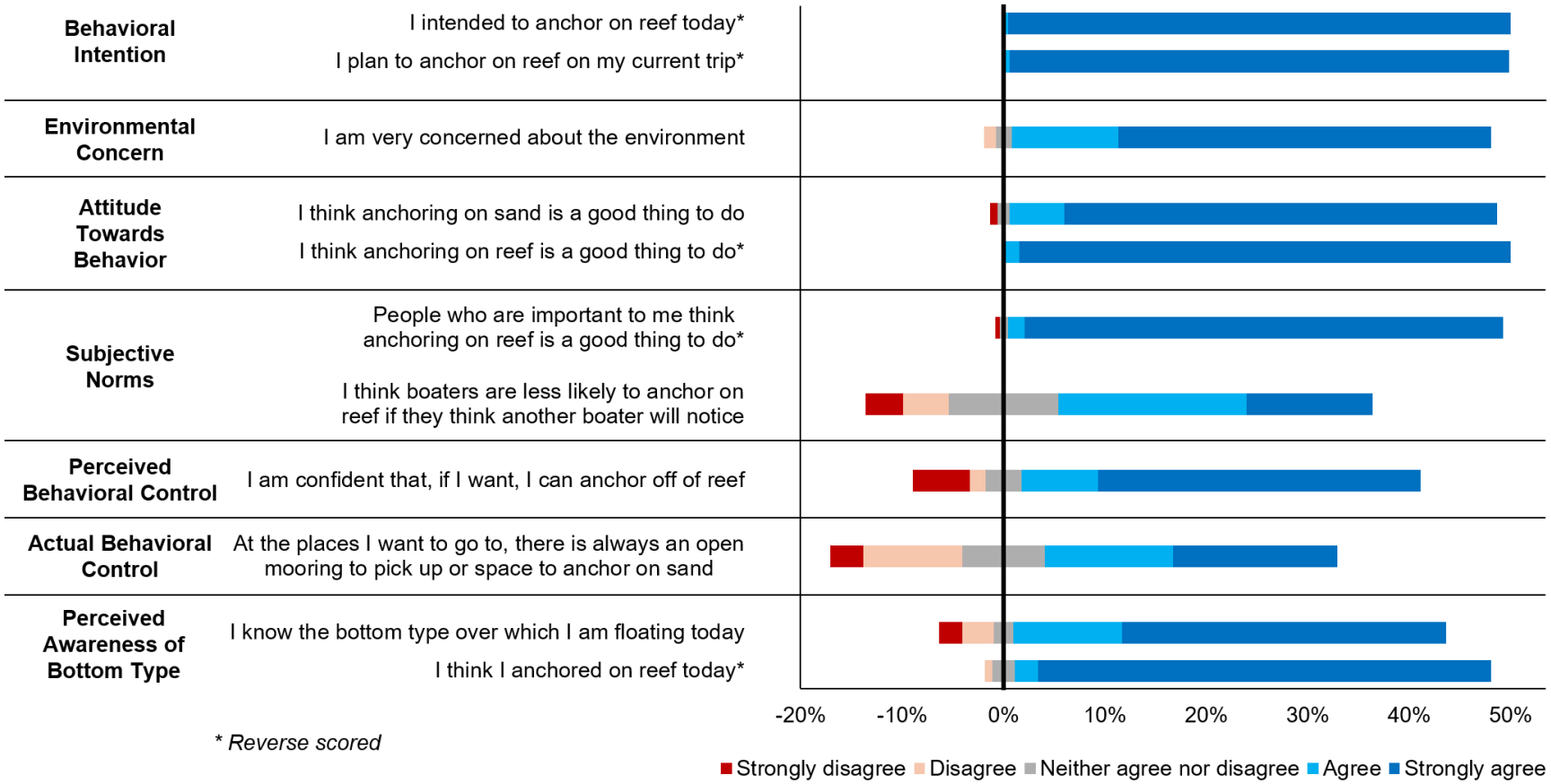


Figure 1. Results of hypotheses about the decision to anchor on reef. Hypotheses were inspired by the Theory of Planned Behavior (TPB) and the arrows show the direction of the hypothesized causal links between responses to questions based on the TPB framework. Dashed lines show that none of the hypothesized pathways about anchoring on reef were supported by statistical tests.

The ubiquitous intention to not anchor on reef was consistent with boaters' environmental concern, attitudes towards the behavior, subjective norms, and perceived and actual behavioral control (Fig. 2). Boaters had strong negative attitudes towards anchoring on reef, and said those close to them felt the same way. 94% of boaters agreed or strongly agreed they are very concerned about the environment ($\overline{x}$ = 4.66, SD = 0.66). 100% of respondents disagreed or strongly disagreed that anchoring on reef is a good thing to do ($\overline{x}$ = 1.03, SD = 0.17) and 96% of respondents agreed or strongly agreed the environmentally-responsible alternative of anchoring on sand is a good thing to do ($\overline{x}$ = 4.78, SD = 0.63). 98% of boaters disagreed or strongly disagreed that people who are important to them think anchoring on reef is a good thing to do ($\overline{x}$ = 1.10, SD = 0.47). Additionally, there was a moderate amount of perceived peer-pressure between boaters to avoid anchoring on reef ($\overline{x}$ = 3.63, SD = 1.17). There was also near-universal agreement among boaters regarding their perceived behavioral control, as most boaters were confident they can avoid reef when anchoring ($\overline{x}$ = 4.17, SD = 1.35). Boaters expressed moderate support for being able to find an available mooring to pick up or space to anchor on sand at the places they wanted to go to ($\overline{x}$ = 3.58, SD = 1.30), suggesting environmentally-responsible alternatives were not a limiting factor during the season in which this study was completed. None of these factors were significantly influenced by the operator type, country of residence, or perceived awareness of anchoring/mooring regulations.



* *Reverse scored*

Figure 2. Responses to interview questions about the decision to anchor on reef. Different colored sections represent the proportion of boaters who responded with that level of agreement. Questions where "strongly agree" supported the behavior of anchoring on reef were reverse scored for clarity. These questions are marked with an asterisk (*).

3.2.2. Hypothesis 2: Anchoring on coral reef is unintentional due to a lack of awareness

The results of this study suggest that anchoring on coral reefs is caused by a mismatch between perceived and actual awareness of the bottom type. Respondents had a high perceived awareness of the bottom type ($\overline{x}$ = 4.34, SD = 1.11) and 100% of anchored boaters strongly disagreed they thought they anchored on reef that day. However, of the boaters who were anchored and ground-truthed (n = 14), 21% were anchored on reef (n = 3). This represents 4% of all boaters interviewed on the water.

3.3. Why do some boaters anchor rather than moor?

Anchoring was frequently a planned behavior. 60% of boaters agreed or strongly agreed they planned to anchor on their current trip ($\overline{x}$ = 3.62, SD = 1.46). 74% of boaters who were anchored when interviewed agreed or strongly agreed that they planned to anchor again on their current trip ($\overline{x}$ = 4.57, SD = 0.728), indicating that intention to anchor is likely a strong predictor of future anchoring behavior (Fig. 3).

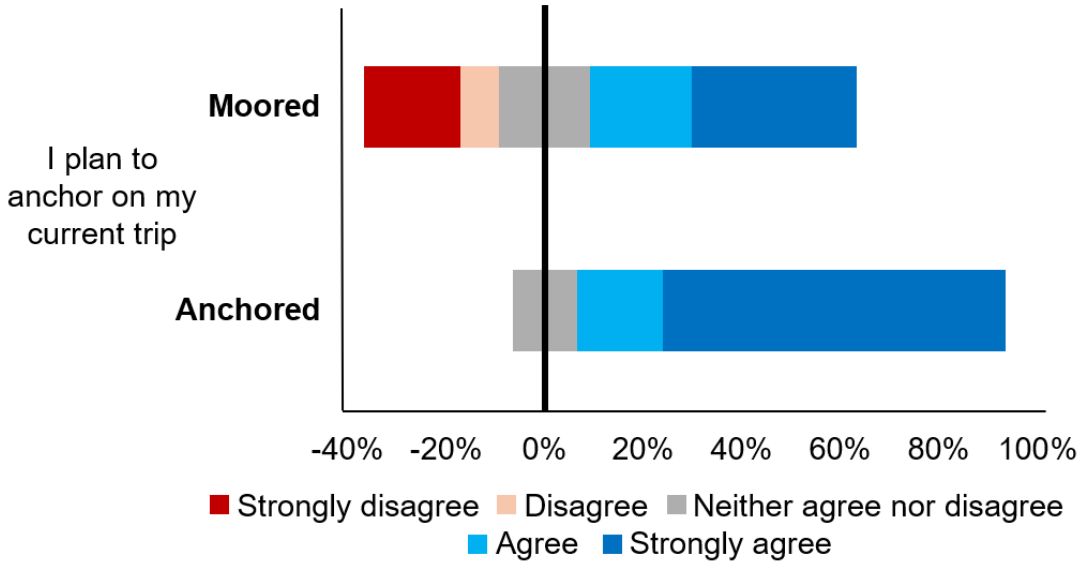


Figure 3. Boaters' future anchoring intentions depended on whether they were moored or anchored when interviewed. Different colored sections represent the proportion of boaters who responded with that level of agreement.

