



Research article

Identifying social factors that undermine support for nature-based coastal management

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ABSTRACT

Human use and degradation of coastal ecosystems is at an all-time high. Thus, a current challenge for environmental management and research is moving beyond ecological definitions of success and integrating socioeconomic factors. Projects and studies with this aim, however, have focused primarily on monetary valuations of ecosystem functions, overlooking the behaviors and psycho-social motivations of environmental management. Using a nature-based salt marsh restoration project on Martha's Vineyard, Massachusetts, we assess the role of human attitudes and preferences in evaluating social success for ecosystem management. We use structural equation modeling to compare the strengths of social variables in predicting restoration project support, and find public understanding to be a more important predictor than personal values. Our results show that even among stakeholders with strong pro-environmental values, a weak understanding of the management initiative can undermine support. We also find that project support does not necessarily translate to the prioritization of similar management strategies. Instead, when individuals consider overall management priorities, differences arise between particular resource user-groups. This suggests that strong public support for individual initiatives can misconstrue complexities in stakeholder preferences that emerge in more comprehensive management considerations. Future investigations of the psycho-social components of management solutions should address the potentially tiered nature of human preferences, as well as whether public perceptions of management effectiveness act as an additional context-dependency of social viability.

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1. Introduction

Coastal habitats provide a wide variety of ecosystem services and support diverse ecological communities, but have been severely degraded (MEA, 2005). Salt marshes are one of the most impacted of all coastal habitats due in large part to development practices (Bohn and Kershner, 2002; Lotze et al., 2006). As a result, coastal salt marshes have become the focus of many restoration and management efforts. For restoration to be successful, nature-based strategies are needed that support ecologically and socially desirable outcomes, and not shoreline armoring that drives further habitat loss and disrupts land-water exchange (Bozek and Burdick, 2005). However, nature-based coastal protection interventions are still in their infancy, particularly in high-energy salt marshes

(Scyphers et al., 2015). The coastal management value of these approaches will depend on both ecological and social responses to their implementation.

To utilize a coupled social-ecological systems framework in coastal management, it is necessary to understand how variables from both systems interact and contribute to project success. Currently, empirical understanding of relevant ecological factors exceeds that for social factors (de Juan et al., 2017). Furthermore, the framework for understanding what it means for management to be socially viable is not well established, and rarely operationalized (but see Knight et al., 2010; Klain and Chan, 2012). While socioeconomic assessments of coastal management efforts are becoming more common, monetary valuations dominate (Le Gentil and Mongrue, 2015). Social-psychological research on environmental attitudes and behavior, however, has demonstrated that people are motivated by far more than economic considerations (Stern, 2000). In fact, many have argued that management conflicts (e.g. illicit trade of natural resources, adherence to Marine Protected Area restrictions) are often a struggle of social values rather than

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technical expertise or ecological processes (Mascia et al., 2003; Gelcich et al., 2005).

Human values are described as preferences for certain modes of conduct (means), or outcomes (ends), that act as a motivational framework to guide behavior (Schwartz, 1994). This framework has been adapted to explain the role of personal values in motivating environmentally significant behavior for conservation and management (Stern et al., 1993). This adaptation suggests that concern for environmental issues is based on matters of altruism (a social-altruistic values orientation), self-interest (egoistic orientation), or in the interest of 'all living things' (biospheric orientation). In natural resources management, the extent of concern acts as the precursor to attitudes that shape policy or project support. Therefore, an understanding of human values associated with management support and viability can help managers anticipate behavior (e.g., compliance) or identify potential management alternatives.

This study aimed to inform our understanding of effective social-ecological management by using human values, perceptions, and preferences in assessing what facilitates social viability in coastal management. To operationalize this, we conducted semi-structured interviews with individuals representing multiple stakeholder groups in coastal communities across Martha's Vineyard (MA, USA). A nature-based salt marsh stabilization project was created with a 'living shoreline' design using biodegradable materials. The novelty of this technique coupled with the high visibility associated with the project provided a social landscape well suited for exploring human responses and preferences. Specifically, we sought to determine how social variables influenced project support and mediated choices for potential alternative management strategies.

