Property Owners' Understanding of Erosion Control on Holden Beach, North Carolina

Prepared for:
Geoff Gisler
The Southern Environmental Law Center

Ashley Gordon
Emily Hall
Hillary Smith
Justin Pearce
Melissa Whaling
Sara Cleaver

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Table of Contents

Appendices

Executive Summary

The environmental and socioeconomic implications of terminal groins have been debated nationally and become largely controversial, especially along the North Carolina coast. Coastal communities have recently witnessed the effects of beach erosion on their coastlines, and beachfront properties have already been lost to the sea. These issues are particularly severe on barrier islands and near inlets, both of which are extremely dynamic. Locals often disagree on the best way to control erosion, and town governments struggle to find a balance between safeguarding development on beaches and bearing the economic, environmental, and social costs of erosion intervention options. Terminal groins are one option to slow the impacts of beach erosion or to supplement beach nourishment efforts, despite varied evidence on their level of effectiveness.

The Town of Holden Beach has proposed a terminal groin to save properties that are threatened by beach erosion on the eastern portion of the island. In order to assess homeowners' understanding of beach erosion and the effects of terminal groins, as well as to understand their preferences for erosion intervention alternatives, a web survey was developed for our client, the Southern Environmental Law Center, to be distributed by the Holden Beach Property Owners' Association (POA). The POA circulated the survey to their email list of 1096 addresses, and respondents had two weeks to complete the survey.

Results of this study indicate a mixed level of understanding of beach erosion and the impacts of terminal groins, but respondents were very interested in learning more about what the proposed terminal groin would mean for Holden Beach. There was a nearly identical number of responses from those clearly in support of the proposed groin and clearly against the proposed groin (101 and 100 individuals, respectively). Both cost and environmental impacts were deemed to be very important determinants of whether or not respondents supported the proposed groin. According to our study, there is a need for further dissemination of educational materials on impacts of groins and clearer statements of costs for the proposed erosion intervention alternatives. Respondents expressed a strong desire to be included in decision-making processes regarding erosion intervention on Holden Beach.

I. Problem Statement

1.1. Background

Beach habitats are one of the most valued resources on Earth's surface and are increasingly being influenced by human interactions. In 2010, it was reported that almost half the world's population lives within 150 kilometers of a coastline, and 50 million more people relocate to this narrow coastal zone each year (Stewart, 2009). The National Oceanographic and Atmospheric Administration has called beaches our country's "Economic Engines," contributing to 45% of our nation's GDP in 2011 (NOAA, 2013). Yet, beaches represent transitional ecosystems linking land and sea and thus are dynamic and fragile in nature (Riggs, 2011).

It is becoming increasingly evident that United States coastlines are at risk from climate change. Erosion has been an international issue for decades; statistics from the past century have estimated that the global average sea level has increased by 10-20 centimeters, and 70% of beaches are receding (Vanden et al., 2014). This has numerous implications for areas where beach loss poses problems. Erosion threatens natural habitat, private property, public infrastructure, and the tourism industry (Greene, 2002).

Humans have attempted to combat erosion and beach loss for decades. Among the efforts used by coastal engineers to reduce erosion has been the use of hardened structures, such as terminal groins, breakwaters, and seawalls. Terminal groins specifically are straight structures constructed perpendicular to the coastline in order to reduce erosion by intercepting sediments being carried parallel to the shore (Fleming, 1993). However, great controversy has surrounded terminal groins for years, due to documented evidence of negative environmental and socioeconomic impacts on coastal communities.

When solid, stationary structures are built atop soft, mobile sand, the natural movement of the beach is prevented, down-drift beaches experience increased rates of erosion, and inlet dynamics are altered (Knapp, 2012). While terminal groins may protect adjacent property, they cause an increased need for continued beach nourishment to maintain the beach (Knapp, 2012). Additionally, wildlife is impacted, both directly through loss of habitat for invertebrates, shorebirds, and sea turtles, and indirectly through the negative impacts associated with increased beach renourishment (Knapp, 2012).

In addition to environmental impacts, terminal groins have complex social and economic results. The literature suggests that the long-term costs of terminal groins outweigh the potential long-term benefits (Knapp, 2012). Further, while terminal groins may benefit a few property owners, they put property further down the beach in danger, threatening local safety and tourism (Knapp, 2012). Nonetheless, many coastal states still rely on hardened structures to maintain their beaches, and

several coastal North Carolina towns are currently actively involved in the application process to build new terminal groins in the hopes of protecting their properties (Knapp, 2012).

1.2. Context and Purpose of Study

Coastal North Carolina is famous for its wide, sandy beaches, which exist in part due to barrier islands, a natural buffer between the mainland and ocean. These barrier islands, which have been called "restless ribbons of sand" (Pilkey, 1998), are extremely dynamic in nature and bear the brunt of high-energy storm events (Riggs, 2011). Consequently, there is no guarantee that any structure built on these ecosystems is permanent (Riggs, 2011). Furthermore, in North Carolina, inlets frequently separate these barrier islands, and understanding inlet dynamics is a vital component to erosion management. During strong storm events, a storm surge can break through a barrier island, forming an inlet (Knapp, 2012). In a natural system, these inlets can open and close over time, sometimes even migrating up and down the beach, putting nearby stationary structures in danger (Knapp, 2012). Terminal groins have historically been used to prevent this process from occurring and protect property threatened by inlet dynamics.

Due to the aforementioned complexities surrounding barrier islands, inlets, and terminal groins, North Carolina banned hardened structures from use in 1985, written into law in 2003 (Pilkey, 2008). This decision was based upon the conclusion that unforeseen negative effects to beaches were virtually irreversible, after evaluating lessons learned from New Jersey's shoreline (Pilkey, 2008). However, Senate Bill 599 allowed exceptions to be made to the ban (Pilkey, 2008). Recently, there has been movement to install a terminal groin at the east end of Holden Beach, NC.

The proposed groin in Holden Beach, designated for the East End, is intended to trap sand being eroded by the adjacent inlet's dynamics. The property the Town is hoping to protect consists of approximately ten houses, and the estimated cost of the groin is approximately $34 million over 30 years (Dial Cordy, 2015, pg. 5-156). Due to the contentious nature of terminal groins, our client, the Southern Environmental Law Center, instructed us to design and implement a survey to property owners of Holden Beach to assess their understanding and preferences of the proposed terminal groin project.

1.3. Research Questions

The objective of this study was to answer the following research questions:

1. What do property owners in Holden Beach understand about the effects of terminal groins on beach erosion?
2. What are the property owners' relative preferences among the erosion inventions?

II. Methods and Procedures

2.1. Study Region

Holden Beach, a coastal town located in Brunswick County, North Carolina (Figure 1), occupies an 8-mile-long barrier island running from east to west. It is surrounded on either end by two inlets: Shallotte Inlet to the west and Lockwood Folly Inlet to the east. The Intracoastal Waterway is located to the north, and the Atlantic Ocean to the south.

With a land area of 2.71 square miles and a water area of 0.71 square miles, Holden Beach sustains a total population of 691 residents (US Census, 2014). The median age of residents is 62 years, which is older compared to North Carolina's median age of 37.9 years (US Census, 2014). There are 2,358 housing units, comprised of 18.4% owner-occupied homes and 81.6% vacant or seasonal homes (US Census, 2014). The average home value is $420,200, with an average household income of $101,118 (Table 1).

