LETTER

# Participatory Conservation of Coastal Habitats: The Importance of Understanding Homeowner Decision Making to Mitigate Cascading Shoreline Degradation

Steven B. Scyphers[1,2], J. Steven Picou[3], & Sean P. Powers[1]

[1] Department of Marine Sciences, University of South Alabama & Dauphin Island Sea Lab, Dauphin Island, AL 36528, USA
[2] Present address: Department of Marine and Environmental Sciences, Northeastern University, Marine Science Center, Nahant, MA 01908, USA
[3] Coastal Resource and Resiliency Center & Department of Sociology, University of South Alabama, Mobile, AL 36688, USA

**Keywords**
Coastal sustainability; grassroots conservation; living shorelines; saltmarsh; social-ecological systems; shoreline armoring.

**Correspondence**
Steven B. Scyphers, Department of Marine and Environmental Sciences, Northeastern University, Marine Science Center, Nahant, MA 01908, USA. Tel: 781-581-7370 (ext. 375); fax 781-581-6076.
E-mail: s.scyphers@neu.edu

**Received**
2 February 2014
**Accepted**
18 May 2014

**Editor**
Xavier Basurto

doi: 10.1111/conl.12114

## Abstract

Along densely populated coasts, the armoring of shorelines is a prevalent cause of natural habitat loss and degradation. This article explores the values and decision making of waterfront homeowners and identifies two interlinked and potentially reversible drivers of coastal degradation. We discovered that: (1) misperceptions regarding the environmental impacts and cost-effectiveness of different shoreline conditions was common and may promote armoring; and (2) many homeowners reported only altering their shorelines in response to damage caused by armoring on neighboring properties. Collectively, these findings suggest that a single homeowner's decision may trigger cascading degradation along a shoreline, which highlights the necessity of protecting existing large stretches of natural shoreline. However, our study also found that most homeowners were concerned with environmental impacts and preferred the aesthetics of natural landscapes, both of which could indicate nascent support and pathways for conservation initiatives along residential shorelines.

## Introduction

The seemingly small decisions of individuals and societies have driven environmental declines at local, regional, and global scales (Hardin 1968; Odum 1982). However, the coordinated and collective actions of mutual stakeholders has been shown to promote more favorable social and environmental outcomes (Basurto & Ostrom 2009; Ostrom 2009). Consequently, achieving conservation goals and overcoming modern environmental problems relies on understanding and often modifying human decisions (Ostrom 2009; Schultz 2011). However, most modern environmental problems cannot be solved by simply educating decision makers on the consequences of their decisions, especially in complex scenarios where diverse stakeholder groups are influenced by differing perspectives, values, and social norms (Schultz *et al.* 2005; Biggs *et al.* 2011; Bottrill & Pressey 2012). In these more complex scenarios, and when the environmental problem is caused by the decisions of individuals, understanding and navigating diverse attitudes and motivations is essential for overcoming the planning-implementation gap (Berkes *et al.* 2003; Biggs *et al.* 2011; Heberlein 2012).

The decline of coastal habitats is an excellent example of a global problem caused by the cumulative actions of individuals, small groups, and governments (Lotze *et al.* 2006). Coastal habitats support diverse ecological communities and provide numerous ecosystem services for human societies (MA 2005), but have been severely degraded by centuries of development, habitat degradation, and overharvesting of resources (Vitousek *et al.* 1997; Jackson *et al.* 2001; Lotze *et al.* 2006). Among the most pervasive and visible drivers of habitat loss along urbanized coastlines has been the armoring of shorelines with vertical walls (e.g., bulkheads, seawalls) and similar gray infrastructure, which are typically implemented by waterfront homeowners and other decision makers (e.g., business owners, town officials) to address concerns of coastal erosion or to achieve a socially desirable outcome (e.g., vessel navigation, docking). Vertical walls destroy natural shoreline habitats, disrupt land-water exchange, and alter the biophysical environment (e.g., wave climate, depth profile), potentially indirectly harming other natural habitats (Douglass & Pickel 1999; Bozek & Burdick 2005; NRC 2007). Although the societal and ecological costs of degraded coastal habitats are becoming increasingly recognized (Arkema *et al.* 2013; Barbier *et al.* 2013), coastal populations have continued to expand, and the armoring of shorelines has continued to advance.

The degradation of coastal shorelines exemplifies a scenario where short-term desires can be in direct opposition to long-term ecological sustainability and human well-being (Arkema *et al.* 2013; Barbier *et al.* 2013). This article describes a study of waterfront homeowner decision making and identifies two interlinked and potentially reversible drivers of shoreline armoring and habitat loss. Our study revealed that the decision of a single homeowner to construct a vertical wall triggers reactionary decisions by other nearby homeowners, hence cascading habitat degradation. However, our study also revealed that most homeowners recognize the aesthetic and ecological values of natural habitats and could support alternative strategies if feasible and cost-effective. Collectively, our findings highlight the necessity of protecting existing large stretches of natural shoreline to prevent cascading and legacy effects, but also reveal potential pathways to balance homeowner and conservation objectives for sheltered coastlines.