2. Methods

2.1. Study setting

This study focuses on a community dealing with poor water quality and coastal erosion in Martha's Vineyard. As part of a response to these issues, a restoration effort was undertaken along an eroded salt marsh in Summer 2016. The restoration project involved installation of coconut fiber logs (0.4 m diameter x 3 m length) and bags filled with oyster shells (0.3 m width x 0.6 m length) in Sengekontakt Pond (Fig. 1). This 'living shoreline' design was implemented with the goal of reducing erosion and improving water quality through recruitment of salt marsh vegetation.

2.2. Survey design and data collection

Our 27-question survey instrument was created with multidisciplinary input from social scientists, ecologists, and managers and it included two parts with both quantitative and qualitative measures. First, we collected information using semi-structured, one-on-one interviews on an individual's relationship to Sengekontakt Pond, and the modes and frequencies with which they used it. Second, we allowed participants to self-report basic socioeconomic information (e.g. income level), behavioral norms related to environmental issues, beliefs about the state of the environment, underlying personal values, level of confidence in their understanding of the goals and design of the living shoreline restoration project, support for the restoration project, and preferences for pond restoration management scenarios. An individual's understanding of the restoration project is described as 'confidence' because participants were not required to prove that

they understood the project's goals and design. Environmental beliefs were gauged using the New Ecological Paradigm (NEP) scale (Dunlap and Van Liere, 1978) and underlying personal values were measured using Schwartz's value items organized into environmentally-relevant value orientations (Stern et al., 1993).

The coastal salt ponds on Martha's Vineyard, including Sengekontakt Pond where the living shoreline project is located, experience heavy use by both the residents living on the island, as well as the tourists who vacation there during the summer months (June–September). In particular, Sengekontakt Pond sees a wide range of recreational use along its shoreline, which includes private residences, conservation land, and public beaches. In an effort to capture this complexity in our data collection, we targeted individuals that fell within a 'community of interest' who either: (a) visited a public beach along the pond's eastern side (Joseph Sylvia State Beach); (b) visited a nature reserve along the western side (The Mass Audubon Felix Neck Wildlife Sanctuary); (c) lived or vacationed in a development along the southwestern side (Ocean Heights); or (d) held an active recreational shellfishing permit for the pond (Fig. 1). Study participants were recruited and interviewed in-person during peak tourist season in Summer 2016 at the three locations listed above, with the exception of shellfishers who were identified through a publically available list of active permit-holders and then recruited and interviewed over the phone because of scheduling difficulty. The only difference between interviews conducted in person ($n = 103$) and those conducted over the phone ($n = 7$) were the self-report measures; phone recruits completed these through Qualtrics online survey software. All study participants were dictated the same text describing the basic goals and design of the restoration project immediately prior to being interviewed.

2.3. Analyses

We used structural equation modeling (SEM) to investigate the links between social variables and project support within the dataset. We designed SEM structure in accordance with the relationships outlined by Values-Beliefs-Norms (VBN) theory (Stern et al., 1999), and used multi-model analysis to compare the strength of the VBN pathway in predicting project support against that of project understanding (Fig. 2). Given that the majority of latent variables stem from scales rigorously tested in previous literature, we used simple tests of reliability (Cronbach's alpha; Gliem and Gliem, 2003) to check their validity (Table 1). The latent variable measuring 'egoistic' values reported low reliability and was therefore removed from the model. We used partial-least-squares (PLS) regression as the method of estimation in our SEM due to a relatively small sample size compared with model complexity. This method of estimation does not report a global measure of goodness of model fit. PLS-SEM focuses instead on the explained variance of endogenous variables within a model, making it an adequate method for comparing the predictive strength of different social variable causal chains (Hair et al., 2011). All individual relationships between our social variables and project support were investigated further with one-way ANOVAs, post-hoc pairwise comparisons, and pairwise comparisons using t-tests. Of these, we focus our discussion of results on statistically significant relationships (i.e. ANOVA statistics are not reported because no significant relationships were found between variables compared using ANOVA tests). We also tested for differences across stakeholder groups in the priorities assigned to coastal management alternatives using t-test pairwise comparisons.