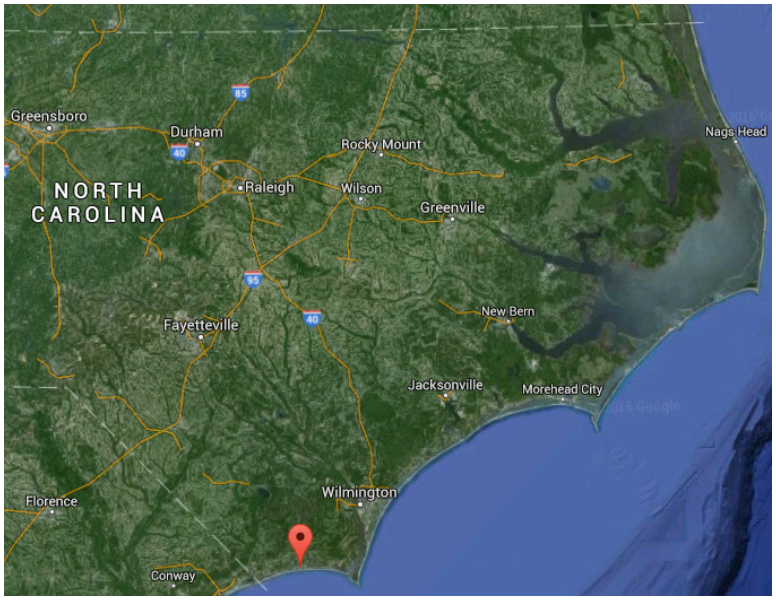

Figure 1. Holden Beach, NC within the larger context of North Carolina.

Holden Beach, NC			
Residential Population	619	Vacant (Seasonal)	81.60%
Median Age	62	Median Home Value	$420,200
Total Housing Units	2,358	Average Household Income	$101,118
Owner Occupied	18.40%	Growth Rate	11.80%

Table 1. Demographic Information (as of July 2014)

2.2. Survey Design

Our group constructed a survey utilizing Qualtrics software. The survey contained a total of 20 questions using a mix of multiple choice, check all that apply, Likert scale, and a concluding open response section (See Appendix A for full survey). The survey included an opening statement reminding respondents that all answers were to be kept confidential and that their participation was voluntary.

The survey primarily addressed Holden Beach homeowners' 1) understanding of beach erosion processes and the implications of engineered shorelines, 2) relative preferences among erosion interventions, and 3) desire for education materials surrounding erosion processes and interventions. To encourage open and honest responses, we included questions with brief background information about the proposed project and concise definitions surrounding some of the more technical concepts.

2.3. Focus Group and Pre-Test

We recruited our focus group participants through the Central Park School for Children in Durham, NC. Raenel Edmonds, Assistant Principal and a personal contact, sent an email invitation (Appendix B) seeking teachers who are or have been beachfront homeowners or renters to participate in a focus group. The participants consisted of one male and five females, with a range of experiences renting and owning beachfront property along the East Coast of the U.S.

The focus group moderator began the focus group with project description and statement of research questions. Participants were then encouraged to introduce themselves, what beaches they usually visit, and how often they visit those beach communities. We then moved on to a discussion of the survey questionnaire, primarily seeking advice on question clarity and content. At the conclusion of the discussion, the moderator also encouraged participants to speak to their opinions surrounding beach erosion and intervention methods in general. (See Appendices C and D for full script and agenda.)

After incorporating feedback from the focus group into revisions of the survey instrument, our client distributed the Qualtrics link via email to the Holden Beach Property Owner's Association (POA) President. He first reviewed the survey and provided feedback, and after we incorporated suggestions, the Board President distributed the questionnaire to the remaining members of the Board for approval. The recorded pre-test responses of the POA Board members were included in the final sample size because we did not modify the survey following their review.

In addition, we asked five friends and family members ranging between 22 and 53 years in age to complete the survey and provide an estimate of completion time for the questionnaire. The results indicated the survey would take approximately ten minutes to finish, and we incorporated this time

estimate in the email to the POA listserv. The responses of friends and family members were removed prior to sharing the final survey link.

2.4. Sampling Methods and Survey Implementation

The POA email listserv was intended to serve as the sample of the target population of property owners in Holden Beach. Given this listserv is intended to include nearly all property owners in the town, the sample is likely nearly equivalent to the population. Those missing from this sample include property owners not on the listserv or property owners with outdated email addresses. The current POA listserv contains 1096 email addresses. For confidentiality purposes, our survey team was never provided with names connecting individuals to the email list or individuals' answers.

The POA Board President distributed the survey via email to the Holden Beach POA listserv on Monday, March 21, 2016 (see Appendix E for email with survey). Additionally, the POA Board posted the survey link and information on their website. The POA Board also provided an email reminder of the survey one week after the initial distribution that also indicated when the survey would close. The survey officially closed on Monday, April 4, 2016, thus remaining open for a period of two weeks.

2.5. Quantitative Analysis

2.5.1. Descriptive Statistics

Qualtrics provided us with a default coding scheme (outlined in Appendix A along with the survey). The majority of the descriptive questions resulted in nominal-level answers. Frequency responses were used to calculate the descriptive statistics from these responses. Percentages were not always available because many of the questions allowed respondents to select multiple answers. Therefore, summing responses to questions that allowed for multiple answers may exceed the 'N' listed for that question.

Ordinal-level data was available for age and the number of years that property was owned. For those, frequency was still used for the graphical information. The mean as well as other measures of central tendency were calculated as well, but are not represented in the figures.

2.5.2. Inferential Statistics

Logistic regression models were used to predict support for the proposed intermediate terminal groin. The dependent variable (*Support for Groin*) is a dichotomous measure of whether respondents supported the terminal groin or not. Responses to a Likert scale question indicating support were

recoded to capture those who somewhat or strongly supported the intermediate terminal groin (*Support for Groin = 1*) and all other responses (*Support for Groin = 0*). These other responses included those who answered neutral, somewhat against, strongly against, and do not know. The proportion of respondents who support the intermediate terminal groin was 37% compared to 63% who did not (Figure 2).

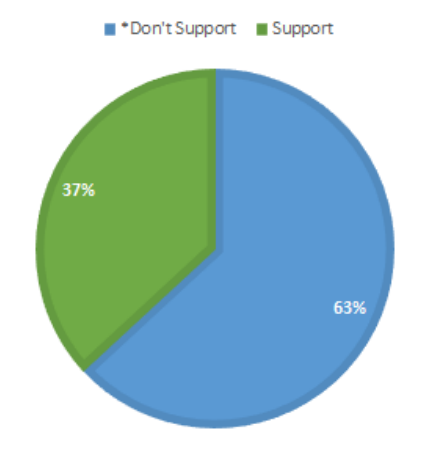

Figure 2. Support for Intermediate Terminal Groin

Predictor variables included a categorical variable capturing respondents' age (*Age*) and characteristics of their property including whether they were permanent residents (*Permanent Resident*), and owned and property on the East End of the island (*East End*). Other variables included whether respondents indicated they were knowledgeable about terminal groins (*Knowledge of Groins*), if they disagreed that a groin would prevent erosion on their property (*Won't Prevent Erosion*), if they thought the groin would slow erosion on Holden Beach in general (*Slow Erosion*), that the project would be too costly (*Costly*), and that it would help tourism (*Tourism*). Additionally, an index (0-4) was constructed that captured respondents' perception of the negative environmental impacts of groins (*Negative Environment)*. If a respondent agreed with a statement suggesting a negative environmental impact of a terminal groin, they received one point with a total of four possible points. (For summary statistics for all variables included in the model, see Appendix F.)

The interpretation of coefficients in logistic regression becomes the effect of each predictor on the log odds of the outcome modeled as a linear combination of the variables. Log odds were converted to odds ratios to aid interpretation of key relationships. Results are reported as marginally significant for test statistics between alpha .10 and .05, and significant at alpha .05 or less. The results from the full model are presented in the results section; however, all variables were added in a stepwise fashion. As each predictor was added to the model the Akaike Information Criterion (AIC) and the Bayes Information Criterion (BIC) were checked to guide variable selection while maintaining a parsimonious model. Model

fit is reported using the Pseudo R-square and postestimation checks included the variance inflation factor to look for problems of multicollinearity among regressors.