## Methods

### Study setting

Mobile Bay represents a classic estuarine system, covering more than 1,070 km$^2$ with approximately 135 km of shoreline and an average depth of 3.3 m. Urbanization and other development-related pressures have heavily impacted the system (Ellis *et al.* 2010). Shoreline armoring has increased by approximately 0.5% per year since 1955, with 38% of the bay's shorelines armored by 2009 (Douglass & Pickel 1999; Jones *et al.* 2009), and more than 90% recently experiencing erosion (Jones *et al.* 2009). Vertical walls, which have been considered the most ecologically damaging approach to shoreline stabilization (NRC 2007; Bilkovic & Roggero 2008; Jones *et al.* 2009), are the most common type of artificial structure and define more than one quarter of the bay's shorelines (Jones *et al.* 2009).

### Survey design and data collection

We conducted a mail-returned survey of waterfront homeowners in Mobile Bay, AL. Prior to survey delivery, an analysis of waterfront properties was conducted using Google Earth$^{TM}$ Version 6.1.0.5001, and all potential single family residences were enumerated within five geographic zones (Figure S1). A total of 1,000 printed surveys were distributed proportionally within each zone at homes that did not appear vacant or marked for sale or rent. At each selected residence, a waterproof survey packet including a coversheet and letter explaining the purpose of the survey, "Frequently Asked Questions" sheet (including telephone and e-mail contacts for questions or assistance), entry card for a voluntary prize raffle, and postage-paid return envelope was marked by a fluorescent flag and placed in a visible location near the driveway or mailbox. Three weeks after delivery, we revisited all residences where survey packets were delivered and recovered any surveys still visible from roadside ($n = 3$).

Our 41 question survey instrument was developed by an interdisciplinary team of coastal scientists, practitioners, and waterfront homeowners. The survey evaluated shoreline characteristics, decision-influencing criteria, and measured the perceived value, status, and management of coastal habitats. The first series of questions focused on shoreline characteristics and asked homeowners about their shoreline length, condition (natural, vertical wall, rip–rap revetment), condition of neighboring shorelines, construction and maintenance costs, as well as whether any decisions to modify the shoreline were made by them. The next series of questions focused on decision making and asked homeowners to rank the most influential criteria for their decisions to maintain or modify their shoreline (cost, effectiveness, durability, aesthetics, maintenance, environmental impact, water access, permitting). The third series of questions focused on homeowners' perceptions of shorelines, including how different shoreline types performed for the various ecological, economic, and social criteria. This series of questions also asked homeowners about when they perceived marine life and shorelines of Mobile Bay to have been in the healthiest or best condition, and whether a coastal saltmarsh has greater "real estate value if developed" or "ecological value if protected."

 

The survey instrument also included sociodemographic questions to document gender, age, annual household income, education, environmental dependence, years lived at residence and on Mobile Bay. Finally, the last section of the survey allowed respondents to describe their experiences and broader perspectives as a waterfront homeowner. All returned surveys were transcribed into a survey database using Qualtrics™ Survey Research Suite.

## Analyses

We utilized multivariate and univariate statistics to evaluate the relationships among waterfront homeowners' values, beliefs, and decisions on shoreline management. First, we applied the Fisher's exact test (FET) to determine if perceptions of best historical condition and greatest marsh values differed across respondents with differing shoreline types. To evaluate which factors were most predictive of a waterfront homeowner's (1) current shoreline condition and (2) current preference if forced to address a presently eroding shoreline, we utilized tree-based classification models constructed using the Chi-squared Automatic Interaction Detection (CHAID) growing method. The CHAID method identifies the independent variable with the strongest interaction at each step of the process and merges categories that are not significantly different with respect to the dependent factor. In the CHAID tree growing method, scale independent variables are automatically banded into discrete groups prior to the analysis. The first tree model focused on current condition and considered three scale variables (age, years at current residence, shoreline length), three nominal variables (education, geographic zone, neighboring shoreline condition, environmental dependence) and one ordinal variable (income category). The second tree model focused on current preference and included all of these variables, in addition to annual maintenance costs. Ordered response variables were then converted to Likert scores prior to analyses, and percent responses are also shown for clarity. Nonresponses and responses of "do not care" were not included in the analyses. For all tests, $P \leq 0.05$ was considered statistically significant, and all tests were computed using the Statistical Package for the Social Sciences (SPSS), Version 21.

