

LIFE Recreation ReMEDIES Behaviour Change Project:

Understanding the behavioural context

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Clare Twigger-Ross, Sian Morse-Jones, Paula Orr, Rebecca Jones, Jackie Andrade, Elizabeth Gabe-Thomas



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Further information

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LIFE Recreation ReMEDIES Behaviour Change Project

Understanding the behavioural context – Evidence report

**Collingwood Environmental Planning (CEP) in partnership with
the University of Plymouth and Plymouth Marine Laboratory**

01 April 2021

**LIFE 18 NAT/UK/000039 Reducing and Mitigating Erosion and Disturbance Impacts
affecting the Seabed (ReMEDIES) project. Action C1: Changing Stakeholder
Behaviour Project**

Preface

Connecting people with nature is a priority for Natural England, and it aligns with the ambitions set out by the government in its 25 Year Environment Plan. We recognise the importance that outdoor spaces, both terrestrial and marine, have as places that people can use for recreation and, at the same time, connect with nature and access the range of health and wellbeing benefits that we know this can provide.

We also know that some of our most special marine habitats, designated as Special Areas of Conservation¹, are not currently in favourable condition as a result of a range of factors including fishing activity, pollution, industry and invasive species. Many of these factors are being addressed in other projects, but recreational pressures – including the impacts of recreational boating and disturbance related to access – have received less attention. To help address this gap, one action (C1) of the EU LIFE-funded Recreation ReMEDIES² project (also referred to simply as ‘ReMEDIES’) has focused on how we can work with local communities, including recreational boaters, to restore and reduce the impacts from their activities on Annex 1 habitats and their sub-features.

Seagrass and maerl are the habitat features that are most at risk at the sites included in the ReMEDIES project, and both of these habitat features are important. Seagrass beds are diverse and productive ecosystems and they tend to be restricted to shallow, sheltered waters and soft sediments. As a result, their distribution often overlaps with safe anchorages. Maerl is a very slow growing coral-like habitat, which is effectively non-renewable. Both seagrass and maerl provide nursery habitats for many species of invertebrate and fish and both can capture and store significant quantities of ‘blue carbon’, so have an important role in climate regulation. However, both seagrass and maerl are being inadvertently damaged and destroyed through human actions including anchoring and mooring, boat launching and bait digging. Pressures on these important habitats are increasing, partly due to increasing numbers of recreational visits to sites where they can be found.

The first step in understanding how we can work with the recreational boating community to reduce these kinds of impacts on these habitats is to develop our understanding of recreational boating communities. By taking this approach, we can identify strategies that should be more likely to work, both for boaters and for these precious habitats. A behaviour change project was commissioned to deliver this piece of work, to inform the ReMEDIES project. Due to resource constraints, this piece of work focuses on two recreational behaviours, anchoring and mooring, at two of the five sites included in ReMEDIES - Plymouth Sound Special Area of Conservation and Solent Maritime Special Area of Conservation - and only impacts on seagrass were considered, given that maerl is not present at these sites.

¹ See <https://jncc.gov.uk/our-work/special-areas-of-conservation-overview/> for more information about Special Areas of Conservation and the habitats they set out to protect.

² LIFE Recreation ReMEDIES is led by Natural England in partnership with Marine Conservation Society, Ocean Conservation Trust, Plymouth City Council/Tamar Estuaries Consultative Forum and Royal Yachting Association. ReMEDIES stands for ‘reducing and mitigating erosion and disturbance impacts affecting the seabed’. Visit <https://www.gov.uk/government/publications/life-recreation-remedies-project> to find out more.

This report brings together and builds on the evidence relating to the anchoring and mooring behaviours of recreational boaters, the range of factors influencing these, and what we know about the impact of different kinds of intervention on those behaviours. The findings identify some key areas that require our attention: around information (the locations of seagrass beds), training (how to anchor and moor in such a way as to avoid damaging seagrass) and evidence (that the behaviours of recreational boaters affect seagrass (and how), and that alternative behaviours and devices like Advanced Mooring Systems are effective). Interventions planned for ReMEDIES will address these issues, and the information presented in this report provides us with a baseline against which we can measure the effectiveness of these interventions for driving change.

- *Dr Emma Hinton, Senior Specialist in Social Science at Natural England and project manager for the Behaviour Change Project*
- *Fiona Crouch, LIFE Recreation ReMEDIES project manager at Natural England*

Summary

Introduction

The main aim of the ReMEDIES Behaviour Change Project is to help Natural England and partners develop evidence-based interventions to influence the behaviour of recreational boaters to reduce disturbance and damage to seagrass. The purpose of this report is to present the findings from the Project relating to 'Understanding the Behavioural Context'. It is aimed at interested stakeholders, with a focus on those involved in the ReMEDIES project.

This report responds to the Behaviour Change Project's objectives to review current knowledge on:

- Recreational boating behaviours - specifically anchoring and mooring – with relation to their impacts on seagrass and the effectiveness of existing mitigation measures, and
- The behavioural context at two test sites: Plymouth Sound and Estuaries and the Solent Maritime Special Areas of Conservation.

Whilst the focus of this Project is on the behaviours of recreational boaters, we acknowledge that there are other threats to seagrass habitats.

Methodology

We used the COM-B behaviour change model (Michie and others, 2011) and associated Behaviour Change Wheel as an overarching framework to ensure we considered a broad range of factors that may affect boating behaviour. Using this framework, we studied the extent to which boaters felt their Behaviour in relation to seagrass was influenced by:

- **Capability** (e.g. do boat users feel they can control the extent to which their activity causes damage?),
- **Opportunity** (e.g. do they have options for anchoring away from vulnerable areas?), and
- **Motivation** (e.g. to what extent do they feel that protecting seagrass matters to them?).

In addition to COM-B, we used the Theory of Planned Behaviour developed by Ajzen (1991) to explore boaters' motivation in more detail.

Data collection methods

The project involved three strands of data collection:

- **Literature review:** a focussed review of peer-reviewed and grey literature on interventions to change anchoring and mooring behaviours of recreational boaters in seagrass.
- **Qualitative research:** including interviews with 8 key stakeholders to provide insight into boaters' attitudes and beliefs about the importance of seagrass, as well as current practices which might affect seagrass; and 3 meetings (18 people in total) with members of the recreational boating community to explore participants' boating practices, their knowledge and views of seagrass and their knowledge and views on approaches to mitigating damage to seagrass (i.e.

Advanced Mooring Systems (AMS), Voluntary No Anchor Zones (VNAZ), Anchoring with Care).

- **Quantitative research:** an online survey was developed to understand the broader behavioural context, which had 173 respondents.

Summary of key findings

Damage to seagrass from anchoring and mooring behaviours of recreational boaters

The findings from the primary research indicate mixed levels of awareness and acceptance among the recreational boater community of damage to seagrass caused by recreational boater anchoring and mooring. Other boating and non-boating causes of damage to seagrass identified by participants in this research include gunning the engine, fishing boats and storm damage. Views were expressed by some of the recreational boaters involved in this research that local seagrass is not in decline and that it can adapt and recover.

Anchoring behaviours identified by interviewees and meeting participants in this research as having potentially damaging effects included: plough anchors³; dragging the anchor; not bedding in the anchor properly; putting down more anchor chain than is required; and dropping anchor but not reversing on it. As evidenced by the survey results, anchoring in seagrass is not an uncommon practice among boaters and many do so with prior knowledge that seagrass is in the area. The dominant reason for anchoring in seagrass is safety, as many places where seagrass grows are safe, sheltered locations.

Differences between boaters' behaviours: perceived and actual

Boaters perceive there to be differences between yacht boaters and motorboaters in terms of anchoring and mooring behaviours that impact on seagrass. However, the distinction between the two groups cannot be clearly defined, as the survey results show that many yacht boaters also use motorboats and vice versa. Factors that boaters perceive to be responsible for differences in the anchoring and mooring behaviours of different boater types include experience level, belonging to a club/association, and environmental awareness.

Findings from the boater meetings suggest that anchoring and mooring behaviours depend on the type of boat trip or activity: for example, whether they plan to stop at all and, if they do plan to stop, how long they plan to stop for. There were mixed perceptions about whether 'day tripping' or overnight stops would be more responsible for damage to seagrass.

There was some limited evidence from the literature review that the size of boat also impacts the level of damage to seagrass. However, there was some variation in the perceptions of those boaters participating in the boater meetings as to whether smaller or larger boats are more responsible for damage to seagrass by anchoring and mooring.

³ A plough anchor is a type of anchor that works by lodging into the seabed or floor of the body of water. It is designed for heavier craft.

Approaches to changing the anchoring and mooring behaviours of recreational boaters

There is a lack of evaluations of approaches to changing the anchoring and mooring behaviours of recreational boaters, of both the effectiveness of technical equipment (e.g. Advanced Mooring Systems) and behaviour change strategies.

Across the boater meetings and the evidence review both positive and questioning views were raised towards AMS. More information and proof of their effectiveness was asked for by participants in the meetings and questions were raised as to how effective they could be in crowded areas, and specifically in the UK tidal range.

With respect to interventions intended to encourage anchoring away (i.e. restricted anchoring and voluntary no anchor zones), there were mixed opinions across the evidence review and the boater meetings as to their effectiveness to reduce pressures on seagrass from recreational boating.

From the boater meetings, alternative anchoring techniques e.g. using a trip line provoked concern as to whether it would be effective in reducing damage to seagrass and whether it was an effective way to retrieve an anchor.

The evidence review showed that navigational aids (e.g. buoys) could be effective and that educational outreach/information could raise awareness but was best used in conjunction with other approaches to be effective. Overall, approaches that combined interventions were considered to be most effective in changing anchoring and mooring behaviours.

Barriers and facilitators to boaters taking action

Overall, the boaters in the meetings and the survey expressed connectedness to the ocean and strong motivations to protect it. There appears to be a willingness to change behaviours that damage seagrass but this is coupled with a strong resistance to enforcement; boaters want the freedom to choose where they go and to choose what they perceive as safe options for anchoring and mooring. Given this, education and information about seagrass and approaches to avoiding impacts were the preferred approaches to interventions.

Lack of information on both seagrass (e.g. its value as an ecosystem, its location, damage from boaters etc) and behaviours to reduce impacts on seagrass was perceived as a key barrier. Strong messaging is needed to educate boaters on how boating behaviours damage seagrass and how changes will protect it. Current information about seagrass locations is poor, with participants largely not knowing where it is located at the two sites or how to access information about where it is located. Royal Yachting Association and harbour authorities are respected sources of information and have a strong role to play in establishing social norms to protect seagrass.

Implications for behaviour change strategies

A number of key implications can be derived from the findings:

- Recognise that any behaviour change strategy needs to cover the psychological (e.g. motivations, emotions), social (e.g. social norms) as well as the physical (e.g. Advanced Mooring

Systems, Voluntary No Anchor Zones) aspects. That is, to be effective, interventions should be combinations of activities that address these different aspects.

- Build on the desire of boaters to protect the ocean and their sense of connection to it through developing consistent information about seagrass, the impacts of boaters on it and the actions that they can take. When planning to deploy interventions in ReMEDIES, attention should be paid to incorporating messages that facilitate ocean connectedness, and considering how different images may evoke feelings of connectedness.
- Collaborate with boaters on deploying the interventions, specifically Advanced Mooring Systems and Voluntary No Anchor Zones, to explore the strengths and weaknesses of each intervention for a particular location. Encourage boaters to engage with the science around Advanced Mooring Systems, to discuss the evidence, and to develop co-created solutions which could be in terms of user centred design of Advanced Mooring Systems as well as decision making around installation/deployment decisions. Encourage discussion around Advanced Mooring Systems as a solution for seagrass protection, in addition to discussion of boaters' concerns about safety and having alternative safe places to anchor when needed.
- Work to reframe the issue as one that encourages co-operation between boaters to reduce damage to seagrass, and value seagrass in general for its environmental benefits, rather than using a narrative that implies blame on one group or another. The participants in this research were predominantly experienced, interested recreational boaters. Given their comparatively greater levels of interest and engagement in the subject, it is recommended that efforts are made to target these kinds of boater and to encourage them to become ambassadors for seagrass and its protection. Train up a network of volunteers to talk to their clubs/marinas about the topic. This could also be used to reach new boaters and help establish desired behaviours early on in their boating.
- Use trusted authorities e.g. Royal Yachting Association and other national organisations (e.g. Natural England) to put out consistent messages at the national and local level. 'Trust' and 'influence' play out differently for different individuals, for example, depending on past experiences, so it would be useful to consider widening the reach of influencers, to include those who may appeal via 'celebrity' status to different audiences (e.g. well-known sailors). Doing this would need some research into who would be most appropriate for different audiences and looking at the evidence from other campaigns to see what their impact is in practice.
- Carry out multiple strategies in one place so that boaters are hearing about the issues from a wide range of sources.

Further implications for specific interventions, limitations of the research and recommendations for future research are made in Section 8.

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List of abbreviations

| | |
|--------------|--|
| AMS | Advanced Mooring Systems |
| ANOVA | Analysis of variance |
| COM-B system | Framework for behaviour change. Three essential conditions for behaviour change: capability, opportunity, motivation |
| EMS | European Marine Site |
| ESA | Ecologically Sensitive Area |
| ESA | Environmentally Sensitive Area |
| GDPR | General Data Protection Regulation |
| IFCA | Inshore Fisheries and Conservation Authorities |
| JWEG | Joint Water Evidence Group |
| MCS | Marine Conservation Society |
| MCZ | Marine Conservation Zone |
| MMO | Marine Management Organisation |
| NE | Natural England |
| OCT | Ocean Conservation Trust |
| PICO | Population, Intervention, Comparators, Outcomes |
| QHM | Queen's Harbour Master |
| ReMEDIES | Reducing and mitigating erosion and disturbance impacts affecting the seabed |
| RYA | Royal Yachting Association |
| RQ | Research question |
| SAC | Special Area of Conservation |
| TPB | Theory of Planned Behaviour |
| UK | United Kingdom |
| US/USA | United States of America |
| VNAZ | Voluntary No Anchor Zones |

1. Introduction

Context

The LIFE Recreation ReMEDIES project is a four-year project that will improve the condition of four marine habitats of European importance⁴. Seagrass and maerl beds are key features of these habitats and are most at risk from damage. Seagrass beds generate ecosystem services including supporting, provisioning, regulating and cultural services, for example as nursery and foraging habitat for fish, shellfish and wildfowl, capturing carbon and providing shoreline stabilisation and protection from erosion. These habitats are also home to several protected species such as seahorses, stalked jellyfish and rare seaweeds.

The ReMEDIES project focuses on five key Special Areas of Conservation (SACs) in the UK: Isles of Scilly Complex; Fal and Helford; Plymouth Sound and Estuaries; the Solent Maritime; and Essex Estuaries. Seagrass and maerl are sub-features within the Annex 1⁵ habitats that have been identified as being in 'unfavourable' condition within these SACs⁶. The Behaviour Change Project seeks to understand and influence some of the behaviours of recreational boaters which can affect seagrass; one of a number of possible solutions to improve the condition of seagrass meadows in two test sites, Plymouth Sound and Estuaries and the Solent Maritime⁷. There are several other anthropocentric factors which can affect the health of seagrass: the ReMEDIES project focuses on the impacts of recreational boating because this is a comparatively under-researched area and not because recreational boaters are considered to be the only, or main, cause of impacts to seagrass.

Recreational boating practices can affect these sensitive marine habitats in several ways. Anchoring and mooring⁸ have the potential to cause abrasion, penetration and changes in seabed features and certain other boating practices also have a negative impact on seagrass habitats. Seagrass can be physically damaged by boat propellers and anchoring; use of moorings located in sensitive habitats can lead to scour; and speeding can indirectly affect seagrass by disturbing sediment. On some sites, boat launching and bait digging also flatten seagrass and prevent its natural regeneration. The scope for managing mooring practices to reduce damage to seagrass habitats is affected by the

⁴ These four habitats are: H1110 (Sandbanks which are slightly covered by sea water all the time); H1130 (Estuaries); H1140 (Mudflats and sandflats not covered by seawater at low tide) and H1160 (Large shallow inlets and bays)

⁵ Of the EU Habitats Directive.

⁶ For further information on the two SACs focused on in the Behaviour Change Project – i.e. Plymouth Sound and Estuaries SAC and Solent Maritime SAC – see:

<https://designatedsites.naturalengland.org.uk/Marine/MarineFeatureConditionDirect.aspx?SiteCode=UK0013111&SiteName=plymouth&SiteNameDisplay=Plymouth%20Sound%20and%20Estuaries%20SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAAarea=&NumMarineSeasonality=4>; and <https://designatedsites.naturalengland.org.uk/Marine/MarineFeatureConditionDirect.aspx?SiteCode=UK0030059&SiteName=solent&SiteNameDisplay=Solent%20Maritime%20SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAAarea=&NumMarineSeasonality=>.

⁷ Maerl is not present at these two sites, and so this project has focused on boater behaviours in relation to seagrass.

⁸ In this research, by 'anchoring', we mean dropping an anchor to secure a boat, and by 'mooring' we mean securing a boat by attaching to a buoy or another fixed point (e.g. marina or pontoon).

complex organisational responsibilities for mooring which involve a number of organisations including landowners and licensing bodies and their level of connection with and ability to influence boaters.

Key issues concerning recreational boater behaviours in relation to the habitats at the ReMEDIES sites include for example that: seagrass (and maerl) are easily damaged by disturbance such as scouring and abrasion; few people know about the seabed's sensitive features, their location and importance; and recreational pressures are increasing. The ReMEDIES project includes a number of interventions intended to influence the behaviours of recreational boaters to help mitigate further damage to these habitats. These include, for example, the installation of Advanced Mooring Systems (AMS)⁹, training events for boaters (e.g. on best practise anchoring and AMS), voluntary no anchor zones and voluntary codes of conduct, sharing information via existing boating apps, communications (e.g. via videos and social media), citizen science workshops, engaging with people at roadshows and boat shows, and natural capital infographics to communicate the importance of these marine habitats.

The Behaviour Change Project is one part of the wider ReMEDIES project and is the focus of this report.

Aims and objectives

The main aim of the Behaviour Change Project ultimately is to help Natural England and partners develop evidence-based interventions to change the behaviour of boaters in order to reduce disturbance and damage to seagrass¹⁰.

This report responds to the behaviour change project's objectives to review:

- Current knowledge on recreational boating behaviours, specifically anchoring and mooring; their

⁹ Advanced Mooring Systems (AMS) avoid or limit the physical pressures on marine habitats, including seagrass, caused by anchors and traditional swing moorings (Amec Foster Wheeler, 2017). Various designs of AMS (also known as 'environmentally friendly moorings' or 'eco-moorings') exist but generally all feature either a ground weight or sediment penetrating system and a method to eliminate or reduce chain abrasion on the seabed using bungees, riser buoys, floating rode and other creative options (Luff and others, 2019; Parry-Wilson and others, 2019). Examples of frequently used AMS include the Ezyrider design, the Seaflex system, the modified Hazlett system, the Stirling Mooring system and the helical mooring system.

¹⁰ Seagrass is an umbrella term; there are four species of seagrass in the UK, two are eelgrass species and two are tasselweed species. (<https://www.wildlifetrusts.org/habitats/marine/seagrass>). Tasselweed is found in freshwater. In this report, we are using the term "seagrass" as a general term to cover the range of varieties reported on in the studies reviewed, which include studies from Florida, Greece as well as the UK. We recognise that there are a number of different species around the world that are referred to generically as "seagrass".

- impacts on seagrass; and the effectiveness of existing mitigation measures, and
- The behavioural context in the two test sites.

Scope of work

The scope of the work is focused as follows:

- **Geographically:** the project is focused on two Special Areas of Conservation: Plymouth Sound and Estuaries and Solent Maritime (referred to in this report as the two test sites)¹¹. These are large areas containing seagrass meadows and have some of the greatest recreation pressures.
- **Behaviourally:** the project is focused on recreational boater behaviours related to anchoring and mooring in seagrass¹² which are the main issues of concern at the two test sites as specified by Natural England. Other recreational boating behaviours which may impact seagrass, such as bait collection and speeding, are outside of scope for this project given that they are of less concern at the two test sites, in addition to resource constraints.
- **Population:** the project is focused on the recreational boating community at the two test sites who engage in mooring and anchoring, for example, recreational boaters using yachts and motor cruisers. Recreational boaters who do not engage in mooring and anchoring, for example, kayakers, canoers and jet skiers, are out of scope.

Purpose of report

The purpose of this report is to present the findings from the first phase of this project on 'Understanding the Behavioural Context'. It is aimed at interested stakeholders with a focus on those involved in the ReMEDIES project. The evidence from this report is intended to be used to provide a sound base to inform the development of interventions in ReMEDIES.

¹¹ The two test sites are subsequently referred to in this report as 'Plymouth' and 'the Solent'.

¹² Maerl is found in Fal and Helford, but not the Plymouth and Solent test sites.

2. Methodology

Overall approach

Research questions

The approach taken for this piece of research was guided by four research questions:

1. What are the behaviours of recreational boaters in relation to anchoring and mooring that cause seagrass damage generally and specifically at each of the two test sites? What is the frequency and nature of those behaviours? What are recreational boaters' perceptions of these behaviours?
2. To what extent are these behaviours related to types of recreational boaters (in terms of attitudes, values and a range of other factors) and types of boat generally and specifically at each of the two test sites? To what extent do recreational boaters themselves perceive these behaviours to be related to types of boaters / types of boat?
3. Approaches to changing the anchoring and mooring behaviours of recreational boaters:
 - 3.1 What approaches to changing the anchoring and mooring behaviours of recreational boaters have been effective (or not), generally and specifically at each of the two test sites? What approaches to changing anchoring and mooring behaviours of recreational boaters do recreational boaters themselves perceive to be potentially effective generally and at each of the two test sites?
 - 3.2 What approaches to changing the anchoring and mooring behaviours of recreational boaters have been developed but not yet tested?
4. What are the barriers and facilitators to boaters (in particular, different types of recreational boaters) taking action at each site? To what extent are these related to capability, opportunity and motivation?