To determine if the level of support for each of the six proposed erosion intervention options varied significantly, we conducted a Kruskal-Wallis (KW) test, which is a ranks-based nonparametric alternative to a one-way analysis of variance (ANOVA). Prior to running the KW test, all non-responses and "don't know" responses were removed from the data set. Responses were coded on a scale of 1 (strongly against) to 5 (strongly support) with regard to level of support for the erosion intervention projects. To identify significant pairwise differences between erosion intervention options, we conducted a Dunn pairwise comparisons test, which is appropriate for groups with unequal numbers of observations. The Bonferroni adjustment was applied for calculation of p-values to control for family-wise error rate.

2.6. Qualitative Analysis

At the end of the survey, respondents were asked to "please provide any additional comments you may have about the topics discussed in this survey". The open response answers from this question were first coded into four mutually exclusive categories: 1) "Positive" (in support of the proposed groin), 2) "Negative" (against the proposed groin), 3) "Need more information" (the respondents articulated that they were not informed enough on the topics to form an opinion), and 4) "Other" (responses which did not appear to have a definitive opinion).

Before classifying appropriate responses into the "Other" category, we looked at the respondent's answers to a previous survey question which asked, "Please indicate your level of support for each alternative", as well as the respondent's level of support for Alternative 6, the proposed intermediate terminal groin. If a response to this question was "strongly against" or "strongly support", this provided some clarity if we were unsure of the tone of the respondent's response to the open response question.

We also coded the open responses into three categories to determine which factors respondents identified as the most influential in forming their opinions. The three categories were not mutually exclusive, so some responses fell into more than one category. These three categories were: 1) "Erosion or Environmental Issues", 2) "Economic or Financial", and 3) "Mistrust" (of government or personal issues). Prior to looking at the survey results we had assumed there may be some mention of impacts of groins on wildlife, but that category was eliminated due to zero mentions of that topic.

III. Error Structure

Given the online structure of the survey, there are potential sources of error that were difficult to control and are important to recognize, as they can introduce bias in our survey results. Sampling error refers to the chance variability resulting from sampling a portion of the population rather than all units (SMRQSD, 2001). The target population for our survey was property owners in Holden Beach. Because our survey was distributed via the Holden Beach POA email listserv, a substantial portion of the population of Holden Beach property was contacted. Additionally, some residents or vacationers of Holden Beach had the opportunity to partake in the survey because the POA board members included the link on their website.

Although we were interested in specifically property owners, four respondents indicated they were not property owners in Holden Beach, and thus were removed from the survey for final analysis. This provides an example of erroneous inclusions that can lead to over-coverage error (SMRQSD, 2001). The possibility of individuals completing the survey multiple times also contributes to over-coverage error. For example, the members of the POA board who pretested the survey may have completed it a second time after it was distributed to the listserv, although this is unlikely.

In addition to over-coverage, under-coverage is another potential source of error that occurs when some participants of the target population are excluded from the sampling process (SMRQSD, 2001). The President of the Holden Beach POA informed us that 80 emails bounced, and thus these individuals did not receive the link directly to complete the survey. Unless these individuals were able to access the survey via the website, they were excluded from the survey sampling frame. This also applies for any property owners who are not on the POA listserv. Furthermore, it is possible some property owners did not open the email containing the survey link until after the survey duration had ended; however, this is an unlikely source of error given the sampling period spanned two weeks.

After accounting for the 80 emails that bounced, there were 1016 emails successfully sent. Given we had 295 survey responses, our initial response rate was 29%; thus 71% of sampled participants did not respond, providing an estimate of unit nonresponse error. Item nonresponse error results from a responding participant not completing an item or items on the survey questionnaire. To adjust for this source of error, any respondent who answered less than 10% of the survey questions was removed from the analysis. This resulted in 17 more individuals being dropped from the survey for a final total of 274 responses. Thus the adjusted response rate based on the sample size used for analysis was 27%. After removing all unusable responses, the response rate for each individual question item was calculated (Appendix G). Overall, item response rate was high, with a 94% response rate minimum.

It is important to recognize the possibility that survey respondents may feel particularly passionate about the subject, which could bias our results. However, our response answers consistently showed individuals answering within the neutral column, and thus we do not think only those who strongly favor or oppose terminal groins participated in the survey.

Error in our survey results could also be from analysis. We did not robustly check the assumptions in the regression, and we tried our best to account for each question having a different number of respondents. Additionally, in our qualitative analysis, while we were careful to not make assumptions or imply meanings that were not directly stated by respondents, the nature of coding an open response section can be somewhat subjective based on interpretation of responses.

IV. Findings

4.1 Descriptive Statistics

4.1.1. Demographics

The average age of people living on Holden Beach is 62 years old (Table 1). The survey had 93 respondents (or 34%) answer that they are within the 55-64 year old age range, and 92 people (or 33%) respond they were between 45-55 years old (Figure 3).

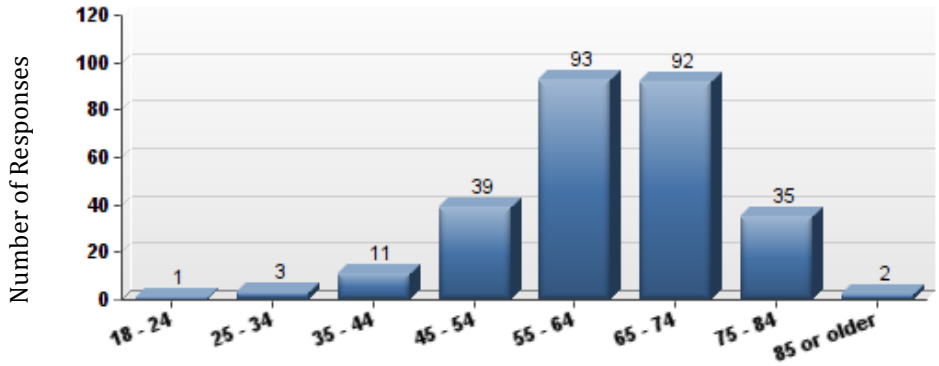

Figure 3. Responses to Question, "What is your age?" n= 276.

Approximately 63% of our respondents have owned property in Holden Beach for over 10 years (Figure 4). Despite the long-term property ownership, less than 25% of respondents (50 people) consider themselves to be permanent residents. The majority of our respondents, 199 people, appear to use their Holden Beach property as a second home. (Figure 5)

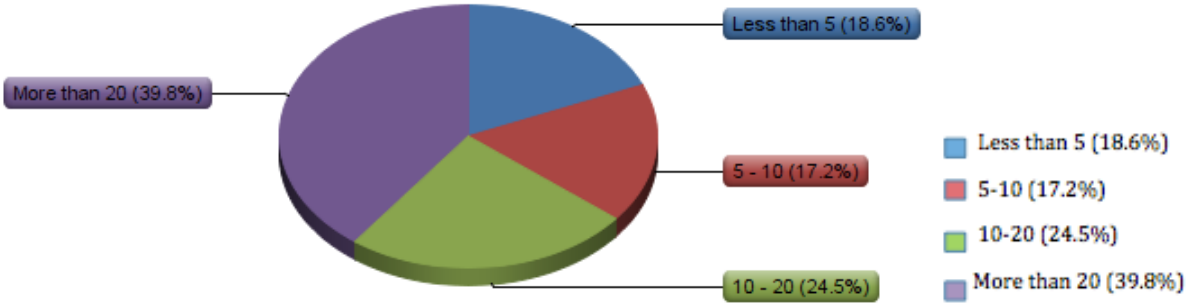

Figure 4. Responses to Question, "How many years have you owned property?" n=274

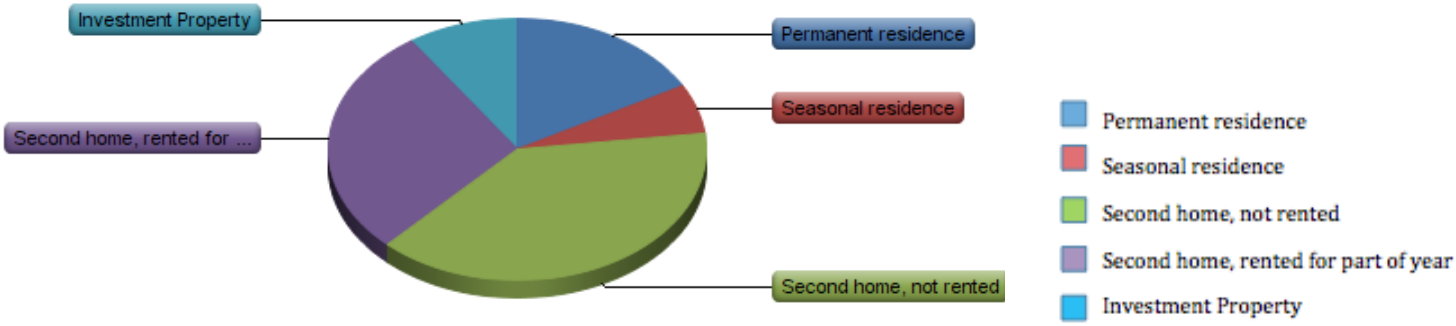

Figure 5. Responses to Question, "Select the options that best describe your residency in Holden Beach." n= 275