# Results

## Sample description and property characteristics

A total of 360 surveys were completed and returned for a response rate of 36% (33–38% range across zones). Compared to the sociodemographics of the broader coastal counties, the survey sample of waterfront residents was composed of mostly males (75%), college graduates (mode: 71% Bachelor's degree or higher), higher household incomes (mode: 37% greater than $150,000), and older (median: 64 years) individuals. Nearly 75% of respondents perceived their occupation or economic livelihood to be independent or depend very little on healthy coastal waters. Nearly all survey respondents owned the waterfront property where the survey packet was delivered (97%) and 75% considered it their primary residence. On average, respondents had lived at their current residence for 19.4 years (range = 1–76 years) and along the shorelines of Mobile Bay for 26.0 years (range = 1–76 years). Nearly 60% of respondents were owners of their current property if/or when the shoreline condition was modified.

**Table 1** Descriptive characteristics of the three most prominent shoreline conditions

| | | Vertical wall | Natural | Revetment |
|---|---|---|---|---|
| Shoreline condition | % | 72.4% | 18.7% | 6.4% |
| | *N* | 260 | 67 | 23 |
| Shoreline length | Meters | 29.9 (± 1.4) | 32.1 (± 1.6) | 36.5 (± 3.5) |
| | *N* | 257 | 63 | 23 |
| Initial cost ($m^{-1}$) | $ | $561 (± 49) | n/a | $467 (± 129) |
| | *N* | 150 | n/a | 15 |
| Annual maintenance | Days | 11.0 (± 1) | 12.6 (± 3.3) | 8.5 (± 3.6) |
| | *N* | 176 | 40 | 17 |
| | $ ($m^{-1}$) | $31 (± 4) | $16 (± 6) | $20 (± 10) |
| | *N* | 195 | 44 | 15 |
| Structure age | Years | 25.1 (± 1.1) | n/a | 17.3 (± 4.4) |
| | *N* | 251 | n/a | 23 |
| Expected longevity | Years | 27.4 (± 5.0) | 63.4 (± 7.9) | 37.7 (± 9.0) |
| | *N* | 205 | 33 | 17 |

Values in parentheses are standard error.

## Values, perspectives, and decisions

The three most prominent shoreline conditions of vertical walls, rip–rap revetments, and natural or unaltered shoreline represented 97.5% of all respondents (Table 1). Vertical walls, sometimes supplemented by other structures (i.e., rip–rap, groin) characterized 72.4% of respondents' shorelines, while natural or unaltered (18.7%) and revetments (6.4%) were less common. According to respondents, the initial cost of vertical walls ($561 $m^{-1}$) was higher than revetments ($467 $m^{-1}$), and homeowners with natural shorelines ($16 $m^{-1}$) and revetments ($20 $m^{-1}$) reported lower maintenance costs than homeowners with vertical walls ($31 $m^{-1}$). Homeowners with natural or unaltered shorelines expected the future longevity of their current shoreline condition to be much longer than homeowners with armored shorelines. When asked for their current preference if faced with an eroding natural shoreline, more the 75% of homeowners with an

  

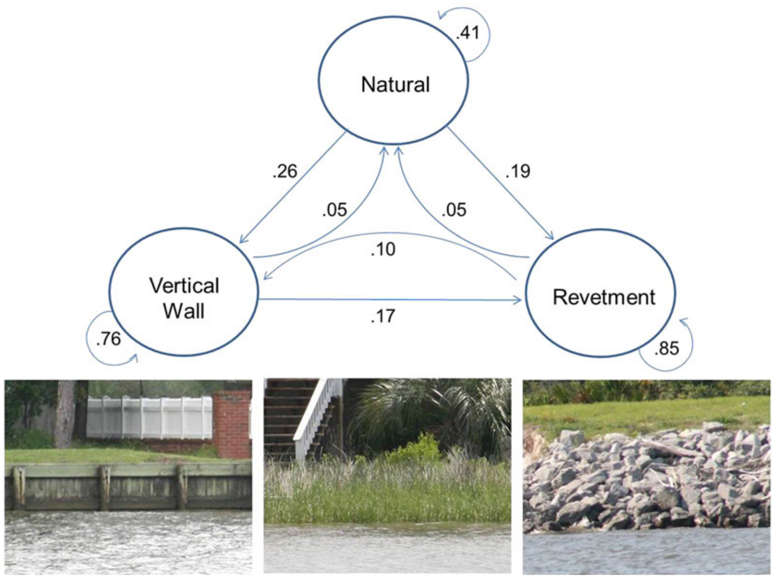


**Figure 1** State diagram showing the proportion of waterfront homeowners that would choose the same or different shoreline conditions if currently faced with an eroding natural shoreline (above). Only natural, vertical wall, and revements are shown and accounted for approximately 98% of all responses. Photographs of residential shorelines with vertical wall, natural salt marsh (*Spartina alterniflora*) and rip–rap revetment (below).

armored shoreline stated that they would select the same type of structure and only 5% would prefer their shoreline to remain natural (Figure 1). Of homeowners with natural shorelines, 26% would choose a vertical wall and 19% a revetment, while 41% would retain the natural condition. Nearly 15% of homeowners stated that they preferred none of the three options or were undecided.