Boaters' intention to anchor was also multifaceted and mediated by awareness, attitudes, perceived behavioral control, and trust in the moorings (Fig. 4, Fig. S5). Boaters with more negative attitudes towards mooring had stronger intentions to anchor (r = -0.356, p < 0.001). These negative attitudes (r = 0.309, p < 0.001), as well as a higher intention to anchor (r = -0.323, p < 0.001), were influenced by a lack of trust that the moorings were safe to use. This is further supported by the qualitative responses of several boaters who provided examples of times they had mooring lines break on them or saw moorings break on others. Environmental concern did not influence attitudes towards moorings (r = 0.047, p = 0.599).

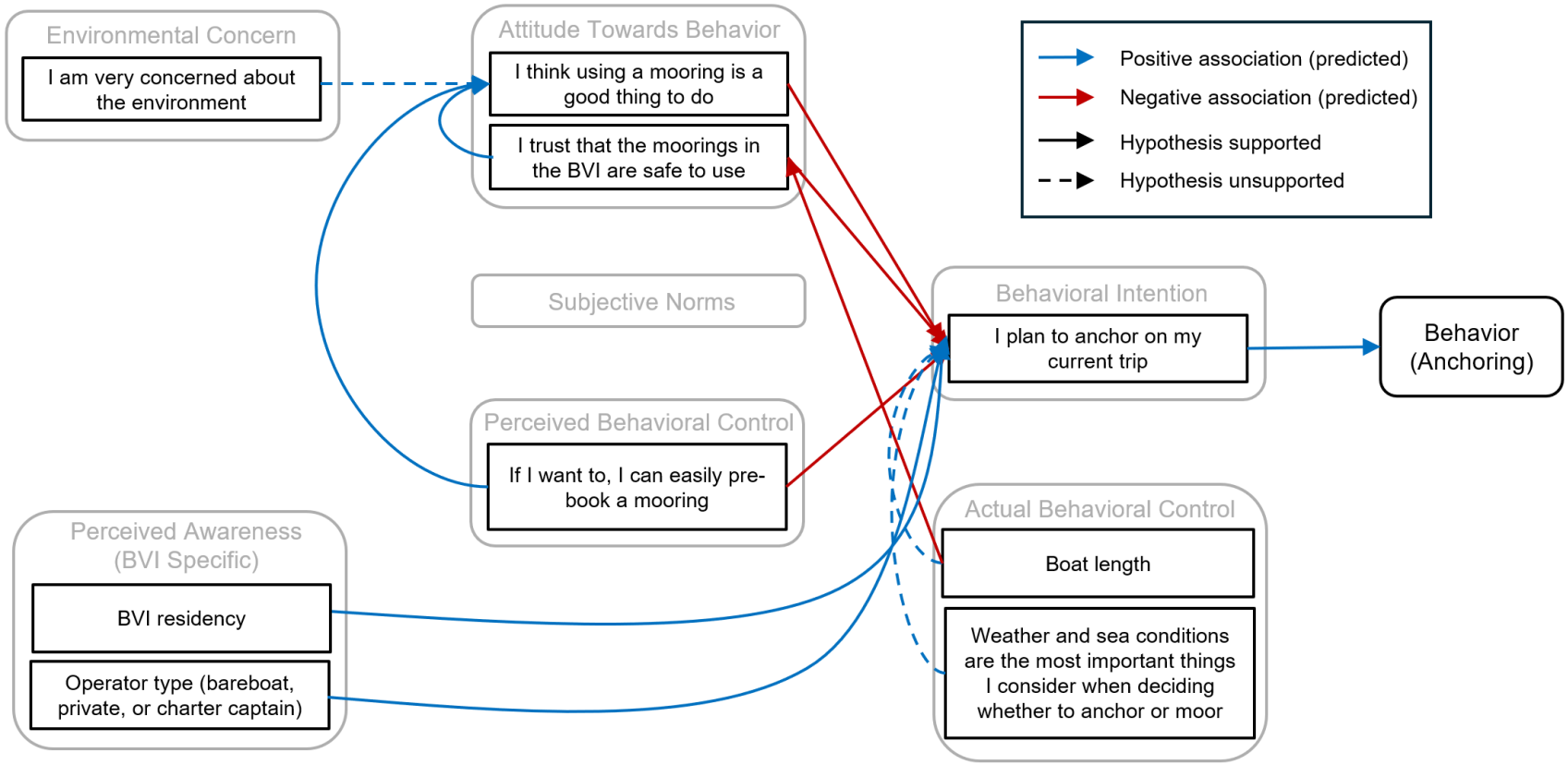


Figure 4. Results of hypotheses about the decision to anchor. Hypotheses were inspired by the Theory of Planned Behavior (TPB) and the arrows show the direction of the hypothesized causal links between responses to questions based on the TPB framework. Solid arrows show hypothesized pathways that were supported by statistical analyses; dashed arrows show ones that were not supported.

Boaters who perceived they had lower behavioral control over their ability to moor were also more likely to plan to anchor. Those who felt they could not easily pre-book a mooring had more negative attitudes towards mooring (r = 0.270, p = 0.002) and a higher intention to anchor (r = -0.186, p = 0.038). Boaters reported a variety of problems with the BoatyBall reservation system that could have reduced this perceived behavioral control. Common complaints included the need for internet connection, the rush of competition to reserve early in the morning, and the ability to only pre-book for that day.

The intention to anchor was also influenced by the boaters' familiarity with BVI waters. BVI residents had a higher perceived awareness of the bottom type than non-residents (Mann-Whitney U test, z = 2.528, p = 0.011). Captains of crewed yachts (primarily BVI residents) were more likely to plan to anchor than bareboaters (Kruskal-Wallis H test, H = -26.418, p = 0.002, Bonferroni corrected), as were private boat owners (Kruskal-Wallis H test, H = -22.053, p = 0.023, Bonferroni corrected). Anchoring requires more specific knowledge than mooring, as mooring leans on the knowledge of those who installed it. This could explain why charter captains and private boat owners were more likely to plan to anchor than bareboat captains.

A lack of available moorings could be a reason that those who do not plan to anchor end up anchoring. Many boaters mentioned they prefer mooring over anchoring, but many also said there are not enough moorings available to use. This is especially pertinent for boats over 18 m (60 ft.) long, as almost all moorings in the BVI are only rated to hold boats up to 18 m (59 ft.). Boats above this threshold therefore face a limit to their actual behavioral control. Respondents on boats over 18

m long also had less trust in moorings than those on boats less than 18 m (Mann-Whitney *U* test, $z = -2.515$, $p = 0.012$), possibly because most moorings are not rated to be safe for them to use. As such, those on boats over 18 m were more likely to be anchored ($\chi^2_{(1)} = 11.242$, $p < 0.001$, continuity corrected). This is supported by the qualitative responses of boaters on boats over 18 m long, who said they do not have the option to moor.

3.4. How does bay choice influence boaters' decision to anchor vs. moor?

These results support the notion that bay choice can affect, or be affected by, boaters' decision to anchor or moor (Fig. 5). Respondents stated safety ($\overline{x} = 4.72$, SD = 0.67), the ability to stay overnight ($\overline{x} = 4.47$, SD = 0.93), and weather and sea conditions ($\overline{x} = 4.63$, SD = 0.80) as the most important factors when choosing a bay or anchorage. While weather and sea conditions can affect the decision to anchor or moor ($\overline{x} = 3.82$, SD = 1.30), they were not a significant predictor of anchoring intention ($r = 0.132$, $p = 0.141$). Weather and sea conditions do overwhelmingly affect bay choice, so they are most important at this step, rather than in deciding whether to anchor or moor once a bay has been selected. Many respondents also listed their planned itinerary as an important factor when choosing a bay. Cost was unimportant in selecting a bay ($\overline{x} = 1.70$, SD = 0.96), suggesting cost is not a deterrent to selecting bays with moorings.