Behaviour change theory and framework

We used the COM-B behaviour change model (Michie and others, 2011) and associated Behaviour Change Wheel (Figure 1) as an overarching framework to ensure we considered a broad range of factors that may affect boating behaviour. This framework has been widely used in relation to health behaviours, to understand how personal perceptions and motivation intersect with legal and environmental factors to influence behaviour. COM-B offers both a model of behaviour as well as a practical approach to intervention design and implementation by helping to identify the relative likely impacts of changing infrastructure and working with organisations or individuals. The COM-B model was considered to be most appropriate for this work because it is a systematic overview of existing frameworks for behaviour change making it robust and focussed on policy interventions rather than academic theory development. These frameworks were evaluated using three key criteria: comprehensiveness, coherence and a clear link to an overarching model of behaviour change. Multiple frameworks were reviewed to generate the behaviour change wheel (19 in total) which has at its centre sources of behaviour (physical and psychological capability, physical and social opportunity, reflective and automatic motivation), with intervention functions (education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement) in the next circle and finally policy categories (guidelines, fiscal measures,

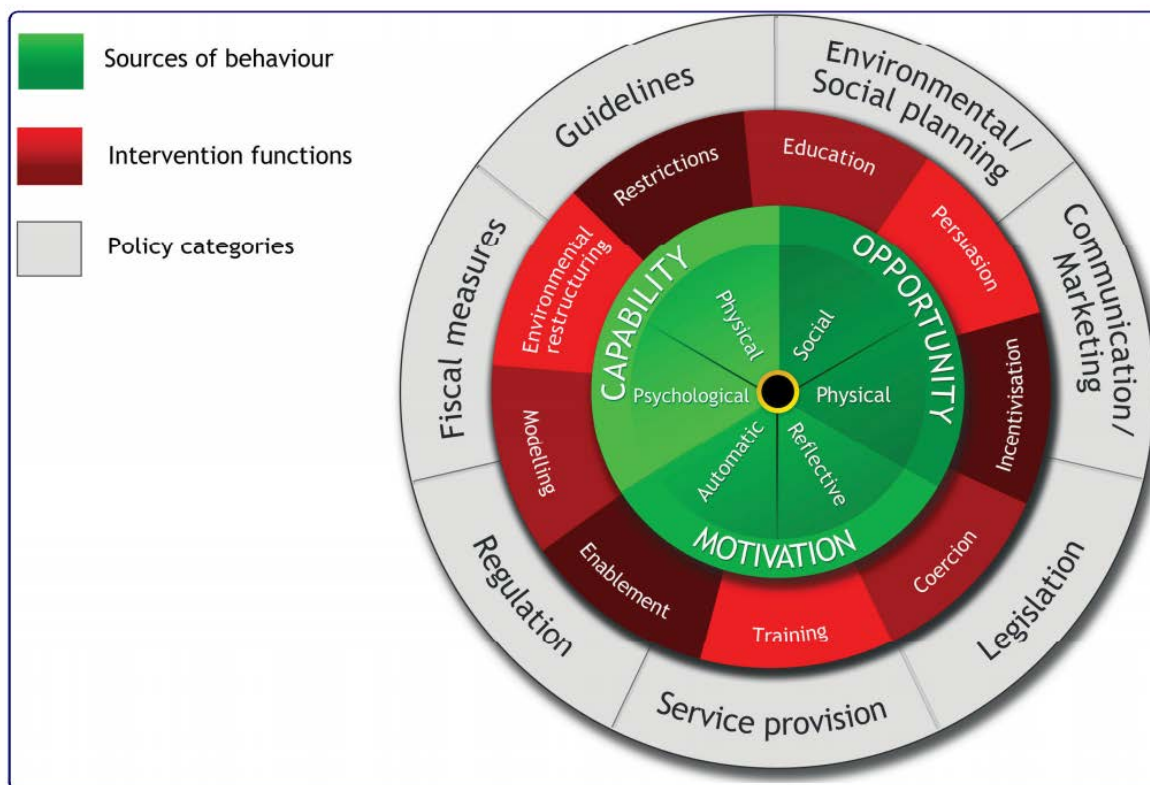


Figure 1. COM-B Behaviour Change Wheel. Source: Michie and others, 2011. ©2011 Springer Nature, reproduced under license [CCBY2.0](https://creativecommons.org/licenses/by/2.0/).

environmental/social planning, regulation, service provision, legislation, communication/marketing) in the outer circle. What this allows is for existing interventions to be reviewed to see if there are options that are being neglected. Further, the approach provides a useful overview of the key aspects of behaviour change theories but then allows the use of a more detailed theory (in this case Theory of Planned Behaviour) to elaborate on the relationships between the psychological variables. Although its use has been within the public health arena we felt that would transfer well into the environmental domain. Using this framework, we studied the extent to which boaters felt their **B**ehaviour in relation to seagrass was influenced by:

- **C**apability (e.g. do boat users feel they can control the extent to which their activity causes damage?),
- **O**pportunity (e.g. do they have options for anchoring away from vulnerable areas?), and
- **M**otivation (e.g. to what extent do they feel that protecting seagrass matters to them?).

In addition to COM-B, we used the Theory of Planned Behaviour (TPB) developed by Azjen (1991) to explore boaters' motivation in more detail. The TPB helps to understand the personal and social factors that influence people's intentions to behave in particular ways. The theory suggests that how strongly someone intends to do a behaviour is influenced by three factors: their attitudes about the outcome of the behaviour and the value placed upon the outcome (e.g. anchoring away would help protect seagrass and that would be a good outcome); their perception of what other people think about the behaviour and their desire to do what other people think is right (e.g. their perception that other boaters think protecting seagrass is important); and their perceived behavioural control. Perceived behavioural control in the TPB is, in COM-B terms, the extent to which the person feels they have the capability to perform the behaviour given current opportunities. For example, someone might rate their perceived behavioural control as low if they know how to use a trip line but do not

have room in their boat to store one. The TPB can be used to explain the processes that lead to behaviours. It can also be applied to help develop appropriate programmes to bring about long-lasting changes in behaviours. For the purposes of our research, the theory helped us to understand the extent to which different perceptions of the impact of boating behaviours on seagrass, the behaviours of other boaters, and personal capability to protect seagrass influenced boaters' feelings about protecting seagrass and the extent to which these variables would be effective targets for influencing behaviour. Applied to behaviours to protect seagrass, the theory suggests that to increase these behaviours, you might need to change attitudes toward seagrass, anchoring and mooring; increase perceptions that other boaters behave in a way that protects seagrass; and increase confidence and opportunity to carry out protective behaviours towards seagrass through their anchoring and mooring practices. Our research aimed to establish the relative importance of these different influences on behaviour.

Finally, we included in the survey a few questions about how people imagine the outcomes of their behaviour, because research (Solbrig and others, 2018) shows that particularly successful behaviour change interventions are those that help individuals to imagine feeling good about succeeding in the behaviour. These additional approaches – TPB and imagery – helped us to understand in detail the broad categories of barriers and opportunities to behaviour change identified by COM-B.

Data collection methods

Literature review

A focussed review (see Appendix 1) was undertaken drawing on three strands of evidence:

- Reports and studies identified by the ReMEDIES Behaviour Change project steering group.
- An advanced Scopus¹³ search to identify key academic papers on recreational boating behaviours and their impacts on seagrass from 2015 onwards, supplemented by citations and references search on key papers of relevance (See Appendix 1 for details on how the searches were carried out).
- Search in Google to identify other relevant sources e.g. grey literature.

Scopus was used as it is an academically respected database with high quality, breadth and reliability of sources and it is internationally recognised. Papers written in English, focused on interventions to change anchoring and mooring behaviours of recreational boaters in seagrass were reviewed. Nine search strings were tested with five of them returning relevant papers. Here is one of the search strings as an example:

TITLE-ABS-KEY(("recreational boat*" OR boat*) AND (anchor* OR moor*) AND behav* AND ("seagrass*" OR "seagrass bed*" OR "maerl bed*" OR Zostera))

We included maerl and Zostera on the advice of the project steering group given their similarity to seagrass which could lead to insights for the research. 2015 was chosen as the cut off point for

¹³ Scopus is a bibliographic database containing abstracts and citations for academic journal articles www.scopus.com.

papers (past five years) as reasonable given the resources for the review. Any key papers or reports before that date that were known to the project team or steering group were also included.

The papers were prioritised in terms of relevance to the research questions (and overall quality¹⁴) and those assessed as most relevant were reviewed in full. Data was extracted into an Excel spreadsheet, and analysed in relation to the four research questions.

Interviews with key stakeholders

The purpose of the stakeholder interviews was to provide insight into boaters' attitudes and beliefs about the importance of seagrass, as well as current practices which might affect seagrass. Stakeholders were selected who have regular contact with different kinds of boaters and as such were well-placed to talk about wider boater perspectives. The interview questions can be found in Appendix 2.

These interviews were held over the phone or using Zoom videoconferencing software between August and September 2020 with stakeholders from each site. The recruitment of stakeholders was informed by suggestions made by ReMEDIES partners, including staff from Natural England, RYA and MCS, and efforts were made to involve a range of stakeholders to enable use to include a range of perspectives. Each interviewee was sent details of the behaviour change project, a consent form and the ReMEDIES privacy notice. GDPR protocol was adhered to throughout. Each interview lasted between 30 – 45 minutes. Notes of the interview were taken by the interviewer and sent back to the interviewee for confirmation. Two members of the research team shared the interviews with the stakeholders. Details of the interviewees' roles can be found in Section 3.

Meetings with boaters

Following the stakeholder interviews, a small number of meetings with boaters were delivered. The purpose of these meetings was to explore participants' boating practices, their knowledge and views of seagrass and their knowledge and views on approaches to mitigating damage to seagrass (i.e. Advanced Mooring Systems, Voluntary No Anchor Zones, Anchoring with Care). Information collected during the stakeholder interviews informed the questions asked in these meetings. Three meetings were held with members of the local boating communities: one with boaters from Plymouth, one with boaters from the Solent and one with boaters from both sites, focussed on motorboaters as they had been in the minority at the other meetings¹⁵. The rationale for the third meeting was also to increase the number of participants in these boater meetings, given a lower than expected turnout for the preceding two meetings. The meeting questions can be found in Appendix 4. As part of the meeting participants were shown images of seagrass beds, the impact of anchoring and moorings on seagrass in the South Coast of England, Advanced Mooring Systems and anchoring with a trip

¹⁴ Documents were assessed by whether or not they were peer reviewed and the overall quality of paper was based on the expert judgement of team members as to whether or not a paper was of sufficient quality to be part of the review. For example, if the document was produced for government or their agencies it is assumed that the process has been rigorous.

¹⁵ The three meetings are referred to throughout the report as the 'Plymouth meeting', 'the Solent meeting', and 'joint meeting', respectively.

line¹⁶. These boater meetings were carried out between September – November 2020 between 6.30 – 8.30 pm via Zoom videoconferencing software¹⁷. Three to four members from the project team from a pool of five were present at each meeting to facilitate and to take notes. To reduce bias from having different team members in each meeting, a clear script was developed for the meetings for facilitators to work from together with a trial run before each of the meetings. One project team member facilitated in all three meetings.

Participants were recruited using a combination of snowball¹⁸ and opportunity¹⁹ sampling. ReMEDIES Partners and interviewees shared a recruitment notice inviting boaters to sign up to attend one of the meetings via email and social media (e.g. in tweets from NE, RYA and OCT). In addition, sailing clubs and marinas in the Plymouth and the Solent areas were sent details of the information and asked to circulate it amongst their members. Participants were asked to fill in short form via a weblink with their age, gender, type of boat, location of boat together with their contact details. These data were collected to enable sampling in the case of there being too many people wanting to participate and to build a profile of the meeting participants. Once received, a member of the research team sent them further details, a consent form for the meetings and the ReMEDIES privacy notice. GDPR protocol was adhered to throughout the process. There was no overlap between the participants in the meetings and the local stakeholders who were interviewed. Notes were taken throughout each meeting. Details of the meeting participants can be found in Section 3.

Survey of boaters

To understand the broader behavioural context, an online survey was developed. The survey covered current boating behaviours, awareness and understanding of the impact of boating behaviours on seagrass, observations of behaviours by others which could impact seagrass, awareness of existing interventions, attitudes towards potential interventions, and socio-demographics. The survey items on attitudes and behaviour were designed following the Theory of Planned Behaviour. The survey questions can be found in Appendix 6.

The survey was created in Survey Monkey and could be completed online only. Participants were invited to complete the survey using a combination of snowball and opportunity sampling. As with the meetings, ReMEDIES partners, interviewees and meeting participants were asked to share the details of the survey through their networks. Organisations (e.g. sailing clubs and marinas) in each of the areas were also sent the link to the survey. The link was also put into the RYA newsletter for November 2020. The survey was targeted at boaters in the Solent and Plymouth and this was communicated in the recruitment materials. The survey was open from 5 November – 11 December 2020. During that time, several reminders to complete were issued via social media from the ReMEDIES communications officer. Details of the survey respondents can be found in Section 3.

¹⁶ The images were used to explore awareness and for providing information (see Appendix 4).

¹⁷ Meetings were carried out virtually given government restrictions on social contact due to the Covid-19 pandemic.

¹⁸ Snowball sampling is where those who have already been interviewed suggest others to take part – in this case, stakeholders who had been interviewed shared the invitation to the meetings with their networks.

¹⁹ Opportunity sampling is where anyone within a specific population is invited to take part. In this case the invitations were sent widely to organisations and groups to invite participants from the boating community.

Notes on methods

The different methods used in this piece of research provide different types of data. The interviews and the survey allow people to respond individually without direct reference to other people, although there will be some internal reference to group norms. The meetings allowed us to hear people discussing the issues, responding to similar and different views and asking questions about the information. Whilst group norms were likely to have formed to some extent in those meetings, our ground rules specified that all views counted and facilitators, as far as possible, ensured everyone was able to express their views and that there were no right/wrong answers. The data from the meetings comes out of the conversations between the participants and the facilitators have influence in so far as they are asking the questions and structuring the time.

The interviews and meetings were held virtually due to the Covid-19 pandemic. Ideally, we would have held the meetings in person in the two locations. There were also times during the research when recreational boating was not allowed. This made the experiences the boaters were discussing less immediate. Two of the meetings were held in September when there were no restrictions and one meeting was held in November in national lockdown.

Analytical methods

Interviews and meetings

Data collected in the interviews and meetings was analysed in Excel. Thematic analysis was used to identify and explore the main themes in Excel. The findings were then clustered around the overarching research questions. The summary of interview findings is in Appendix 3 and the summary of the meeting findings is in Appendix 5. In the write up of the findings all quotes come from the notes taken in the interviews and meetings as transcripts were not made.

Survey

The survey data was downloaded from Survey Monkey. Descriptive statistics were carried out on all the questions via Survey Monkey (see Appendix 7: Summary of survey results for descriptive statistics for each of the questions). In addition, where appropriate, inferential statistics (ANOVAs²⁰; t-tests²¹ regression²²) were used to test for significance between groups (types of boater, boaters

²⁰ ANOVA determines whether there are any statistically significant differences between the means of two or more independent groups. Post hoc pairwise comparisons using the Tukey procedure are conducted to reveal statistically significant differences between all possible combination of group means. Differences between three types of boaters were examined (those who indicated that they boated in yachts only, those who indicated that they boated in motorboats only and those who indicated that they boated in both yachts and motorboats).

²¹ T-tests determine whether there are any statistically significant differences between the means of two independent groups. In this case differences between Plymouth and Solent boaters were tested. The significance is given by the p-value which is the probability of obtaining results at least as extreme as the observed results of a statistical hypothesis test, assuming that the null hypothesis is correct.

²² Regression analyses allow us test what factors predict intentions to carry out certain behaviours to help reduce damage to seagrass.

from different locations). Inferential, as opposed to descriptive, statistics are used to allow examination of the relationship between two (or more) variables within a sample. This allows inferences to be made about how these variables would relate to each other in the wider population. They can tell us if there is a statically significant relationship (i.e. not occurring by chance) between two or more variables. Where the text refers to t-tests, ANOVA or regression analyses and is accompanied by significance levels (p values), these are inferential statistics. These analyses are appropriate only when the data on which they are performed (the dependent variables) is numeric rather than categorical (e.g. series of numbers verses discrete categories). It is possible to perform inferential statistics with a categorical outcome variable, indeed Chi square test could have been performed on some of the data where two categorical variables were compared e.g. boater type (Yacht, motorboat or both) and whether or not the respondent reported trying to avoid seagrass (yes/no). However, 'empty cells' were often present in these cases meaning that the frequencies of some of the combinations of categories was equal to zero (e.g. there were no instances of that particular combination of categories). This makes the data inappropriate for Chi square analysis unless there is some meaningful aggregation of categories. Other analyses could be used but these require more time to implement than we were allowed. Often these analyses were not integral to the research questions and so descriptive statistics are presented in these cases.

The data analysis and reporting of statistics, as in any research project, is guided by the research questions. Therefore, statistics are presented only when relevant to the research questions. The inferential statistics and multivariate statistics were carried out using the statistical package R. The inferential statistics can be found in Section 7.

3. Sample

Literature review

From our search of the literature according to the methodology set out in Section 2, there did not appear to be a lot of available literature on behaviour change of recreational boaters for the protection of seagrass. A total of 32 documents were reviewed, of which 26 were included in the review report (Appendix 1) and a further six documents were excluded²³. Of the final list of literature that was included in the review, 12 documents were peer reviewed papers, eight were grey literature such as policy reports, and six were other grey literature sources such as webpages and information leaflets. The full review is included in Appendix 1.

Key themes of the literature reviewed included:

- Understanding damage to seagrass caused by boating activities, such as anchoring and mooring.
- Assessing different mitigation and management interventions for the protection of seagrass beds and marine environments.
- Understanding links between behaviour change and environmental conservation.
- Understanding the potential for and responses to Advanced Mooring Systems (AMS)²⁴.
- Measuring recreational use of marine environments to inform marine management.

Interviews and meetings' samples

Interviews

Eight people were interviewed, four from Plymouth Sound and Estuaries and four from the Solent Maritime. The interviewees covered a range of roles in relation to recreational boating (see Table 1). Six of the interviewees had managerial positions which brought them into contact with recreational boaters, both sailing and motor yachters. Three were self-described experienced sail yachters.

²³ After a detailed review six documents were deemed not relevant to the research questions.

²⁴ The terms eco-moorings, environmentally friendly moorings, conservation moorings and Advanced Mooring Systems (AMS) describe the same thing and can be used interchangeably. Under the LIFE ReMEDIES project the term Advanced Mooring Systems (AMS) has been chosen to include moorings referred to by these other terms (MacLennan, 2020). Therefore, this report will refer to all as AMS (unless quoting a source that uses a different name).

Table 1 Characteristics of interviewees

| Role | Harbour Master | Marina manager | Moorings manager | Estuary manager | Sailing Association | Conservation volunteer |
|--------|----------------|----------------|------------------|-----------------|---------------------|------------------------|
| Number | 1 | 1 | 2 | 2 | 1 | 1 |

Meetings

A total of 18 people participated in three recreational boater meetings across the two study locations. The sample of meeting participants was a mix of sailors and motorboaters. As shown in Table 2, the sample was biased towards men and those over 45. It was not possible to compare this sample with existing demographic data of the wider recreational boating community in the UK, so it is not possible to conclude whether this bias is representative of the wider community or not. Meeting 1 and 2 focused on one specific location, whereas the third meeting included participants from both locations. These meetings are referred to throughout the report as the 'Plymouth meeting', the 'the Solent meeting', and the 'joint meeting'.

Table 2 Summary of meeting sample key characteristics

| | Meeting 1 | Meeting 2 | Meeting 3 | Total |
|---------------------------------|-------------|------------|-----------------|-------|
| Target audience | Plymouth | The Solent | Joint locations | |
| Meeting date | 25 Sep 2020 | 6 Oct 2020 | 23 Nov 2020 | n/a |
| Total Number of Participants | 5 | 4 | 9 | 18 |
| Male | 4 | 3 | 9 | 16 |
| Female | 1 | 1 | 0 | 2 |
| Age range | 45+ | 45-64 | 55+ | 45+ |
| Number of Sailors ²⁵ | 4 | 2 | 4 | 10 |
| Number of Motorboaters | 1 | 1 | 5 | 7 |
| Number of boat business owners | 0 | 1 | 0 | 1 |

²⁵ This distinction is based on self-recorded data and reflects which type of vessel participants *mainly* use, some participants used more than one boat type.

Survey sample

138 participants completed the survey with another 35 who completed some of the survey²⁶. We have included all the responses. The number of responses to each question is provided so it is clear what the basis for that question is (all statistics are provided in Appendix 7: Summary of survey results). 10 of the participants in the survey indicated that they had participated in one of the boater meetings (Q50).

Overall, the sample was older (71% over 55) (Q48, n=140), male (78%) (Q49, n=139), and experienced (83% boating for over 11 years) (Q10, n=161), with the majority (70%) having more than one boat/personal craft (Q4, n=166). The majority (90%) had boats over 13ft (Q3, n=168). In terms of how often people went boating (Q11, n=154) the majority reported weekly or less with 52% taking one trip per week.

Responding to the types of activities that boaters mainly do when they go boating (Q9, n=158), '*sailing / cruising on the water*' was selected by the majority (84%) of the participants. '*Finding a nice spot to either have lunch*' (49%) or '*meet friends*' (25%) were the next two most popular activities, with '*fishing*' (22%) and '*swimming/snorkelling*' (18%) not far behind.

In terms of where the participants mainly go boating for recreation (Q6, n=167), Plymouth Sound and Estuaries was the most popular location, with over a third of participants mainly boating here. A quarter of participants mainly go boating in the Solent/Isle of Wight, and a considerable minority mainly go boating in '*all of the south coast*' and '*internationally, including the UK South Coast*'. Table 3 shows the distribution for this question. This study is focused on recreational boating activity particularly in Plymouth Sound and Estuaries and the Solent and Isle of Wight, therefore participants who responded that they do not go boating anywhere on the South Coast (2%) were routed out of the survey at this point.

²⁶ This was partly due to the routing of the survey where some questions skipped if other questions had not been answered and partly due to some participants not finishing the survey.

Table 3 Location of boating for recreation

| Q6 Where do you mainly go boating for recreation? | % | Responses |
|---|-----|-----------|
| The Solent/Isle of Wight | 25% | 42 |
| Plymouth Sound and estuaries | 38% | 63 |
| All of the South Coast | 17% | 29 |
| Other areas of the UK | 1% | 2 |
| Internationally including the UK South Coast | 17% | 29 |
| None of the above% | 1% | 2 |

Survey sample profiles for Plymouth and the Solent

The sample profiles for respondents who mainly go boating in Plymouth and the Solent/Isle of Wight are presented in Table 4. The sample from Plymouth included comparatively more older boaters, male boaters and boaters with more experience than the sample who go boating mainly in the Solent/Isle of Wight. However, the sample from the Solent/Isle of Wight included comparatively more boaters with larger boats (over 24 ft) and more boaters with sail yachts. The Plymouth sample was characterised by a greater proportion of smaller vessels, compared to the Solent/Isle of Wight sample.

Table 4 Key differences in the profiles of the samples from each area

| | Plymouth and Estuaries (n = 63) | The Solent/Isle of Wight (n= 42) |
|---|---------------------------------|----------------------------------|
| Proportion of sample over 55 | 80% | 50% |
| Proportion of sample that were male | 86% | 62% |
| Experience - over 11 years | 84% | 71% |
| Boat size - over 24 ft | 35% | 62% |
| Proportion of sample that mainly use a yacht | 38% | 50% |
| Proportion of sample that mainly use a motorboat | 25% | 26% |
| Proportion of sample that mainly use smaller vessels e.g. RIB | 17% | 10% |

All variables were analysed looking at differences between these two samples. Where the data was continuous²⁷ it was possible to carry out t-tests of significance comparing the two samples. This was the case for questions answered on a Likert scale where participants responded to what extent they agreed/disagreed with a statement. Significant differences between the responses of the samples in

²⁷ Continuous data is quantitative data that is measurable in some way.

the two locations were only found for the following six questions (see Section 7 for further details). In the following questions, participants were asked to rate to what extent they agreed or disagreed with each statement:

- Q39 (b) 'Anchoring away from seagrass would be inconvenient',
- Q39 (e) 'Other boaters tend to anchor away from seagrass',
- Q40 (h) 'It will be easy for me to anchor away from seagrass',
- Q43 (a) 'There is often an AMS available for me to use when I go out boating',
- Q43 (c) 'Thinking about where I moor my boat, there are plenty of places for me to moor that are not in seagrass',
- Q46 (f) 'To protect the environment and preserve life'.