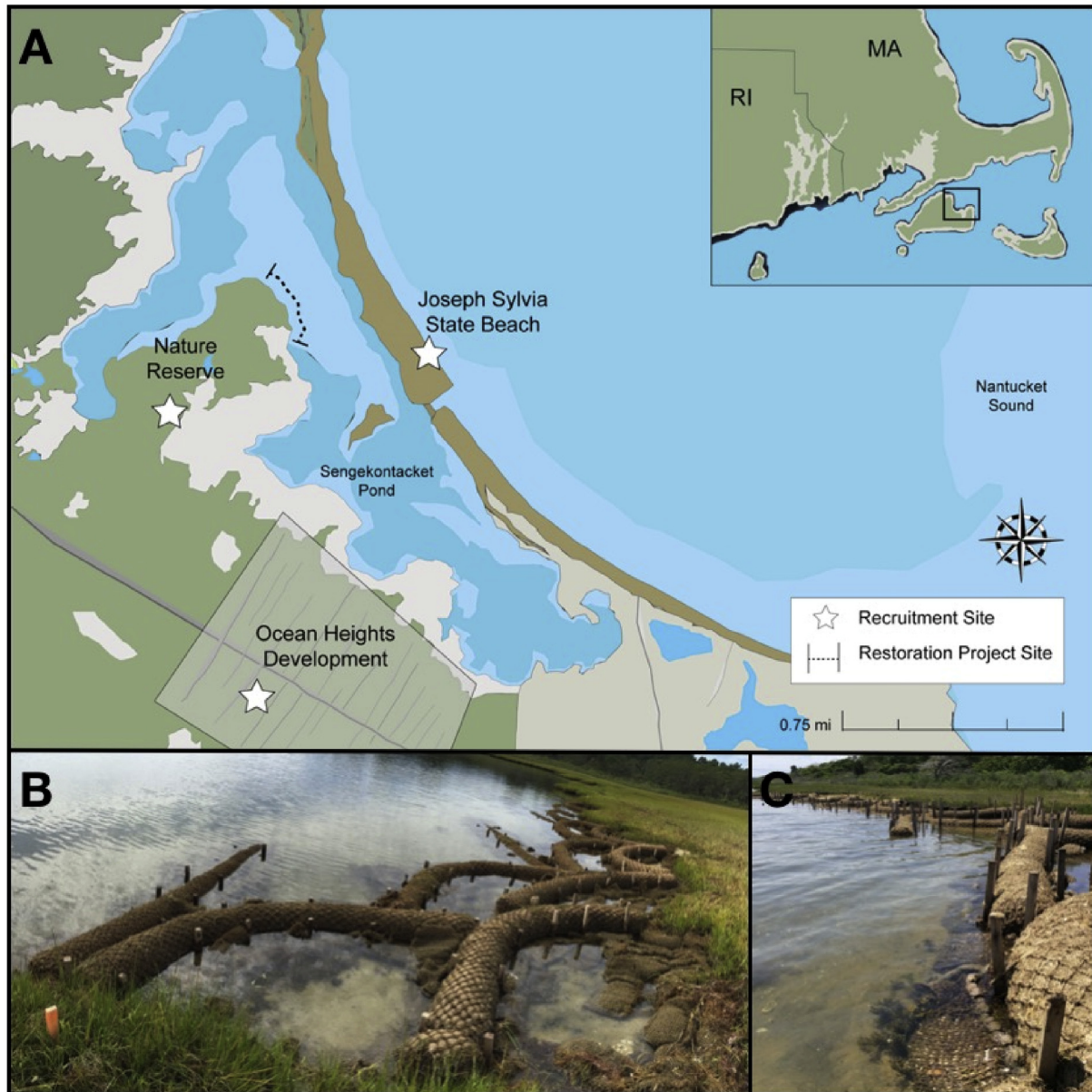


Fig. 1. Study site including: A) locations of interview recruitment sites relative to the living shoreline restoration project site, B) living shoreline restoration project, and C) detail of living shoreline design using coconut fiber logs and bags of oyster shell as a biodegradable shoreline stabilization and salt marsh habitat facilitation structure.