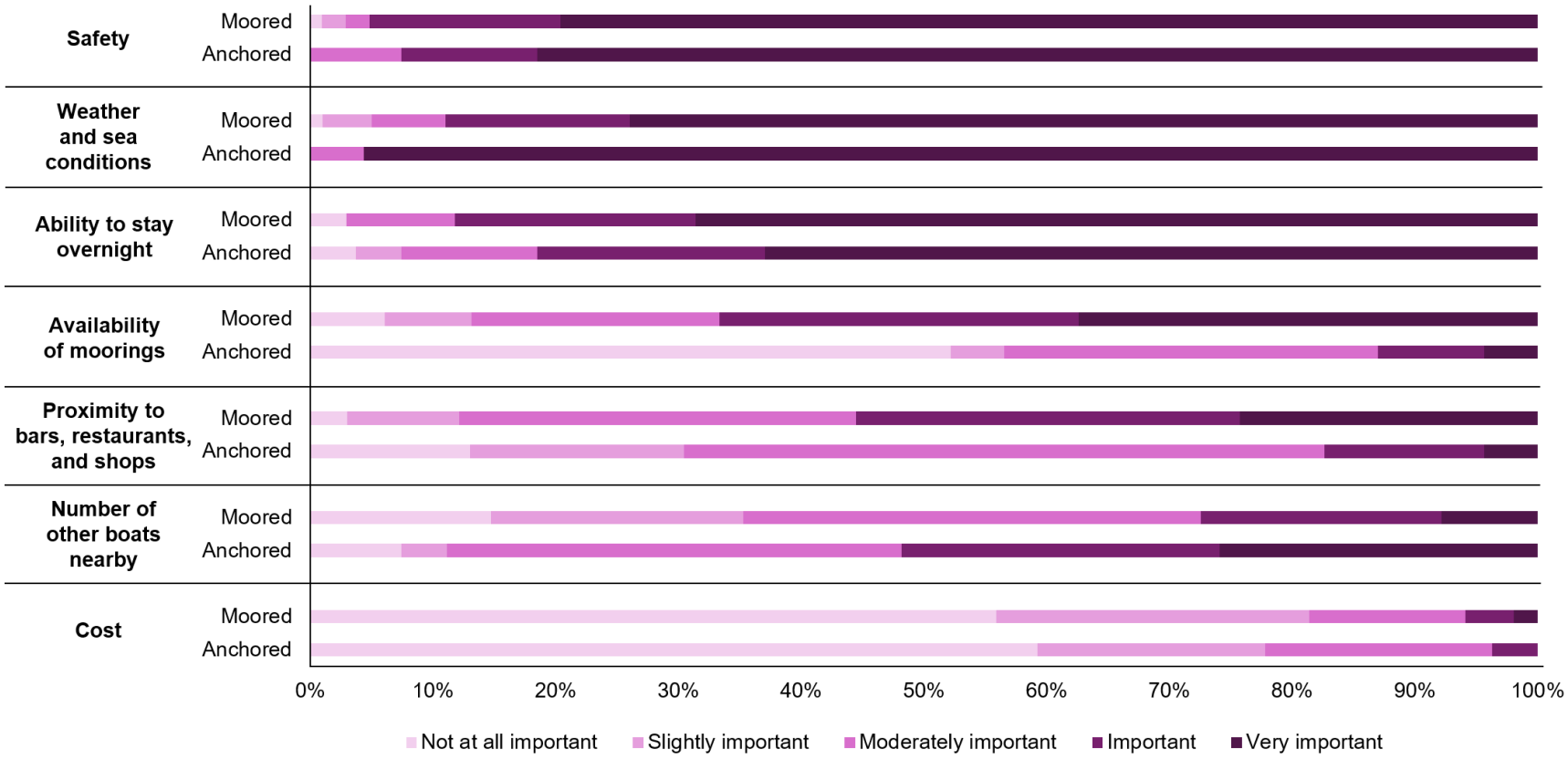


Figure 5. Importance of different factors when boaters decide on a bay in which to secure their vessel. “Anchored” and “moored” refer to the method by which boats were secured when interviewed. Different colored sections represent the proportion of boaters who rated the factor that level of importance.

A strong intention to anchor was associated with an avoidance of crowding and a lower priority of being near to bars, restaurants, and shops. Boaters with a stronger intention to anchor on their trip gave lower importance to the availability of moorings when selecting bays (r = -0.402, $p < 0.001$). They also considered the proximity of bars, restaurants, and shops to be of relatively low importance (r = -0.257, p = 0.004), but the number of other boats nearby to be of higher importance (r = 0.302, $p <$ 0.001).

Most boaters had a high perceived awareness that there are bays where anchoring is not legal. 93% of boaters agreed or strongly agreed there are MPAs where anchoring is not legal ($\overline{x}$ = 4.65, SD = 0.84) and 80% of these boaters agreed or strongly agreed they know where these MPAs are located ($\overline{x}$ = 4.16, SD = 1.16). This should mediate boaters' choices of bays, but anecdotal evidence suggests perceived awareness might not be accurate or not strongly influence actual bay choice. For example, Muskmelon Bay, Guana Island is a Fisheries Priority Area, but is a popular anchorage.

4. DISCUSSION

The results of this study strongly suggest that anchoring on reef is unintentional and happens despite people preferring not to anchor on reef. This is consistent with past work in the Florida Keys that found scuba divers to have a near-universal feeling of embarrassment if they were seen anchoring on reef (Anderson and Loomis, 2011), suggesting that most individuals who recreate in areas with coral reefs do not want to anchor on them. The intentions to avoid this environmentally-irresponsible behavior also appear to be stronger than those for other environmentally-irresponsible behaviors, like allowing fishing waste to enter the ocean (Simmons and Fielding, 2019).

We observed a small minority (4%) of boaters anchored on reef. While this appears to be an insignificant number, it is important to consider that this study took place during shoulder season, when moorings are rarely limiting, and only a minority (21%) of boaters anchored to begin with. Past work found that from 2006-2022, about 12% of boaters in the BVI anchor on reef, suggesting that as moorings become more limiting in high season, a higher proportion of boaters anchor, and thus more anchor on reef (Forrester, 2020 & unpublished).

Proper anchoring behavior requires a higher level of skill and awareness than many other environmentally-responsible behaviors. Our results strongly suggest anchoring on reef arises due to a mismatch between perceived and actual awareness of the bottom type. Environmentally-responsible behaviors such as keeping fishing waste out of the ocean (Simmons and Fielding, 2019), choosing green hotels (Chen and Tung, 2014; Han et al., 2010), and buying green furniture (Xu et al., 2020) do not typically require a high level of awareness. In contrast, behaviors such as no-contact

scuba diving and anchoring on reef do require a level of skill and experience (Anderson and Loomis, 2011). Past work suggests that more scuba diving experience leads to not only stronger intentions to not damage reefs (Anderson and Loomis, 2011), but also to less diver contact on coral reefs (Luna et al., 2009). Thus, lower levels of awareness and skill may ultimately lead to a disconnect between intention and behavior.

Past work suggests anchoring on sensitive marine habitats is not always a result of a mismatch between perceived and actual awareness of the bottom type. While we found the majority of boaters in this study thought they knew the bottom type, research by Lloret et al. (2008) in Cape Creus found that 76% of boaters said they were unaware of the bottom type on which they were anchored. These researchers also found anchoring on sensitive marine habitat to be much more common, with 50% of anchored boats on seagrass beds, compared to 21% of anchored boats being on coral reefs here. The differences in perceived awareness and actual behavior between these two studies could be explained by the difference in boaters' level of environmental concern. Nearly all boaters in our study said they were very concerned about the environment and did not think anchoring on reef was a good thing to do, but an unspecified majority of boaters in Cape Creus stated they did not care on which bottom type they anchored. Environmental conditions, such as weather, water visibility, and bottom type, also vary between the Mediterranean and the Caribbean, which could also impact differences between behaviors in the two locations.

Since anchoring on reef appears to be unintentional, it becomes important to understand why some boaters anchor rather than moor in the first place. Because more

anchoring is expected to lead to more unintentional anchoring on reef, mooring is a potential solution to this problem. Our finding that the decision to anchor is multifaceted is consistent with past research, but the factors that can influence this decision are not always the same. Factors influencing anchoring intention, as well as those influencing bay choice, both play a role in the decision-making process. Though other work suggests the cost of moorings is important in deciding whether to anchor or moor (Diedrich et al., 2013; Parry-Wilson et al., 2019), our results imply cost is not an important factor because it was given little weight when choosing bays to visit. Additionally, our results show that boaters who intend to anchor tend to have more negative attitudes towards moorings, which is associated with having less trust that the moorings are safe to use and perceiving they have less control over their ability to pre-book moorings. This contrasts previous work in Southwest England, which suggested that the majority of boaters tend to prefer moorings, citing reasons such as moorings being the more secure option (Parry-Wilson et al., 2019). This could be explained by local differences in mooring maintenance or boaters' experiences anchoring on different bottom types, as not all seabed habitats hold anchors equally. The types of boats and boaters also differ between these locations, as the BVI tends to have larger, chartered vessels compared to the smaller recreational vessels in much of Europe. Finally, boaters who intended to anchor tended to prefer more secluded areas, away from other boaters, which do not always have moorings available. This is supported by past work that showed boaters' perceived well-being and safety decreases as the amount of crowding in a bay increases (Ashton and Chubb, 1972; Diedrich et al., 2011; Tseng et al., 2009).