Of those property owners, 204 respondents answered that they own one property. Twelve respondents own four or more properties on the island (Figure 6). The geographic distribution of the property owners on the island is quite evenly distributed (Figures 7 and 8).

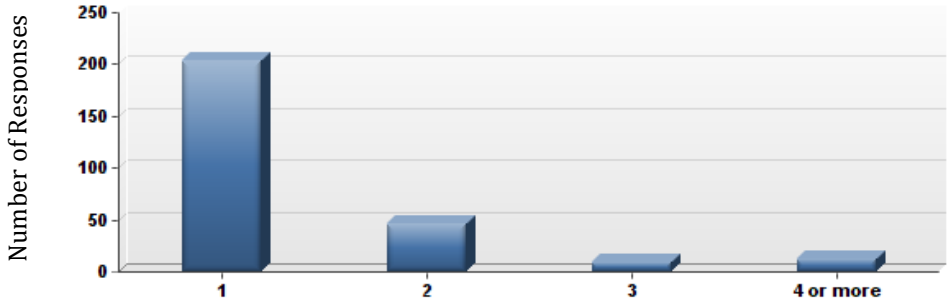

Figure 6. Responses to Question, "How many properties do you own?" n=273

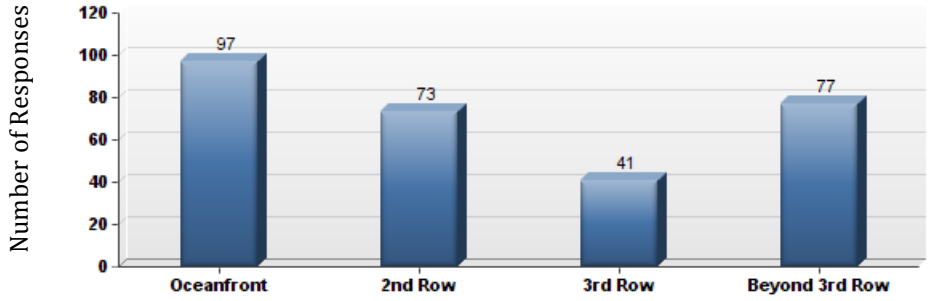

Figure 7. Responses to Question, "How close is your property (or properties) to the beach? (For more than one property check all that apply). n=271

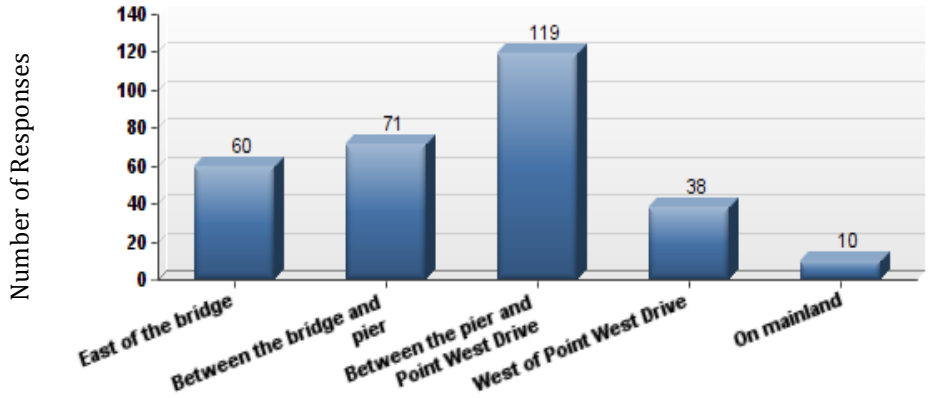

Figure 8. Responses to Question, "Where is your property (or properties) located on the island? (For more than one property check all that apply)." n=273

Despite the 97 of our respondents saying their properties were located oceanfront (Figure 7), only 43 believe that the property if threatened by beach erosion (Figure 9).

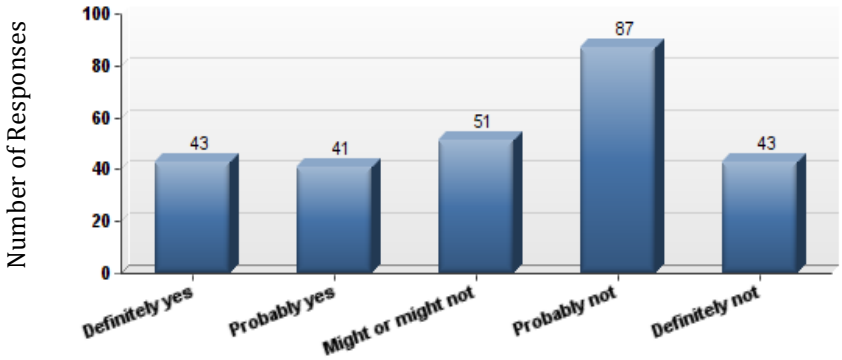

Figure 9. Responses to Question, "Do you feel your property (or properties) is threatened by beach erosion?" n=265

When asked about their initial reaction to the proposed intermediate groin, 79 respondents initially had a somewhat positive response. This was the highest category of responses. The next highest response was "somewhat negative" (Figure 10).

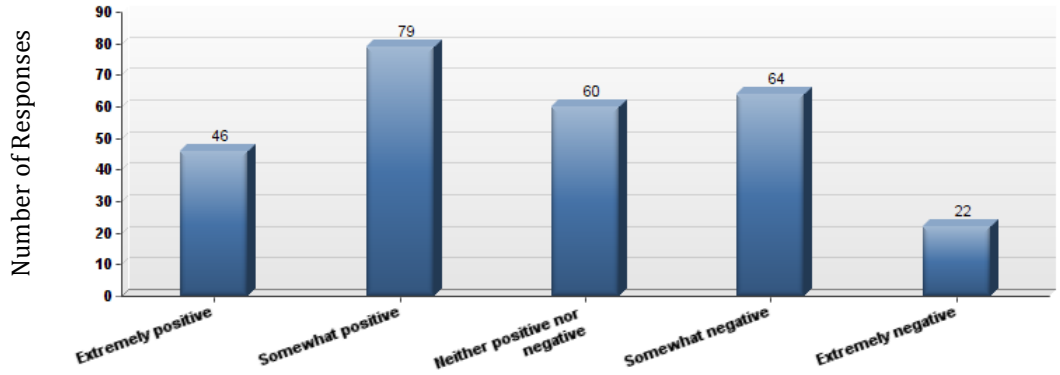

Figure 10. Responses to Question, "What is your initial reaction to this project?" This question refers to the intermediate terminal groin. n=271

When asked how they believe the intermediate terminal groin should be paid for, over 50% of respondents believe that Beach, Preservation, Access, Recreation, and Tourism (BPART) taxes is the preferred method of payment. (BPART taxes are collected from tourism revenue on Holden Beach.) Our second most popular response revealed that 79 respondents would not support any form of public funding to construct the groin (Figure 11).