3. Results

3.1. Sample description

A total of 110 individual interviews were conducted between June and September 2016. Out of these interviews, 89 progressed far enough to be included in final data analyses. Sample sizes of individual analyses, however, vary due to the rights of study participants to refuse questions. Overall, participants skewed older (median age = 59 yrs), were almost evenly split by gender (51% female; 49% male), and trended towards higher affluence with high levels of education (44% reporting graduate or professional degrees) and high annual household income (37% earning \$150 K or more) compared to national trends (US Department of Commerce, 2015) (see Supporting Information for more information on demographics). Forty-five percent of interviewees were Martha's Vineyard residents and the other 55% were tourists.

3.2. Environmental attitudes

Overall, interview participants held strong pro-environmental attitudes (Table 2). Personal values oriented towards altruism, traditionalism and biospherism were scored similarly on average, with biospherism being highest overall. Personal values oriented towards egoism were scored lowest overall. The average NEP score among participants was 27.92, indicating a strong belief that ecosystems are currently threatened by human societies. On average, individuals were more concerned about environmental threats to plants, animals, and the local community than about environmental threats to themselves and their families.

3.3. Project support

Overall, results indicated the 'living shoreline' approach was a socially viable option among this community of interest. Less than

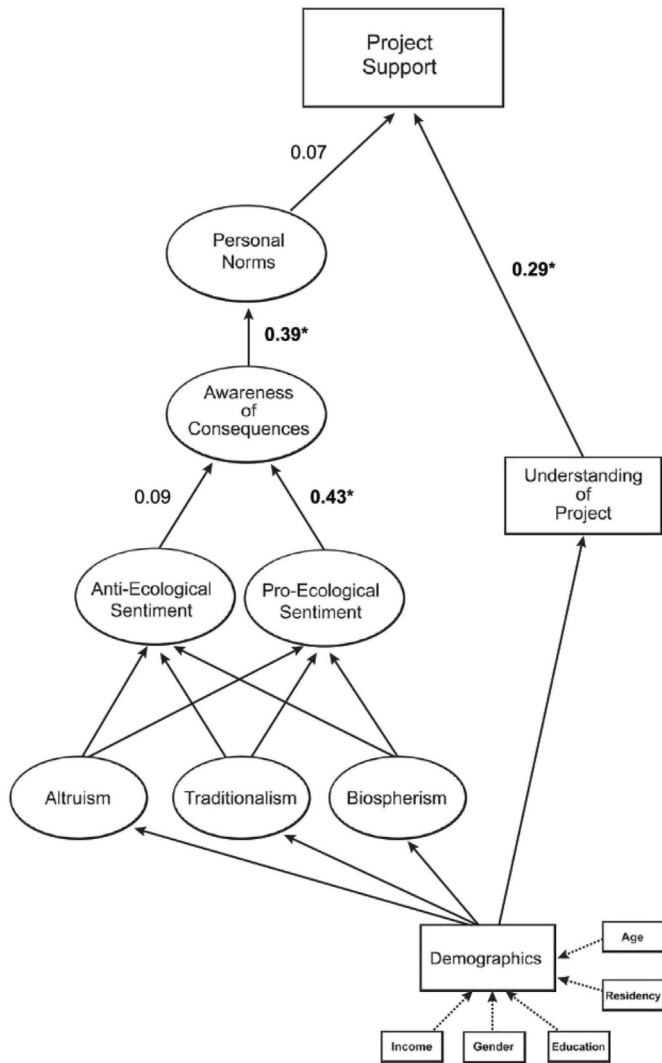


Fig. 2. Structural equation model (SEM) of restoration project support predicted by values-beliefs-norms (VBN) attitudinal variables and an individual's level of understanding of the project. Variables represented by squares are state variables and those in circles are latent variables. Descriptions of each variable are listed in Table 1; NEP scores are split along the NEP scale dichotomy of pro-ecological and anti-ecological sentiment. Demographic variables are visually represented as a single state variable to simplify the figure, but predictive pathways from all five variables were tested. Values on pathways are regression coefficients. *indicates statistical significance at the $p < 0.05$ level.

12% of study participants expressed an attitude of neutrality or opposition towards the restoration effort in Sengekontaktet Pond. Results from the SEM indicated relationships between social variables that are consistent with VBN theory (Stern et al., 1999) (Fig. 2). An individual's concern for the health of the world's ecosystems (reflected in NEP score) was positively related to their awareness of the consequences of degraded ecosystems ($\beta = 0.43$, $p < 0.05$), and this awareness was positively related to the strength of environmentally-relevant personal norms (e.g. staying informed on environmental issues) ($\beta = 0.39$, $p < 0.05$). However, the VBN causal chain did not significantly explain the variance seen in restoration project support. Instead, multi-model analysis showed a significant predictive pathway between an individual's stated project understanding and restoration project support. Additionally, a simple pathway from exogenous demographic variables through stated project understanding explained twice as much of the variance in