A primary objective of our study was to understand how waterfront homeowners perceive various shoreline protection schemes in terms of cost and function, as well as how they prioritize these attributes. Vertical walls, followed by rip–rap revetments, were perceived as the most effective and durable choices (Figure 2a, b), but also the most environmentally harmful (Figure 2c). Natural or unaltered shorelines were regarded as the most visually appealing (Figure 2d), but also were perceived to require the most annual maintenance (Figure 2e). When asked to prioritize the criteria that influenced their coastal protection decisions, nearly half of all respondents ranked effectiveness as the most important attribute, which was followed by cost and durability (Figure 2f). Overall, these top three responses accounted for more 80% of all rankings, while access to water, aesthetics, and permitting approval were rarely selected as the most influential criteria. We also assessed how waterfront homeowners perceived the value of coastal marshes and the environmental problem of shoreline armoring. We found that the vast majority of homeowners, regardless of their own shoreline condition, recognized the decline of Mobile Bay's shorelines (Figure 3a; FET $= 5.528$, $P = 0.831$) and marine life (Figure 3a; FET $= 5.144$, $P = 0.869$). Most homeowners also perceived the ecosystem services provided by coastal saltmarshes to have similar or greater economic value than potential developed real estate values (Figure 3b; FET $= 1.867$, $P = 0.761$).

To identify the most powerful predictors of a homeowner's shoreline condition or current preference, we used classification tree analysis. The final tree model for predicting a homeowner's current condition revealed that neighbor's shoreline condition was the most powerful explanatory variable (Figure 4a). Among homeowners neighbored by a shoreline with a vertical wall, the probability of also having a shoreline protected by a vertical wall was >90%. Vertical walls were most common in zone 4, where they were prevalent among 98% of homeowners. Conversely, among homeowners not neighbored by a vertical wall, the probability of having a natural shoreline was >60%, while vertical walls only represented 19%. In the final tree model for understanding a homeowner's current preference if deciding today, the neighboring shoreline condition was again the most powerful predictor (Figure 4b). Among homeowners neighbored by a shoreline with a vertical wall, the probability of choosing a vertical wall was 75%. However, among homeowners not neighbored by a vertical wall, the probability of choosing a vertical wall was only 36%.

## Discussion

On the surface, the armoring of coastal shorelines and resulting degradation of natural habitats resembles an environmental "tyranny of small decisions," where a series of small, independent decisions drive an overall shift in condition (Kahn 1966; Odum 1982). However, our study

 