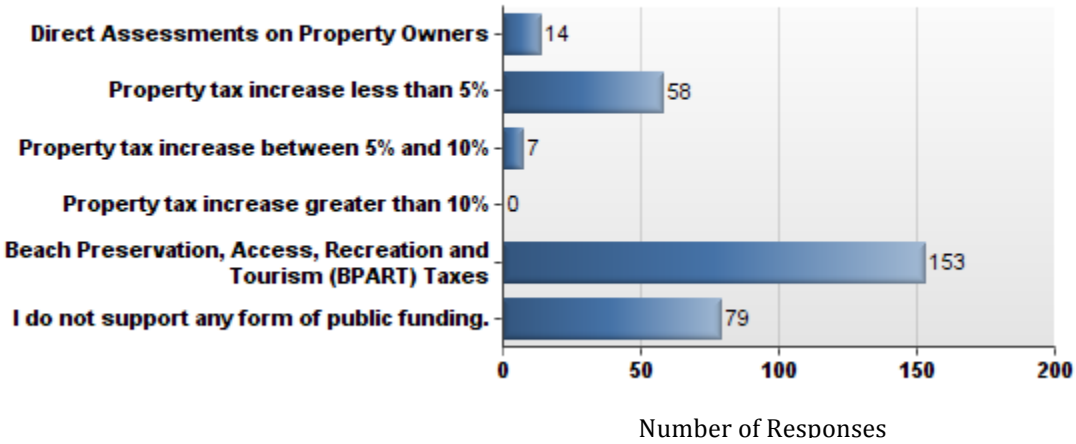

Figure 11. Responses to Question, "The proposed terminal groin is projected to cost $34.4 million over 30 years. If it is built, how should the Town pay for the construction and maintenance of the groin? Please check all options you would support." n=260

4.1.2. Knowledge and Perceptions of Beach Erosion and Terminal Groins

Residents were asked to describe their overall understanding of both beach erosion and terminal groins. Comparing the results of the ordinal scale responses across questions, it is apparent that residents perceive themselves as more knowledgeable about beach erosion than terminal groins (Figures 12 and 13). While 'somewhat knowledgeable' was the most common response to both questions, 28% felt either extremely or very knowledgeable about beach erosion compared to only 16% who felt equivalently knowledgeable about terminal groins.

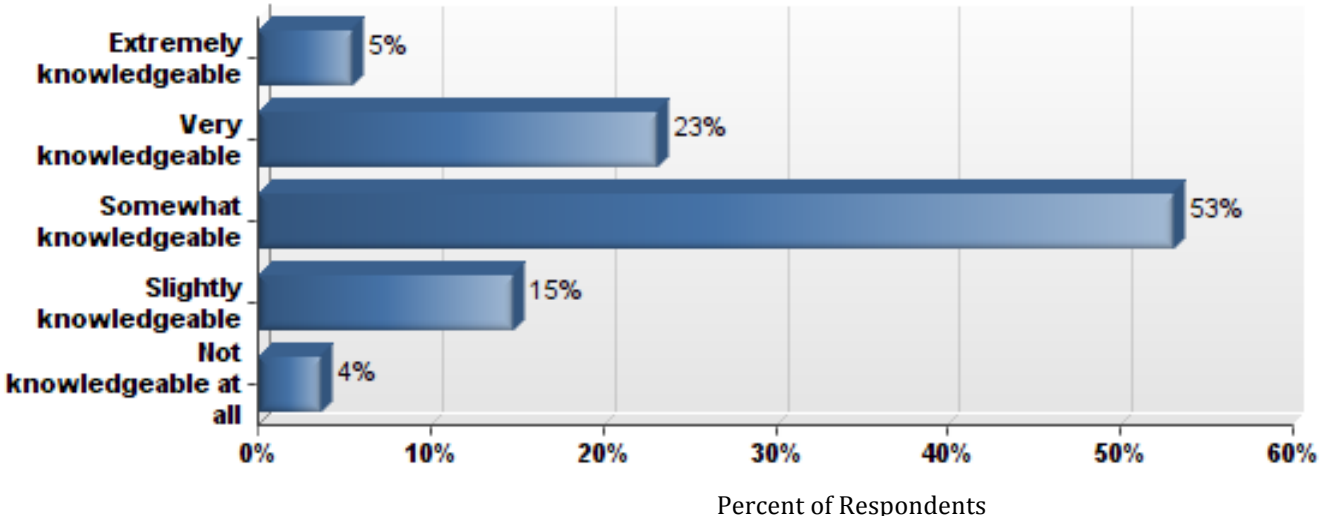

Figure 12. Response to Statement, "Rate your overall knowledge of beach erosion." n=277

Figure 13. Response to the Statement, "Rate your overall knowledge of terminal groins." n=277

4.1.3 Relative Preferences Among Erosion Interventions

Six erosion intervention options were offered for respondents to indicate their level of support: 1) No action, 2) Abandon/Retreat, 3) Beach Nourishment, 4) Inlet Management/Beach Nourishment, 5) Short Terminal Groin, and 6) Intermediate Terminal Groin (current proposed project). Beach nourishment received the highest level of support (179), followed by beach nourishment/inlet management (168) (Figure 14). No action (123) and abandon/retreat (140) received the highest number of responses that were clearly against the project (Figure 14). The short terminal groin received very similar response levels for those in support (93) and against (98), the project; the proposed intermediate terminal groin project also reflected these results, with nearly identical levels of support (101) and lack of support (100) for the project (Figure 14).