project support than the entire VBN pathway. According to the model, increases in stated project understanding significantly predicted increases in project support ($\beta = 0.29$, $p < 0.05$), while increases in the strength of personal environmental norms did not ($\beta = 0.07$, $p = 0.598$). This finding is reinforced by patterns among individuals who expressed higher (moderate or strong) and lower support (neutrality or opposition) towards the project. Individuals in these categories showed no significant difference in NEP scores (F-value = 3.25_{82,1}, $p = 0.263$), but individuals expressing lower support reported lower confidence in project understanding (F-value = 0.13_{84,1}, $p < 0.05$) (see Supporting Information).

3.4. Alternative management strategies

Despite strong support for the living shoreline project, a majority of stakeholders did not see habitat restoration approaches as the primary solution for Sengekontaktet Pond's degraded ecosystem (Fig. 3). Over 50% of study participants chose a coastal management strategy other than habitat restoration when asked to indicate which should be the priority for future initiatives. In particular, restrictions on new development in coastal watersheds and new regulations on septic and sewer systems were cited as important alternatives. This broader consideration of coastal management approaches also introduced differences between stakeholder groups (Table 3). On average, tourists assigned higher priority to habitat restoration (F-value = 0.77_{81,1}, $p < 0.05$), and residents assigned higher priority to dredging and breaching coastal ponds (F-value = 37.66_{81,1}, $p < 0.05$). Recreational shellfishers felt that habitat restoration was of lower priority (F-value = 0.35_{81,1}, $p < 0.05$) and updates to septic and sewer systems were of higher priority (F-value = 2.93_{81,1}, $p < 0.05$) compared to individuals who did not regularly shellfish.

4. Discussion

Our results suggest that an individual's confidence in understanding coastal management initiatives can mediate support more strongly than general environmental attitudes. Instances of low project support were not explained by weak environmental concern, but instead by a stated weak understanding of project design and objectives. Despite strong overall support for the living shoreline restoration strategy, a diversity of perspectives arose when considering priorities for future coastal management initiatives. More than half of those interviewed felt that habitat restoration was not of highest priority, and this demonstrated mismatches in the preferences of different resource-user groups.