The full survey results can also be found in Appendix 7. Any further differences and similarities between the two location samples are reported under each research question.

Sample profiles of boaters categorised by type of boat

In terms of the samples of survey respondents categorised by type of boat, the most common boater type was those boaters who mainly use a yacht and not a motorboat ('yachters')²⁸. The sample who mainly use a motorboat and not a yacht ('motorboaters')²⁹ had a higher proportion of boaters aged under 55 compared to the other two sample groups, although the majority were still over 55. The yachters had the highest proportion of female boaters compared to the other two sample groups. The majority of each sample had at least 11 years of experience, although the 'motorboaters' sample had a higher proportion of boaters with less than 11 years of experience. The sample of motorboaters had the smallest proportion of boaters with larger boats (over 24ft), most of the boaters in this sample had boats between 13-24 ft (56%).

²⁸ Participants who answered 'yacht' to Q2 'What type of vessel do you mainly use when you go boating for recreation?' and did not select 'motorboat' as a response to Q4 'Do you use any other kinds of boats when you go boating for recreation?' / Q5 'If yes, please select all that apply'. Note that these respondents may have another craft (Q5) but it would not be a motorboat.

²⁹ Participants who answered 'motorboat' to Q2 'What type of vessel do you mainly use when you go boating for recreation?' and did not select 'yacht' as a response to Q4 'Do you use any other kinds of boats when you go boating for recreation?' / Q5 'If yes, please select all that apply'. Note that these respondents may have another craft (Q5) but it would not be a yacht.

Table 5 Profile of sample of each boater type

| | Yachters (n =78) | Motorboaters (n=32) | Boaters who use both ³⁰ (n=35) |
|--|------------------|---------------------|---|
| Proportion of the sample over 55 | 72% | 67% | 75% |
| Proportion of the sample who were male | 77% | 83% | 84% |
| Experience - over 11 years | 84% | 79% | 91% |
| Boat size - over 24 ft | 75% | 41% | 71% |
| Proportion of the sample who mainly boat in Plymouth | 57% | 54% | 58% |
| Proportion of the sample who mainly boat in the Solent/Isle of Wight | 43% | 46% | 42% |

All variables were analysed looking at differences between the three sub-samples of boater type. Where the data was continuous it was possible to carry out ANOVAs³¹ of significance between the three samples. This was the case for questions answered on a Likert scale where participants responded to what extent they agreed/disagreed with a statement. Of the questions that were analysed for differences, only the following were found to show significant differences between the sub-samples of boater type based on type of vessel mainly used for recreational boating. In the following questions, participants were asked to rate to what extent they agreed or disagreed with each statement:

- Q18 (b) 'Seagrass improves water quality',
- Q18 (c) 'Seagrass is an important habitat for marine wildlife',
- Q18 (d) 'Seagrass plays an important role in removing carbon from the air',
- Q39 (g) 'When it comes to matters of recreational boating I tend to do what the Royal Yachting Association (RYA)/local harbour authority thinks I should do'.
- Q42 (b) 'It's up to me whether or not I would use an Advanced Mooring System',
- Ocean Connectedness scale ('I feel very close to the marine environment' / 'I have a clear understanding of how my actions affect the ocean' / 'I often feel a sense of oneness with the ocean around me').³².

The full survey results can also be found in Appendix 7. Any further differences and similarities between the three subsamples based on main type of vessel used for recreational boating are reported under the relevant research questions.

³⁰ This included all boaters who put both yacht and motorboat as either their 'main' boat (Q2) or their 'other' craft (Q5).

³¹ ANOVA determines whether there are any statistically significant differences between the means of two or more independent groups. Post hoc pairwise comparisons using Tukey procedure were conducted to reveal statistically significant differences between all possible combination of group means.

³² Ocean connectedness is a new scale (unpublished) based on the wording of a nature connection scale (see Mayer and Frantz, 2004). The survey included three items from the ocean connectedness scale based on analysis of the psychometric properties from unpublished data.

4. Damage to seagrass from anchoring and mooring behaviours of recreational boaters

This section addresses research question 1: *What are the behaviours of recreational boaters in relation to anchoring and mooring that cause seagrass damage generally and specifically at each of the two test sites? What is the frequency and nature of those behaviours? What are recreational boaters' perceptions of these behaviours?*

Summary box

The findings from the primary research indicate mixed levels of awareness and acceptance among the recreational boater participants of damage to seagrass caused by recreational boater anchoring and mooring. Other boating and non-boating causes of damage to seagrass identified by participants in this research include gunning the engine, fishing boats, storm damage. Views were expressed by some of the recreational boaters involved in this research that local seagrass is not in decline and can adapt and recover.

Anchoring behaviours identified by interviewees and meeting participants in this research as having potentially damaging effects included: plough *anchors*; dragging the anchor; not bedding in the anchor properly; putting down more anchor chain than is required; and dropping anchor but not reversing on it.

As evidenced by the survey results anchoring in seagrass is not an uncommon practise among boaters and many do so with prior knowledge that seagrass is in the area. The dominant reason for anchoring in seagrass is safety; seagrass is often found in sheltered locations which offer safe places to anchor for example during storms. (Perceptions of safety and how this might influence decisions about anchoring and mooring behaviours are further discussed in Section 7).

Literature review

Recreational boating behaviours including anchoring and use of traditional swing moorings have been found to cause significant physical damage to seagrass and restrict its recovery (Parry-Wilson and others, 2019; Luff and others, 2019; Sagerman and others, 2020). Long-lasting impacts are caused by direct regular physical disturbance such as sediment erosion, and partial or total destruction of the seagrass cover (see Jackson and others, 2013 cited by Ouisse and others, 2020).

Recreational boating can cause damage to seagrass during all three stages of the anchor cycle: anchor drop, while anchored by the drag of the anchor through the seabed, and anchor retrieval (Parry-Wilson and others, 2019; Amec Foster Wheeler, 2017). For example, anchor chains can cut and uproot seagrass as boats rotate with changing winds and the ebb and flow of tides (Kelly and others, 2019).

Mooring is often seen as a way to mitigate damage from individual anchoring, however the most commonly used traditional swing mooring can also cause damage by scouring the underlying seabed (Griffiths and others, 2017; Amec Foster Wheeler, 2017) leading to the creation of “*mooring scars*” (p.1), circular areas of bare ground surrounding the mooring, which can be seen in satellite imagery (Luff and others, 2019). Damage from traditional mooring methods can also occur when the main anchoring blocks and chains are renewed or raised and lowered for inspection (Amec Foster Wheeler, 2017). While impacts from mooring infrastructure has been widely studied, few studies have been carried out in areas of increased tidal fluctuation, like those seen in the UK (Luff and others, 2019).

Anchors thrown from individual boats are considered to be more damaging to habitats than fixed moorings because they are potentially thrown repeatedly from various locations therefore damaging multiple smaller areas of sensitive habitats (such as seagrass beds) with potentially longer lasting effects (Milazzo and others, 2004, in Amec Foster Wheeler, 2017). Anchor type and weight can also affect amount of damage (Griffiths and others, 2017; Amec Foster Wheeler, 2017).

Fixed moorings aim to minimise anchoring impacts to seagrass by anchoring on a single point and limiting any habitat damage to a fixed area (Amec Foster Wheeler, 2017; Diedrich and others, 2013). Trot moorings or “*fore and aft*” moorings can also minimise the amount of damage each boat causes to the seabed (Amec Foster Wheeler, 2017). Although fixed moorings are often seen as a way to mitigate the harmful effects of anchoring, swinging chain moorings (a type of fixed mooring) have been found to have a significant impact on seagrass (Unsworth and others, 2017). Unsworth and others (2017) conclude that this loss of UK seagrass from boat moorings is small but significant at the local scale; fragmenting existing meadows reduces their resilience to other stressors such as eutrophication (Unsworth and others, 2015; Maxwell and others, 2016 cited by Unsworth and others, 2017) and reduces the extensive ecosystem service value of seagrass.

Other boating-related damage to seagrass can also be attributed to propellers, the construction of marinas, and the shading from jetties or floating docks (Glasby and West, 2018). Similar to anchoring, propellers can cause physical damage to seagrass that is not spatially restricted (Glasby and West, 2018).

Similarities or differences between locations: Plymouth and the Solent

Plymouth

A scoping study of recreational use within the Plymouth Sound and Estuaries European Marine Site (EMS) found that anchoring events related to several different activities (Langmead and others, 2017). For example, sub-aqua diving, sailing yachts, motor yachts and angling from a vessel. There were clear hotspots of anchoring activity at the Plymouth Breakwater and off Fort Bovisand, with other key areas along the coastline to the north and south of Kingsand, Barnpool, off Cremyl and at West Mud, to the north and east of Drake’s Island and off the seafront along the Hoe (Langmead and others, 2017).

Seasonal anchoring activity was concentrated at the same sites within the Plymouth Sound and Estuaries EMS as on the annual map, but the intensity at some sites varied by season (Langmead and others, 2017). For example, the Plymouth Breakwater is used throughout the year, as is the site off Bovisand. In summer, high intensity anchoring at Kingsand/Cawsand Bay was reported which was much less during autumn, spring and winter (Langmead and others, 2017). Alternatively, some

sites, such as in the lower Tamar (West Mud and off Cremyll), at Barnpool and off the Plymouth Waterfront and north of Drake's island, are used more in winter months (Langmead and others, 2017). This is apparently because of the use of these sites as a weather refuge for boat-based anglers (including charter vessels). Asia Shoal, to the southeast of Drake's Island, is a popular anchoring site in all seasons apart from winter, again this is presumed to be driven by anglers (Langmead and others, 2017). Overnight anchoring was reported to take place at Kingsand/Cawsand Bay, Barnpool, in Millbrook Lake, in the Lynher near Sheviock and at St Germans Quay and at Calstock in the upper Tamar (Langmead and others, 2017).

The literature review did not identify any specific documented evidence on damaging behaviours of recreational boaters in relation to mooring for this location, however this was a short, focused review (see Appendix 1 for search limits) and this does not mean that there is no evidence of damage in this area.

The Solent

The literature review did not identify any specific documented evidence on damaging behaviours of recreational boaters in relation to anchoring and mooring for the Solent, however this was a short, focused review (see Appendix 1 for search limits) and does not mean that there is no evidence of damage in this location.

Qualitative results - interviews and meetings:

Boater awareness of recreational boating impacts on seagrass

Interviews

Most of the interviewees considered that recreational boating has an impact on seagrass but believed that boaters generally have a low level of awareness of seagrass itself and the role it plays environmentally and of the impact of anchoring and mooring practices on this habitat, although all recognised that there are boaters with different views. One suggested that anchoring and mooring practices are routine, and most boaters don't give them much thought. Anchoring and mooring were not the only behaviours considered to be damaging to seagrass habitats. One interviewee talked about the cumulative damage caused by many small actions by boaters; as well as dragging the anchor, this interviewee mentioned motor boaters' practice of 'gunning' the engine (accelerating quickly rather than lifting out the engine and paddling to avoid getting stuck in seagrass).

Meetings

There were mixed levels of awareness among the meeting participants of the damage caused to seagrass by recreational boating behaviours. Those that were aware or had witnessed damage to seagrass generally understood this to be linked to anchoring and mooring behaviours. However, some participants questioned how much damage could be caused by recreational boaters compared to other causes. For example, a few participants suggested that fishing boats and trawlers would more likely be responsible for damage to seagrass, or that water quality and other environmental factors are responsible. It was also suggested that seagrass may recover rapidly from damage.

"I have done snorkelling, on clear day have seen the damage it can cause, bare un-vegetated surfaces." (the Solent meeting participant)

“Haven’t personally seen damage.” (the Solent meeting participant)

“See lots of fishing boats in my area – trawl for scallops etc – would question how much damage can be caused by individuals anchoring compared to other things like trawling. Nature has a good way of recovering very rapidly to lots of things. Not sure how much damage can be being caused [by boaters].” (Joint meeting participant)

A few participants from both locations had not witnessed damage to seagrass or were unaware of damage that can be caused by anchoring and mooring behaviours. After being shown pictures of seagrass damage caused by anchoring and mooring, a few of the participants spoke about their own anchoring behaviours and recognised that they might cause damage. Generally, more participants spoke about seagrass damage from anchoring behaviours than by mooring behaviours.

Boater perceptions of damage caused by anchoring

Interviews

Anchoring was mentioned frequently by interviewees as a cause of recreational boating damage to seagrass. Dragging the anchor on leaving is a practice that exacerbates the damage associated with anchoring. Two interviewees in the Solent area considered that poor anchoring practice was common:

“They’re just grabbing with an anchor and ripping out a line.” (the Solent interviewee).

The interviewees considered the large number of recreational boats using the area would mean that this has a big impact. One interviewee suggested that experienced boaters will avoid anchoring in seagrass because anchoring is more difficult and anchor drag is a safety issue:

“I usually put more chain down than more than 3 times the chain you are supposed to, so with tide turn you can imagine the damage it does. I don’t know if there is a really large area of seagrass – don’t know if I should be going somewhere else. When people say please don’t anchor here, I say fine. Don’t really know how widespread the seagrass is or how much damage the anchor does”. (Plymouth meeting participant)

“Most yachtsmen would accept that anchoring in a seagrass area must disturb the bottom; after all many anchors are known as “plough” anchors”. (Plymouth interviewee).

“If you anchor in seagrass – if you know what you’re doing when you’re anchoring – it’s something you’d rather not do because it would make it difficult to anchor. Either the anchor doesn’t catch hold or it catches hold on a root. And then laterally, your anchor drags”. (the Solent interviewee)

Meetings

Several participants were aware of damage to seagrass due to recreational boaters’ anchoring techniques. For example, participants across all the groups spoke about scarring caused by anchors and chains dragging across the seabed. This was explained to be caused by certain anchoring techniques, such as, putting down more chain than is necessary, or not bedding in the anchor

properly so that it moves around/drag across the floor. One participant said that damage is caused by boaters dropping anchor but “*not reversing on the anchor*”, so it drags across the floor. However, there was some dispute among participants about whether this would cause more, or less damage to seagrass.

“I’m very aware that anchors and chains do dramatically affect the seabed – if turning on tide or wind changes, you drag your chain across a big circle. Sure you do a lot of damage”. (Joint meeting participant)

Boater perceptions of damage caused by mooring

Some meeting participants were aware of damage caused by traditional mooring blocks with chains swinging around. A few participants spoke about moorings that had been installed in certain areas to reduce the amount of anchoring, aiming to protect the seagrass (e.g. at Cawsand Bay and near Poole). A few participants perceived mooring blocks to be more damaging than anchoring because the large chains make a bigger, long-term impact to seagrass. One participant in the Solent meeting said that they had seen illegally placed moorings that had caused scarring in seagrass beds.

“Even the mooring blocks are churning around and make a big impact [...] and it’s probably worse than we are shown here”³³. (Joint meeting participant)

Similarities or differences between locations: Plymouth and the Solent

Interviews

Physical and environmental factors affecting boater behaviours were a strong theme discussed by Plymouth interviewees, with differences across specific areas (Cawsand Bay vs Yealm). For example, it is perceived as difficult to anchor away from seagrass at Cawsand Bay as the seagrass covers most of the area near the shore:

“Would have to dig the dinghy out and row ashore, it’s a long haul”. (Plymouth interviewee)

Whereas at the Yealm, one interviewee thought it would not be too difficult to avoid seagrass as:

“seagrass grows in the very shallow points where boats don’t pass as much”.
(Plymouth interviewee)

This was opposed to another interviewee’s opinion, who thought that the Yealm is a more difficult area as it’s much smaller and only a small number (~10) yachts can anchor and:

“if you’re going to anchor, you can’t avoid anchoring in seagrass”. (Plymouth interviewee)

One interviewee from the Yealm suggested that boating practices don’t impact the seagrass in the estuary very much as the seagrass has “*adapted itself*” and grows better in the places that people are less likely to anchor. It was suggested that this is because the areas where anchoring is most popular are areas where seagrass is under threat from winter weather as well (Cellar Bay and West

³³ The pictures shown to participants are included in Appendix 4.

towards Wembury). It was thought that the seagrass in the Yealm area had been there without decreasing for a long time.

These issues were mentioned throughout many of the interviews and are an overarching theme for this location. The seagrass was perceived to be increasing especially in Cawsand Bay, with interviewees bringing up surveys that were done at Cawsand Bay showing an improvement of the seagrass, which was considered not to help the case for changing anchoring and mooring behaviours. One interviewee questioned how long the seagrass has historically been present:

“we don’t know how long seagrass has been in Cawsand Bay anyway or Plymouth Sound. Now, this is the other thing we just don’t know. We know this is its presence, may have even come in the last 25 years, that’s all”. (Plymouth interviewee)

Similarly at the Yealm, it was perceived by one interviewee that the seagrass was generally stable:

“there has been seagrass here for a long time and it hasn’t decreased. The places where people anchor pose most threat are usually the places where the seagrass is at risk from winter weather anyway. Cellar’s bay and Wembury side”. (Plymouth interviewee)

Some other interviewees also noted that factors other than recreational boating may affect seagrass, for example, weather and pollution.

“especially in Cawsand Bay the seabed is subject to huge scarring in times of storms”. (Plymouth interviewee)

Meetings

Some participants were aware of seagrass damage by anchoring and mooring in certain areas, for example Studland Bay, but were unaware that it was an issue in their local area. One participant from the Solent meeting who regularly anchors in Osborne Bay, a popular area, did not think that there was seagrass there. However, another participant in the same group said that Osborne Bay is a “*fantastic seagrass bed*” and that they were aware of a big hole in this seagrass bed and wondered if this represented a hotspot of daytime anchoring activity. Participants in both locations acknowledged that anchoring could cause damage to seagrass, but also questioned whether the amount of damage by recreational boaters was significant compared with other causes and wanted to find out more. For example, doubt was expressed as to whether anchoring was causing any damage in Cellar Bay, a location referred to by a number of Plymouth participants as a preferred spot to anchor.

“My taking on seagrass is largely derived from the yacht club bar where there are a lot of experts which say the seagrass – especially Cellars – some will say the seagrass is gravely endangered and anchoring in Cellars is very anti-social thing to do. Others say seagrass is actually quite healthy there. I’ve been told its actually increasing. Proponents say it’s no problem there is nice healthy seagrass there. I don’t know which part is true. I want to learn more to put some facts into the bar room chatter!” (Plymouth meeting participant)

Quantitative results: online survey

Boater attitudes towards protecting and avoiding seagrass

Most boaters surveyed held positive attitudes towards protecting and avoiding seagrass. Of those who answered Q44 (n=133) 90% agreed or strongly agreed with the statement '*I want to protect seagrass*' and 88% of respondents said they would try to avoid seagrass if they knew where it was located (Q21, n=154). However, a lower proportion reported looking to see if there is seagrass where they plan to anchor (Q24): of those responding to the question (n=147), 54% said yes, 38% said no, and 7% were unsure. For those that looked before anchoring, 30% sourced information on seagrass location from other boaters, 24% of respondents from leaflets, 23% from online searches, and 51% of respondents used '*other*' sources, including, experience and local knowledge, looking / diving / swimming to check the seabed, charts (e.g. by the Green Blue), harbour masters / local harbour authority, buoyed areas, almanac and yachting magazines (Q25, n=79).

Boater anchoring behaviours in seagrass

Anchoring in seagrass was not uncommon among survey respondents. Q26 (n=146) asked about boaters anchoring behaviours. Of those who responded, only 17% reported never having anchored in seagrass, while 42% had anchored in seagrass and a further 41% were unsure. For those that had anchored in seagrass (n=61), the most common reason for doing so was for a safe place to anchor (74%) (Q27). Other reasons include '*I always anchor there*' (20%) and '*I thought it was okay to anchor in seagrass*' (20%), as well as '*other*' reasons (26%). Anchoring in seagrass appears to be a planned decision for most boaters surveyed (Q28): 62% who anchored in seagrass were aware that seagrass was in the area before they anchored, while 31% were not aware, and 7% were unsure. For those that were aware that seagrass was in the area (n=37), 32% of respondents sourced this information from other boaters (e.g. via social media), 11% from leaflets (11%), 14% from online searches, and 59% from '*other*' sources the majority of which were from experience and local knowledge, as well as looking at the bottom, diving and swimming, and charts, pilot books, plotters and press releases (Q29).

Boater experiences of training on anchoring and awareness of the Green Blue campaign

While the majority of boaters (61%) surveyed (n= 160) had received training on anchoring (Q14), for most of these (75%) this did not cover preventing damage to the seabed (Q15). The main source of training on anchoring (Q16) was from RYA recognised centres (68%). Most of the boaters surveyed (n=160) were aware of the Green Blue campaign (Q13): 42% were familiar with it and 24% had heard of it but were not familiar, while a further 31% had not heard about it.

Similarities or differences between locations: Plymouth and the Solent

Similarities and differences in boater behaviours and attitudes were evident between Plymouth and the Solent.

Boater attitudes towards protecting and avoiding seagrass

The majority of boaters in both locations want to protect seagrass (this is down to a combination of factors and discussed in Section 7). A higher proportion of boaters in Plymouth (49%) compared

with the Solent (35%) had looked to see if there is seagrass where they plan to anchor (Q24). Some differences were also evident on where information is sourced (Q25), for Plymouth boaters' leaflets (35%) accounted for a higher proportion, and online sources (8%) a much lower proportion of the information sources used compared with Solent boaters (leaflets 8% and online searches 23%) - it is noted that a larger proportion of the Plymouth sample were over 65 compared with the Solent who may prefer leaflets to online searches, but it could also be that there are more leaflets being used in Plymouth.

Boater anchoring behaviours in seagrass

Several differences are evident in boater anchoring behaviours in seagrass between locations. A higher proportion of Plymouth boaters (46%) had anchored in seagrass (Q26) compared with the Solent boaters (22%). For those boaters anchoring in seagrass, while for both locations the most common reason (Q27) for this was safety (just over 60% of respondents in each location), '*I always anchor there*' was selected by a higher proportion of Plymouth boaters (28%) compared with the Solent boaters (13%). Additionally, while a minority of Plymouth boaters (16%) reported anchoring in seagrass because '*I thought it was okay to anchor in seagrass*', none of the Solent boaters selected this reason. The majority of Plymouth boaters that anchored in seagrass were aware that seagrass was in the area before anchoring (68%) compared with a much smaller proportion of the Solent boaters (38%) (though note the small sub-sample size for the Solent n=8 compared with Plymouth n=25) (Q28).

Boater experiences of training on anchoring and awareness of GreenBlue

The proportion undertaking anchoring training was similar in both locations (Q14). Of those receiving this, RYA recognised training centres account for a much larger majority among the Solent boaters (83%) compared with Plymouth boaters (68%), whereas other training sources accounted for a larger minority among Plymouth boaters (32%) compared with the Solent (9%) (Q15). None of the boaters from Plymouth nor the Solent reported using the Green Blue Campaign as a source of anchoring training, though this may reflect that its current guidance is in the form of a booklet. Awareness of the Green Blue campaign (Q13) differed between locations with the majority of the Solent boaters (51%) familiar with it, compared with a minority of Plymouth boaters (26%).

Discussion

There is evidence in the literature reviewed that anchoring and mooring behaviours of recreational boaters can cause significant damage to seagrass, although few studies have been conducted in the UK and in the test sites specifically.