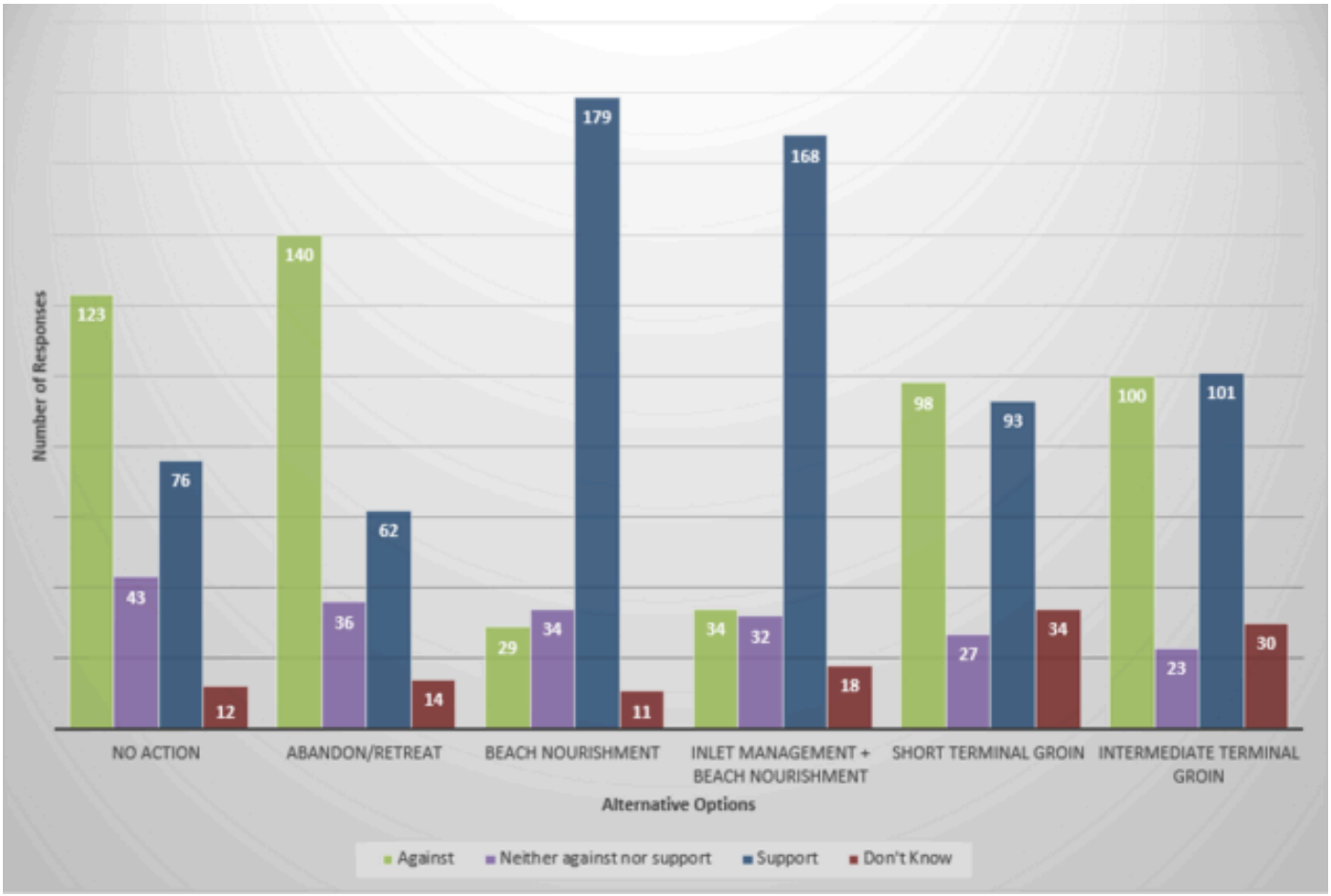

Figure 14. Response to the Statement, "Please indicate your level of support for each alternative." n=252

4.1.4 Support of Alternatives and Proposed Project

The results of the Kruskal-Wallis (KW) test indicated significant differences existed in the level of support for each erosion intervention option ($p<0.001$). The follow-up Dunn's pairwise comparisons test

indicated 10 of the 15 comparisons were significant (See Appendix H). Most notably, abandon/retreat had lower levels of support than the intermediate terminal groin project ($p<0.001$), and beach nourishment and inlet management/beach nourishment had higher levels of support than the intermediate terminal groin project ($p<0.001$ for both comparisons). Support did not significantly differ between the short and intermediate terminal groin projects.

4.2 Regression Analysis

The results from the Logit model are presented in Table 2. The effect of owning property on the East End of the island significantly increased the odds of supporting the groin. Those who owned property on the East End of the island were 280% more likely to support the groin than those who did not ($p=0.01$). Respondents who did not believe the proposed groin would prevent erosion on their private property were less likely to support it. Those who did not believe the groin would prevent erosion on their property were 40% less likely to support the groin and this effect was marginally significant ($p=0.87$). Belief that the groin would slow erosion on Holden Beach generally increased the likelihood of supporting the groin. Those who believed it would slow erosion were nearly four times as likely to support the groin compared to those who did not; this effect was highly significant ($p<0.01$). The opinion that the groin was necessary to sustain beach tourism had the largest, positive effect on support. The odds of supporting the groin were 700% higher for those who believed the groin was essential for tourism compared to those who did not agree with this statement and this effect was highly significant ($p<0.01$). Understanding of known negative environmental effects of terminal groins was associated with lower support for the proposed groin. For every additional negative effect a respondent associated with terminal groins, there was a 30% decrease in the odds they supported the proposed groin and this effect was significant ($p=0.02$). In the model the effect of age, permanent resident status and knowledge of terminal groins were not significant predictors of support for the proposed groin. The model pseudo R-square was 0.30, indicating 30% of the variance was explained by the model. The model did not suffer from issues of collinearity among predictors (mean VIF= 1.2 and all VIF<2).

	OR	SE	T	p
Support Groin				
East End	2.80**	1.08	2.66	0.01
Age	1.07	0.15	0.53	0.60
Permanent Resident	1.14	0.48	0.30	0.77
Knowledge of Groins	0.93	0.45	-0.16	0.87
Won't Prevent Erosion	0.567 +	0.19	-1.71	0.09
Slow Erosion	3.83** *	1.47	3.52	0.00
Costly	0.406*	0.15	-2.44	0.02
Tourism	6.96** *	3.12	4.33	0.00
Negative Environment	0.71*	0.11	-2.32	0.02
Constant	0.213 +	0.19	-1.77	0.08
AIC 270.809				
BIC 307				
+ p<.10, * p<0.05, ** p<0.01, *** p<0.001				

Table 2. Logistic Regression Results.

4.3 Qualitative Analysis

The open response question at the end of the survey yielded 62 responses, eight of which were simply email addresses or comments thanking us for having developed the survey, so those were not included in our statistics. Six of the responses (11%) were positive (meaning they were in support of the proposed groin), 30 responses were negative or against the proposal (56%), six were other (11%), and 12 respondents (22%) needed more information (Figure 15).

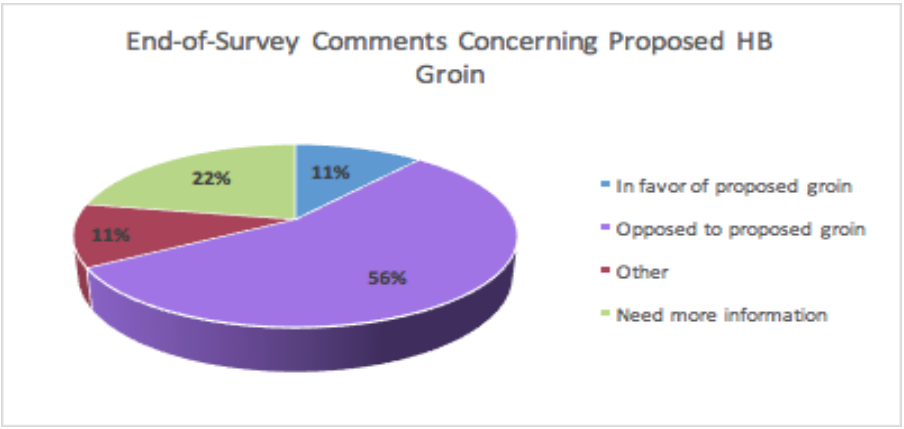

Figure 15. Responses to open response question, "Please provide any additional comments you may have about the topics discussed in this survey". n=54

Thirty-four of the comments mentioned either beach erosion and dynamics, nature, or environment, which was the most frequently mentioned category in the open response section (Figure 16). Twenty-four people mentioned economics or financial reasons as influencing their opinion of the proposed groin, and six mentioned not trusting either the government or other property owners. Interestingly enough, three respondents mentioned Orrin Pilkey and their support of his position on groins. Additionally, we noted that many of the open responses were quite poetic and philosophical about nature, however none mentioned impacts of groins on wildlife (See Appendix I for word cloud containing most frequently used phrases).