4.1. Importance of situational factors

As situational constraints to environmentally-significant behaviors increase, human values and beliefs lose explanatory power (Steg and Vlek, 2009). Syntheses of environmental behavior theory assert that actions are a product of internal and situational factors; that the effects of pro-environmental intent on performed behavior function relative to context (Guagnano et al., 1995; Maio, 2003). In this study, we see the influence of situational constraints in the relationship between an individual's stated understanding of the restoration effort and their willingness to voice support for it. Our sample demonstrated a near unanimous attitudinal predisposition for pro-environmental behavior, but a portion expressed little to no understanding of how the restoration project aims to contribute to the coastal habitat. We identify this stated weak understanding as a situational factor rather than an internal condition because our sample showed no relationship between education and stated project understanding.

Table 1
List of variables including factors, reliability of latent factors using Cronbach's alpha (Sim and Wright, 2005), descriptions, and data type.

Variable	Factor	Reliability (Cronbach's alpha)	Description	Data Type
Demographics	Resident vs. Tourist	–	Whether respondent is visiting or living on island at the time of interview; seasonal residents categorized as residents	Categorical
	Pond Use	–	Most frequent activities within or around pond that serves as restoration project site	Categorical
	Gender	–	–	Binary; (Male, Female)
	Age	–	–	Continuous
	Education	–	Highest obtained education degree	5-point Likert-type scale; 'less than high school' - 'graduate or professional degree'
	Income	–	Household annual income	5-point Likert-type scale; 'less than \$25,000' - '\$200,000 or more'
Values	Altruistic Values	0.701	Importance of the follow items as 'guiding principles' in the life of respondent: (1) social justice, (2) equality, (3) world peace	5-point Likert-type scale
	Biospheric Values	0.850	Importance of the follow items as 'guiding principles' in the life of respondent: (1) unity with nature, (2) respecting earth, (3) preserving nature	5-point Likert-type scale
	Egoistic Values	0.502	Importance of the follow items as 'guiding principles' in the life of respondent: (1) influential, (2) wealth, (3) authority	5-point Likert-type scale
	Traditional Values	0.701	Importance of the follow items as 'guiding principles' in the life of respondent: (1) self-discipline, (2) family security, (3) honoring elders	5-point Likert-type scale
Beliefs	NEP Score	0.830	Score on dichotomous scale representing endorsement of a 'new ecological paradigm' vs. the 'dominant social paradigm' (Dunlap and Van Liere, 1978)	7-35 Score; 7 (strongest endorsement of dominant social paradigm); 35 (strongest endorsement of new ecological paradigm)
	Awareness of Consequences (AC)	0.779	Perceived threat of degraded Martha's Vineyard coastal ponds to: (1) local plants and animals, (2) them and their family, (3) the local community	5-point Likert-type scale
Personal Norms	Environmental Behavior Norms	0.774	(1) Effort spent staying informed on ecological conservation and restoration issues, (2) extent that ecological considerations drive daily behavior	5-point Likert-type scale
Project Understanding (PU)	PU Score	–	Score representing extent of respondent's understanding of the restoration project, project design, and project goals	1-4 Score; 3 binary (Yes, No) questions on project aspect understanding
Restoration Strategy Preference	Strategy Preference	–	Prioritization of specific restoration strategies in order to achieve successful coastal pond ecosystem restoration success	1-3 Ranking; top 3 priority strategies ranked
Project Support	Project Support	–	Extent of support or opposition of Martha's Vineyard living shoreline restoration project	5-point Likert-type scale

Table 2
Value-Belief-Norm (VBN) variable mean scores and measures of dispersion.