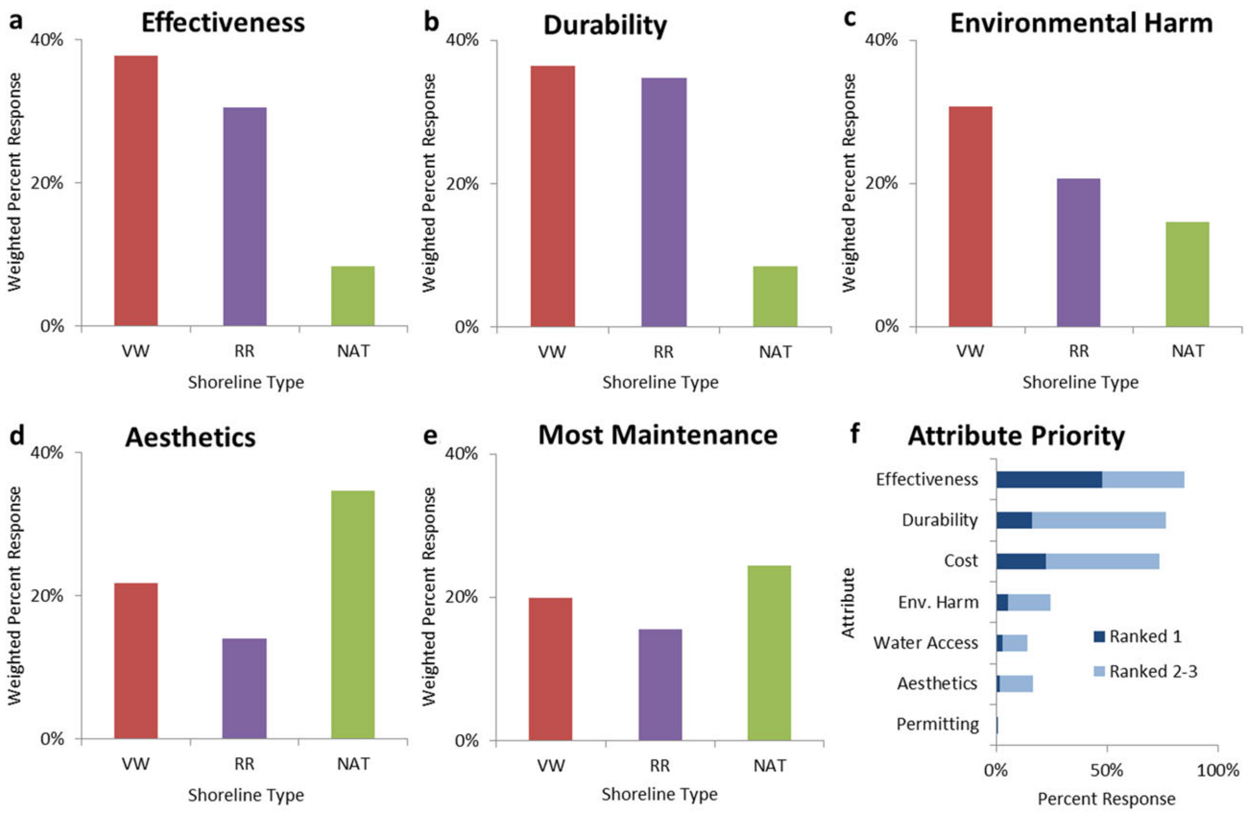


**Figure 2** Perceived function and impact of various shoreline conditions and structures. The top three schemes for each metric were weighted by ranking and weighted percent response is shown. The different conditions and structures shown are vertical wall (VW), rip–rap revetment (RR), and natural (NAT).

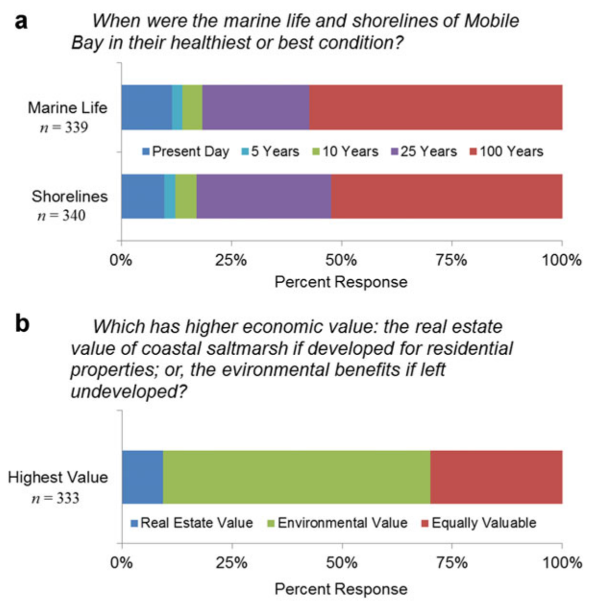


**Figure 3** Perspectives on (a) when Mobile Bay marine life and shorelines were in their healthiest or best condition and (b) the relative value of coastal marsh habitats separated by respondents' shoreline condition.

shows that while the initial construction of a vertical wall may be an independent decision, potentially resulting from misperceptions, the presence of a single wall can trigger a chain reaction of armoring, driven by homeowners reacting to biophysical changes along their shoreline (e.g., accelerated erosion, higher wave energies). The cascading nature of these decisions and their lasting legacy highlights the critical importance of protecting large expanses of natural shoreline since the construction of a single vertical wall could initiate armoring throughout an entire region. Alternatively, a high appreciation for the aesthetics and ecosystem services of natural shorelines, coupled with broad recognition of their decline, suggests that many waterfront homeowners could be supportive of more sustainable, cost-effective alternatives for coastal protection.

Understanding the decision making of stakeholders is an essential component of assessing or enhancing the sustainability of a coupled social–ecological system (Schultz 2011), but this is often challenging for complex or controversial environmental problems (Stern *et al.* 1999; Dietz 2003; Biggs *et al.* 2011). The interactions between

  