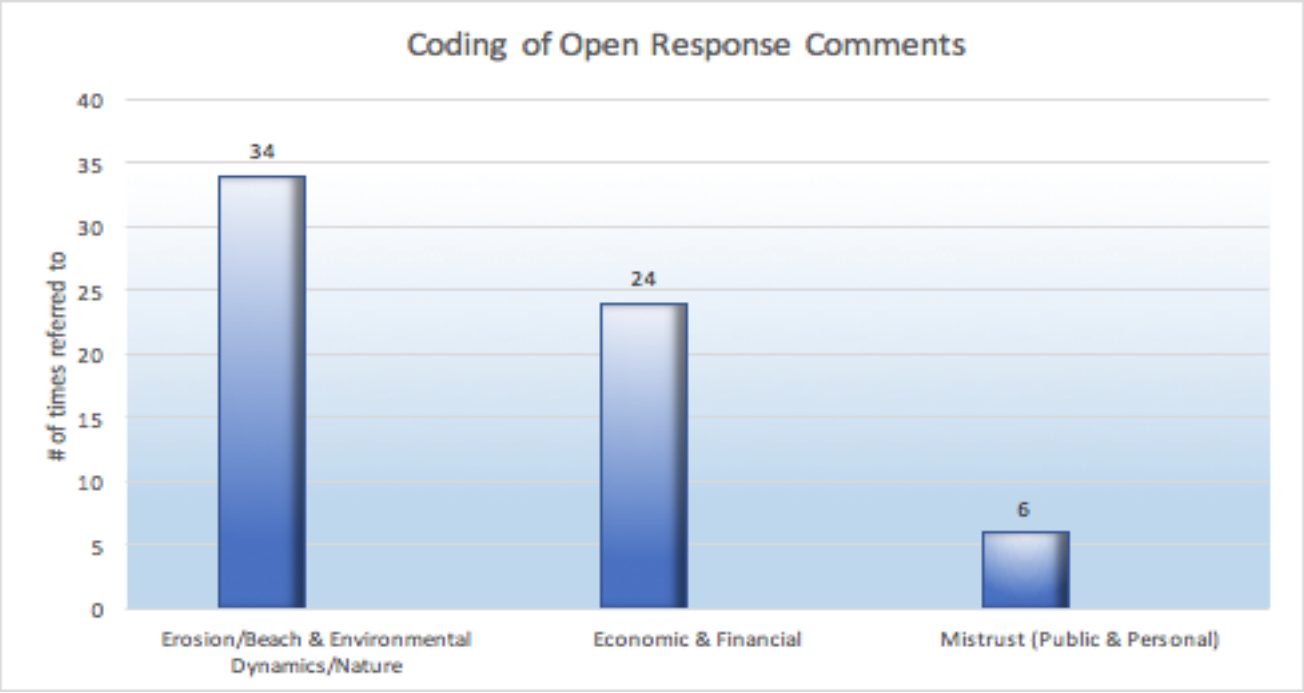

Figure 16. Responses to open response question, "please provide any additional comments you may have about the topics discussed in this survey". n=54

Only 30 of the 295 total respondents (10%) made a point of vocalizing their opinions against the proposed groin in the open response section. However, most of these were very strongly in opposition to the groin, and only three people vocalized their support of the groin in the open response section. Due to only 10% of respondents commenting in the open response section, it is critical to not let the strong vocal opposition of the project (in the open response section) bias our interpretation of the overall responses. It is necessary to consider the quantitative results rather than make an assumption based purely on our few answers to the open response question.

V. Implications

With the topic of terminal groins regarded as a contentious issue, the purpose of our study was to investigate the perceptions of property owners specifically in Holden Beach regarding a proposed intermediate terminal groin project. Through our survey analysis, we aimed to answer two central research questions: 1) What do property owners in Holden Beach understand about the effects of terminal groins on beach erosion? and 2) What are the property owners' relative preferences among the erosion interventions?

There is an apparent need to raise awareness of what a terminal groin is in general. Only 16% of our survey respondents felt they were either "Very" or "Extremely" knowledgeable about terminal groins, whereas 22% had little to no knowledge about them. Responses indicate a clear pattern of greater knowledge of beach erosion than of terminal groins. Additionally, their perception on the social, environmental, and economic impacts of the groin varied widely. Overall, many respondents felt that groin would slow beach erosion nearby (179 people) as well as be costly to build (231 people). Our analysis further revealed several educational gaps and opportunities for SELC to increase awareness of terminal groins. A total of 81% of respondents indicated that they wanted more information about terminal groins, and 92% indicated email would be their preferred mode of receiving this information.

Of the six erosion intervention methods presented, including the proposed intermediate groin, the beach nourishment and inlet management/beach nourishment options received the most support (179 and 168 respondents respectively). Furthermore, more respondents were clearly against the no action or abandon/retreat options than were against the terminal groin projects. There was also a nearly even number of respondents for those clearly in favor or against each groin project, indicating there is a clear divide in opinions of groins throughout the community. Less than half of respondents (37%) clearly support the proposed groin.

Those who support the terminal groin tend to own property on the East End of the island, believe the groin is essential to sustain beach tourism, and believe it will slow erosion on their property. Deterrents to support include the cost of the project, knowledge of negative environmental impacts, and doubt that the project would prevent erosion on private property. The cost of the project appeared to be the significant deterrent to support for the groin and remains a major concern among respondents. Therefore, raising awareness of the cost of the project would most likely allow respondents to develop their opinions of the proposed groin. When it comes to paying for the proposed terminal groin the overall opinion is the cost should be covered either through tourism revenue or sources outside of public funding such as individual property owners.

In summary, our analysis supports an increase in environmental education could shift perspectives of the proposed terminal groin. Particularly, we recommend outreach materials focus on providing background information on terminal groins and their related environmental impacts. Furthermore, given that cost is a major consideration for many respondents, we encourage providing information on the relative costs of the various alternative projects. The descriptive information about who tends to support the groin and why can help the SELC further direct its information campaign. Therefore, the prospects for increased education and awareness of the impacts, costs and implications of terminal groins appear to be promising.

VI. References

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APPENDIX A: Survey Instrument and Coding Scheme

Property Owners' Understanding of Erosion Control on Holden Beach

This survey is being conducted in partnership with the Southern Environmental Law Center (SELC) and Duke University. This survey of Holden Beach property owners will assess understanding of the effects of terminal groins and ask property owners to prioritize erosion response projects. Your participation in this survey is voluntary and all responses will remain anonymous. You are free to discontinue your participation at any time. Do you wish to proceed?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Survey

Q1 Do you own property in Holden Beach?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To What is your age?

Q2 Select the options that best describe your residency in Holden Beach (check all that apply).

- ❑ Permanent residence (1)
- ❑ Seasonal residence (2)
- ❑ Second home, not rented (3)
- ❑ Second home, rented for part of the year (4)
- ❑ Investment Property (5)

Q3 How many years have you owned property in Holden Beach?

- ❍ Less than 5 (1)
- ❍ 5 - 10 (2)
- ❍ 10 - 20 (3)
- ❍ More than 20 (4)

Q4 How many properties do you own?

- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 or more (4)

Q5 In the last 5 years, have you rented out any portion of your property for at least part of the year?

- ❍ Yes (1)
- ❍ No (2)

Q6 How close is your property (or properties) to the beach? (For more than one property check all that apply.)

- ❑ Oceanfront (1)
- ❑ 2nd Row (2)
- ❑ 3rd Row (3)
- ❑ Beyond 3rd Row (4)

Q7 Where is your property (or properties) located on the island? (For more than one property check all that apply.)

- ❑ East of the bridge (1)
- ❑ Between the bridge and pier (2)
- ❑ Between the pier and Point West Drive (3)
- ❑ West of Point West Drive (4)
- ❑ On mainland (5)

Q8 What is your age?

- ❍ 18 - 24 (1)
- ❍ 25 - 34 (2)
- ❍ 35 - 44 (3)
- ❍ 45 - 54 (4)
- ❍ 55 - 64 (5)
- ❍ 65 - 74 (6)
- ❍ 75 - 84 (7)
- ❍ 85 or older (8)

Q9 How would you describe your overall understanding of beach erosion?

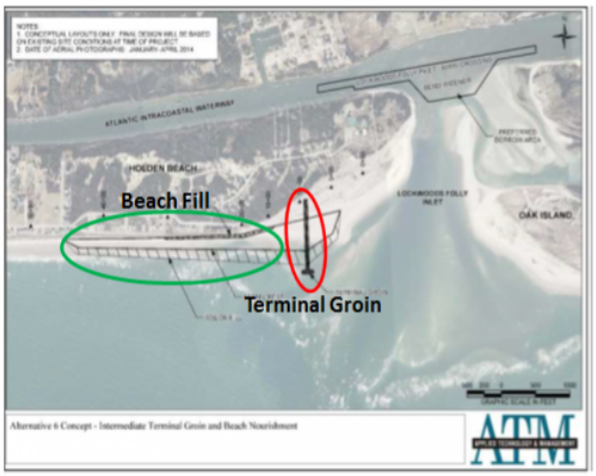
- ❍ Extremely knowledgeable (1)
- ❍ Very knowledgeable (2)
- ❍ Somewhat knowledgeable (3)
- ❍ Slightly knowledgeable (4)
- ❍ Not knowledgeable at all (5)

Q10 How would you describe your overall understanding of terminal groins?