Some participants in the interviews and meetings conducted as part of this research spoke of damage seen at the test sites understood to be from anchoring and mooring e.g. "*a big hole in the seagrass beds*". However, awareness levels and acceptance of the damage caused to seagrass by recreational boating among recreational boaters involved in this research were mixed. While some participants demonstrated awareness of how poor anchoring and mooring practices can damage the seabed, other participants had low levels of experience and awareness or were unaware.

Some participants questioned the extent to which damage from recreational boaters anchoring and mooring behaviours would be of significance given other practises such as "*gunning the engine*" which may also threaten seagrass. Consistent with the literature review (see Appendix 1),

participants also suggested that other non-recreational boating activities may also be responsible for seagrass damage, such as fishing boats and trawlers, poor weather (e.g. winter storms), and water quality. These are valid concerns and many of these factors are being addressed in other projects, however recreational boater impacts from anchoring and mooring have received less attention, hence the focus of this project. These findings suggest that in seeking to influence behaviours it may be useful to raise awareness among recreational boaters of the importance of their individual behaviours linking this to pro-environmental narratives about how personal, individual actions can collectively make a difference (see Section 7 for further discussion).

Views were also expressed that seagrass decline was not a problem locally. Participants spoke of seagrass levels which were locally stable or increasing and of how seagrass can adapt to pressures and recover quickly from damage. It was also noted that seagrass may in fact be a relatively new habitat locally.

Anchoring in seagrass is not uncommon among the recreational boaters surveyed in this research and many do so with prior knowledge that seagrass is in the area. The dominant reason given for anchoring in seagrass is safety. Safety came across as a key concern for many boaters during discussions. However, seagrass beds are often safer places to anchor because of geography (ie they are often in a sheltered location), not due to the presence of seagrass. During the meetings, it was noted that experienced boaters recognise that anchoring in seagrass itself can be difficult and bring on safety issues because of the nature of the seagrass (e.g. anchors won't hold). In seeking to influence behaviour, this may be a useful point to raise in training and education given the high priority placed on safety among recreational boaters. Albeit that in times when boaters need to anchor safely (e.g. in storms) these difficulties may be overridden by the need for shelter. The perception that seagrass is safer is further discussed in Section 7.

The findings of the research show that most recreational boaters surveyed want to protect seagrass and are willing avoid it if they know where it is. But an apparent gap exists between intentions and behaviour for some boaters, with a much lower percentage looking to see if seagrass is located where they plan to anchor. Participants spoke of physical and environmental factors which can affect the ability of boaters to anchor away from seagrass, such as the extent, proximity to shore and depth of seagrass, as well as size of the anchoring location. For example, there was a perception that in some locations you can't avoid anchoring in seagrass. Discussions also highlighted a view that boaters do not want to be told they cannot anchor in preferred locations such as Cellar Bay. This raises an important issue of how to deal with alternative mooring and anchoring options in seeking to influence boater behaviour which is further discussed in Section 7.

A lack of common understanding on where local seagrass is located, its health and the efficacy of acting to avoid anchoring in seagrass was expressed by some participants involved in this research. For example, participants described being told how seagrass was both "*gravely endangered*" and "*actually quite healthy*"; "*not at risk*" and "*at risk*"; and anchoring in these locations was "*very anti-social*" or "*not a problem*". Some boaters expressed a desire for clarity on these issues including the extent to which recreational boating impacts seagrass and what should be done. This suggests the need for clear localised evidence and guidance and/or that where this exists that there may be a potential mismatch such that information is not reaching the relevant boaters or not convincing them on the impacts and behaviours to adopt.

There was a perception among a few participants in this research that poor anchoring practises are commonplace. Examples of anchoring behaviours in seagrass identified by participants as having

potentially damaging effects included: plough anchors; dragging the anchor; not bedding in the anchor properly; putting down more anchor chain than is required; and dropping anchor but not reversing on the anchor (ie so it drags across the seabed). It is notable that for most of the boaters surveyed that had received anchoring training, this did not cover how to prevent damage to the seabed. This gap in information provision is an area that the ReMEDIES project is seeking to address and is discussed further in Section 7.

Location specific findings

In both Plymouth and the Solent perceptions differed among some participants on the extent of seagrass in specific local areas (ie whether seagrass was present or absent), and a few participants who questioned the amount of damage that could be caused by recreational boating. Positive attitudes and behavioural intentions towards protecting and avoiding seagrass were reported by boaters in both locations, with the vast majority wanting to protect seagrass and being willing to avoid seagrass if they know where it is, though a much smaller proportion have ever looked to see if there is seagrass where they anchor. In both locations a minority have anchored in seagrass, though the proportion was much higher among Plymouth boaters compared with the Solent.

Plymouth

The literature review identified that in Plymouth, anchoring (though not specifically in seagrass) has been associated with sailing yachts, motor yachts, angling from a vessel and sub-aqua diving. The intensity of anchoring at some locations varied by season: at some sites, higher anchoring intensity is observed in summer, while at other sites it is higher in winter linked to use by vessel-based anglers as a weather refuge. The literature review identified Cawsand Bay as a location for high intensity anchoring in summer as well as overnight anchoring (Langmead and others 2017). A strong theme among Plymouth boaters was the perception that physical and environmental factors can influence ability to anchor away from seagrass. Cawsand Bay was also frequently mentioned by participants as an anchoring area, but also that it would be difficult to anchor away from seagrass in this location due to the extensive cover of seagrass close to shore. The seagrass was perceived to be increasing in Cawsand Bay and generally stable in the Yealm: this highlights the importance of nuanced messaging locally which takes into account any site-specific differences in seagrass. The Yealm was also referred to by participants as an area for anchoring, but that it is both easy and difficult to avoid anchoring in seagrass, where seagrass was described as being only in shallower parts. Cellar Bay was also frequently mentioned in relation to anchoring spots, though participants were not convinced that anchoring was damaging the seagrass in this area. The majority of Plymouth recreational boaters agreed or strongly agreed with statement '*I want to protect seagrass*' (89%) and would try to avoid seagrass if they knew where it was located (85%); though a much smaller proportion have ever looked to see if there is seagrass where they anchor (49%). 46% of boaters in the Plymouth sample have anchored in seagrass.

The Solent

The short literature review did not identify any specific evidence on damaging behaviours of recreational boaters in relation to anchoring and mooring for this location. Osborne Bay was mentioned by participants as an anchoring site. Different views were expressed on the extent of seagrass in certain locations e.g. Osborne Bay which was considered by one participant to have no seagrass, while another described it as having a "*fantastic seagrass bed*". It was also described by as having a big hole in the seagrass bed by one participant who wondered if this represents a hotspot of daytime anchoring activity. The majority of the Solent recreational boaters responding to the

survey agreed or strongly agreed with the statement (Q44) '*I want to protect seagrass*' (91%) and (Q21) would try to avoid seagrass if they knew where it was located (95%); though (Q24) a much smaller proportion have ever looked to see if there is seagrass where they anchor (35%). Only 22% of the Solent boaters have anchored in seagrass (Q26).

5. Differences between boaters' behaviours: perceived and actual

This section aims to answer research question 2: *To what extent are these behaviours related to types of recreational boaters (in terms of attitudes, values and a range of other factors) and types of boat generally and specifically at each of the two test sites? To what extent do recreational boaters themselves perceive these behaviours to be related to types of boaters / types of boat?*

Summary box

Boaters perceive there to be differences between yacht boaters and motorboaters in terms of anchoring and mooring behaviours that impact on seagrass. However, the distinction between the two groups cannot be clearly defined, as the survey results show that many yacht boaters also use motorboats and vice versa.

Factors that boaters perceive to influence the anchoring and mooring behaviours of different boater types included experience level, belonging to a club/association, and environmental awareness.

Findings from the boater meeting only suggest that anchoring/mooring behaviours depend on the type of boat trip/activity. For example, whether planning to stop at all or not, and how long they plan to stop for. There were mixed perceptions about whether 'day tripping' or overnight stops would be more responsible for damage to seagrass.

There was some limited evidence from the literature review that size of boat also impacts level of damage to seagrass. However, there was some variation in the perceptions of boaters participating in boater meetings as to whether smaller or larger boats are more responsible for damage to seagrass by anchoring and mooring.

Literature review

Understanding the extent to which the behaviours that cause damage to seagrass relate to different types of recreational boater or boat type offers the potential to enable interventions to be better designed and targeted, for example through tailored messaging and/or dissemination channels to reach particular sub-groups. As Barry and others (2020) report "*not all boaters are the same*" (p.2) and taking a social marketing type approach can enable a focus on sub-groups where research shows certain characteristics may present particular opportunities or constraints to adopting a new behaviour. However, the literature review did not identify any studies that had boater differentiation (or segmentation) as a central focus. There was some limited evidence from four papers to suggest that some attitudes and behaviours of the recreational boating community in relation to seagrass can be related to different types of boater (for example, experience levels, frequency of boating), as well as boat types. The limited evidence draws on studies in the UK, France and US and includes those looking specifically at anchoring and mooring in seagrass, as well as studies examining behaviours related to propeller scarring in seagrass. It is noted that contexts may vary between studies which could affect the transferability of the findings.

Types of boater

In a UK study of recreational boaters in Torbay, it was found that those anchoring around the Marine Conservation Zone were more likely to be male powerboat boaters from the local or regional area without membership to any local or national boating groups, but whom could be reached through local harbours, mooring providers or through local cafes, retailers etc (Parry-Wilson and others, 2019).

A US study to evaluate the effectiveness of different interventions to reduce seagrass propeller scarring by recreational boaters found that the recreational boating audience could be segmented by experience level to better target educational messages in future seagrass protection efforts (Barry and others, 2020). The study found that recreational boaters with more experience rated seagrass scarring as more of an issue than those with less experience (Barry and others, 2020). The study also found that more frequent boaters were more likely to have scarred seagrass in the last year regardless of experience level. However, no evidence was found to suggest that activity type (e.g. fishing, scalloping, etc) was a significant segmentation factor, although it has been reported in other studies that primary activity can be influential (Lloret and others, 2008 in Barry and others 2020). However, Barry and others (2020) found that almost all boaters surveyed, regardless of experience levels of other factors, rated seagrass as important or extremely important.

Types of boat

According to the literature review, the behaviours of recreational boaters have been found to differ according to type of boat (e.g. sailboat, powerboat, deck/pontoon boat) as well as boat length.

For example, in a study to assess behavioural response to an AMS trial in Torbay, UK, Parry-Wilson and others (2019) found that a higher percentage of sailboats compared to powerboats used the trial AMS when given the choice to do so over anchoring in the seagrass. This was suggested to be in part due to the type of boater, where sailors could be expected to have a greater awareness of AMS through exposure to training and information from the RYA, but also security reasons related to the deeper water where the AMS was situated (50m from shoreline) being better suited to accommodate the keels of sailboats given they were on average longer than most of the powerboats recorded at the sites (Parry-Wilson and others 2019). In this study, there was no traditional mooring present at the site, so boaters did not have the opportunity to choose between a traditional mooring and the AMS, only between using the AMS or anchoring.

In a US study to evaluate the effectiveness of different interventions on recreational boaters' behaviours, both larger boats (>21 ft) and deck/pontoon boats were more likely to slow down at greater distances away from navigational seagrass warning buoys (Barry and others 2020). Additionally, both before and after buoy placement, deck/pontoon boats were more likely to approach at slower overall speeds, and boaters who slowed down at greater distances were more likely to trim up their motors (which avoids propeller damage to the seagrass or stirring up the seabed) (Barry and others 2020).

Similarities or differences between Plymouth and the Solent

There was nothing in the reviewed literature that looked at how anchoring and mooring behaviours were related to different types of boaters in these locations.

Qualitative results - interviews and meetings

This section draws on some information from the interviews but primarily draws on information from the boater meetings as the interview questions did not explicitly explore differences between types of boaters. Some themes did emerge from the boater meetings about the extent to which damage to seagrass may relate to the behaviours of different types of recreational boaters. General themes included types of boater (e.g. yachters vs motorboaters), experience level, type of trip/outing, and size of boat.

Type of boater: motorboaters vs yacht boaters

Although a few participants commented that most recreational boaters are environmentally conscious, there was a consensus among meeting participants that some types of boaters are more/less likely to be responsible for certain damaging behaviours. For example, some meeting participants felt that recreational boaters who own sailboats/yachts are more environmentally aware than motorboat/powerboat owners and are therefore less likely to damage seagrass. This was generally met with agreement from other meeting participants in all three groups.

“Anyone can be a boater. Some might prefer speed boats that rip up weeds etc, others more careful about the environment”. (the Solent meeting participant)

“Certain people are more keen to make sure the environment is as good as it can be. Other people like to ride around on Rottweilers on water and make a lot of noise. We are totally different people and have different perspectives on the environment”. (Plymouth meeting participant)

Experience level

The perception that motorboaters are more damaging to the environment was related to the perception that motorboaters are less experienced boaters and/or less engaged with the boating community, that is, do not belong to boat clubs. This might therefore affect their knowledge and practices. From the meeting discussions it was clear that all meeting participants were themselves experienced boaters so this might have swayed this viewpoint of being more critical to ‘less experienced’ or newer boaters. One interviewee suggested that experienced boaters will avoid anchoring in seagrass because anchoring is more difficult, and anchor drag is a safety issue. Perceptions of safety and how this might influence decisions about anchoring and mooring behaviours are discussed in Section 7. Another interviewee also suggested that motorboaters might be less likely than yacht boaters to belong to an association.

“I suspect majority do not think about seagrass, and perhaps sailors are more aware, but there is a new breed e.g. plastic fantastic, often buy a boat with little experience and are not really interested in that sort of thing so I think education is very important”. (Joint meeting participant)

“If you anchor in seagrass - if you know what you're doing when you're anchoring – it's something you'd rather not do because it would make it difficult to anchor. Either the anchor doesn't catch hold or it catches hold on a root. And then laterally, your anchor drags. So from a yachter's point of view, I don't think they understand the importance the seagrass has to the environment. They're more looking at it from a recreational [viewpoint] probably”. (the Solent interviewee)

Although mentioned in each of the meetings, the discussion of whether motorboaters are more damaging was more extensive in the joint location meeting, where most of the participants owned motorboats themselves. Although, most of them were also sailors and generally seemed to consider themselves sailors first and foremost.

“Most of us have been sailing people all our lives and have degenerated into motorboats. We do belong to clubs because we’ve always belonged to clubs. Not the case for all motor boaters”. (Joint meeting participant)

Some participants felt that motorboaters may be less responsible for damage to seagrass than yacht boaters. For example, participants felt that most anchoring is done by yachts/sail boats and that it is also mostly yachts/sail boats that visit the ‘pristine’ areas that are more likely to be at risk. Motorboaters are perceived to mostly either keep their boats in a marina or on land, and mostly use their boats to travel between onshore locations (ie don’t stop off and anchor on the way).

“I suspect most of us here are environmentally aware, responsible boaters and also that most of us anchor in environmentally delightful/delicate places – and the other lot we are talking about go back to the nearest marinas and slipways. ie maybe doing less damage than the thoughtful people [as don’t go to the delicate environments]”. (Plymouth meeting participant)

Types of boat trip

Some of the meeting participants highlighted that only some types of boat trip would involve anchoring at all. For example, participants who used their boats for racing or travelling between different locations/marinas said that they would never/rarely drop anchor. Some meeting participants felt that ‘day boating’ and boaters that visit places and stop for a short time were more responsible for damage caused to seagrass by anchoring. For example, one participant said that if they were stopping for a short time they might go in closer to the shore because they would be less concerned about factors such as changing tides. Therefore, this might mean they are more likely to be anchoring in seagrass beds because seagrass is found in shallower water.

“I don’t do much day boating – tend to go to places for a few days – in Solent quite a few places to go. I think unless individual who anchors rather than go to marinas e.g. to keep costs down – I don’t think the average person thinks about anchoring before they leave, not a planned process. I tend to use my boat to go to and from marinas [...] People who anchor tend to be day boaters – maybe smaller boats, ribs etc that want to spend time in and off the boat. Anchoring in motorboats is aimed at smaller day boats I think”. (Joint meeting participant)

Some participants felt that boats that stop for longer / overnight could be more damaging to seagrass because boaters’ concerns about safety of the vessel might mean carrying out behaviours that are more damaging to seagrass, for example letting down more anchor chain than is needed. Although a few participants felt that concerns about safety would always trump concerns about seagrass when deciding to anchor overnight, one participant said that if they knew they would be causing damage to seagrass in a particular location then that would influence their decision about stopping overnight and they would go elsewhere e.g. to a marina. See Section 7 for more on behavioural barriers and facilitators relating to vessel safety.

Size of boat

A few participants spoke about how the amount of damage to seagrass might depend on the size of the boat. For example, one Plymouth participant felt that it is mostly smaller boats that are looking to anchor within seagrass areas and may be less likely to observe buoys and no-anchor zones. However, another Plymouth participant felt that smaller boats would cause less damage to seagrass because they have smaller anchors and smaller chains.

“Smaller boats that have smaller anchors and smaller chains would guess do less damage”. (Plymouth meeting participant)

“Smaller boats looking to go inside seagrass areas, swimming areas, see smaller boats dropping anchors there, at this stage would say less likely to observe buoys and no-anchor zones etc. But possibly also less damage”. (Plymouth meeting participant)

Similarities or differences between Plymouth and the Solent

There were no noticeable differences between the groups in how boaters perceived behaviours to be related to different types of boaters.

Quantitative results: online survey

Comparing types of boater: yacht boaters vs motorboaters/powerboaters

From the response data from Q2 ‘What type of vessel do you mainly use when you go boating for recreation?’ and Q4 ‘Do you use any other kinds of boats when you go boating for recreation?’ and Q5 ‘If yes, please tick all that apply’, it was possible to segment the results by boater type as categories by three types: motorboaters (mainly use a motorboat³⁴, n=32), yachters (mainly use a yacht, n=78), and boaters who use both a yacht and a motorboat (n=35)³⁵. This allowed us to explore any differences between the answers from the three types of boaters.

Environmental awareness/awareness of seagrass

There was no difference between the boater types in their intention to avoid seagrass: the majority of respondents from each category said that they would try to avoid seagrass if they knew where it was located. 85% of yachters responded ‘yes’ to Q21 ‘Would you try to avoid seagrass if you knew where it was located?’, compared to 89% of motorboaters/powerboaters and 94% of boaters who use both a yacht and motorboat.

Of the three types of boaters, motorboaters (33%) were less likely to say they had ever anchored in seagrass than yachters (46%), and those who use both types of boats (44%) (Q26). Boaters who

³⁴ Note that these respondents may have another craft (Q5) but it would not be a yacht, likewise the ‘yachters’ group may have another craft but it would not be a motorboat.

³⁵ This included all boaters who put both yacht and motorboat as either their ‘main’ boat (Q2) or their ‘other’ craft (Q5)

use motorboats were more likely to be unsure if they had previously anchored in seagrass; 44% of both motorboaters and boaters who use both types of boat, and 38% of yachters said they were unsure if they had previously anchored in seagrass (Q26). Out of those who had ever anchored in seagrass, fewer motorboaters (55%) said that they were aware that seagrass was in the area before they anchored than the other two groups (60% of yachters and 66% of boaters who use both) (Q28).

Yachters and boaters who use both boat types were significantly more likely than motorboaters to agree that '*seagrass improves water quality*', '*seagrass is an important habitat for marine wildlife*', and '*seagrass plays an important role in removing carbon from the air*' (Q18).

Experience level

The majority (>80%) of survey respondents have been boating for recreation for 11 plus years. Boaters who used both a motorboat and a yacht were most likely to fall into this category (91%) compared to 78% of motorboaters and 84% of yachters, although all boater types were most likely to have 11 plus years boating experience (Q10).

Out of the survey respondents, motorboaters were least likely to have undergone any training on how to anchor (50%). This compares to 62% of yachters and 74% of boaters who use both types of boat who answered 'yes' to Q14 '*Have you ever undertaken any training on how to anchor?*'. Out of those who had received training on how to anchor, there was no difference between the three types of boaters for whether that training covered preventing damage to the seabed; only 24% of yachters, 29% of motorboaters, and 28% of boaters who use both said it had covered preventing damage to the seabed.

Organisation membership

34% of motorboaters said that they did not belong to any boating organisation, whereas nearly all yachters and boaters who use both types of vessel belonged to at least one boating organisation. Only 5% of yachters and 2% of boaters who use both types of vessel responded that they did not belong to any organisation (Q12).

Comparing types of boater: size of boat

From the data it was possible to segment the results by responses to Q3 '*What size is the boat you mainly use?*'. This divided boaters into three boat size categories: small (<12 ft, n=6), medium (13-24 ft, n=49), and large (>24ft, n=90). Boaters that mainly use a large boat were slightly more likely to have ever anchored in seagrass (45%) than those who mainly use smaller boats (35% of boaters who use a medium sized boat and 33% of boaters who use small boats). Boaters who use a small or medium sized boat were more likely to be unsure whether they had previously anchored in seagrass (50%, 49% respectively) than boaters who use large boats (37%). Out of those who had ever previously anchored in seagrass, boaters who mainly use a medium boat were more likely (70%) to say they were aware of seagrass before they anchored compared to small (50%) or large (58%) boat users.

Discussion

There were limited findings from the literature review to answer this research question; none of the reviewed studies focused specifically on differentiating between types of recreational boater.

However, there was some limited evidence to suggest that the behaviours of recreational boaters in relation to damage to seagrass can be related to different types of boater, for example, in terms of their experience levels, frequency of boating and the type of boat (for example, sailboats or powerboats, and boat length). This is somewhat reflected in the findings from the qualitative and quantitative research. Below the main themes that emerged across the research streams are discussed.

Type of boater

Despite the limited literature, one UK study found that those anchoring around the Marine Conservation Zone in Torbay were predominately powerboat boaters from the local or regional area without membership of any local or national boating groups (Parry-Wilson and others, 2019).

The recreational boaters that participated in the boater meetings generally perceived motorboaters to be less concerned about protecting the environment/seagrass than yacht boaters. However, in contrast to the Parry-Wilson and others finding, many meeting participants felt that motorboaters would be less likely to anchor in seagrass than yacht boaters. Out of survey respondents, a higher percentage of yacht boaters and boaters who use both boat types (46% and 44% respectively) said they had previously anchored in seagrass compared to 33% of motorboaters, which supports this finding from the boater meetings. Boater meeting participants felt that motorboaters are more likely to have a desired location in mind when they set off and that they are guaranteed to reach, therefore mainly use their boat to get between locations, rather than needing to stop off (and anchor) on the way. Out of the survey respondents who had ever anchored in seagrass, motorboaters were also less likely to be aware that there was any seagrass in the area before they anchored. This somewhat contradicts the perception of the meeting participants that yachters are more concerned with protecting seagrass if they are more likely to anchor in an area where they are aware there is seagrass.

Some meeting participants who felt that motorboaters are more damaging to seagrass than yacht boaters ascribed this to motorboaters being less experienced boaters and having less awareness of the environment and of alternative behaviours to protect seagrass (see also Section 6, Section 7). One study from the literature review also rationalised the higher percentage of sailboats than motorboats to use a trial AMS to be partly due to sailors having greater awareness through exposure to, for example, RYA education courses (Parry-Wilson and others, 2019). This is reflected in the survey results; boaters who were exclusively motorboaters were less likely to have received educational training than yacht boaters or those who use both vessel types. However, it should be noted that only a very small percentage of survey respondents from each group said that they had received training that covered preventing damage to the seabed.