4.1. Recommendations

Since anchoring on reef primarily occurs due to a mismatch between the perceived and actual awareness of boaters who anchor, managers could consider: 1) actions that increase the probability that boaters use a mooring and 2) actions that increase the actual awareness of those who do anchor. There are many possible options to address these two points, and a greater understanding of why boaters responded how they did is needed to determine the most effective pathways.

Increasing the probability that boaters use a mooring will decrease the probability of them anchoring, and thus decrease the likelihood of anchoring on reef. A key part of accomplishing this is to shift attitudes towards mooring to be more positive, especially for those who plan to anchor. Understanding if moorings are actually unsafe to use, or if the safety of moorings needs to be better communicated, would help identify if increased mooring maintenance is needed, or if something like enhanced communication about maintenance schedules would be more beneficial. Additionally, addressing boaters' concerns with the mooring pre-booking system may increase its utilization. For example, some boaters suggested moorings be released in stages throughout the day or be available for pre-booking more than a day in advance. Boaters also described a need for a way to pre-book moorings without internet connection, as not all boaters have access to onboard internet. It may also be of value to address the limited availability of moorings, especially ones that support boats over 18 m. A potential option for managers to consider is installing additional moorings, with a percentage of them being designated specifically for larger vessels. Adding

moorings in less-popular bays preferred by those who anchor may also reduce the amount of anchoring in those areas.

Ultimately, some boaters will still choose to anchor, regardless of improvements to the mooring system. In this case, it may be valuable to improve boaters' cognitive awareness so they are able to safely anchor in sandy areas. One possible solution to consider is enhancing communication of which sites are no-anchoring zones. Additionally, there may be benefits from a more robust pre-charter briefing. Pre-activity briefings have been shown to facilitate environmentally-responsible behavior in similar scenarios (Krieger and Chadwick, 2013; Luna et al., 2009), and this may help ensure all bareboaters are aware of no-anchor areas and how to properly use their anchor. Managers may also consider increasing the number of marine patrols to help ensure boaters are following proper anchoring and mooring protocols.

4.2. Limitations and future research

There are several limitations to this study that could be improved with future research. Funding timelines caused this study to be conducted during shoulder season in the BVI, when moorings are typically not a limiting factor. We encountered only one bay where all moorings were occupied at the time of visiting. This could explain why we encountered such a small percentage of boaters at anchor, and ultimately limited our ability to ground-truth more boats. Qualitative results suggest that, during peak season (December - April), an influx of boaters creates competition for moorings and limits the number of sandy areas available to anchor on, resulting in more boaters anchoring on reef. Qualitative results also suggest many of the boaters present during

shoulder season are experienced enough to know that they should avoid the busy season if they want to be able to pick up moorings and avoid crowds. This group may also be experienced enough to be confident with their ability to anchor properly, suggesting our respondents may not be representative of all types of boaters in the BVI and may have under-sampled less-experienced boaters. Future research should interview boaters during peak season to gain a more comprehensive understanding of boaters' behavioral motivations and limitations.

Future research should also explore the motivations for anchoring versus mooring. Past work suggests that when pro-environmental attitudes are high, external barriers are often the limiting factor in performing the environmentally-responsible behavior (Guagnano et al., 1995). In this case, though pro-environmental attitudes are high, boaters may face external barriers to using a mooring, such as the limited availability of moorings. Gaining a deeper understanding of boater preferences and what causes some boaters to use, or not use, moorings will help determine how to increase the proportion of boaters using a mooring.

4.3. Conclusions

Anchoring on coral reef occurs despite management practices currently in place to prevent it. We found that anchoring on reef is not a planned behavior, but occurs due to a mismatch between boaters' perceived and actual awareness of the bottom type. More anchoring leads to more unintentional anchoring on reef, and finding ways to increase the use of moorings is a potential solution to this problem. Management actions to prevent anchoring on reef can be taken locally, and our results suggest that

finding ways to increase the proportion of boaters using moorings and improve boaters' actual awareness of the bottom type will help reduce anchoring on reef and have substantial environmental benefits.

APPENDICES

Appendix 1: Supplementary figures and tables

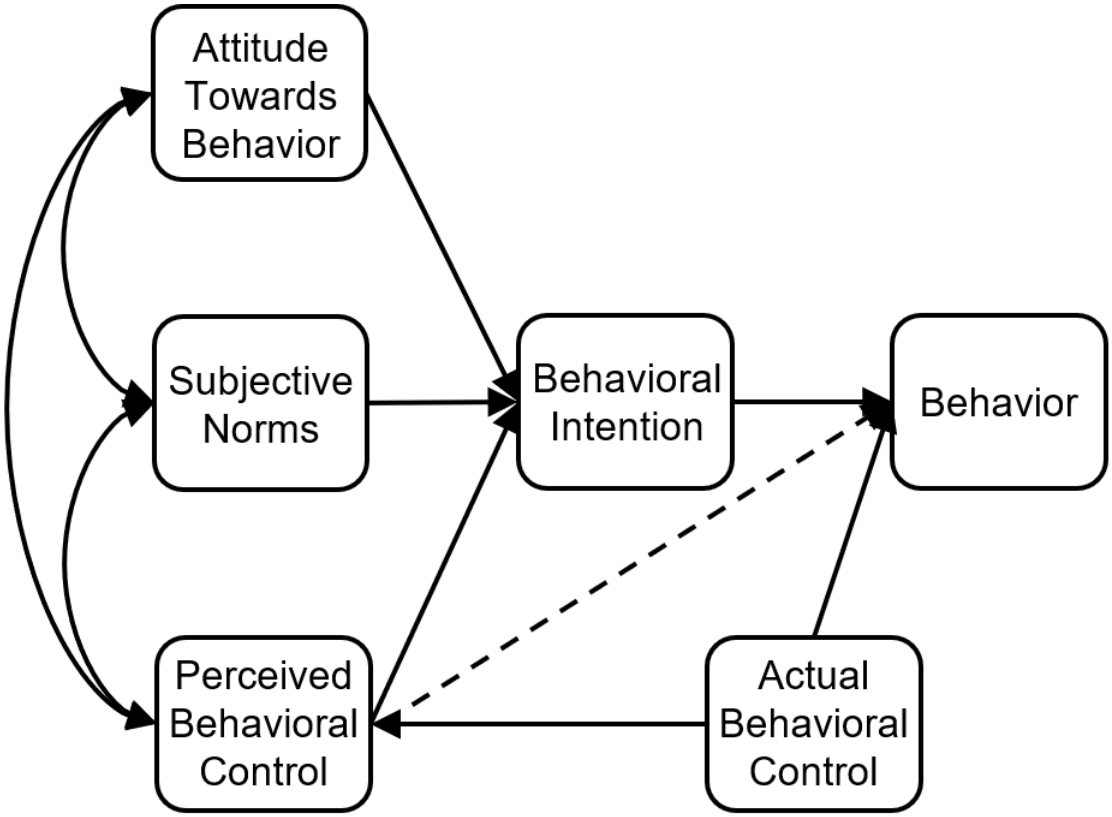


Figure S1. The Theory of Planned Behavior as described by Ajzen (1991).

Figure S2. Map of the British Virgin Islands. Locations where on-water interviews were given and anchored boaters were ground-truthed by snorkeling are marked with red circles.