Variable Category	Variable	Scale	Score			
			Mean	SD	Min	Max
Values	Altruism	1 (weak) - 5 (strong)	4.22	0.71	1.67	5.00
	Biospherism	1 (weak) - 5 (strong)	4.33	0.60	2.33	5.00
	Egoism	1 (weak) - 5 (strong)	3.04	0.62	1.67	4.33
	Traditionalism	1 (weak) - 5 (strong)	4.30	0.55	3.00	5.00
Environmental Concern	Beliefs	7 (DSP endorsement) - 35 (NEP endorsement)	27.92	4.62	14.00	35.00
	Consequences For Plants & Animals	1 (weak) - 5 (strong)	4.56	0.73	2.00	5.00
	Consequences For You & Family	1 (weak) - 5 (strong)	3.57	1.01	1.00	5.00
	Consequences For Local Community	1 (weak) - 5 (strong)	4.37	0.74	2.00	5.00
Personal Norms	Try to Stay Informed	1 (weak) - 5 (strong)	3.44	0.92	1.00	5.00
	Environmental Consequence Guides Behavior	1 (weak) - 5 (strong)	3.88	0.81	1.00	5.00

In case studies of other environmentally relevant behaviors, such as curbside recycling (Guagnano et al., 1995) and use of public transport (Collins and Chambers, 2005), environmental concern is shown to be deficient in overcoming the barriers presented by a lack of access to the resources necessary to perform a certain behavior. Here, we suggest that the instances of weak public

understanding seen to diminish project support in our study could have resulted from a lack of access to information on the living shoreline initiative. If this is true, the state of public support for this initiative may benefit from targeted stakeholder engagement activities.

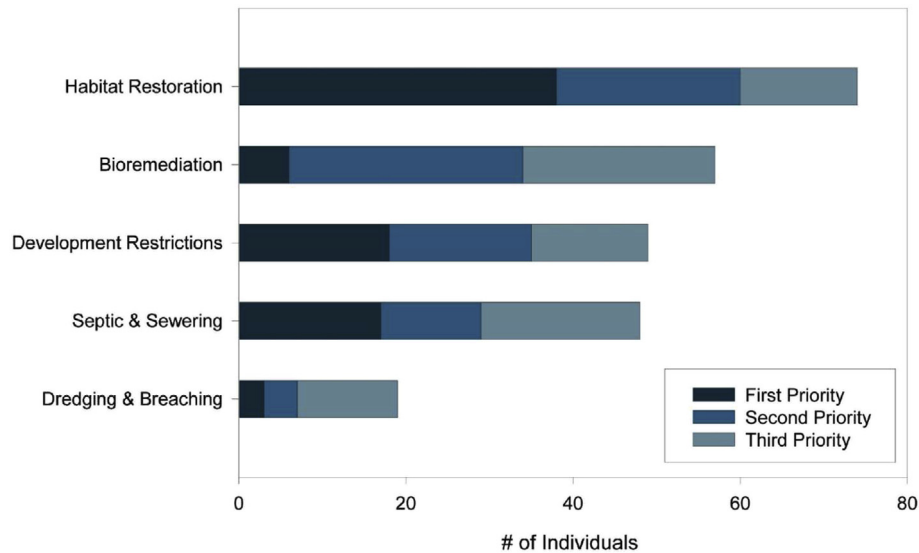


Fig. 3. Study participants' prioritization of strategies for the conservation and management of coastal salt ponds on Martha's Vineyard.

Table 3

Results from independent-samples t-tests of coastal management preferences by Martha's Vineyard residents (R) and tourists (T), and shellfishers (S) and non-shellfishers (NS).

	Residency			Shellfishing		
	F	p-value	Pairwise Comparison	F	p-value	Pairwise Comparison
Habitat Restoration	0.77 _{81, 1}	0.022	R < T	0.35 _{81, 1}	0.012	S < NS
Bioremediation	2.81 _{81, 1}	0.987	–	5.00 _{81, 1}	0.537	–
Septic & Sewer Regulation	0.11 _{81, 1}	0.819	–	2.93 _{81, 1}	0.022	S > NS
Development Restrictions	3.22 _{81, 1}	0.438	–	2.68 _{81, 1}	0.674	–
Dredging & Breaching	37.66 _{81, 1}	0.002	R > T	2.92 _{81, 1}	0.149	–

4.2. Engagement & public understanding

In practice, public engagement ranges from direct participation of the public in development of policies and initiatives, to a simple transfer of information from managers to stakeholders (Rowe and Frewer, 2005). The latter describes the engagement mechanism used in an 'information-deficit' approach to scientific communication, the efficacy of which is contested (Druschke and McGreavy, 2016). In the 'information-deficit' model, a one-way flow of information from 'expert' to 'audience' is seen as sufficient to equip the public to employ scientific knowledge in their own decision-making.