Several boater meeting participants, as well as one of the interviewees, felt that motorboaters would be less likely than yacht boaters to belong to an association/club and that this could affect their knowledge and practices. This is supported by the survey results as 34% of motorboaters responded that they did not belong to any boating organisation, compared to only 5% and 2% of yachters and boaters who use both a yacht/motorboat respectively. Parry-Wilson and others found that the powerboat boaters in their study that were predominately anchoring around the Marine Conservation Zone in Torbay were not members of any local or national boating groups.

Despite the discussed perceived differences between the attitudes and behaviours of motorboaters and yacht boaters in the boaters' meetings and the desk review, the results of the survey show

clearly that the distinction is not defined between these two groups; there was a proportion of the survey respondents that use both types of vessel for recreation (n=35). In fact, there were more respondents that used both types of vessel than those who only used a motorboat (n=32). Similarly, most of the meeting participants that used motorboats also used or previously used sail boats/yachts. In the joint location meeting, many of the participants now owned motorboats but considered themselves sailors first and foremost. It is important to note, however, that the sample sizes for both the boater meetings and the survey are small, particularly for the sub-sample boater types, so it is not possible to draw any concrete conclusions about the differences between these groups. Furthermore, the great majority of participants in the meetings and the survey were experienced boaters and this will influence their perceptions of theirs and other boaters' anchoring/mooring behaviours. For example, the way that many meeting participants were critical of other boaters that they perceived to be 'less experienced'.

Type of boat trip/activity

Some boaters in the boater meetings felt that decisions about anchoring and mooring behaviours depend on the type of boat trip being taken, particularly whether planning to stop or not, and how long they plan to stop for. This translates to some types of boat trip potentially being more damaging to seagrass than others. There were joint perceptions about whether 'day tripping' or overnight stops would be more damaging to seagrass. There was nothing in the literature review relating to anchoring/mooring damage caused to seagrass by different types of boat trips/activities. However, Barry and others (2020) found no evidence that activity type was a significant segmentation factor, although in this case this was referring to activities such as fishing, scalloping, etc. and damage caused by propeller scarring rather than by anchoring and mooring.

Size/length of boat

From this research, it is not possible to conclude whether the size of boat has an influence on damage to seagrass caused by anchoring and mooring behaviours. Parry-Wilson and others (2019) suggested that the reason for more sailboats than motorboats to use a trial AMS was in part due to most sailboats having a longer keel that requires deeper water. Larger boats (>21ft) were also found to be more likely to slow down and trim up their motors at greater distances away from navigational seagrass warning buoys (Barry and others, 2020). However, there were joint feelings among meeting participants over whether smaller boats or larger boats may be more responsible for damage to seagrass caused by anchoring/mooring. Although there was some suggestion from the survey results that larger boats may be more likely to anchor in seagrass, it is not possible to draw any conclusions from the survey data because the 'boat size' sub-samples are too small to be representative of the recreational boating community.

6. Approaches to changing the anchoring and mooring behaviours of recreational boaters

This section addresses research questions 3.1 and 3.2: *What approaches to changing the anchoring and mooring behaviours of recreational boaters have been effective (or not), generally and specifically at each of the two test sites? What approaches do recreational boaters perceive to be potentially effective generally and at each of the two test sites? (RQ3.1) and What approaches to changing the anchoring and mooring behaviours of recreational boaters are recommended but have not yet been tried? (RQ3.2)*

Summary box

There is a lack of evaluation of approaches to changing the anchoring and mooring behaviours of recreational boaters, of both the effectiveness of technical equipment (e.g. AMS) and behaviour change strategies which are inextricably linked.

Across the boater meetings and the evidence review both positive and questioning views were raised towards AMS. More information and proof of their effectiveness was asked for and questions were raised as to how effective they could be in crowded areas, and specifically in the UK tidal range.

With respect to interventions intended to encourage anchoring away (restricted anchoring and VNAZ) there were mixed opinions across the evidence review and the boater meetings as to their effectiveness to reduce pressures on seagrass from recreational boaters.

From the boater meetings, alternative anchoring techniques e.g., using a trip line provoked concern as to whether it would be effective in reducing damage to seagrass and whether it was an effective way to retrieve an anchor.

The evidence showed that navigational aids (e.g. buoys) could be effective, and that educational outreach/information could raise awareness but was best used in conjunction with other approaches to be effective. Overall, approaches that combined interventions were considered the most effective in changing anchoring and mooring behaviours.

This section focuses on the evidence for effective approaches to changing boater behaviours and will be discussed through the lens of the different interventions. The interventions vary as to what types of changes the boaters are being asked to make. For example, Advanced Mooring Systems require that boaters trust the moorings as much as traditional ones, whereas the alternative anchoring techniques require that boaters physically change how they anchor. Likewise, interventions that encourage anchoring away (restricted anchoring and VNAZ) require boaters to think about where they will anchor. Part of the extent to which these approaches are effective lies in how effective the methods are and perceived to be at protecting seagrass from damage from boaters. Lack of consensus around the effectiveness of these approaches for protecting seagrass is likely to lead to less compliance with respect to behaviour change.

This section examines evidence on the effectiveness of the methods themselves to protect seagrass, perceptions of that effectiveness, as well as the effectiveness of approaches to changing the behaviours of recreational boaters and perceptions of the effectiveness of such approaches. The evidence in this section is largely drawn from the evidence review, the interviews and the boater meetings as the survey focussed on asking participants what they would do in relation to possible interventions why, rather than their perceptions of the effectiveness of different interventions.

Advanced Mooring Systems (AMS)

Within the UK there have been limited trials of AMS and there is some uncertainty in the UK around the number of AMS available to recreational boaters. AMS have been trialled in several locations in UK waters, with the RYA website (2020) stating that: '*Trials of EFMs³⁶ for use as vessel moorings have taken place in areas including Lundy, Mylor Yacht Harbour, Calstock (River Tamar), Cawsand Bay, Salcombe, Torbay (Fishcombe Cove, Brixham), and the Isle of Man. EFMs have been used as marker buoys at Studland and the Helford River*'. Whatever the precise number of AMS currently available for use in the UK, it is not large which means that many boaters will not have experienced them. In the survey many more people had heard of them (46%) than have used them (5%)³⁷.

Figure 2 shows a diagram of a specific type of AMS (Stirling Eco-mooring) taken from Parry-Wilson and others (2019). Generally, of the few evaluation studies that exist, AMS have been found to be broadly effective in reducing damage to seagrass. In the studies where effectiveness was shown to be been compromised, material factors such as poor maintenance and poor design (of the specific AMS in use) were factors, with some owners changing back to chain moorings (MacLennan, 2020) were factors. However, Parry-Wilson and others (2019) report that there is uncertainty as to whether AMS could be effective in the UK. Trials of Seaflex mooring, for example, have had mixed results at different locations in the UK, emphasising the need for condition-specific AMS specifically designed for use in areas with a high tidal range like the UK (Luff and others, 2019). The question of the effectiveness of AMS given the tidal range in the UK was also discussed in the boater meetings, with some concerns among that the AMS would still scrape the seabed at low tide therefore be ineffective at protecting seagrass:

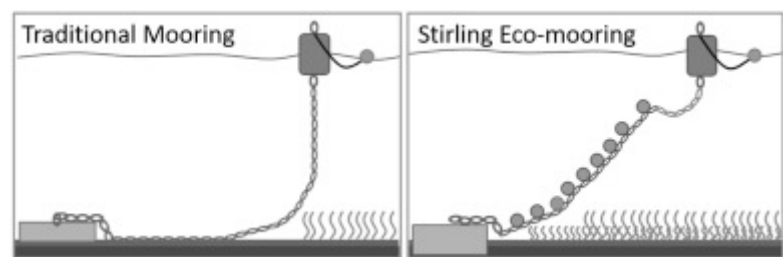


Figure 2 Diagram showing a traditional swing mooring (left) and the National Marine Aquarium's Stirling Eco-mooring (right). The Eco-mooring has buoys along the riser chain keeping it off the seabed and double the tonnage of a standard ground weight. Image adapted from one provided by the National Marine Aquarium. Source: Parry-Wilson and others, 2019. Crown Copyright © 2019 Published by Elsevier Ltd. All rights reserved. Reproduced with permission.

³⁶ RYA uses the abbreviation EFM which refers to 'environmentally friendly moorings'

³⁷ The questions were 'Have you heard of AMS?' (y/n/unsure) and 'Have you used AMS?' (y/n/unsure)

“Various issues with advanced mooring systems – tidal range – need small tidal range to make them effective”. (Joint meeting participant)

“have seen the versions before. I’m looking at the floating one and guessing at low tide that that would scrape the floor as well”. (Joint meeting participant)

The effectiveness of AMS was also questioned by one of the stakeholder interviewees, who perceived them to be only suitable in deep waters. He believed that there is a greater need for moorings that work in the shallower waters as this is where most of the seagrass damage occurs:

“Actually what we really need are more moorings that will work in shallow waters and within the foreshore itself”. (Plymouth interviewee)

Parry-Wilson and others (2019) showed a reduction in anchoring events and a reduction in pressure on the seagrass of 20% after the deployment of AMS in Torbay, UK showing their effectiveness. They were deployed in an area where no moorings previously existed.

A further issue related to effectiveness raised in the boater meetings was the number that might be needed in busy locations:

“I know there is a big debate about AMS – e.g. 80-100 boats over the area, if you want to stop that with AMS how many are you going to put in?” (Plymouth meeting participant)

This echoed a comment from the stakeholder interviews who thought that AMS wouldn’t be helpful for casual boaters, especially in popular areas.

“The boat going into just casually anchoring for the for lunchtime, you would need dozens and dozens of them spread around the Cawsand area for example”. (Plymouth interviewee)

The use of moorings was also considered to be appealing to some boaters as expressed in one of the boater meetings:

“Other areas where combination of popularity and a seagrass bed – could we use some of these other solutions e.g. the AMS. I think most people I’ve talked to, there are anchoring nerds out there that love anchoring, but most people would prefer to pick up a mooring for a couple of hours”. (the Solent meeting participant)

A few meeting participants expressed knowledge of how different forms of AMS work both agreeing that they have the important feature for reducing pressures on seagrass, that of lifting the chain from the seabed.

“have seen footage of them in action – followed development of them for some time – have slightly different characteristics – different capacities to deal with tidal range and things like that. Another type – uses buoyant rope, high-tech rope – similar idea – any traditional mooring relies of same idea – big weight on seabed. Lifting anything that is moving to prevent it abrading the seabed. Static lump is then only thing on seabed”. (the Solent meeting participant)

“yes, just as efficient. If anything helical screw has advantages over anchor block. AMS have got bogged down with helical screw but it’s the elastic rode that actually prevents scouring”. (Joint meeting participant)

A few participants did not feel able to comment on the effectiveness of AMS because they were unfamiliar with the technology. There did not appear to be any strong differences in perceptions of the effectiveness of AMS in reducing pressures on seagrass between the two locations. Overall, across the boater meetings both positive and questioning views were raised towards AMS, with some of the questions over effectiveness mirroring questions raised in the evidence review. Drawing on other areas of communication that involve science that is quite new and relatively untested, good practice (for example: Sciencewise³⁸) suggests that sharing and discussing any potential uncertainties or inconsistencies with key stakeholders, in this case boaters, is the best way forward. Q34 of the survey asked if people would use an AMS over a traditional mooring if it were available (n = 141) with the majority saying yes (53%) and 14% saying no with a substantial minority who were unsure (33%). The comments on this question reflected the range of views on the effectiveness of AMS: 13 comments reflected the view that AMS are good for seagrass; seven were not convinced that the benefits were clearly shown or that there were there more important causes of negative impacts on seagrass, and six wanted more information.

“If they cause less damage to the seabed, that has to be a good choice”. (free text comment from Q34)

“might do less harm than traditional moorings but I remain unconvinced about some alleged damage. I used to own 120 mooring in Poole Harbour and have Scuba dived on them many times in the past and watched their action on the areas around them. Some caused no problem, a very few caused minor problems”. (free text comment from Q34)

“I would require more information”. (free text comment from Q34)

Anchoring away from seagrass: restricted anchoring and voluntary no anchor zones (VNAZ)

As with AMS there are mixed opinions as to whether anchoring away would be effective ways to reduce pressures on seagrass from recreational boaters. La Manna and others (2015) evaluate the effectiveness of traditional mooring systems and anchoring park regulations at preserving seagrass and mitigating the mechanical damage caused by boat anchoring. They found that mooring fields (where anchoring is only permitted via buoys which use traditional mooring systems) and anchoring restrictions did not appear to be efficient systems for the protection of seagrass, in fact anchor scars increased after the tourist season (La Manna and others, 2015). This inefficiency is suggested to be due to strong wave action or misuse of moorings that cause the dump weights to become dislodged,

³⁸ Sciencewise is an internationally recognised public engagement programme which enables policy makers to develop socially informed policy with a particular emphasis on science and technology. This is done by supporting government bodies to commission deliberative public dialogue. Public dialogue provides in-depth insight into the views, concerns and aspirations of a broadly representative sample of the population.

affecting the surrounding areas of the meadow (La Manna and others, 2015). It's worth noting that the paper does not explain what it means by "*misuse of moorings*" (p. 164).

Parry-Wilson and others (2019) found that on-site questionnaire respondents gave mixed opinions about the VNAZ in Torbay, Devon. Over half of respondents provided uncertain or negative comments towards them. The author suggests this could be due to boaters' preference to continue visiting particular sites around Torbay without restrictions suggesting that there could be a lack of compliance which would reduce the effectiveness (Parry-Wilson and others, 2019). It also reflects findings of research conducted in Studland Bay, Dorset, where VNAZ had previously been implemented. Half of the respondents were unwilling to relocate within Studland bay to avoid anchoring in seagrass (see Lloyd and Marsland, 2013 cited by Parry-Wilson and others, 2019). Interestingly, even so, research looking at boat numbers in Studland Bay after the implementing of the VNAZ did show a decrease in boats anchoring in the VNAZ. The authors say that: "*These results are believed to be a reflection of an increased acceptance and awareness of the VNAZ project among boat users but also as the VNAZ remained intact for most of 2011 making it easier to identify the zone (N.B. the VNAZ marker buoys moved or disappeared on a number of occasions in 2010 but only once (mooring rope believed to have been cut) in 2011)*". (p. 35)

These findings suggest that VNAZ could be effective and complied with, however, there is also a sense of resistance to any restrictions within the ocean from boaters.

Similar findings emerged from the boater meetings. There were some positive perceptions of the potential effectiveness of VNAZ which was tempered by a keen interest among many participants not to have enforced restrictions on anchoring. Generally, participants felt that the effectiveness of VNAZ would depend on factors specific to the location in which it was rolled out, for example it would depend on amount of space available to anchor in, the popularity of site and the level of public awareness/support.

"I think it depends on the location – so I think somewhere where there is more space and can accommodate more boats perhaps people will pay more attention to it. But on a really hot summers day in Cellars it will be ignored". (Plymouth meeting participant)

The view that it wouldn't work in some places (e.g. Cellar Bay) was countered by the view that it could work especially where it was clear what was being protected and its importance:

"The Studland bay one makes total sense to me – believe there is a colony of seahorses there and wouldn't want to cause damage to them". (the Solent meeting participant)

Meeting participants did suggest that for VNAZ to be effective there would have to be clear signage together with an explanation of the VNAZ and the importance of seagrass:

"The only thing that has changed my behaviour in seagrass is buoys in Helford area – I think it just said 'seagrass area no anchoring' and we anchored outside the area with no problem and that changed my behaviour. There may have been a map if I went on shore but I wouldn't have picked it up. To me signs on yellow buoy are effective". (Plymouth meeting participant)

The issue of enforcement also arose together with a sense of uncertainty about not knowing how far the area could expand to and whether that would encroach on boaters' freedom.

"I'm okay with it generally but depends where it is. Cause it's like I want to go there sort of thing. How will it be policed? Will it be an ever expanding area? What's the balance really". (the Solent meeting participant)

Concern and resistance to restricting anchoring was also expressed in the meetings:

"would resist strongly any banning of anchoring in Yealm, it's been used for years as an anchorage and it's not doing any harm, the seagrass is getting better every year. [Question from facilitator: What if it was voluntary?] It could be issued as an advice and I would not be against that. But humans need to have something in this race, don't want to cow to an underground lawn!" (Joint meeting participant)

"I do worry if we put a ban on anchoring in areas. I would suggest that should be a long way down the line". (Plymouth meeting participant)

The interviewees provided similar views around designating protected areas of seagrass. Restrictions like those in Studland bay were not considered acceptable: *"Heavy legislation wouldn't work and how would you police it?" (the Solent interviewee)*. However, one interviewee thought that at the Yealm, an area that is not currently popular for stopping (e.g. Misery point) could be designated and be successful if there were a simultaneous education campaign aimed at encouraging boaters to take ownership and foster pride in the habitat, as long as there was a suitable place to anchor or moor elsewhere. In contrast to this, another interviewee mentioned that because the Yealm is a narrow estuary, designating an area wouldn't work:

"they can't put buoys around the seagrass and say 'keep out' because that would just sort of almost block off the Yealm". (Plymouth interviewee)

What is clear is that the effectiveness of any VNAZ scheme will be dependent on the popularity of the location to boaters, the availability of other places to anchor, signage and the physical nature of the location (that is, does it allow for an area to be zoned off or does that cause more issues for boaters). More discussion of integrated approaches can be found in the section on combined approaches.

Alternative anchoring techniques

In the boater meetings, the participants were introduced to the use of a trip line to retrieve their anchor as an alternative way of anchoring that reduces damage to seagrass. Overall, there were concerns about the effectiveness of using a trip line to retrieve anchor among meeting participants in the joint meeting group. Further, there was consensus among participants in the joint meeting group that they could not see the difference this would make in terms of the amount of damage to seagrass.

"no, never seen anyone do that. I haven't ever done that. I honestly can't see what that's going to achieve". (joint meeting participant)

"I don't think the difference of disturbance down below is going to be much changed by this, most of us go slowly to pick up anchor, the notion of dragging one forward and eventually picking up the anchor is not what happens, people pick up the anchor from a vertical position". (joint meeting participant)

In the interviews, the participants were asked more generally about changing anchoring behaviours³⁹ and one interviewee felt that the alternative behaviours being asked of boaters were not difficult to carry out as such. However, convincing people to make the effort was considered potentially difficult, with the risk that those encouraging behaviour change could “cross a delicate line” between appealing to boaters' appreciation for the natural environment and requiring them to change their behaviours in ways that seem alien to the boater culture (the Solent interviewee).

Other approaches

Navigational aids

Barry and others(2020) investigated the use of navigational aids alone, (ie not in conjunction with restricted anchoring), specifically using buoys that included signage which read “*Caution Seagrass Area*”. They found that the installation of these buoys to address the potential barrier of a lack of adequate navigational knowledge/ markers was found to elicit “*a clear behavioural improvement across a broad cross-section of boaters*” (p1), with boaters found to slow down at significantly greater distance away from the seagrass bed after the buoy placement and to trim their motors, which avoids propeller damage to the seagrass or stirring up the seabed. However, no comment is made on the nature of the relationship between these reductions in speed and any changes in seagrass condition.

Generally, as noted in the section on anchoring away from seagrass, participants in the meetings felt that navigational aids in conjunction with explaining anchoring restrictions would lead to the improved effectiveness of the intervention. Some participants commented on the value of signs that make people aware of seagrass:

“Awareness – from what we’ve seen, signs in Helford and Fal⁴⁰ – if make people aware where seagrass is, I think they will respect that. Haven’t seen anyone in anchor where they have been told there is seagrass”. (Plymouth meeting participant)

“Rather than saying can’t anchor, perhaps signs could be put up to inform people that there is seagrass in that area – more people would take more note of that that just a blatant ‘you can’t anchor here’. Salcombe is tidal area, telling tourists not to anchor won’t work, but telling them why – might get more compliance”. (Joint meeting participant)

On the other hand, the usefulness of information on a buoy was questioned:

³⁹ This could include using the appropriate length of chain and warp, raising your anchor and re-anchoring if it is dragging, checking that your anchor is not dragging, raising your anchor correctly when leaving by checking to see how the boat is lying and if the boat is pulling back away from the anchor slowly motoring towards the anchor as the crew pulls in the slack and raises the anchor (advice from 'The Green Guide to Anchoring and Moorings' produced by The Green Blue, available at <https://thegreenblue.org.uk/wp-content/uploads/2021/01/The-Green-Guide-to-Anchoring-Moorings.pdf>).

⁴⁰ The signs in Helford and Fal are attached to buoys that mark out a VNAZ and they say “Eelgrass grass beds no landward anchoring please”.

“if I just saw ‘seagrass area’ on a buoy I wonder how many people would read that. I can’t see how many people would do much. You can’t put that much info on the buoy. You need to provide the info to people before they get on their boat – and part of that is a time thing, the more places you drip that info the better it will come”. (Plymouth meeting participant)

Educational outreach, knowledge and messaging

Some of the reviewed literature highlighted that despite significant investments in boater education programmes, these programmes have had limited success in motivating behaviour change (Valauri-Orton, 2018). Lathrop and others (2017) assess the effectiveness of designated ecologically sensitive areas (ESAs) to protect seagrass damage from boating activities. Their results suggested that although efforts to promote green boating practices to the recreational boating community via public service announcements and an online interactive map of the ESAs have continued, *“messaging alone is insufficient”* (Lathrop and others, 2017, p.285). Notably, the lack of signage along boundaries made it difficult for boaters to judge when they were within the ESA or other special management zones (Lathrop and others, 2017). Helpfully, Barry and others (2020) assessed the effectiveness of two separate interventions, one education-based⁴¹ and the other cue-based (navigational aids), on reducing propeller scarring of seagrass by recreational boaters in Florida, USA. The navigational aids produced clear behavioural improvements across a broad cross-section of boaters (see above section on navigational aids), while the educational intervention appeared to have very minimal effects on boaters’ behaviours (Barry and others, 2020). Valauri-Orton (2018) identify one key downfall of educational outreach materials: that they are usually focused on *“filling a perceived knowledge gap”* (p. 4), often assuming that the reason boaters damage seagrass is due to a lack of knowledge about the properties of seagrass and how to properly boat around seagrass (Valauri-Orton, 2018).⁴² There is research that shows no direct relationship between environmental knowledge and pro-environmental behaviour exists (see Kollmuss & Agyeman, 2002 cited by Valauri-Orton, 2018). Therefore, the assumptions that anti-environment behaviour signifies a knowledge gap, and that filling that knowledge gap will lead to pro-environment behaviour, are not supported (Valauri-Orton, 2018). Broadly, the evidence suggests that education and awareness programmes *alone* are not going to change boater behaviours. Rather, having knowledge of the problem and how to act are part of the package of variables that combine to create effective behaviour change.

Raising awareness of the issues (ie the need to protect seagrass, where and how to anchor safely) and their effectiveness in relation to behaviour change were discussed in the boater meetings. Generally, there was a feeling that more education was needed about the issues and that it could lead to changes in behaviours:

“Need to know where seagrass is. Then can decide whether to anchor there – need pressure not to. Can imagine most places we want to anchor don’t have

⁴¹ Educational campaign materials included boat ramp signage, social media graphics, a website with YouTube videos, slides for public lectures, online fact sheets, stickers, phone cases, and flyers. The materials were distributed through a variety of methods including direct contact at boat ramps, providing flyers and stickers to hotels and boat rental locations, public presentations, social media and website promotion, and publishing online blogs and magazine articles (Barry and others, 2020).