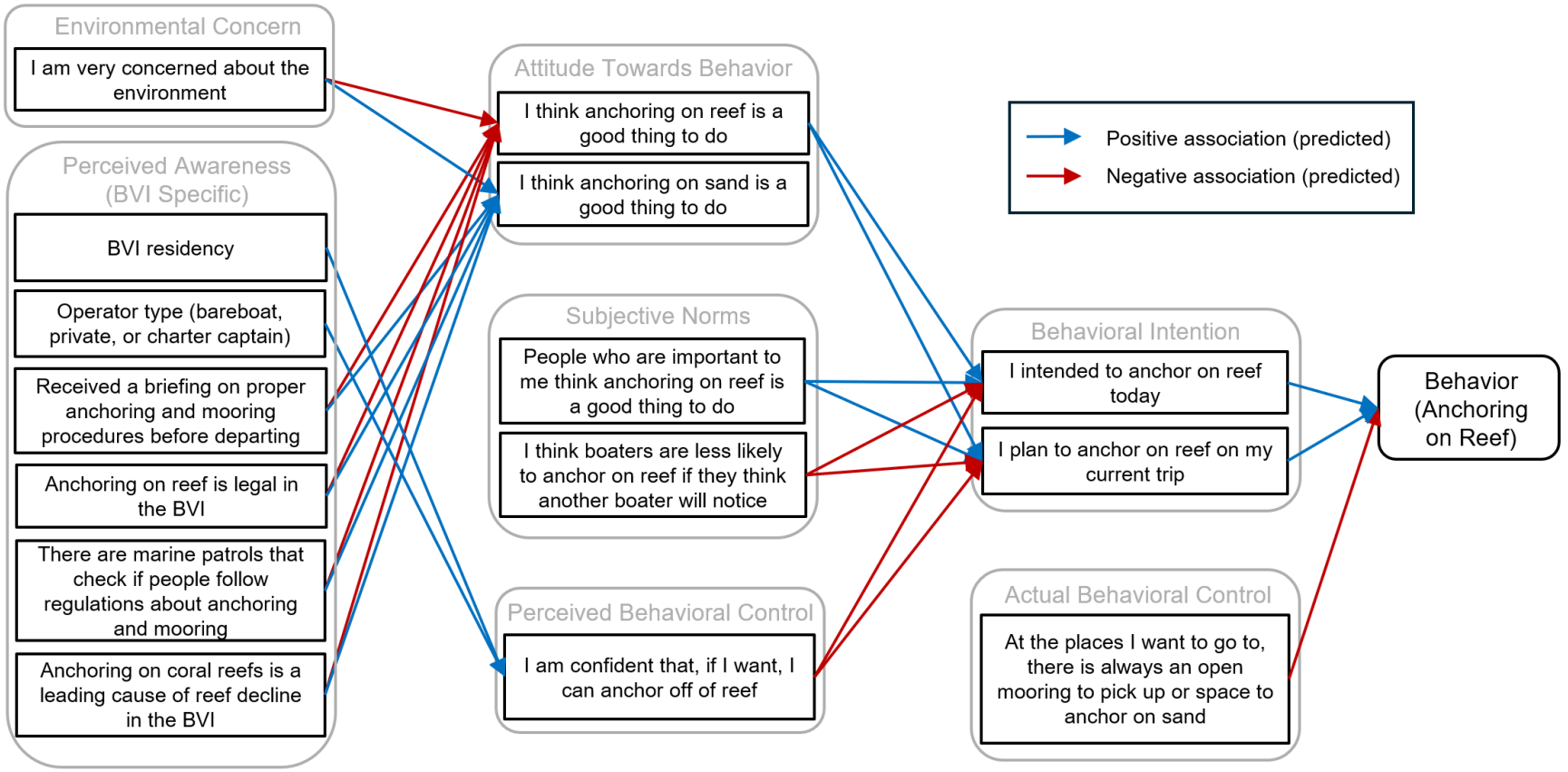


Figure S3. Hypothesized associations between interview questions about the decision to anchor on reef. Blue arrows indicate a predicted positive association; red arrows indicate a predicted negative association. Hypotheses were inspired by the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the arrows show the direction of the hypothesized causal links between responses to questions based on the TPB framework.

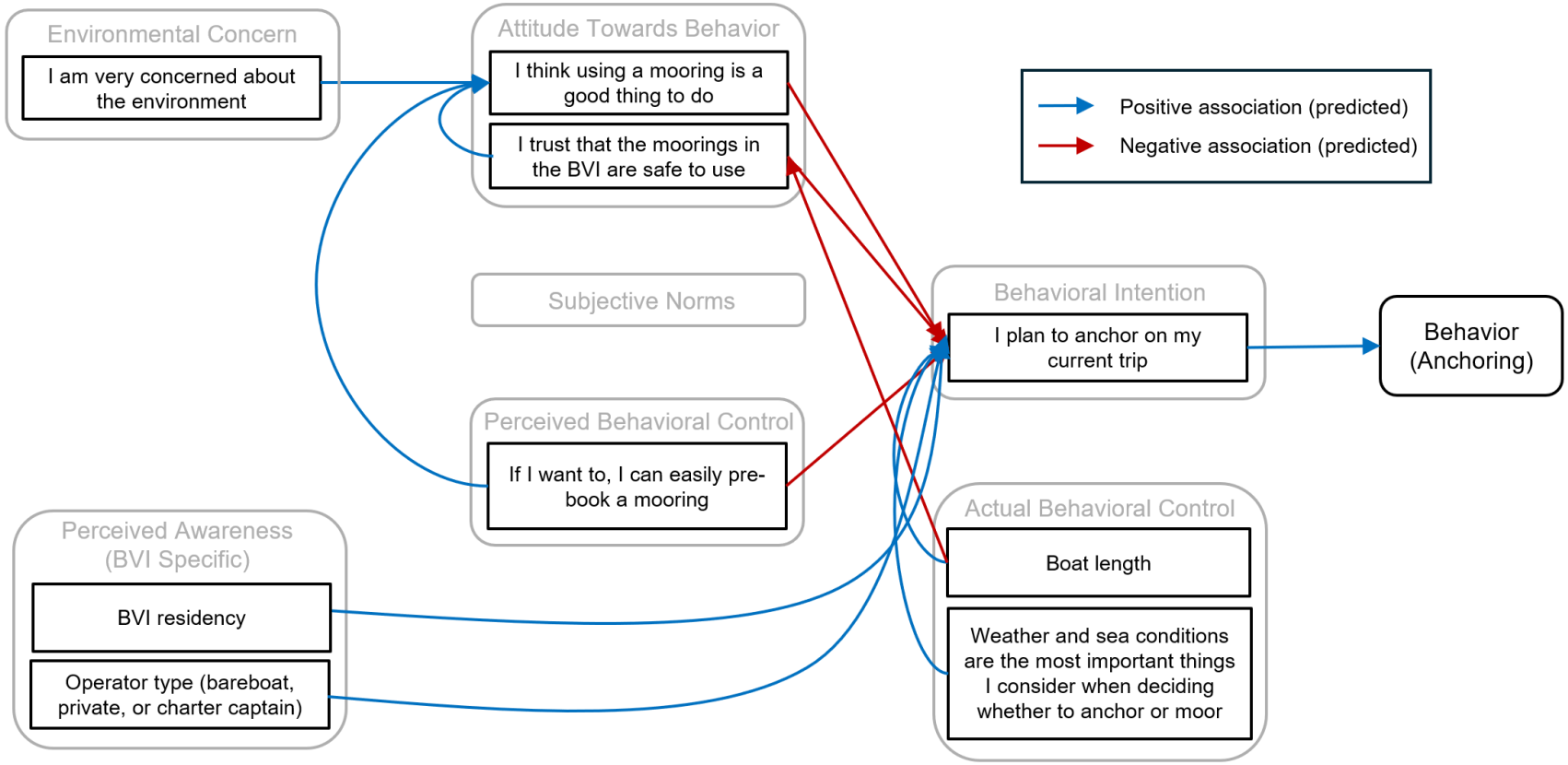


Figure S4. Hypothesized associations between interview questions about the decision to anchor. Blue arrows indicate a predicted positive association; red arrows indicate a predicted negative association. Hypotheses were inspired by the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the arrows show the direction of the hypothesized causal links between responses to questions based on the TPB framework.

Table S1. Hypothesized associations between interview questions for the decision to anchor on reef.