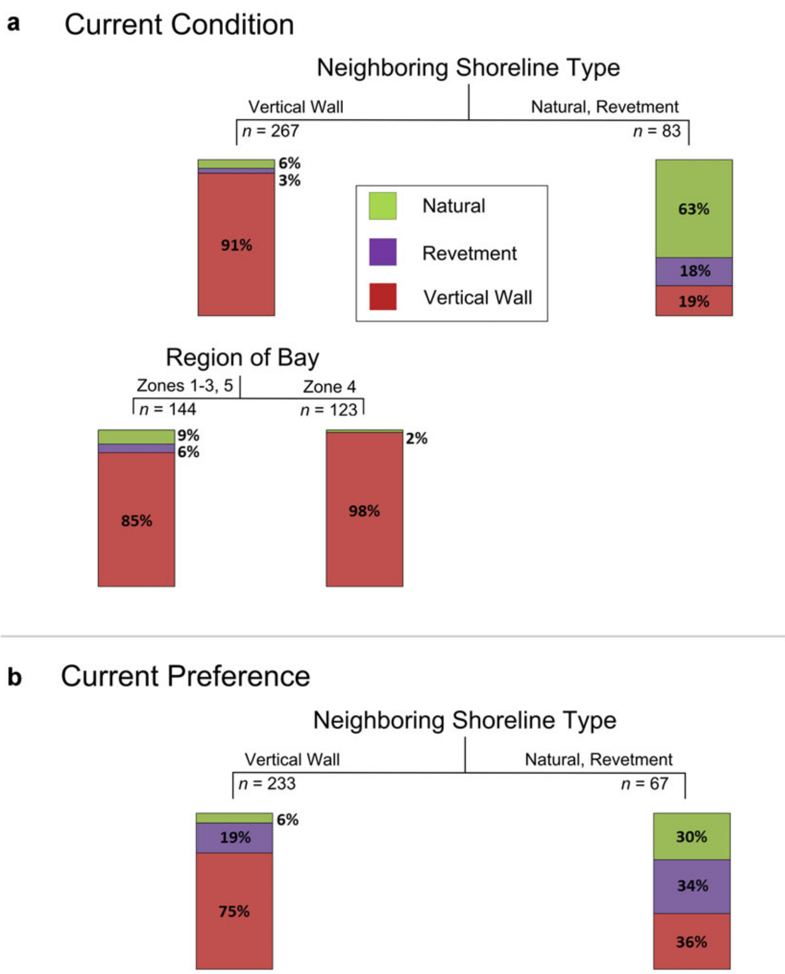


**Figure 4** Classification tree analysis showing the most powerful predictors of respondents' (a) shoreline condition and (b) current decision if faced with an eroding natural shoreline. Separate branches indicate statistically significant differences at $P \leq 0.05$.

homeowners and their landscapes has been considered a model system for understanding complex human–environment interactions especially in urbanized settings (Cook *et al.* 2012). These studies have shown that homeowners' decisions may be influenced by a variety of cognitive factors such as values and beliefs (Stern 2000), as well as personal and property attributes such as weath or housing age (Cook *et al.* 2012). On neighborhood and larger scales, decisions may be driven by a number of other factors including informal social norms and customs, formal homeowners associations, or legacy effects of previous decisions (Jenkins 1994; Foster *et al.* 2003; Lerman *et al.* 2012).

In our study, we discovered that many waterfront homeowners decided to modify their shoreline only after experiencing damage from a neighboring structure, which potentially indicates a strong legacy effect of previous and neighboring decisions. We also found that misperceptions regarding highly prioritized costs, durability, and environmental impacts were common among coastal homeowners. For instance, natural shorelines were perceived to be less durable and require more maintenance than vertical walls, but the opposite scenario was revealed by data derived from homeowner experiences. Many of the more detailed comments provided by homeowners also illustrate the complexity of this relationship (Table 2). For instance, many homeowners attributed recognized environmental declines to the proliferation of shoreline armoring and many also indicated interest or even eagerness in mitigating the environmental consequences of their own shorelines. However, some homeowners indicated strong opposition to any new regulations as to how residential shorelines are managed. Understanding and overcoming this antagonism among even very small groups of homeowners is important given the cascading and legacy effects of implementing vertical walls.

The broad range of risks, costs, benefits, and tradeoffs of natural habitats and gray infrastructure along shorelines are far from well understood and certainly vary by

 

**Table 2** Selected quotes from survey respondents

| Respondent | Quote |
|---|---|
| 1 | *When we were kids in the 1940's, beaches were at least 40 yards farther out. Lots of seagrass and water was clear enough to flounder almost every night. Bulkheads were put up in self-defense as neighbors did it. It was a large-scale mistake that I don't know how to correct.* |
| 2 | *I have tried to leave my shoreline natural only to have over 100 feet of property wash away. If you can provide a natural, environmentally friendly way to stop the erosion, I would gladly listen to you.* |
| 3 | *We need a means to reduce "bathtub" effect with seawalls. I would be willing to place rip-rap in front of my seawall or place riprap several hundred feet from shore and plant seagrass/plants between. Give me the riprap and I'll do the work.* |
| 4 | *I will fight any new regulation as to how I must protect or stabilize my property as well as anything my neighbors may do that could affect my property.* |

location and time (e.g., Koch *et al.* 2009; Arkema *et al.* 2013; Spalding *et al.* 2014), but the implications for coastal plant and animal communities are more clear and of global significance. For instance, vertical walls are widely recognized to provide poor quality habitat for fishes and macroinvertebrates (Seitz *et al.* 2006) and harm adjacent plant species (Douglass & Pickel 1999; Bozek & Burdick 2005). The structural complexity provided by rip–rap and rubble revetments support more diverse ecological communities than vertical walls or unvegetated shorelines (Davis *et al.* 2002; Seitz *et al.* 2006), but usually still less diverse than natural shorelines with marsh (Seitz *et al.* 2006). A more recent body of literature has illustrated that natural habitats designed to function as, or coupled with, armoring structures may mitigate coastal erosion while providing a range of ecosystem services (e.g., Borsje *et al.* 2011; Scyphers *et al.* 2011; Bilkovic & Mitchell 2013; La Peyre *et al.* 2014).