⁴² This is known as the “information deficit model” and is well recognised in behaviour change literature.

seagrass. 5 m contour is good guide. I do anchor within that sometimes but don't think that is damaging seagrass". (Joint meeting participant)

"There is a dearth of info being pushed out to the public – I have a chartlet from the ReMEDIES project. It would be a good way to get information out and not perfect but gives an indication of where the beds are currently in Cawsand Bay. Need to get the information out to people about where it is, and this is why we need to look after it, and would you mind moving along". (Plymouth meeting participant)

Clearly, boaters feel that information is a key part to changing behaviours. It is also clear that trust in the source of information is an important factor in whether the provision of information leads to changes in awareness. Valauri-Orton, (2018) found, unsurprisingly, it is more mainstream sources such as newspaper articles, magazines, and newsletters rather than resource intensive educational videos, conferences and meetings that were more trusted. Simple and consistent messaging was also found to be key.

Consistency was highlighted by the interviewees who noted that some national organisations were promoting the value of seagrass (including Natural England, the Environment Agency and the Inshore Fisheries and Conservation Authorities (IFCA)). However, one commented on a lack of continuity in these efforts: *"But it's not a constant message"* (the Solent interviewee).

With respect to the content of the messages, one of the interviewees expressed concern saying:

"There is a problem with the way that seagrass is portrayed. It's set up as a battle between boaters who want to anchor on a nice sandy beach and environmentalists. That's a dangerous way of looking at the issue." (the Solent interviewee)

This suggests a possible need for re-framing of the issue of boater damage to seagrass and the solution.

The common thread across the data in this section is that whilst there is an important role for knowledge and education, care needs to be taken not to invoke the 'information deficit' model of behaviour change and that messages are consistent across organisations providing simple actionable messages. More focus on these issues can be found in Section 7.

Combined approaches

Much of the research from all three evidence sources points to a combination of interventions being the most efficacious in terms of protecting seagrass, but also in terms of changing boater behaviours. Altering the behaviour of recreational boaters to prevent damage to seagrass is acknowledged to be a complex process that involves *"knowledge, efficacy, concern for natural resources, and boating skills in shallow areas"* (Barry and others 2020, p. 6). Many of the papers reviewed in the evidence review recommend the use of multiple interventions to change recreational boater behaviour (see Parry-Wilson and others, 2019; Kelly and others 2019; La Manna and others 2015; Venturini and others 2018; Lathrop and others 2017; Barry and others 2020). Table 6 shows the range of aspects highlighted in the evidence review:

Table 6 Intervention options

| Intervention options |
|--|
| Education/awareness raising (Parry-Wilson and others 2019; Kelly and others 2019; La Manna and others 2015; Lathrop and others 2017) |
| AMS (Parry-Wilson and others 2019; La Manna and others 2015; Venturini and others 2018), |
| Designated areas for mooring / anchoring (away from seagrass) (Kelly and others 2019; La Manna and others 2015; Venturini and others 2018), |
| Need for social acceptance of interventions (Parry-Wilson and others 2019; Venturini and others 2018), |
| Monitoring, surveillance and enforcement (Kelly and others 2019; La Manna and others 2015; Lathrop and others 2017), |
| Use of navigational aids / signage (Kelly and others 2019; La Manna and others 2015; Barry and others 2020), |
| Establishing the carrying capacity of sites for sustainable use by recreational boaters ⁴³ and using this in management and communication tools (La Manna and others 2015; Venturini and others 2018) |
| Financial incentives (Parry-Wilson and others 2019). |

Box 1 presents an example a combination of actions that could be implemented at the same time to more effectively protect seagrass.

Box 1 Example of multiple approaches

In a study of the effectiveness of interventions in La Maddalena Archipelago National Park, Sardinia, La Manna and others (2015) suggest six management, legislative, monitoring and education actions that marine parks should put into practice to effectively protect seagrass:

1. Use free zones for anchoring in places where seagrass is not present to reduce the pressure on sensitive areas / no anchor zones and mooring fields.
2. Establish the maximum number of boats / carrying capacity of the area.
3. Replace traditional mooring systems in seagrass with seagrass-friendly systems, with attention given to the number, concentration and location of buoys.
4. Implement local surveillance “also employing video technologies and closer co-operation with law enforcement” (p. 166).
5. Implement a periodical educational programme to raise awareness and change boaters’ attitudes and behaviours regarding anchoring in coastal areas; and, particularly key.
6. Design a long-term monitoring plan to measure the effectiveness of new management strategies.

What is interesting is that these interventions are largely driven by the material aspects, e.g. putting in AMS or a VNAZ, with the behavioural aspects taking perhaps a secondary role. The evidence reviewed suggests that social science (and CBSM⁴⁴) approaches have not been widely used to

⁴³ For example, working out how many boats a site can sustainably accommodate based on the maximum number of eco-friendly moorings, and anchorages available in sandy bottom areas (La Manna and others 2018).

⁴⁴ “Community-based social marketing (CBSM) blends community organization techniques with commercial marketing research principles, including audience analysis, plans to reduce the barriers to change, and targeted communication to promote socially beneficial action” (Barry and others, 2020, p2).

change boater behaviours. Rare and the Behavioural Insights team (2019) in their research on changing conservation behaviours suggest that effective strategies are ones that centre on:

- Motivating the change (by harnessing appropriate incentives, emotions, cognitive biases),
- Socializing the change (by leveraging the social nature of behaviour),
- Easing the change (by removing the hassle, helping people to plan, and creating supporting environments).

The authors acknowledge that conventional tools such as legislation, incentives and education are still important, but that strategies from this perspective offer “*an alternative and a new lens*” (p. 8) to approach conventional tools, particularly where monitoring and enforcement is not possible (Rare and The Behavioural Insights Team, 2019).

This comment was echoed in the interviews. It was felt that initiatives need to focus on convincing people that protecting seagrass is important to them, rather than telling them they have to change:

“Instead of a ‘you will do this because we say so’, you’ve got to take people with you, get them to understand why they’re doing it and try and engender this sense of ownership – ‘this is your local area and its beautiful. You need to keep it that way’.” (the Solent interviewee).

Also emphasising the need for people to value seagrass, another argued that seagrass is not recognised as important in Britain as being as say, coral reefs in the Caribbean, where they are very important to the economy because of tourism. A similar sentiment was raised in the boater meetings, showing how education might combine with rules or restrictions:

“Think that education and engaging people with that habitat is really important so that people choose to – rather than only reason for obeying regulations being to avoid prosecution. When growing up near New Forest, everyone used to drive and park cars all over the place and then that was restricted and now people wouldn’t imagine ever doing it. Make the environment more valued”. (the Solent meeting participant)

This shows a recognition of the role of developing social norms in behaviour change which approaches will need to take if success is to be improved. In the boater meetings there was also a discussion of using multiple methods, recognising differences in context:

“the Solent is an extremely tricky place to put together what everyone wants to do. Maybe a case for no anchoring areas in some of the more pristine seagrass beds.[...]. Other areas where combination of popularity and a seagrass bed – could we use some of these other solutions e.g. the AMS”. (the Solent meeting participant)

“Its education [first] improve anchoring technique, and give them something to work out where it is e.g. a chartlet, and use depth gauge to understand, buoys to indicate the edge of the bed and have a sign to say anchor to the north etc. Help people to know where it is and of course [have] eco-moorings”. (Plymouth meeting participant)

Recommended approaches to changing the anchoring and mooring behaviours of recreational boaters

This section draws only on the literature review and sets out areas related to recreational boaters anchoring and mooring for which further research and trials are recommended.

Further research and trials

The desk review identified recommendations for additional research and trialling of interventions to improve understanding, experience of interventions, and provide evidence which could support behaviour change in relation to anchoring and mooring in sensitive habitats (Amec Foster Wheeler, 2017; MacLennan, 2020). For example:

- Trials of AMS that take into account a holistic set of factors, not just ecological needs, e.g. ‘whole life’ costs and local circumstances. For example, whole life AMS costs for selected MPAs “*to provide a better basis for assessing variation across the UK*”, for example, focusing on MPAs which do not currently have mooring provision and on systems with minimum overheads (Amec Foster Wheeler, 2017 p. 47)
- Development of AMS best practice in general terms, as well as standards for UK conditions, coupled with the collection of evidence and better information management to avoid misinformation (Amec Foster Wheeler, 2017).
- Future AMS workshops to report on trials, provide examples of success and include a wider range of delegates e.g. drawing on the experience of harbour masters using these systems (MacLennan 2020).

MacLennan (2020) comments on several projects which are underway in the UK to address the impact of anchoring and mooring on seagrass, which may provide additional information: the Tevi project⁴⁵ to promote private sector growth into industry (funded by a different strand of European funding to ReMEDIES), and a potential swimming buoy trial underway in Plymouth.

Discussion

Overall, the literature review found there is a lack of evaluations of approaches to changing the anchoring and mooring behaviours of recreational boaters, of both the effectiveness of technical equipment (e.g. AMS) and behaviour change strategies. Clearly, the ReMEDIES project is going to provide vital information as it is gathering effectiveness of a range of types of AMS in a range of locations in UK waters.

The one study identified in the evidence review which evaluated the impact of AMS in the UK demonstrated their effectiveness: in their study of AMS deployment in Torbay, UK, Parry-Wilson (2019) found a reduction in anchoring events and a reduction in pressure on the seagrass at the site of 20%. Clearly more studies are needed to understand the impact of specific context and location which is what the ReMEDIES project aims to do.

⁴⁵ <https://tevi.co.uk/tag/seagrass/>

Across the boater meetings and the evidence review both positive and questioning views were raised towards AMS. More information and proof of their effectiveness was asked for together with questions as to how effective they could be in crowded areas, and specifically in the UK given its tidal range. This suggests that more work is needed on testing and trialling the AMS and to build trust it would be good to carry this out alongside discussions with interested boaters which is a part of the work that the ReMEDIES project is doing.

With respect to anchoring away (i.e. restricted anchoring and VNAZ) there were mixed opinions across the evidence review and the boater meetings as to their effectiveness to reduce pressures on seagrass from recreational boaters. It was suggested that VNAZ could be effective and complied with depending on the location, however, there was also a sense of resistance to any restrictions on the ocean from boaters. This is brought out more in the analyses for RQ4 in Section 7 and will be important to address in the design of further interventions.

From the boater meetings, alternative anchoring techniques e.g. using a trip line provoked concern as to whether it would be effective in reducing damage to seagrass and whether it was an effective way to retrieve an anchor. More information and discussion of how that would work in practice would help in influencing behaviours.

There is evidence that navigational aids (e.g. buoys) could be effective and that educational outreach/information could raise awareness but was best used in conjunction with other approaches to be effective. Specifically, combined approaches (e.g. VNAZ, navigational aids, information online/leaflets, monitoring etc) were recommended as being the most effective for changing boater behaviours, with a focus on encouraging stewardship of the seagrass beds rather than taking a punitive approach.

In terms of differences between the two locations, there were few clear differences in boaters' responses to interventions to influence their anchoring and mooring behaviours, with the exception that boaters in Plymouth had more experience of VNAZ and more views on their effectiveness.

7. Barriers and facilitators to boaters taking action

This section addresses research question 4: *What are the barriers and facilitators to boaters (in particular, different types of recreational boaters) taking action at each site? To what extent are these related to capability, opportunity and motivation?*

Summary box

Boaters feel connected to the ocean and are strongly motivated to protect it.

There is willingness to change behaviours that damage seagrass but also a strong resistance against enforcement; boaters want freedom to choose where they go and to choose what they perceive as safe options.

A clear argument needs to be communicated about how some boating behaviours damage seagrass and how changes will protect it.

Current information about seagrass locations is poor.

RYA and harbour authorities are respected sources of information and have a strong role to play in establishing social norms to protect seagrass.

We have used Michie and others' (2011) framework to organise the evidence on the essential conditions for behaviour change: capability, opportunity, and motivation. We discuss the barriers and facilitators to boaters' taking action to protect seagrass under these headings.

Capability

Capability is defined as the individual's "*psychological and physical capacity to engage in the activity concerned*" (Michie and others, 2011, p.4), which includes the necessary knowledge and skills to engage in the behaviour.

Knowledge and awareness of seagrass

Simply increasing people's knowledge about a problem is often insufficient to change their behaviour (Parry-Wilson and others, 2019; Barry and others, 2020; Rare, 2019). Our survey found self-rated knowledge of seagrass to be unrelated to intentions to protect it by anchoring away ($r = -0.05$, $p =$

0.54)⁴⁶ or using an AMS ($r = -0.07$, $p = 0.42$)⁴⁷. However, boaters generally agreed that knowledge of seagrass was an important starting point for feeling able to protect it.

"I would like to know more about seagrass. We are talking about protecting seagrass, but I'm not clear on why we are protecting it". (joint meeting participant)

Although the desk review found low levels of knowledge of seagrass (e.g. MacLennan, 2020), the boaters in our study generally felt they had good knowledge. For example, all Plymouth meeting participants, and some of those in the Solent and joint meetings, were able to identify the photos of seagrass. Many were aware of the importance of seagrass for wildlife, though one commented that they were ignorant. A few were aware of the link with seahorses in Studland Bay. Survey responses confirmed the general high level of awareness, with 96% of respondents answering yes to Q17 '*Have you heard of seagrass before this survey?*' ($n=156$) and 34% agreeing with the statement in Q18 '*I know a lot about seagrass*' ($n=156$).

"Home to fry and seahorses. It needs to be cared for – vulnerable". (Plymouth meeting participant)

"I'm totally ignorant. I look for sand banks, wrecks and divers but I don't have much other concern about what is beneath me." (joint meeting participant).

Most respondents agreed or strongly agreed with statements in Q18 ($n=156$) about its environmental impact ('*seagrass improves water quality*': 73%; '*seagrass is an important habitat for marine wildlife*': 85%; '*seagrass plays an important role in removing carbon from the air*': 63%). They tended to rate their own knowledge above that of other boaters, with one interviewee suggesting that the majority of boaters would have only a '*vague awareness*' about seagrass itself and the environmental role it plays. This over-confidence is common when people are asked to rate their own knowledge against that of others (Kruger and Dunning, 1999), but it may also reflect a tendency for more knowledgeable individuals to take part in the study. We note that the majority (83%) of those who completed the survey chose the option '*11 plus years*' when asked Q10 '*How long have you been boating for recreation?*' ($n=161$), so it is reasonable to assume their capability to be higher than that of novices.

Meeting and interview participants commented that there has been more communication about the importance of seagrass in the last few years, with two interviewees mentioning that television programmes like Countryfile were helping to increase awareness. Barry and others (2020) found a disconnect between awareness of the importance of seagrass and concern about damage to it. A few meeting participants showed a similar disconnect, being unconvinced that boating is damaging seagrass.

⁴⁶ This is the result of a correlation between the items Q18 '*I know a lot about seagrass*' and Q40 '*I intend to anchor away from seagrass when boating*'. The very small r value means that people who intended to anchor away were not more likely to know a lot about seagrass. The p value means that any apparent association between knowledge and intention was due to chance.

⁴⁷ This is the result of a correlation between the items Q18 '*I know a lot about seagrass*' and Q42 '*I intend to help protect seagrass by using an Advanced Mooring System if it were available*'.

“... when you come to grasses, I now know a little about seagrass but didn’t know much a while ago”. (Plymouth meeting participant)

“I wouldn’t have a problem but yet to see any good science to tell me that is the case [i.e. that seagrass need protection]”. (Plymouth meeting participant)

“There is limited information available to yachtsmen on the health of local seagrass meadows, and whether there is firm evidence that anchoring is adversely affecting seagrass”. (Plymouth interviewee)

Knowledge and awareness of seagrass in specific locations

An aim of the ReMEDIES project is to get more detailed information onto charts and maps. Responses from interviewees and meeting participants indicated that this would help them protect seagrass. Interviewees said that lack of knowledge about precise seagrass locations reduced their capability to protect it. For example, one said that it was very difficult to avoid seagrass at Cawsand Bay and at Cellar Bay in the Yealm Estuary because of a lack of detail in information brochures. Some meeting participants were able to name some locations that they understood to have seagrass beds, but many were unsure whether the locations they visit regularly have seagrass. The survey showed a similar picture with 54% answering ‘yes’ to Q20 ‘Do you know if there is seagrass where you usually go boating for recreation?’ (n=155); 22% answered ‘no’ and 24% ‘unsure’⁴⁸. Many participants across all meeting groups said that they were interested in finding out more about where seagrass is located around the South Coast.

“The ‘Plymouth Waterways’ brochure produced by Plymouth City Council/QHM does show areas of seagrass but as rather vague blobs on a sketch chart of the area”. (Interview participant)

“I’m aware of some seagrass in Salcombe Estuary but apart from Studland Bay, I’m not aware of any other areas”. (joint meeting participant)

Capability in relation to alternative seagrass-friendly behaviours

Alternative anchoring techniques

Most meeting participants were aware of the technique of using a trip line to retrieve anchor in hazardous terrain or to avoid debris that might get caught on the anchor, despite many not using it themselves. Only a few were familiar with it as a technique to protect seagrass.

“I know it’s a way of getting an anchor out when stuck under underwater obstruction, not thought of it as environmental protection”. (joint meeting participant).

A few were not familiar with the technique at all. Several felt that education would be needed to encourage boaters to use this technique to protect seagrass as this is not the usual purpose. Overall, capability did not seem to be the main barrier to using a trip line as an alternative anchoring behaviour

⁴⁸ Survey responses from Solent and Plymouth were similar unless otherwise stated

once you had learned how to use one. However, there was a sense, covered in the Motivation section, that trip lines were an unwelcome hassle.

Advanced Mooring Systems (AMS)

Knowledge and awareness of AMS varied among meeting participants. Many participants were aware of some of the types of AMS and their purpose to protect seagrass, others had not heard of them (*"Never seen in boat shows in Southampton"* (the Solent meeting participant)) and were only aware of traditional mooring blocks. A few participants were aware of AMS being trialled in certain locations in the UK, including on the south coast. One or two participants knew of other boaters who used or planned to install AMS, however most participants had not used an AMS themselves. One participant in the Solent meeting, who was fairly knowledgeable about AMS but did not have direct experience of using one, said that they weren't a new technology.

"I understand there has been some experimenting on them in Cawsand Bay."
(Plymouth meeting participant).

"Aware of them, have seen one of two of them out of the water. Don't personally use them. Not aware if currently any in the Solent. Aware of the elastomer model. New to us but not to the rest of the planet. They require – helical system – different installation. Have been installed elsewhere in the UK. Helical piling is not a new method". (the Solent meeting participant)

Survey results showed a similar picture, with only 46% answering 'yes' to Q32 *'Have you heard of Advanced Mooring Systems (aka eco-moorings, environmentally friendly moorings) or AMS?'* and only 5% answering 'yes' to *'Q33 Have you used an Advanced Mooring System'*.

In terms of possessing the necessary skills to be able to use AMS as an alternative mooring behaviour, meeting participants generally felt this would not be a barrier as it would require the same common skills as *"picking up ring on top of mooring buoy – basic skill for a boater"* (Plymouth meeting participant). Survey responses showed similar confidence with only 13% agreeing with the statement in Q41 that *'Using an Advanced Mooring System would be inconvenient'* and 59% agreeing with the statement in Q42 that *'I am confident that I would be able to use an Advanced Mooring System'*.

There is a need to raise awareness of AMS but in general capability did not seem to be the main barrier to their use; other barriers (see Opportunity and Motivation) were more significant.

Restricted access / VNAZ

Meetings and interviews did not raise specific barriers to anchoring away from seagrass other than lack of awareness of seagrass and the need to protect it, and knowledge of its locations, which apply to all interventions. 84% of survey respondents said 'yes' to Q35 *'Have you heard of restricted anchoring or voluntary no anchor zones?'* (n=143) and 38% responded 'yes' to Q36 *'Have you been anywhere there was a voluntary no anchor zone?'* (n=143), of whom 98% said they observed it (Q37, n=53). However, agreement with statements in Q40 (n=141) of the survey suggested that capability in relation to anchoring away was relatively low. 54% agreed with *'I expect that I will be able to anchor away from seagrass'*, 45% agreed with *'I am confident that I can almost always anchor away from seagrass'*, and 33% agreed with *'It will be easy for me to anchor away from seagrass'*. Only 26% disagreed with the statement in Q39 (n=141) that *'Anchoring away from seagrass would be inconvenient'*. Responses were recorded on a 1 (strongly disagree) to 5 (strongly agree) scale for statistical analysis. In general, the Solent respondents reported higher capability to anchor away

than Plymouth respondents, rating it as more convenient (Q39 reverse-coded: 3.15 versus 2.63, $t = -2.59$, $df = 67.16$, $p\text{-value} = .01$) and easier (Q40 *'It will be easy for me to anchor away from seagrass'*, 3.58 versus 2.98, $t = -2.26$, $df = 57.63$, $p\text{-value} < .0527$). On the surface, these responses suggest that participants observed VNAZ when they encountered them, but were not confident they could always do so. To interpret these somewhat contradictory responses, it is necessary to consider the role of memory and habits. People are more likely to remember a VNAZ that led to them anchoring elsewhere than one that they ignored or did not notice, potentially inflating the percentage who reported observing a VNAZ. Respondents who were used to anchoring away from an established VNAZ may have interpreted the questions about future behaviour in relation to new VNAZ, knowing that the ReMEDIES project is concerned with increasing protection for seagrass. If new VNAZ block access to habitual anchoring spots, then perceived capability to find somewhere new to anchor would be lower because it involves a change of behaviour and potential uncertainty about alternative anchoring spots.

Education and information as facilitators of behaviour change

There was consensus among meeting participants in all groups that more education is needed to raise awareness of seagrass to facilitate seagrass-friendly boating behaviours. Most participants felt that if recreational boaters were provided with information on *why* they need to avoid/protect seagrass then they would be more likely to follow advice on the alternative behaviours. Some participants also wanted more information on why the proposed alternative behaviours are better for seagrass, and also of their effectiveness in terms of safety.

"I want evidence I am doing damage by mooring and I want evidence a trip line is any better than my current practice". (Plymouth meeting participant).

"I don't think you will get some emotion unless you do the education bit first, and I think that is a really important part of this". (Plymouth meeting participant)

"need education on why I would want to anchor in deeper water, with a longer line and longer row to get to shore – we need to understand what the benefits would be for anchoring further out, so if you want to change my behaviour you need to make a good argument for why". (joint meeting participant)

Many meeting participants also called for more information about *where* seagrass is located to facilitate the adoption of seagrass-friendly boating behaviours.

"if going to anchor, you're going to cause damage – don't see any way of avoiding if dropping anchor. Need to know where seagrass is. Then can decide whether to anchor there". (joint meeting participant)

"if I knew I was going to damage something delicate I just wouldn't do it – goes back to education and also some simple tips." (Plymouth meeting participant)
"electronic charts don't show seagrass bed, if they did, people would be more aware. Have details about shingle bed etc but not seagrass". (Plymouth meeting participant)

Although awareness of environmental issues was high, boaters needed clear, consistent and widely available information and education about specific locations of seagrass, why it needs protecting, and how behaviour change can make a difference. Boaters who knew about AMS felt it would be easy to use, but there was less confidence about being able to anchor away. The following sections

on Opportunity and Motivation suggest that capability to anchor away would be increased by better information and signage and by addressing conflicting motivations to anchor in favourite, safe locations.