Our results suggest that public support for the living shoreline project, although robust, may have benefited from deeper public understanding of the particular coastal management strategy. It is tempting to characterize this finding as support for an information-deficit approach to public engagement; however, all individuals in our study were given basic information regarding the goals and design of the living shoreline project prior to interviews. Individuals varied in how confidently they felt they understood the management initiative, despite being provided this information and independent of education level. Considering this, it will be important for studies to investigate other potential factors contributing to an individual's perception of their own ability to access and employ scientific knowledge, particularly with regard to management and decision-making processes (Poe et al., 2014). This is an objective that points to the utility of 'contextual' approaches to scientific communication and public engagement, which emphasize the context-dependencies of the public's relationship to scientific information (Druschke and McGreavy, 2016).

Public engagement efforts that target the specific exigency of a group can function as a form of democracy that facilitates both representativeness and the delivery of pertinent information (Wilsdon and Willis, 2004). Many of the individuals we interviewed who reported a weak understanding of the living shoreline project were disaffected towards matters of coastal management more generally. In some cases, we were asking them to weigh-in on a local initiative that they were previously unaware of. Lack of trust resulting from poor communication can act as a roadblock to policy support even among individuals where pro-environmental values and beliefs are strong (e.g., Stern, 2008). Future studies should examine the links between public perceptions and local management processes, and in particular be able to account for interactions between the two.

4.3. Integrated coastal management

It is important to note that coastal management goals often require comprehensive measures that stretch beyond the scope of a single initiative and a single governing body (Berkes, 2009). In scaling up our assessment of public preferences, we see a more nuanced response to the living shoreline project. Studies have demonstrated user-groups to prioritize ecosystem functions differently (de Juan et al., 2017), potentially leading to differences in perceptions of appropriate conservation measures. Our study suggests that strong public support for a nature-based management strategy does not necessarily translate to the prioritization of similar initiatives. Instead, we show heterogeneity in public preference and the potential for divergence between user-groups. For

example, dredging coastal ponds to maintain tidal flushing was cited as an important coastal management strategy by island residents, and was notably unpopular among tourists. Dredging projects are often controversial (Cutroneo et al., 2014) and the local context that substantiates them may be unavailable to tourists, promoting controversy.

Differences in opinion were also seen within particular resource-user groups. For instance, perceptions of the importance of updating septic and sewer systems were significantly higher among residents who regularly shellfished in the region's coastal ponds compared to those that did not. Considering the problem of polluted waters as potentially more salient among those who harvest from them, this result may not be surprising. However, new septic and sewer regulations infer a cost to homeowners, highlighting a management trade-off between residents who rely on clean water for provisioning resources, and those looking to develop in coastal watersheds for personal use or to access a tourism economy.

5. Conclusions

The rate of change and complexity of environmental management implores that we identify, prioritize, and act quickly upon areas of agreement. This requires conservationists, managers, and stakeholder groups to work together in identifying areas of overlap and to address mismatches where they occur. Our results show that practitioners should consider situational constraints of stakeholder support beyond environmental ideologies as well as the trade-offs that exist between groups interacting in multiple-use coastal environments. These findings underscore the complexity of the human dimension in social-ecological coastal management. Careful consideration of social factors in the context of ecosystem functioning will equip coastal managers with the ability to determine locally viable policies and initiatives, thereby allowing for more appropriate allocation of limited resources. Future research should work to integrate public perceptions of management effectiveness, and to track these with ecological success in a coupled social-ecological systems framework.

Competing interests statement

Conflicts of interest: none.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at

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