The interactions of waterfront homeowners and coastal habitats form a complex social–ecological systems and in many ways resembles a large-scale participatory conservation experiment. Moreover, considering the dense distributions of human and natural capital in coastal regions, it is also a high stakes one (Koch *et al.* 2009; Arkema *et al.* 2013; Barbier *et al.* 2013). While the innovation of coastal protection schemes has been rapidly progressing (Pilkey & Cooper 2012) and provides for optimism that more sustainable solutions will be developed (Borsje *et al.* 2011; Spalding *et al.* 2014), our research highlights the critical importance of not only understanding the drivers of stakeholder behavior, but also the necessity of integrating them into planning and decision-making processes. Given the complexity of coastal zone management policies (NRC 2007) and the potential for legacy effects long after regulatory change (Foster *et al.* 2003), adaptive co-management aimed at protecting vulnerable areas of coastline while promoting reciprocal learning on the economic and ecological consequences of coastal habitat degradation may be essential for achieving conservation goals along residential coastlines (Olsson *et al.* 2004; Armitage *et al.* 2008).

## Acknowledgments

Our study was conducted under the auspices of the University of South Alabama's Institutional Review Board (Protocol #10-211). Funding and support for this work was provided by the American Recovery and Reinvestment Act, NOAA, The Nature Conservancy, and the National Science Foundation (OCE-1215825). We are grateful to N. Merrill, A. McKinnell, K. Nixon, and the Fisheries Ecology Lab at the Dauphin Island Sea Lab, for assisting with survey delivery and logistics. We thank L. Coen, R. Gittman, J. Grabowski, K. Heck, X. Basurto and two anonymous reviewers for advice and comments on our manuscript.

## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

**Figure S1.** Map of Mobile Bay, Alabama, showing shoreline condition and study subregions.

### References

Arkema, K.K., Guannel, G., Verutes, G., *et al.* (2013). Coastal habitats shield people and property from sea-level rise and storms. *Nat. Clim. Change*, **3**, 913-918.

Armitage, D.R., Plummer, R., Berkes, F., *et al.* (2008). Adaptive co-management for social-ecological complexity. *Front. Ecol. Environ.*, **7**, 95-102.

Barbier, E.B., Georgiou, I.Y., Enchelmeyer, B. & Reed, D.J. (2013). The value of wetlands in protecting southeast Louisiana from hurricane storm surges. *PLoS ONE*, **8**, e58715.

  

Basurto, X. & Ostrom, E. (2009). Beyond the tragedy of the commons. *Economia delle fonti di energia e dell'ambiente* **1**, 35–60.

Berkes, F., Colding, J. & Folke, C. (2003). *Navigating social-ecological systems: building resilience for complexity and change*. Cambridge University Press, New York, NY.

Biggs, D., Abel, N., Knight, A.T., Leitch, A., Langston, A. & Ban, N.C. (2011). The implementation crisis in conservation planning: could "mental models" help? *Conserv. Lett.*, **4**, 169-183.

Bilkovic, D. & Roggero, M. (2008). Effects of coastal development on nearshore estuarine nekton communities. *Mar. Ecol. Prog. Ser.*, **358**, 27-39.

Bilkovic, D.M. & Mitchell, M.M. (2013). Ecological tradeoffs of stabilized salt marshes as a shoreline protection strategy: effects of artificial structures on macrobenthic assemblages. *Ecol. Eng.*, **61, Part A**, 469-481.

Borsje, B.W., van Wesenbeeck, B.K., Dekker, F., *et al*. (2011). How ecological engineering can serve in coastal protection. *Ecol. Eng.*, **37**, 113-122.

Bottrill, M.C. & Pressey, R.L. (2012). The effectiveness and evaluation of conservation planning. *Conserv. Lett.*, **5**, 407-420.

Bozek, C.M. & Burdick, D.M. (2005). Impacts of seawalls on saltmarsh plant communities in the Great Bay Estuary, New Hampshire, USA. *Wetlands Ecol. Manage.*, **13**, 553-568.

Cook, E.M., Hall, S.J. & Larson, K.L. (2012). Residential landscapes as social-ecological systems: a synthesis of multi-scalar interactions between people and their home environment. *Urban Ecosyst.*, **15**, 19-52.