Opportunity

This section covers boaters' perceptions of the external factors that enable or facilitate behaviours to protect seagrass (Michie and others, 2011). As our desk review found, additional infrastructure is likely to be required to provide boaters with the opportunity to take action (Valauri-Orton, 2018). This infrastructure potentially includes information, training, legislation and signage as well physical equipment such as AMS. Our desk review identified lack of suitable mooring options and unclear signage as barriers to behaviour change (Diedrich and others, 2013; Barry and others, 2020; Lathrop and others, 2017).

Information and education

Perhaps not surprisingly given boaters' focus on knowledge as the key requirement for changing behaviour, all interviewees mentioned a need for information and education campaigns, especially as an alternative to restrictions. A few meeting participants also mentioned that it was important to make sure any information about seagrass and changing behaviours was communicated sensitively. For example, one participant said it is important to be "even handed" to make sure it does not seem like it is "bashing yachties again". Education and encouragement were preferred over restrictions. There was particular concern over possible restrictions to popular locations in Plymouth.

"I think you go sailing to enjoy the freedom so to be told you can't do this or that [i.e. is not good]... You can gradually encourage people to change their behaviours so people understand why they need to change their behaviour. Let me know about the seagrass, so if you can encourage me to do the right thing, I can probably change what needs to be done". (joint meeting participant)

"If there were restrictions in Cawsands Bay or in the Yealm or North Drakes island that would then start to impact on leisure sailors. At the moment there isn't really a direct impact, the other grass around the sound I think in areas where yachtsman don't hang and unlikely to be unlikely to be conflict". (Plymouth meeting participant).

Plymouth interviewees saw a lack of information about the location of seagrass as a particularly significant barrier. Current marine charts are not sufficiently informative. One interviewee suggested that a priority should be to publish more detailed marine charts. Meeting participants agreed that better information would change their behaviour.

"the areas of seagrass are marked on a chart there, [in] blocks, but not more accurately than that". (interview participant)

"An early priority should be to publish a detailed marine chart showing the location and extent of seagrass areas. Then yachtsmen could take an informed and responsible decision when anchoring". (interview participant)

"If I go to Cawsand, I may damage the seagrass, and if I saw some signage, I would avoid or change, go for example a hundred yards in a different direction".
(joint meeting participant).

Overall, participants seemed to believe that navigational buoys and signage could be an effective facilitator of boater behaviour change, as long as the messaging is clear and direct. Information buoys were suggested as a possible solution at Cawsand Bays. It was acknowledged that they would be costly and need annual inspection but were used elsewhere. Many Plymouth interviewees suggested improved signage, but one interviewee felt that this may spoil enjoyment of the natural environment at the Yealm.

"Helford have buoys where seagrass beds begin and ask you to anchor on the other side, drop anchor outside of seagrass area". (Plymouth meeting participant).

"...do you really want to put signs up and spoil that area? National Trust own the adjacent land [and] they don't want really want signs". (interview participant)

Messaging needs to be clear and memorable. For example, a joint meeting participant suggested that in Cawsand Bay:

"my advice would be if you anchor out of 5m contour, that more or less means you are outside of the seagrass beds so if you have a simple message like that then they are more likely to abide by it than a complicated chart". (joint meeting participant)

It is important to link the information to the desired behaviour. Joint meeting participants offered examples of where this link was inadequate. There was a feeling that good signage would be effective.

"In Cawsand there are maps of the bay which highlight seagrasses but it doesn't say 'don't anchor in this area'". (joint meeting participant)

"Studland, it wasn't clear whether buoys marked area to anchor in or not to anchor in". (joint meeting participant)

"The only thing that has changed my behaviour in seagrass is buoys in Helford area – I think it just said 'seagrass area no anchoring' and we anchored outside the area with no problem and that changed my behaviour". (Plymouth meeting participant).

The importance of education about seagrass was raised by interviewees and meeting participants at both the Solent and Plymouth. They offered suggestions for the content and delivery of education. One interviewee suggested posters at launching points, adverts in the local press and on television, using influencers and celebrities to deliver the message as well as involving behaviour change experts to help design the information campaign. Another interviewee suggested that boating organisations might help administer an information campaign; marinas, marine businesses such as chandleries and Princess Yachts in Plymouth, and MoD river police who already disseminate information on speeding and anti-social behaviour. This interviewee perceived the Plymouth boating community to be fairly small and compact, making an information campaign easy to administer.

“There are plenty of ways of communicating to boaters and yachtsman, particularly in the Plymouth area, it's a fairly nice, compact community with clubs and marinas and launching places where an intensive campaign information campaign will be... [successful]”. (Plymouth interviewee)

An interviewee expressed the importance of consistent messaging from different marine organisations and thought that boaters would take more notice of messages from institutions that have boater's best interests at heart, like the RYA. Although clubs had an important role to play, it was recognised that not all boaters belong to clubs and would need to be reached some other way.

“people who have small high-power boats – they are not members of clubs - how do you educate those people?” (Plymouth meeting participant).

Suggestions included providing information through annual renewals of permits and insurance policies, and in publications like tide timetables and visitor guides. Some meeting participants suggested providing information at multiple points of contact with boaters, for example signage where boaters get onto their boat at piers or marinas (*“the more places you drip that info the better it will come.”* (Plymouth meeting participant), incorporating information into training, and providing it at seagrass locations or safe anchoring zones. Education needed to explain why protecting seagrass was important and how boaters' behaviours could make a difference.

“do the RYA incorporate these things in any of their courses e.g. day skipper, competent crew etc? I've never seen anything like this”. (joint meeting participant)

“in terms of info, how would we receive info? I wouldn't get it from social media, but if I go elsewhere, the Harbour Master will give us their info”. (joint meeting participant)

Some participants used phone apps to find information and felt that environmental information could be incorporated. It was important to use existing apps and not create a new one. At the Solent meeting participant commented that apps were feasible because seagrass is coastal so would generally be within mobile phone signal range.

“if I want to check tide times the first place I look is online”. (the Solent meeting participant)

Access to necessary infrastructure

Most meeting participants were unaware of AMS existing along the South Coast. Those who were aware of the trial AMS at Cawsand Bay had not used them themselves. There was a sense that trials had been poorly communicated: *“Haven't heard any feedback on using them”. (joint meeting participant).*

“we have some of these in Cawsand as part of trial, believe there has been good progress around the 5 trial buoys, I've signed up to replace 20 moorings out of perhaps [150??] boats on a summer day and we are identified on charts as anchorage, and we will continue to suffer unless we have more moorings which can be used by visitors we will continue to have problems”. (joint meeting participant)

“If mooring, Salcombe is predominantly mooring there is no marina, the HBA own all the mooring buoys, there are probably 500 moorings and I can see the two on

the right hand side are, but the ones there are exclusively the traditional moorings". (joint meeting participant)

Some meeting participants agreed that they would use an AMS if it were available, as did 53% of survey respondents (Q34 *'If you had the choice would you choose an AMS over a traditional mooring?'* (n=141); 14% answered 'no', 33% 'unsure'). There was higher agreement to statements of intention, with 68% agreeing with statements in Q42 (n=141) that *'if an AMS were available in the future I would use it'* and 69% agreeing that *'I intend to help protect seagrass by using AMS if it were available'*, suggesting that increasing opportunity could facilitate behaviour change. Cost and safety, particularly for larger boats, were potential barriers. These perceived barriers have been noted in the literature too (Amec Foster Wheeler, 2017). We note that traditional moorings can be weighted with a range of ad hoc materials yet safety concerns are not typically raised in relation to these because they are familiar. There was some concern that the costs of installing new AMS systems at scale would be passed onto boaters, as a Plymouth meeting participant expressed:

"I know there is a big debate about AMS – e.g. 80-100 boats over the area, if you want to stop that with AMS how many are you going to put in? And at the moment there is talk of no charge, but I find that difficult to accept given the costs involved in providing eco-mooring for a substantial part of that number".

(Plymouth meeting participant)

Alternative mooring and anchoring options

Survey respondents were asked their agreement with statements about opportunities to anchor away from seagrass. Responses were converted on a 5-point scale such that 'strongly disagree' became 1 and 'strongly agree' became 5. The Solent survey respondents agreed more with statements in Q43 that *'Thinking about the places I stop (when I go out boating) there are often plenty of places for me to anchor away from seagrass'* (3.90) compared with Plymouth respondents (3.05, $t = -2.81$, $df = 40.87$, $p\text{-value} < 0.01$), and that *'Thinking about where I moor my boat, there are plenty of places for me to moor that are not in seagrass'* (4.08 versus 3.50, $t = -2.31$, $df = 63.44$, $p\text{-value} < .05$)⁴⁹. Therefore, participants from the Solent were significantly more likely to agree that there were lots of mooring opportunities at their location.

Access to personal equipment

A few participants highlighted access to a trip line as a potential barrier for some boaters. One the Solent meeting participant considered it a hazard, *"an extra thing you need to store properly, can easily get tangled up e.g. with chain or anchor"*. One Plymouth participant thought that small boats would not carry enough rope to use as a trip line but another said that *"Most people have enough rope on their boats but wouldn't think to use it"*, suggesting that this may not be an opportunity barrier but a motivation or capability barrier.

⁴⁹ The t statistic and associated p value tell us whether or not there is a statistically significant difference between the means for the two groups (Solent vs Plymouth). Simplistically, the larger the t statistic the more different the means are and the smaller the p -value the less likely that the results are down to chance. At the $p < 0.05$ level there is a less than 5% chance that there is no difference between the means.

Motivation

This section considers boaters' personal motivations in the sense of the psychological processes that drive their behaviour, including beliefs, desires, emotions, attitudes and perceptions of others. We focus on personal motivations and perceived social norms as our desk review identified these as essential ingredients for adopting seagrass friendly anchoring and mooring behaviours (Diedrich and others, 2013; Parry-Wilson and others, 2019; Valauri-Orton, 2018).

Personal motivations

Most of the interviewees said that seagrass was important to them on a personal and professional level. All expressed a need or moral duty to be environmentally mindful, to "do their bit" and ensure species are not "wiped out". Many meeting participants considered themselves somewhat environmentally aware, which was why they had chosen to attend the meeting. A few already took behavioural action to protect seagrass by anchoring away from shallow water or by using anchoring techniques. The survey also showed high levels of concern about protecting the environment (Q47, n=136), with 23% responding that they were slightly or reasonably concerned and 77% very or extremely concerned. Agreement was generally high to statements about environmental values in Q46 (n=138), with the Solent respondents agreeing more strongly on average than Plymouth respondents (4.40 versus 4.04, $t=2.26$, $df = 74.556$, $p = 0.03$). The majority expressed a desire to help, agreeing or strongly agreeing with the statements in Q44 (n=137) that '*I want to protect seagrass*' (91%) and '*I can clearly imagine how good it would feel to be protecting seagrass*' (67%). There was similarly high agreement with statements about ocean connectedness in Q45 (n=140). Respondents agreed with statements that '*I feel very close to the marine environment*' (91% agree or strongly agree), '*I have a clear understanding of how my actions affect the ocean*' (84%), and '*I often feel a sense of oneness with the ocean around me*' (76%). A majority of survey respondents had positive attitudes, agreeing or strongly agreeing that '*Anchoring away from seagrass is a good thing to do*' (Q39 76%) and '*Using an AMS is a good thing to do*' (Q41, 67%).

The survey revealed some mismatch between respondents' stated motivation and their behaviour. It is a common finding that behavioural intentions do not strongly predict actual behaviour (Gollwitzer and Sheeran, 2006) but the mismatch here could also reflect changing awareness of seagrass and environmental issues in recent years. The majority of survey respondents answered 'yes' to Q21 (n=154) '*Would you try to avoid seagrass if you knew where it was located?*' (88%) and agreed with statements in Q40 (n=141) that they intended to anchor away in future (range 57-74%), but only 54% had ever looked to see if there is seagrass where they plan to anchor (Q24, n=147). 42% had '*ever anchored in seagrass*' (Q26, n=146, 41% were '*unsure*' if they had). When asked to select one or more reasons why they had anchored there (Q27, n=61), 74% chose the option '*It was a safe place to anchor*'. Other choices were '*I always anchor there*' (20%), '*I thought it was okay to anchor in seagrass*' (20%), '*did not have a tender so needed to be close to the shore for access*' (3%) and '*Other*' (26%). Several meeting participants felt they were unable to effectively change their behaviours to protect seagrass because they did not know which areas to avoid, implying that they had motivation but lacked capability.

Despite boaters' strong motivation to protect seagrass, they also expressed strong motivation to be free. Most survey respondents agreed that '*It's up to me whether or not I anchor away from seagrass*' (Q40, n=141, 58% agreed) and '*It's up to me whether or not I would use an Advanced Mooring System*' (Q42, n=141, 60%). Boaters were wary of initiatives to protect the marine environment (such as Marine Conservation Zones) that might impose changes in their practices. Interviewees felt that boaters in general valued the freedom to go where they want to and, as a Plymouth meeting

participant expressed, “*no longer being able to go there becomes an emotive issue*”. Anchoring was seen as an inherent part of this freedom, of “*being a boater*” and not restricted to going to places with moorings:

“Picking up buoy is easier. But part of the enjoyment of owning a boat is to be able to go somewhere, drop anchor and have a swim. To be herded where everyone else is, that takes away from it”. (the Solent meeting participant)

Our desk review found that highly visible monitoring of restricted areas helped to change behaviour in Studland and Skomer (Griffiths and others, 2017), and that lack of enforcement was a barrier to change (Lathrop and others, 2017). However, among our participants there were generally negative attitudes to enforcing restrictions, and a feeling that enforcement would be ineffective.

“No, don’t think enforcement will work – they have enough trouble trying to enforce speed limits in estuaries – ‘don’t anchor here’ not a cat in hell’s chance!”
(meeting participant)

“Agree Cellars would be an issue. Wonder about Cawsand – despite trying to get message out, feel that some people would anchor anyway”. (Plymouth meeting participant)

“there’s limits to what you can do. You can’t sort of do enforcement side of stuff unless it’s specifically noted in the harbour general directions”. (harbour master interviewee).

“[diverting resources to conserve seagrass] could have huge economic effects for the community [of] Kingsands and Cawsands and also a huge diversion of resources to police it”. (interview participant)

A few participants felt that without proper enforcement, interventions like VNAZ would be ineffective, but education was generally seen as a more viable option.

“Enforcing anything like that [restricted access] at sea is difficult. Think that education and engaging people with that habitat is really important so that people choose to – rather than only reason for obeying regulations being to avoid prosecution”. (the Solent meeting participant).

It was clear from the boater meetings that safety was also a very important factor in boaters’ choice of anchoring or mooring behaviour. As already mentioned, survey respondents who knowingly anchored in seagrass often did so because they felt the location was safe. Many meeting participants voiced concerns about the effectiveness and safety of using an AMS or trip lines.

“These [safety] concerns trump decisions over seagrass and I think will always trump things to do with seagrass.” (Plymouth participant).

“I have had more trouble with broken moorings that haven’t been serviced properly than I have with anchoring. Trust my anchor over mooring.” (joint meeting participant)

"I understand the physics of having a lot of heavy chain to hold my boat in place and a bit of elastic doesn't give the same comfort – so it would be good to have the evidence on e.g. helical moorings., we have had a talk in yacht club on helical and I think it was well received". (joint meeting participant)

Concerns about overcrowding were expressed in relation to freedom and safety. Although some participants said they would be happy to abide by restrictions, others were more reluctant. A few Plymouth meeting participants felt that VNAZ would not be adhered to at popular locations (e.g. Cellars Bay and Cawsand Bay) because it would be too crowded. Crowding also increased concerns about safety.

"I would be more than happy with the restriction if there was one and I would think most boaters would feel the same". (Plymouth participant)

"The Studland bay [VNAZ] makes total sense to me – believe there is a colony of seahorses there and wouldn't want to cause damage to them. If I was told I couldn't anchor elsewhere then that would be disappointing – if no seahorses there. The Solent is like the M25 at the best of times. Limiting where people can go will have negative impacts e.g. crowding". (the Solent meeting participant).

"My concern would be on Cellar beach on sunny afternoon, you have extra boats anchoring and trip lines, would make it more complicated e.g. have a trip line around my propeller!" (joint meeting participant).

Participants suggested possible solutions to the problem of conflicting motivations. A few meeting participants said that insurance could help change attitudes towards using AMS. Another was optimistic that, although restrictions seem unappealing and unenforceable now, attitudes change.

People are nervous, people will be assured if the insurance broker would cover it – I think we need to put pressure on insurers". (joint meeting participant).

"When growing up near the New Forest, everyone used to drive and park cars all over the place and then that was restricted and now people wouldn't imagine ever doing it. Make the environment more valued". (the Solent meeting participant).

An important theme was achieving a balance: *"boaters value their independence and don't like being told what to do but they will listen if they are told something in the right way"*. There was a willingness to compromise to retain freedom to visit favourite places. One Plymouth participant said that if it meant protecting an area that they cared about then they may be willing to avoid that particular area at certain times of year. As at the Solent meeting participant expressed it, there is a need for a *"flexible suite of approaches"* to allow boaters to continue to visit popular locations.

"If on odd occasion I have anchored, it looks more stressful to mess around with an additional line, but maybe if you did it all the time... My interest is to maintain access to areas for boaters, so whatever we need to do to make that happen I am happy to do". (joint meeting participant).

"I don't think anyone thinks I won't go to Cellars in the spring because the seagrass is particularly vulnerable... But if someone told me in May it's

particularly harmful to the seagrass then I would avoid it". (Plymouth meeting participant)

Social norms

People are generally motivated to follow social norms, to behave as others like them do (Ajzen, 1991), and many interviewees commented that there is a common duty to protect seagrass. Another raised the importance of a communal feeling of stewardship of this habitat. One meeting participant commented on the importance of bar-room chat in sailing clubs.

"Everyone now is more environmentally minded. It's morally right to protect the habitat". (interview participant)

"We probably need to work a bit more with local people. So that people start to learn to love the seagrass that's here and find out more about it". (interview participant)

"My take on seagrass is largely derived from the yacht club bar where there are a lot of experts which say the seagrass – especially Cellars – some will say the seagrass is gravely endangered and anchoring in Cellar is very anti-social thing to do. Others say seagrass is actually quite healthy there. I've been told its actually increasing. Proponents say it's not a problem, there is nice healthy seagrass there. I don't know which part is true. I want to learn more to put some facts into the bar room chatter!" (Plymouth meeting participant)

Strong peer relations within at least some parts of the boating community strengthened social norms. Advice from other boaters was important and that boaters *"are quite ready to tell others where they are going wrong – and are quite responsive to being told"* (interview participant). Another commented that boaters are aware of and care about how they are seen by other boaters. This interviewee noted that the concern about how they are perceived by others is not shared by all boaters.

"There's a lot of embarrassment comes with owning a boat. If [anchoring away from seagrass] were part of training and part of a captain's qualification, I think then people would be worried about what other people think of them because they would assume they also have that qualification". (interview participant)

Meeting participants and survey respondents reiterated the view that not all boaters care about the environment. Although participants viewed protecting seagrass as a communal responsibility, a few felt that *"most people do not think at all about the condition of the seabed when they lift their anchor."* (Plymouth meeting participant). They perceived wide variations in boater behaviours and attitudes:

"Certain people are more keen to make sure the environment is as good as it can be and others like to ride around on rottweilers on water, we are totally different people and have different perspectives on the environment". (Plymouth meeting participant)

"I suspect majority do not think about seagrass, and perhaps sailing are more aware, but there is a new breed e.g. plastic fantastic, often buy a boat with little experience and are not really interested in that sort of thing". (joint meeting participant)

Only a minority of survey respondents agreed or strongly agreed with items that '*other boaters tend to anchor away from seagrass*' (Q39, n=141, 12%) or '*...use an AMS*' (Q41, n=141, 38%). Respondents from the Solent had higher agreement that other boaters anchor away than those from Plymouth (3.04 compared with 2.52, $t=2.55$, $df = 45.416$, $p= 0.014^{50}$), perhaps reflecting their stronger perception, discussed in Opportunity, that there are more opportunities to anchor away from seagrass in the Solent. A minority agreed that '*people who are important to me value anchoring away from seagrass*' (Q39, 39%) or '*...using an AMS*' (Q41, 35%). There was stronger endorsement of personal norms, thus around half of respondents agreed that '*people like me*' would anchor away (Q39, 52%) or use AMS (Q41, 57%). Overall, boaters who took part in our research saw themselves as more concerned to protect seagrass than other types of boater. This may reflect a general ingroup bias (Tajfel, 1974), whereby people tend to view members of the same group as themselves more favourably than members of other groups. It may also reflect a sampling bias, in the sense that people who are concerned about the environment may have been more likely to take part in the study than those who are less concerned.

Authorities such as harbour masters, the Queen's harbourmaster, Plymouth City Council and Natural England, were seen as having a role in protecting seagrass. There was a feeling that this role was one of reinforcing a social norm of environmentally sensitive behaviour, and that boaters would respond better to information than to regulatory enforcement. As one interviewee expressed, boaters would also respond better to messages from organisations to which they belong and which represent boaters.

"If something comes from a city or a corporation or Natural England... oh! If it comes from the RYA, there's more listening because they know the RYA and places like that, they will protect people on the water". (interview participant)

Many survey respondents agreed that the '*RYA would prefer me to anchor away from seagrass*' (Q39, n=141, 60%) or use an AMS (Q41, n=141, 44%) and they were generally inclined to do what the RYA or local harbour authority thinks they should do (Q39, 69%). There was considerable uncertainty about the RYA's views however, with 55% responding 'neither agree nor disagree' or 'don't know' to the statement in Q41 that '*the RYA thinks that I should use an AMS where they are available*'. A smaller but still sizeable proportion (37%) were uncertain about whether the RYA prefers boaters to anchor away from seagrass (Q39). These responses suggest that better communication from boater organisations could be a strong motivator.

What predicts intentions to anchor away or use an AMS?

The survey was designed using the theory of planned behaviour (Ajzen, 1991), which is widely used to predict people's behavioural intentions in terms of their perceived social norms, attitudes, and perceived behavioural control (that is, perceived capability given existing constraint or opportunity). We also included items on imagination – measured as agreement to '*I can clearly imagine how good it would feel to be protecting seagrass*' and '*I can clearly imagine how I would avoid anchoring near seagrass/use AMS*' – based on work that shows a key role for emotional imagery in desire and confidence to achieve behavioural goals (Kavanagh and others, 2005; Kavanagh and others, 2020). Regression analyses tested how well these variables accounted for variations in boaters' intentions

⁵⁰ This is a t-test showing the differences between the means on this question. See footnote in the Method section under Analytical Approaches

to protect seagrass. Specific intentions to anchor away were predicted by a model containing social norm (*'people like me anchor away from seagrass'*) and attitude (*'Anchoring away from seagrass is a good thing to do'*), $r^2 = 0.69$, $p < .001$. Adding imagery items, knowledge of environmental benefits of seagrass, and environmental concern did not improve how well the model predicted intentions to anchor away ($p = 0.27$). In other words, intentions to anchor away were driven by feeling that this would be a good thing to do and that other people like me would do it too, rather than by general environmental concerns or knowledge.