Anchoring on Reef

TPB Factor	Hypothesis #	Path	Hypothesis	Result
Environmental Concern	H1	Environmental concern → thinking anchoring on reef is a good thing to do	Environmental concern is negatively associated with thinking anchoring on reef is a good thing to do	Unsupported
	H2	Environmental concern → thinking anchoring on sand is a good thing to do	Environmental concern is positively associated with thinking anchoring on sand is a good thing to do	Unsupported
Perceived Awareness (BVI Specific)	H3	BVI residency → confidence in ability to anchor off of reef	Being a BVI resident is positively associated with confidence in being able to anchor off of reef	Unsupported
	H4	Operator type → confidence in ability to anchor off of reef	Being an operator type that is more familiar with BVI waters is positively associated with confidence in being able to anchor off of reef	Unsupported
	H5	Received a proper briefing → thinking anchoring on reef is good	Receiving a briefing on proper anchoring and mooring procedures is negatively associated with thinking anchoring on reef is a good thing to do	Unsupported
	H6	Received a proper briefing → thinking anchoring on sand is good	Receiving a briefing on proper anchoring and mooring procedures is positively associated with thinking anchoring on sand is a good thing to do	Unsupported
	H7	Aware anchoring on reef is legal → thinking anchoring on reef is good	Perceived awareness that anchoring on reef is legal in the BVI is negatively associated with thinking	Unsupported

			anchoring on reef is a good thing to do	
	H8	Aware anchoring on reef is legal → thinking anchoring on sand is good	Perceived awareness that anchoring on reef is legal in the BVI is positively associated with thinking anchoring on sand is a good thing to do	Unsupported
	H9	Aware of marine patrols → thinking anchoring on reef is good	Perceived awareness that there are marine patrols in the BVI is negatively associated with thinking anchoring on reef is a good thing to do	Unsupported
	H10	Aware of marine patrols → thinking anchoring on sand is good	Perceived awareness that there are marine patrols in the BVI is positively associated with thinking anchoring on sand is a good thing to do	Unsupported
	H11	Aware of anchor damage to reef → thinking anchoring on reef is good	Perceived awareness that anchoring is a leading cause of reef decline in the BVI is negatively associated with thinking anchoring on reef is a good thing to do	Unsupported
	H12	Aware of anchor damage to reef → thinking anchoring on sand is good	Perceived awareness that anchoring is a leading cause of reef decline in the BVI is positively associated with thinking anchoring on sand is a good thing to do	Unsupported
Attitude Towards Behavior	H13	Thinking anchoring on reef is good → intention to anchor on reef that day	Thinking anchoring on reef is a good thing to do is positively associated with intending to anchor on reef that day	Unsupported
	H14	Thinking anchoring on reef is good →	Thinking anchoring on reef is a good thing to do is positively associated with	Unsupported

		intention to anchor on reef in future	planning to anchor on reef on their current trip	
Subjective Norms	H15	Other people think anchoring on reef is good → intention to anchor on reef that day	People who are important to the boater thinking anchoring on reef is a good thing to do is positively associated with intending to anchor on reef that day	Unsupported
	H16	Other people think anchoring on reef is good → intention to anchor on reef in future	People who are important to the boater thinking anchoring on reef is a good thing to do is positively associated with planning to anchor on reef on their current trip	Unsupported
	H17	Being less likely to anchor on reef if others will notice → intention to anchor on reef that day	Thinking boaters are less likely to anchor on reef if they think another boater will notice is negatively associated with planning to anchor on reef that day	Unsupported
	H18	Being less likely to anchor on reef if others will notice → intention to anchor on reef in future	Thinking boaters are less likely to anchor on reef if they think another boater will notice is negatively associated with planning to anchor on reef on their current trip	Unsupported
Perceived Behavioral Control	H19	Confidence in being able to anchor off of reef → intention to anchor on reef that day	Boaters' confidence in their ability to anchor off of reef is negatively associated with intention to anchor on reef that day	Unsupported
	H20	Confidence in being able to anchor off of reef → intention to anchor on reef in the future	Boaters' confidence in their ability to anchor off of reef is negatively associated with intention to anchor on reef on their current trip	Unsupported

Actual Behavioral Control	H21	Availability of alternatives to anchoring on reef → anchoring on reef	Thinking there are open moorings to pick up or space to anchor on sand at the places they want to go to is negatively associated with being anchored on reef	Unsupported
Behavioral Intention	H22	Intention to anchor on reef that day → anchoring on reef	Intention to anchor on reef that day is positively associated with being anchored on reef	Unsupported
	H23	Intention to anchor on reef in the future → anchoring on reef	Intention to anchor on reef on their current trip is positively associated with being anchored on reef	Unsupported

Table S2. Hypothesized associations between interview questions for the decision to anchor.

Anchoring vs. Mooring

TPB Factor	Hypothesis #	Path	Hypothesis	Result
Environmental Concern	H24	Environmental concern → thinking mooring is a good thing to do	Environmental concern is positively associated with thinking using mooring is a good thing to do	Unsupported
Perceived Awareness (BVI Specific)	H25	BVI residency → intention to anchor	Being a BVI resident is positively associated with planning to anchor on their current trip	Supported
	H26	Operator type → intention to anchor	Being an operator type that is more familiar with BVI waters is positively associated with planning to anchor on their current trip	Supported
Attitude Towards Behavior	H27	Thinking mooring is a good thing to do → intention to anchor	Thinking mooring is a good thing to do is negatively associated with planning on anchor on their current trip	Supported
	H28	Trust in the moorings → thinking mooring is a good thing to do	Trusting that the moorings in the BVI are safe to use is positively associated with thinking mooring is a good thing to do	Supported
	H29	Trust in the moorings → intention to anchor	Trusting that the moorings in the BVI are safe to use is negatively associated with planning to anchor on their current trip	Supported
Perceived Behavioral Control	H30	Ease of pre-booking moorings → thinking mooring is a good thing to do	Perceiving that being able to pre-book moorings is an easy thing to do is positively associated with thinking that mooring is a good thing to do	Supported

	H31	Ease of pre-booking moorings → intention to anchor	Perceiving that being able to pre-book moorings is an easy thing to do is negatively associated with planning to anchor on their current trip	Supported
Actual Behavioral Control	H32	Boat length → trust in the moorings	Boat length is negatively associated with trust that the moorings in the BVI are safe to use	Supported
	H33	Boat length → intention to anchor	Boat length is positively associated with planning to anchor on their current trip	Unsupported
	H34	Weather and sea conditions → intention to anchor	Weather and sea conditions being important in deciding whether to anchor or moor is positively associated with planning to anchor on their current trip	Unsupported
Behavioral Intention	H35	Intention to anchor → anchoring	Planning to anchor on their current trip is positively associated with being anchored	Supported

Table S3. Justifications for not including certain interview questions and observations in analyses.

Question/Observation	Justification for not including in analyses
Weather and sea conditions	Inconsistent measurement method and did not record for all interviews
Boat name	Did not record for most boats and removed for privacy reasons
Boat size class	Boat length encompasses the same information and is more informative than size class
Number of times chartered	Years of experience encompasses the same information and is more informative
Activities	Question was unclear and interpreted inconsistently
I am more likely to use a mooring if the reef below looks pristine	Question was unclear and interpreted inconsistently
Whether or not I use a mooring is completely up to me	Question was unclear and interpreted inconsistently
Whether or not I anchor on reef is completely up to me	Question was unclear and interpreted inconsistently
Weather and sea conditions are the most important things I consider when deciding whether to anchor on sand or on reef	Most boaters felt they could not answer because anchoring on reef was not an option they considered
Importance of proximity to natural attractions in bay choice	Question was unclear and interpreted inconsistently
Importance of presence of sensitive marine habitat in bay choice	Question was unclear and interpreted inconsistently