Davis, J.L., Levin, L.A. & Walther, S. (2002). Artificial armored shorelines: sites for open-coast species in a southern California bay. *Mar. Biol.*, **140**, 1249-1262.

Dietz, T. (2003). What is a good decision? Criteria for environmental decision making. *Hum. Ecol. Rev.*, **10**, 33-39.

Douglass, S.L. & Pickel, B.H. (1999). The tide doesn't go out anymore—the effect of bulkheads on urban shorelines. *Shore Beach*, **67**, 19-25.

Ellis, J.T., Spruce, J.P., Swann, R.A., Smoot, J.C. & Hilbert, K.W. (2010). An assessment of coastal land-use and land-cover change from 1974 to 2008 in the vicinity of Mobile Bay, Alabama. *J. Coast. Conserv.*, **15**, 139-149.

Foster, D., Swanson, F., Aber, J., *et al*. (2003). The importance of land-use legacies to ecology and conservation. *Bioscience*, **53**, 77-88.

Hardin, G. (1968). The tragedy of the commons. *Science (New York, N.Y.)*, **162**, 1243-1248.

Heberlein, T.A. (2012). *Navigating environmental attitudes*. Oxford University Press, New York, NY.

Jackson, J.B.C., Kirby, M.X., Berger, W.H., *et al*. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science*, **293**, 629-638.

Jenkins, V.S. (1994). *The lawn: a history of an American obsession*. Smithsonian Institution Press, Washington, DC.

Jones, S.C., Tidwell, D.K. & Darby S.B. (2009). Comprehensive shoreline mapping, Baldwin and Mobile Counties, Alabama: Phase 1. Open File Report 0921. Geological Survey of Alabama, Tuscaloosa, Alabama.

Kahn, A.E. (1966). The tyranny of small decisions: market failures, imperfections and the limits of economics. *Kyklos*, **19**, 23-47.

Koch, E.W., Barbier, E.B., Silliman, B.R., *et al*. (2009). Non-linearity in ecosystem services: temporal and spatial variability in coastal protection. *Front. Ecol. Environ.*, **7**, 29-37.

La Peyre, M.K., Humphries, A.T., Casas, S.M. & La Peyre, J.F. (2014). Temporal variation in development of ecosystem services from oyster reef restoration. *Ecol. Eng.*, **63**, 34-44.

Lerman, S.B., Turner, V.K. & Bang, C. (2012). Homeowner associations as a vehicle for promoting native urban biodiversity. *Ecol. Soc.*, **17**, 438–450.

Lotze, H.K., Lenihan, H.S., Bourque, B.J., *et al*. (2006). Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science*, **312**, 1806-1809.

MA. (2005). *Millennium ecosystem assessment. ecosystems and human well-being: synthesis*. Island Press, Washington, DC.

NRC. (2007). *Mitigating shore erosion along sheltered coasts*. National Academies Press, Washington, DC.

Odum, W.E. (1982). Environmental degradation and the tyranny of small decisions. *Bioscience*, **32**, 728-729.

Olsson, P., Folke, C. & Hahn, T. (2004). Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecol. Soc.*, **9**, 2.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, **325**, 419–422.

Pilkey, O.H. & Cooper, J.A.G. (2012). "Alternative" shoreline erosion control devices: a review. Pages 187–214 in J.A.G. Cooper & O.H. Pilkey, editors. *Pitfalls of shoreline stabilization: selected case studies*. Coastal Research Libary 3, Springer, Netherlands.

Schultz, P. (2011). Conservation means behavior. *Conserv. Biol.*, **25**, 1080-1083.

Schultz, P.W., Gouveia, V.V., Cameron, L.D., Tankha, G., Schmuck, P. & Franek, M. (2005). Values and their relationship to environmental concern and conservation behavior. *J. Cross-Cultural Psychol.*, **36**, 457-475.

Scyphers, S.B., Powers, S.P., Heck, K.L. & Byron, D. (2011). Oyster reefs as natural breakwaters mitigate shoreline loss and facilitate fisheries. *PLoS ONE*, **6**, e22396.

 

Seitz, R., Lipcius, R., Olmstead, N., Seebo, M. & Lambert, D. (2006). Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay. *Mar. Ecol. Prog. Ser.*, **326**, 11-27.

Spalding, M.D., McIvor, A.L., Beck, M.W., *et al*. (2014). Coastal ecosystems: a critical element of risk reduction. *Conserv. Lett.*, **7**, 293–301.

Stern, P.C. (2000). New environmental theories: toward a coherent theory of environmentally significant behavior. *J. Soc. Iss.*, **56**, 407-424.

Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A. & Kalof L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Hum. Ecol. Rev.*, **6**, 81-98.

Vitousek, P.M., Mooney, H.A., Lubchenco, J. & Melillo, J.M. (1997). Human domination of Earth's ecosystems. *Science*, **277**, 494–499.

  