Predictions of intention to use an AMS were somewhat different. For this behaviour, all three elements of the theory of planned behaviour were important: perceived behavioural control (agreement to statements in Q42 on ease and confidence of using AMS) as well as social norms and attitude ($r^2 = 0.66$, $p < .001$). Adding items on imagery (imagining using AMS and imagining how good it would feel to be protecting seagrass), knowledge of seagrass' environmental role, and environmental concern significantly improved the model (increase in $r^2 = 0.10$, $p < .001$). That is, intentions to use an AMS were influenced by a wide range of factors including concern for the environment, knowledge about seagrass, ability to imagine feeling good protecting seagrass by using AMS, believing other boaters would use AMS, having capability and having a positive attitude to using AMS. The difference between the two behaviours might be due to the fact that using AMS is a less familiar behaviour than anchoring away. For boaters who are interested and have learned something about AMS, it offers the opportunity to do something novel and positive for the environment. With anchoring away, many boaters have already experienced the downsides of avoiding favoured anchoring spots; we note that confidence regarding anchoring away was lower than for using AMS and that reported behaviour fell short of stated intentions for anchoring away (see [Capability](#)).

Discussion

Participants in the study were highly motivated to protect the environment generally and seagrass specifically. This motivation sometimes conflicted with their motivation to preserve their freedom to enjoy favourite places and to stay safe while boating, for example to use more familiar mooring or anchoring techniques or to anchor in the sheltered bays where seagrass grows. The overriding feeling was that behaviour change required education and information rather than legislation and enforcement. Boaters were willing to compromise to protect their freedom, for example to voluntarily avoid seagrass at some times of year or use an AMS to preserve access to a favourite location. Barriers to change included perceived lack of concern about seagrass from some boaters, and the fact that many boaters did not belong to organisations that could disseminate information. The most important facilitator was thought to be education about the importance of seagrass, how boating behaviours are damaging it, and how alternative behaviours will protect it. There was a feeling that current messages focus on the importance of seagrass without explaining how boating behaviours affect it. There was a strong need for better information about seagrass locations, to facilitate voluntary avoidance of those locations. Participants expressed the importance of the boating community for disseminating information and establishing norms of good behaviour and professionalism. Survey responses were generally similar across the two locations sampled, with the exception that the Solent respondents had higher environmental values and stronger opportunity, capability, and social norms in terms of anchoring away from seagrass.

We suggest that successful behaviour change strategies will reinforce perceived social norms that boaters care about the ocean, provide a clear rationale for protecting seagrass, and enhance perceived behavioural control by providing information about seagrass locations, alternative mooring

and anchoring locations or technology, and opportunities to practice behaviours that will protect seagrass. Messaging and education should work at an emotional level to amplify the sense that it will feel good to protect seagrass.

8. Conclusions

Summary of key findings

A summary of the key finding by research question is presented in this section.

Damage from seagrass: anchoring and mooring behaviours of recreational boaters

There were mixed levels of awareness and acceptance of damage to seagrass caused by anchoring and mooring behaviours of recreational boaters expressed by the research participants. Other boating and non-boating causes identified included gunning the engine, fishing boats, storm damage. Views were expressed by some meeting participants that local seagrass is not in decline and can adapt and recover.

Anchoring behaviours identified by participants as having potentially damaging effects included: using plough anchors dragging the anchor; not bedding in the anchor properly; putting down more anchor chain than is required; and dropping anchor but not reversing on it.

Overall, the majority of the survey respondents held positive attitudes towards acting to avoid seagrass, however for many a gap exists between intention to anchor with care and their behaviour.

Anchoring in seagrass is not an uncommon practice among boaters and many do so with prior knowledge that seagrass is in the area. The dominant reason for anchoring in seagrass is safety, as seagrass grows in sheltered shallow bays which are good safe locations to anchor.

Meeting participants were unclear where seagrass was located in their local areas. They also expressed low levels of knowledge about the health of seagrass and the potential impacts of anchoring in seagrass. Common information sources used to plan where to anchor and are other boaters / social media, leaflets, online searches, experience and local knowledge. For the majority of those who received training on anchoring this did not cover preventing damage to the seabed.

Some differences were evident between Plymouth and the Solent boaters: a higher proportion in Plymouth had anchored in seagrass and reported looking to see if there is seagrass where they plan to anchor. Plymouth boaters also mentioned the environment and physical factors as an important influence on the ability to anchor away from seagrass. A higher proportion of the Solent boaters had received anchoring training from RYA recognised centres and were familiar with the Green Blue campaign.

Differences between boaters' behaviours: perceived and actual

Boaters perceive there to be differences between yacht boaters and motorboaters in terms of anchoring and mooring behaviours that impact on seagrass. However, the distinction between the two groups wasn't clearly defined in our research. The survey results show that many yacht boaters also use motorboats and vice versa. Using that three-way distinction across the survey data showed very few areas of difference, suggesting the perception of difference is not borne out in the data.

Factors that boaters perceive to influence anchoring and mooring behaviours of different boater types included experience level, belonging to a club/association, and environmental awareness.

Findings from the boater meetings only suggest that anchoring/mooring behaviours depend on the type of boat trip/activity. For example, whether planning to stop at all or not, and how long they plan to stop for. There were mixed perceptions about whether 'day trippers' or overnight stops would be more responsible for damage to seagrass.

There was some limited evidence from the literature review that size of boat also impacts level of damage to seagrass. However, there were mixed perceptions of boaters in boater meetings about whether smaller or larger boats are more responsible for damage to seagrass. It would be useful to investigate this further in a specific location.

Approaches to changing anchoring and mooring behaviours of recreational boaters

This question focussed on the evidence around approaches to changing anchoring and mooring behaviours of recreational boaters in order to reduce damage to seagrass. The approaches examined included deployment of AMS and VNAZ, alternative approaches to anchoring, navigational aids, and educational materials. This question drew mainly on data from the evidence review, the interviews, and the boater meetings as topics covered here were not focused on in the survey.

Overall, a lack of evaluations of approaches to changing the anchoring and mooring behaviours of recreational boaters, of both the effectiveness of technical equipment (e.g. AMS) and behaviour change strategies was found in the evidence review. However, in their study of AMS deployment in Torbay, UK, Parry-Wilson (2019) found a reduction in anchoring events and a reduction in pressure on the seagrass at the site of 20%. Perhaps because of the lack of evaluations, more information on AMS and their effectiveness specifically in the UK given its tidal range was asked for by the meeting participants. The work of the ReMEDIES project will be especially useful in providing UK focussed evidence on the effectiveness of AMS.

Opinions were mixed as to the effectiveness of anchoring away to reduce pressures on seagrass from recreational boaters, with the suggestion VNAZ could be effective and complied with depending on the location. Specifically, when there are no alternative places for boaters to anchor, and if the areas are particularly sheltered and safe, it was thought less likely that they would be complied with. Concern at potential curtailment of the freedom that boaters enjoy was also expressed and this was picked up on under research question 4.

Alternative anchoring techniques (e.g. using a trip line) provoked concern from meeting participants as to whether they would be effective in reducing damage to seagrass and whether it was an effective way to retrieve an anchor. There was a recognition that changing anchoring behaviours was possible for boaters, but for it to happen more discussion and understanding of what impact those changes might have on seagrass, and on boaters' usual behaviours was needed.

The evidence showed that navigational aids (e.g. buoys) could be effective, especially if they have clear actions for the boaters on the buoys. There was mention of those in the Helford area as being effective at keeping the VNAZ. Likewise, it is clear that whilst there is an important role for knowledge and education, care needs to be taken not to invoke the 'information deficit' model of behaviour change and is best used in conjunction with other approaches to improve effectiveness.

Perhaps unsurprisingly, combining approaches (e.g. VNAZ, navigational aids, information online/leaflets, monitoring etc) was recommended from the evidence review and from the participants in the meetings and interviews as being the most effective for changing boater behaviours. A focus on encouraging connection to the ocean and stewardship of the seagrass beds was preferred to more punitive, restrictive approaches.

Barriers and facilitators to boaters taking action

Overall, the boaters in the meetings and the survey expressed connectedness to the ocean and strong motivations to protect it. There appears to be a willingness to change behaviours that damage seagrass but this is coupled with a strong resistance to enforcement; boaters want the freedom to choose where they go and to choose what they perceive as safe options for anchoring and mooring. Given this, education and information about seagrass and approaches to avoiding impacts were the preferred approaches to interventions. The issue of both wanting to protect the environment coupled with the reality of staying safe is a challenge for interventions to protect seagrass, especially given that some locations will be better suited to provided other safe areas to anchor than others. It will be important to understand the physical constraints in different locations as well as the perceptions and values of local boaters.

Lack of information on both seagrass (e.g. its value as an ecosystem, its location, damage from boaters etc) and behaviours to reduce impacts on seagrass was perceived as a key barrier. Strong messaging is needed to educate boaters on how boating behaviours damage seagrass and how changes will protect it.

Current information about seagrass locations is poor, with participants largely not knowing where it is located at the two sites or how to access information about where it is located.

RYA and harbour authorities are respected sources of information and have a strong role to play in establishing social norms to protect seagrass.

Implications / recommendations for behaviour change strategies

Across the different research questions a number of key implications can be derived from the findings. These can be usefully discussed in three sections:

- General implications to reduce barriers and increase facilitators to changing behaviours.
- Implications relating to specific interventions.
- Implications relating to the two locations.

General implications

- Recognise that any behaviour change strategy needs to cover the psychological (e.g. motivations, emotions), social factors (e.g. social norms) as well as the physical (e.g. AMS, VNAZ) aspects. That is, to be effective, interventions should be combinations of activities that address these different aspects.
- Build on the desire of boaters to protect the ocean and their sense of connection to it through

developing consistent information about seagrass, the impacts of boaters and actions that can be taken. Work in the interventions could usefully examine the types of messages that facilitate ocean connectedness and how different images may evoke feelings of connectedness.

- Collaborate with boaters on the interventions, specifically, AMS and VNAZ where the evidence is still uncertain to explore the strengths and weaknesses for a particular location. Encourage boaters to engage with the science around AMS, to discuss different evidence, and to develop co-created solutions which could be in terms of user centred design of AMS as well as decision making around installation/deployment decisions. Encourage messaging around AMS as a solution for seagrass protection and consider way to address concerns about safety and having alternative safe places to anchor when needed.
- Work to reframe the issue as one that encourages co-operation between boaters to reduce damage to seagrass in particular, and value seagrass in general for its environmental benefits, rather than using a narrative that implies blame on one group or another.
- The participants in this research were predominantly experienced, interested recreational boaters. Given their comparatively greater levels of interest and engagement in the subject, it is recommended that efforts are made to target these kinds of boater and to encourage them to become ambassadors for seagrass and its protection. Train up a network of volunteers to talk to their clubs/marinas about the topic. This could also be used to reach new boaters and help establish desired behaviours early on in their boating.
- Use trusted authorities e.g. RYA and other national organisations (e.g. NE) to put out consistent messages at the national and local level. ‘Trust’ and ‘influence’ play out differently for different individuals, for example, depending on past experiences, so it could be useful to investigate widening the reach of influencers, to include those who may appeal via ‘celebrity’ status to different audiences (e.g. well-known sailors). Doing this would need some research into who would be most appropriate for different audiences and looking at the evidence from other campaigns to see what their impact is in practice.
- Carry out multiple strategies in one place so that boaters are hearing about the issues from a wide range of sources.

Implications for specific actions in ReMEDIES

AMS

The low numbers of studies on the effectiveness of AMS, together with mixed feelings amongst boaters about their effectiveness, suggests that working through the evidence with interested boaters to explore its strengths and weaknesses, what more information is needed to convince them of their efficacy for both boaters and reducing damage to seagrass, and where AMS might reasonably be installed with low levels of controversy to build confidence (e.g. it could be that they are more acceptable in harbours as opposed to open water) would be a useful approach. Ensure that installation of AMS is linked to an information campaign around the importance of seagrass, its location in the local areas, and the benefits of AMS.

VNAZ

Provide clear opportunities for boaters to go elsewhere, perhaps encourage the exploration of areas away from the popular areas with seagrass. Make it a positive attribute to look beyond those popular areas with seagrass – appeal to the “freedom” narrative by encouraging people to other areas rather than away from the seagrass.

Information boards/leaflets/apps

These need to activate social norms (ie that boaters feel connected to the ocean and care about protecting it). They could feature 'boaters like me' who other boaters could identify with and emphasise that caring about seagrass as part of being a 'responsible boater' in addition to positive emotions associated with protecting seagrass.

There would need to be explanations of how behaviours affect seagrass, together with providing information on which alternative behaviours should be carried out and where to find out more. This type of information should help improve self-efficacy of boaters with respect to behaviours in relation to seagrass.

Using existing platforms to build in new information on seagrass rather than developing new ones would mean that boaters would be familiar with the platform and more likely to engage with the information. This could apply to apps and websites etc.

Training

The same issues under information boards/leaflets should be included into training materials, to appeal to social norms and self-efficacy. In addition, a key benefit of training could be the possibility of boaters being able to practice some of the behaviours for themselves and to imagine doing the behaviours, e.g. making a plan of where they could go to avoid seagrass, trying out different approaches to anchoring, etc. Reaching those who don't belong to clubs should be considered, brief training could be included at the point when people hire boats, as part of the routine information given to boaters.

Implications for the two locations

From our research there were few clear differences between boaters' attitudes and intentions between the two locations. However, there was evidence of some difference in experience of VNAZ and AMS and differences in environment. Boaters in Plymouth who took part in this study expressed more experience of VNAZ and AMS than the boaters in the Solent who took part in this study. Further there was some indication that the environment in Plymouth is more challenging with the areas where seagrass also being the sheltered and safe areas for anchoring. What comes through is the importance of understanding the specific locations of seagrass and how those are currently used and the implications for boaters of any further interventions. Taking a collaborative approach with local boating communities to work through key issues would be the best way forward in areas where there could be concern as to the location of further interventions which is what further work on the ReMEDIES project will be doing.

Limitations and future research

Limitations

The sample for the boater meetings and the survey was limited by the recruitment method to those boaters who were mostly male, older, experienced and had heard of seagrass. This was to be expected given the opportunity and snowball approach. Ideally, we would have been able to compare our sample to a representative sample of boaters, however, there were no easily accessible statistics to draw on within the scope of this project. Given this, it is difficult to say how far our sample differs from the true range of boaters but it is likely that this method did not account for day-trippers, non-

locals, or other kinds of boaters who come to this area more occasionally. We have suggested some further research which could examine this further.

It is not possible to calculate the response rate for the survey given that it was not sent to a set number of participants. Given the length and complexity of the questionnaire, together with the fact it was not sent directly to a specific sample, and it was on a very specific topic area we suggest that the number of responses was on the low side but acceptable and enabled us to carry out some inferential statistics. It was sent out during the Covid-19 pandemic which meant that there were no face to face ReMEDIES activities happening which could have encouraged more people directly to fill in the questionnaire. To increase the number of responses the questionnaire could have been shorter and targeted to specific people/email lists via key stakeholders. We make a suggestion for further research that could address this issue.

Recommendations for future research

We would suggest a number of areas where this future research would be useful in helping to understand boater behaviours in relation to seagrass, specifically anchoring and mooring.

Test the findings on a representative sample of boaters

Our research took an opportunity and snowball approach to sampling making it not possible to generalise the findings to the wider population of boaters and it was likely there were groups of boaters who did not take part in the research (e.g. visitors, day-trippers, boaters with very little experience). To assess how far our findings are representative of the total boating population, we recommend future research in this area (i.e. examining boaters' anchoring and mooring behaviours in relation to seagrass) takes a structured sampling approach to reflect the full range of boaters. This would require having knowledge of the full range of boaters in order to structure the sample. The RYA is part of the group that commissions the Watersports Participation Survey and it may be that data from that survey could be used to help design a sampling approach that is representative of that full range. The data from the Watersports Participation Survey is not available publicly and would require Natural England to organise data sharing with the RYA. We would recommend that resources are put into a market research recruitment process to ensure all types of boaters are included (i.e. day trippers, visitors, local boaters, those with more and less experience). If there is national data on boaters then quotas could be derived from that to cover the different types of boater. This could be used to carry out a formal segmentation study on boaters to see how far there are clearly different types of boater associated with different types of behaviours which would require different approaches to influencing behaviours.

Gather detailed data on boaters' decision making in real time

Future research could usefully examine recreational boaters' decision making in the moment through an ecological momentary assessment study to investigate for example, how habitual or automatic boaters' decisions around anchoring or mooring are, particularly for experienced boaters, and to explore all factors influencing decision-making. This would enable analysis of the key decision points where changes could be made to influence behaviours. It could also explore the range of factors that influence where people anchor and moor and the different weighting given to these factors when

they are in conflict e.g. relatively weighting put on pro-environmental attitudes and environmental/physical factors of the boating location.

Contextualise boaters anchoring and mooring behaviours in relation to seagrass in a wider framework of related behaviour change projects

The evidence review was focused on research that examined boaters' anchoring and mooring behaviours in relation to seagrass, and the possibility of influencing those behaviours to reduce damage to seagrass, from 2015 – 2021. Only a small amount of literature on behaviour change related to seagrass was returned by the searches and resources prevented a wider search. Given this, it would be useful to search for other behaviour change projects involving UK recreational boaters more generally as there may be relevant literature on differentiation within boating communities (e.g. different types of boaters), which could contextualise this specific project. The search could also be widened to include older papers and reports.

9. References

- AJZEN, I. (1991). The theory of planned behaviour. *Organizational behaviour and human decision processes*, 50(2), 179-211.
- AMEC FOSTER WHEELER ENVIRONMENT & INFRASTRUCTURE UK LIMITED. (2017) Potential for eco-moorings as management option for Marine Protected Areas (MPAs) Final Report. Cefas/ Defra.
- BARRY S.C., RASKIN K.N., HAZELL J.E., MORERA M.C., MONAGHAN P.F. (2020) Evaluation of interventions focused on reducing propeller scarring by recreational boaters in Florida, USA. *Ocean and Coastal Management*
- COLLINS A.M., COUGHLIN D., MILLER J., KIRK S. (2015) The Production of Quick Scoping Reviews and Rapid Evidence Assessments: A How to Guide. December 2015. Joint Water Evidence Group (JWEG), Defra.
- DIEDRICH A., TERRADOS J., ARROYO N.L. AND BALAGUER P. (2013). Modeling the influence of attitudes and beliefs on recreational boaters' use of buoys in the Balearic Islands. In *Ocean and Coastal Management*.
- GLASBY T.M. & WEST G. (2018) Dragging the chain: Quantifying continued losses of seagrasses from boat moorings. *Aquatic Conservation: Marine and Freshwater Ecosystems*
- GOLLWITZER, P. M., & SHEERAN, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in experimental social psychology*, 38, 69-119.
- GRIFFITHS, C.A., LANGMEAD, O.A., READMAN, J.A.J. AND TILLIN, H.M. (2017). Anchoring and Mooring Impacts in English and Welsh Marine Protected Areas: Reviewing sensitivity, activity, risk and management. Report for Defra.
- KAVANAGH, D. J., ANDRADE, J., & MAY, J. (2005). Imaginary relish and exquisite torture: the elaborated intrusion theory of desire. *Psychological review*, 112(2), 446.
- KAVANAGH, D. J., TEIXEIRA, H., CONNOLLY, J., ANDRADE, J., MAY, J., GODFREY, S., ... & CONNOR, J. P. (2020). The Motivational Thought Frequency Scales for increased physical activity and reduced high-energy snacking. *British journal of health psychology*, 25(3), 558-575.
- KELLY J.J., ORR D., TAKEKAWA J.Y. (2019) Quantification of damage to eelgrass (*Zostera marina*) beds and evidence-based management strategies for boats anchoring in San Francisco Bay. *Environmental Management*.
- KRUGER, J., & DUNNING, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121–1134

- LA MANNA G., DONNO Y., SARÀ G., CECCHERELLI G. (2015) The detrimental consequences for seagrass of ineffective marine park management related to boat anchoring. *Marine Pollution Bulletin*.
- LANGMEAD, O., TILLIN, H., GRIFFITHS, C; AND BASTOS, E, MILBURN, H, BUTLER, J. & ARNOLD, M. (2017) *EMS Recreation Study Document 04. Survey of recreational use within the Plymouth Sound and Estuaries European Marine Site: Scoping report and survey results*. A report for Plymouth City Council prepared by the Marine Biological Association of the UK.
- LATHROP R.G., BOGNAR J., BUENAVENTURA E., CIAPPI M., GREEN E., BELTON T.J. (2017) Establishment of Marine Protected Areas to Reduce Watercraft Impacts in Barnegat Bay, New Jersey. *Journal of Coastal Research*.
- LUFF, A.L., SHEEHAN E.V., PARRY M., HIGGS N.D. (2019) A simple mooring modification reduces impacts on seagrass meadows. *Scientific Reports*.
- MACLENNAN, J. (2020) Advanced Mooring Systems (AMS) Workshop 2020. Workshop Report 30/01/2020. LIFE Recreation ReMEDIES (LIFE18 NAT/UK/000039 Reducing and Mitigating Erosion and Disturbance impacts affecting the Seabed. Natural England.
- MAYER, F. S., AND FRANTZ, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*. 24(4), 503-515.
- MICHIE AND OTHERS (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*. 2011, 6:42 <http://www.implementationscience.com/content/6/1/42>
- OUISSSE V., MARCHAND-JOURAVLEFF I., FIANDRINO A., FEUNTEUN E., YSNEL F. (2020) Swinging boat moorings: Spatial heterogeneous damage to eelgrass beds in a tidal ecosystem. *Estuarine, Coastal and Shelf Science*.
- PARRY-WILSON, H., 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.
- RARE AND THE BEHAVIOURAL INSIGHTS TEAM (2019) Behavior Change For Nature: A Behavioral Science Toolkit for Practitioners. Arlington, VA: Rare.
- ROYAL YACHTING ASSOCIATION (RYA) (n.d.) EFM Projects and Trials. RYA website. Available from: <https://www.rya.org.uk/knowledge-advice/planning-environment/Pages/efm-projects-trials.aspx> [last accessed 21/09/20]
- SAGERMAN J., HANSEN J.P., WIKSTRÖM S.A. (2020) Effects of boat traffic and mooring infrastructure on aquatic vegetation: A systematic review and meta-analysis. *Ambio*.
- SOLBRIG, L., Whalley, B., Kavanagh, D.J., May, J., Parkin, T., Jones, R., and Andrade, J. (2019) Functional imagery training versus motivational interviewing for weight loss: a randomised controlled trial of brief individual interventions for overweight and obesity *International Journal of Obesity* Apr;43(4):883-894

TAJFEL, H. (1974) Social identity and intergroup behaviour. *Social science information*, 13(2), 65-93.

UNSWORTH, R. K., WILLIAMS, B., JONES, B.L. AND CULLEN-UNSWORTH, L.C. (2017) Rocking the Boat: Damage to Eelgrass by Swinging Boat Moorings. *Frontiers in Plant Science*.

VALAURI-ORTON, A (2018) Changing Boater Behavior to Protect Seagrass: A Toolkit for Designing and Implementing a Behavior Change Campaign for Seagrass Damage Prevention. The Ocean Foundation.

VENTURINI S., MASSA F., CASTELLANO M., FANCIULLI G., POVERO P. (2018) Recreational boating in the Portofino Marine Protected Area (MPA), Italy: Characterization and analysis in the last decade (2006–2016) and some considerations on management. *Marine Policy*

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