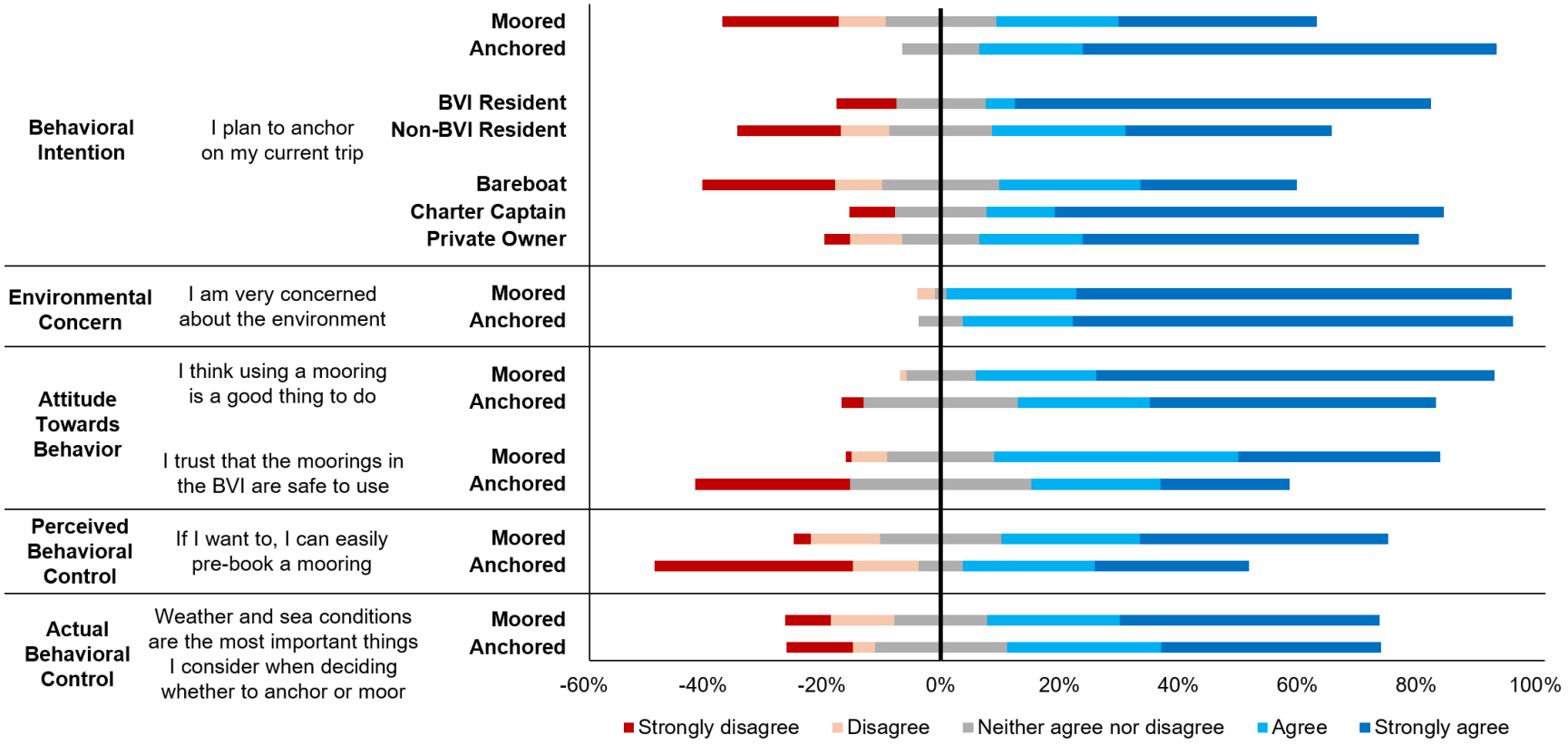


Figure S5. Responses to interview questions about the decision to anchor vs. moor. Different colored sections represent the proportion of boaters who responded with that level of agreement.

Appendix 2: Interview questions

Survey ID #:

Location: _____

Date: _____ **Time**: _____

Weather conditions: _____ **Sea conditions**: _____

		Notes
Boat type	☐ Sailboat ☐ Powerboat	**Boat name**: _____
Boat size class	☐ < 25 ft ☐ 26-39 ft ☐ 40-64 ft ☐ 65+ ft	
Boat operation	☐ Bareboat charter ☐ Crewed charter ☐ Privately owned	
Boat secured by	☐ Anchor ☐ Mooring	**If anchored, anchored on**: ☐ Sand ☐ Reef ☐ Other: _____

Survey ID #:

Part 1: Boating Experience and Demographics

1. What is your age? _____
2. What is your gender identity?
   ❒ Male ❒ Female ❒ Other / prefer not to say
3. In what country do you primarily reside? _____
4. How many years of boating experience do you have? _____
5. In your lifetime, how many times have you chartered a yacht in the BVI? _____
6. What are your primary reasons for chartering a yacht on your current trip? (choose all that apply)
   ❒ Diving ❒ Snorkeling ❒ Sightseeing ❒ Fishing ❒ Other (please specify): _____
7. Did you receive a briefing on proper anchoring and mooring procedures from the charter company before departing?
   ❒ Yes ❒ No

Part 2: Bay/Anchorage Choice

The following questions refer to your decision to choose **the bay/anchorage in which you are currently secured**. During these questions, you will be asked about **securing your vessel**.

Securing your vessel refers to fixing your boat in a given location, for example, by using a mooring or anchoring.

How important to you is each of the following factors when deciding **which bay/anchorage** to secure your vessel in?	Not at all important (1)	Slightly important (2)	Moderately important (3)	Important (4)	Very important (5)
1. Weather and sea conditions	☐	☐	☐	☐	☐
2. Cost	☐	☐	☐	☐	☐
3. Number of other boats nearby	☐	☐	☐	☐	☐
4. Proximity to bars, restaurants, and shops	☐	☐	☐	☐	☐
5. Proximity to natural attractions	☐	☐	☐	☐	☐
6. Overnight use	☐	☐	☐	☐	☐
7. Safety	☐	☐	☐	☐	☐
8. Availability of moorings	☐	☐	☐	☐	☐
9. Presence of sensitive marine habitat	☐	☐	☐	☐	☐

10. Are there any other factors you consider when deciding which bay/anchorage to secure your vessel in? If yes, what are they?

Survey ID #:

Part 3: Anchoring / Mooring Motivations

The following questions refer to your **decision to anchor or moor** in the bay/anchorage you are currently secured in. During these questions, you will be asked about **anchoring on reef**.

Anchoring on reef means your anchor and/or chain touches coral or may touch coral *at any point during your stay* in a given fixed location.

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
1. I think anchoring on sand is a good thing to do	☐	☐	☐	☐	☐
2. I think anchoring on reef is a good thing to do	☐	☐	☐	☐	☐
3. I think using a mooring is a good thing to do	☐	☐	☐	☐	☐
4. People who are important to me think anchoring on reef is a good thing to do	☐	☐	☐	☐	☐
5. Weather and sea conditions are the most important things I consider when deciding whether to anchor or moor	☐	☐	☐	☐	☐
6. I am more likely to use a mooring if the reef below looks pristine	☐	☐	☐	☐	☐
7. If I want to, I can easily pre-book a mooring	☐	☐	☐	☐	☐
8. Whether or not I use a mooring is completely up to me	☐	☐	☐	☐	☐
9. At the places I want to go to, there is always an open mooring to pick up or space to anchor on sand	☐	☐	☐	☐	☐
10. I trust that the moorings in the BVI are safe to use	☐	☐	☐	☐	☐
11. I know the bottom type over which I am floating today	☐	☐	☐	☐	☐
12. (if anchored) I think I anchored on reef today	☐	☐	☐	☐	☐
13. I intended to anchor on reef today	☐	☐	☐	☐	☐
14. I plan to anchor on my current trip	☐	☐	☐	☐	☐

Survey ID #:

15. I plan to anchor on reef on my current trip	☐	☐	☐	☐	☐
16. Whether or not I anchor on reef is completely up to me	☐	☐	☐	☐	☐
17. Weather and sea conditions are the most important things I consider when deciding whether to anchor on sand or on reef	☐	☐	☐	☐	☐
18. I am confident that, if I want, I can anchor off of reef	☐	☐	☐	☐	☐
19. I think boaters are less likely to anchor on reef if they think another boater will notice	☐	☐	☐	☐	☐

Part 4: Regulations and Environmental Concern

The following questions refer to possible regulations in the BVI. During these questions, you will be asked about **marine protected areas**.

Marine protected areas are defined regions of environmental concern that are managed with the goal of long-term conservation of marine resources.

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
1. Anchoring on reef is legal in the BVI	☐	☐	☐	☐	☐
2. There are specific marine protected areas in the BVI where anchoring is not legal	☐	☐	☐	☐	☐
2a. (if responded 4 or 5 to Q2) I know where the marine protected areas in the BVI are located	☐	☐	☐	☐	☐
3. There are marine patrols that check if people follow regulations about anchoring and mooring	☐	☐	☐	☐	☐
4. I am very concerned about the environment	☐	☐	☐	☐	☐
5. Anchoring on coral reefs is a leading cause of reef decline in the BVI	☐	☐	☐	☐	☐

6. If there is anything else you would like to tell us about boating, mooring, and anchoring in the BVI, please share it here: _____

BIBLIOGRAPHY

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes, Theories of Cognitive Self-Regulation 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Allen, I.E., Seaman, C.A., 2007. Likert Scales and Data Analyses. Quality Progress 40, 64–65.

Anderson, L.E., Loomis, D.K., 2011. SCUBA Diver Specialization and Behavior Norms at Coral Reefs. Coastal Management 39, 478–491. https://doi.org/10.1080/08920753.2011.598813

Ashton, P.G., Chubb, M., 1972. A preliminary study for evaluating the capacity of waters for recreational boating. Journal of the American Water Resources Association 8, 571–577. https://doi.org/10.1111/j.1752-1688.1972.tb05179.x

Beeden, R., Maynard, J., Johnson, J., Dryden, J., Kininmonth, S., Marshall, P., 2014. No-anchoring areas reduce coral damage in an effort to build resilience in Keppel Bay, southern Great Barrier Reef. Australasian Journal of Environmental Management 21, 311–319. https://doi.org/10.1080/14486563.2014.881307

Bernard, H.R., 2017. Research Methods in Anthropology: Qualitative and Quantitative Approaches. Rowman & Littlefield.

BoatyBall, 2024. How To [WWW Document]. BoatyBall. URL https://boatyball.com/howto.html (accessed 3.13.24).

BVI National Parks Trust, 2024. National Parks Trust of the Virgin Islands, British Virgin Islands [WWW Document]. National Parks Trust. URL https://www.bvinpt.org (accessed 3.13.24).

CharterWorld, 2024. A list of Caribbean yacht charter boat companies. [WWW Document]. CharterWorld. URL https://www.charterworld.com/index.html?sub=caribbean-yacht-charter-company (accessed 3.18.24).

Chen, M.-F., Tung, P.-J., 2014. Developing an extended Theory of Planned Behavior model to predict consumers' intention to visit green hotels. International Journal of Hospitality Management 36, 221–230. https://doi.org/10.1016/j.ijhm.2013.09.006

Day, J.C., 2002. Zoning—lessons from the Great Barrier Reef marine park. Ocean & Coastal Management 45, 139–156.

de Leeuw, A., Valois, P., Ajzen, I., Schmidt, P., 2015. Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. Journal of Environmental Psychology 42, 128–138. https://doi.org/10.1016/j.jenvp.2015.03.005

Diedrich, A., Balaguer Huguet, P., Tintoré Subirana, J., 2011. Methodology for applying the Limits of Acceptable Change process to the management of recreational boating in the Balearic Islands, Spain (Western Mediterranean). Ocean & Coastal Management 54, 341–351. https://doi.org/10.1016/j.ocecoaman.2010.12.009

Diedrich, A., Terrados, J., Arroyo, N.L., Balaguer, P., 2013. Modeling the influence of attitudes and beliefs on recreational boaters' use of buoys in the Balearic

Islands. Ocean & Coastal Management 78, 112–120. https://doi.org/10.1016/j.ocecoaman.2013.02.027

Dinsdale, E.A., Fenton, D.M., 2006. Assessing Coral Reef Condition: Eliciting Community Meanings. Society & Natural Resources 19, 239–258. https://doi.org/10.1080/08941920500460815

Dinsdale, E.A., Harriott, V.J., 2004. Assessing Anchor Damage on Coral Reefs: A Case Study in Selection of Environmental Indicators. Environmental Management 33, 126–139. https://doi.org/10.1007/s00267-003-3056-9

Eddy, T.D., Lam, V.W.Y., Reygondeau, G., Cisneros-Montemayor, A.M., Greer, K., Palomares, M.L.D., Bruno, J.F., Ota, Y., Cheung, W.W.L., 2021. Global decline in capacity of coral reefs to provide ecosystem services. One Earth 4, 1278–1285. https://doi.org/10.1016/j.oneear.2021.08.016

Everitt, J., 2007. Chasing Twenty-first Century smokestacks: tourism research in the British Virgin Islands. Prairie Perspectives 10, 89–112.

Fishbein, M., Ajzen, I., 1975. Belief, Attitude, Intention, and Behavior An Introduction to Theory and Research. Addison-Wesley, Reading, MA.

Flynn, R.L., Forrester, G.E., 2019. Boat anchoring contributes substantially to coral reef degradation in the British Virgin Islands. PeerJ 7, e7010. https://doi.org/10.7717/peerj.7010

Forrester, G.E., 2020. The influence of boat moorings on anchoring and potential anchor damage to coral reefs. Ocean & Coastal Management 198, 105354. https://doi.org/10.1016/j.ocecoaman.2020.105354

Forrester, G.E., Flynn, R.L., Forrester, L.M., Jarecki, L.L., 2015. Episodic Disturbance from Boat Anchoring Is a Major Contributor to, but Does Not Alter the Trajectory of, Long-Term Coral Reef Decline. PLOS ONE 10, e0144498. https://doi.org/10.1371/journal.pone.0144498

Francour, P., Magréau, J.F., Mannoni, P.A., Cottalorda, J.M., Gratiot, J., 2006. Management guide for Marine Protected Areas of the Mediterranean Sea, permanent ecological moorings. Université de Nice-Sophia Antipolis & Parc National de Port-Cros, Nice, France.

García Mejías, M.V., Arroyo-Arcos, L., Segrado-Pavón, R.G., De Marez, L., Ponnet, K., 2021. Factors influencing the intention to adopt a pro- environmental behavior by tourist operators of a Mexican national marine park. Turismo y Sociedad 29, 221–238. https://doi.org/10.18601/01207555.n29.10

Gautam, V., 2020. Examining environmental friendly behaviors of tourists towards sustainable development. Journal of Environmental Management 276, 111292. https://doi.org/10.1016/j.jenvman.2020.111292

Giglio, V.J., Ternes, M.L.F., Mendes, T.C., Cordeiro, C.A.M.M., Ferreira, C.E.L., 2017. Anchoring damages to benthic organisms in a subtropical scuba dive hotspot. Journal of Coastal Conservation 21, 311–316. https://doi.org/10.1007/s11852-017-0507-7

Guagnano, G., Stern, P.C., Dietz, T., 1995. Influences on attitude-behavior relationships: a natural experiment with curbside recycling. Environment and Behavior 27, 699–718.

Ha, N.T., Cong, L., Wall, G., 2021. China's scuba divers' marine-based environmental behaviors. Journal of Sustainable Tourism 29, 616–638. https://doi.org/10.1080/09669582.2020.1820016

Han, H., Hsu, L.-T. (Jane), Sheu, C., 2010. Application of the Theory of Planned Behavior to green hotel choice: Testing the effect of environmental friendly activities. Tourism Management 31, 325–334. https://doi.org/10.1016/j.tourman.2009.03.013

Kirner, K., Mills, J., 2019. Introduction to Ethnographic Research: A Guide for Anthropology. SAGE Publications.

Kollmuss, A., Agyeman, J., 2002. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research 8, 239–260. https://doi.org/10.1080/13504620220145401

Krieger, J.R., Chadwick, N.E., 2013. Recreational diving impacts and the use of pre-dive briefings as a management strategy on Florida coral reefs. Journal of Coastal Conservation 17, 179–189. https://doi.org/10.1007/s11852-012-0229-9

Lloret, J., Zaragoza, N., Caballero, D., Riera, V., 2008. Impacts of recreational boating on the marine environment of Cap de Creus (Mediterranean Sea). Ocean & Coastal Management 51, 749–754. https://doi.org/10.1016/j.ocecoaman.2008.07.001

Luna, B., Pérez, C.V., Sánchez-Lizaso, J.L., 2009. Benthic impacts of recreational divers in a Mediterranean Marine Protected Area. ICES Journal of Marine Science 66, 517–523. https://doi.org/10.1093/icesjms/fsp020

Maichum, K., Parichatnon, S., Peng, K.-C., 2016. Application of the Extended Theory of Planned Behavior Model to Investigate Purchase Intention of Green Products among Thai Consumers. Sustainability 8, 1077. https://doi.org/10.3390/su8101077

Panwanitdumrong, K., Chen, C.-L., 2021. Investigating factors influencing tourists' environmentally responsible behavior with extended theory of planned behavior for coastal tourism in Thailand. Marine Pollution Bulletin 169, 112507. https://doi.org/10.1016/j.marpolbul.2021.112507

Parry-Wilson, H.M., Rees, S.E., Leather, H., Cole, R., Rugg, C., Attrill, M.J., 2019. Assessing behavioural and social responses to an eco-mooring trial for Zostera marina conservation management in Torbay, Southwest England. Ocean & Coastal Management 180, 104906. https://doi.org/10.1016/j.ocecoaman.2019.104906

Simmons, E.C., Fielding, K.S., 2019. Psychological predictors of fishing and waste management intentions in Indonesian coastal communities. Journal of Environmental Psychology 65, 101324. https://doi.org/10.1016/j.jenvp.2019.101324

Tseng, Y.-P., Kyle, G.T., Shafer, C.S., Graefe, A.R., Bradle, T.A., Schuett, M.A., 2009. Exploring the Crowding–Satisfaction Relationship in Recreational Boating. Environmental Management 43, 496. https://doi.org/10.1007/s00267-008-9249-5

Virgin Islands Fisheries Regulations, 2003. Statutory Instrument No. 20. Tortiola, British Virgin Islands.

Xu, X., Wang, S., Yu, Y., 2020. Consumer's intention to purchase green furniture: Do health consciousness and environmental awareness matter? Science of The Total Environment 704, 135275. https://doi.org/10.1016/j.scitotenv.2019.135275

Zemore, S.E., Ajzen, I., 2014. Predicting substance abuse treatment completion using a new scale based on the theory of planned behavior. Journal of Substance Abuse Treatment 46, 174–182. https://doi.org/10.1016/j.jsat.2013.06.011