- ❍ Extremely knowledgeable (1)
- ❍ Very knowledgeable (2)
- ❍ Somewhat knowledgeable (3)
- ❍ Slightly knowledgeable (4)
- ❍ I have heard the term "terminal groin", but am not knowledgeable at all (5)
- ❍ I have never heard the term "terminal groin" before (6)

The Town has proposed to build a 1,000 foot long terminal groin near Lockwood Folly Inlet in an effort to slow erosion on the East End. The groin would consist of a 300-ft anchoring section extending landward from the toe of the primary dune and a 700-ft extension across the beach and into the ocean. The groin would be built with 4-5 ft diameter granite stone, which would allow some sand to pass through the structure. The groin would be approximately 40 ft wide at the base and 5 ft wide at the crown. In addition, the Town would commit to place 100,000 to 150,000 cubic yards of sand on the East End every four years through beach nourishment. Beach nourishment is the process of pumping sand from elsewhere and adding it to an eroding section of beach. The proposed project is estimated to cost $34.4 million over 30 years. Compared to taking no action (i.e. no beach nourishment or other erosion management), the Town estimates that building the proposed terminal groin will protect 12 oceanfront properties and 670 feet of infrastructure.

The picture to the left identifies the location of the proposed intermediate groin in Holden Beach, NC. The picture to the right displays an example of a terminal groin in Atlantic Beach, NC (Photo: Program for the Study of Developed Shorelines Western Carolina University).



*Alternative 6. Intermediate Terminal Groin

*Terminal Groin in Atlantic Beach, NC

Q11 What is your initial reaction to this project?

- ❍ Extremely positive (1)
- ❍ Somewhat positive (2)
- ❍ Neither positive nor negative (3)
- ❍ Somewhat negative (4)
- ❍ Extremely negative (5)

Q12 Please select the option that best reflects your position on the following statements regarding the environmental impacts of the proposed terminal groin for Holden Beach.

	Disagree (1)	Neutral (2)	Agree (3)	Don't Know (4)
It will disturb natural beach processes. (1)	❍	❍	❍	❍
It will increase erosion on other parts of the beach. (2)	❍	❍	❍	❍
It will slow beach erosion nearby. (3)	❍	❍	❍	❍
It will disturb wildlife habitat. (4)	❍	❍	❍	❍
It will be visually displeasing. (5)	❍	❍	❍	❍

Q13 Please select the option that best reflects your position on the following statements regarding the social and economics impacts of the proposed terminal groin for Holden Beach.

	Disagree (1)	Neutral (2)	Agree (3)	Don't Know (4)
It will make swimming safer. (1)	❍	❍	❍	❍
It will be costly to build. (2)	❍	❍	❍	❍
It will eliminate the need for beach nourishment on the East End. (3)	❍	❍	❍	❍
It will eliminate the need for beach nourishment on the Central Reach. (4)	❍	❍	❍	❍
It will be costly to maintain. (5)	❍	❍	❍	❍
It is necessary to sustain beach tourism. (6)	❍	❍	❍	❍
It will be a legal liability for the Town. (7)	❍	❍	❍	❍

Q14 The proposed terminal groin is projected to cost $34.4 million over 30 years. If it is built, how should the Town pay for the construction and maintenance of the groin? Please check all options you would support.

- ❑ Direct Assessments on Property Owners (1)
- ❑ Property tax increase less than 5% (3)
- ❑ Property tax increase between 5% and 10% (4)
- ❑ Property tax increase greater than 10% (5)
- ❑ Beach Preservation, Access, Recreation and Tourism (BPART) Taxes (6)
- ❑ I do not support any form of public funding. (7)

Q15 Do you feel your property (or properties) is threatened by beach erosion?

- ❍ Definitely yes (1)
- ❍ Probably yes (2)
- ❍ Might or might not (3)
- ❍ Probably not (4)
- ❍ Definitely not (5)

Q16 For the following statement, please rate how strongly you agree or disagree. A terminal groin would be effective at preventing beach erosion on at least one of my properties.

- ❍ Strongly agree (1)
- ❍ Somewhat agree (2)
- ❍ Neither agree nor disagree (3)
- ❍ Somewhat disagree (4)
- ❍ Strongly disagree (5)
- ❍ I don't know/need more information (6)

Below is a table of all proposed erosion intervention alternatives for the East End of Holden Beach. The option in bold is the proposed groin project. Information retrieved from Chapter 3 of the Holden Beach Environmental Impact Statement.

Alternatives	Description
1. No Action (Status-Quo)	The town would continue to rely solely on the U.S. Army Corps of Engineers' beneficial use projects for shore protection of the East End of Holden Beach (i.e. beach nourishment)
2. Abandon and Retreat	A 30-year managed retreat plan to relocate or demolish structures threatened by erosion
3. Beach Nourishment	The town would be responsible for implementing a 30-year nourishment-only plan with nourishment occurring every 2 years
4. Inlet Management and Beach Nourishment	Similar to alternative 3 but with additional inlet management, meaning periodic relocations of the outer inlet channel (Lockwood Folly Inlet)
5. Short Terminal Groin and Beach Nourishment	A "short" terminal groin of ~800ft would be constructed and beach nourishment would continue at 4-year intervals
6. Intermediate Terminal Groin and Beach Nourishment (current plan)	**A terminal groin of ~1000 ft would be constructed and beach nourishment would continue at 4-year intervals**

Q17 Please indicate your level of support for each alternative.

	Strongly against (1)	Somewhat against (2)	Neither against nor support (3)	Somewhat support (4)	Strongly support (5)	Don't Know (6)
1. No action (1)	❍	❍	❍	❍	❍	❍
2. Abandon and retreat (2)	❍	❍	❍	❍	❍	❍
3. Beach nourishment (3)	❍	❍	❍	❍	❍	❍
4. Inlet management plus beach nourishment (4)	❍	❍	❍	❍	❍	❍
5. Short terminal groin and beach nourishment (5)	❍	❍	❍	❍	❍	❍
6. Intermediate terminal groin and beach nourishment (6)	❍	❍	❍	❍	❍	❍

Q18 Would you be interested in receiving more information about the proposed terminal groin on Holden Beach?

❍ Yes (1)

❍ No (2)

If No Is Selected, Then Skip To Click to Please provide any additional comments…

Q19 How would you prefer to receive informational materials about this project? (Check all that apply)

❑ Email (1)

❑ Community Information Session(s) (2)

❑ Webinar (3)

❑ Mail (4)

❑ Other (please explain) (5) _____

Q20 Please provide any additional comments you may have about the topics discussed in this survey.

Thank you for your participation in this survey.

APPENDIX B: Focus Group Email Invitation

Dear Raenel,

My class at Duke is doing a group project and I was hoping that a few of your teachers or parents could help us out for one of our steps. Because of the time constraints, this is very last minute and we understand if this makes it inconvenient. See the information below:

I am currently taking a Survey Methods for Environmental Management course at Duke, and we have been assigned a client for which to design and implement a survey regarding a specific environmental issue. We are looking to organize a focus group of 6 people who own beach property or visit beaches frequently. Since our survey will be administered to the property owners of Holden Beach, NC, we want to test our survey before sending it out.

Holden Beach, NC is proposing a large, very costly terminal groin project to protect houses on the east end of the island from erosion. Our group's client, the Southern Environmental Law Center, is interested in gauging the residents' knowledge of beach erosion and priorities of intervention options on Holden Beach.

This focus group would take place next Thursday, 2/25 around lunchtime, but we are flexible. Our group can come to Central Park School and provide lunch for the participants. If you are interested, we really appreciate it, and please let us know if this works for you. Thank you so much again, and your help is greatly appreciated.

Best,
Melissa Whaling

APPENDIX C: Focus Group Script

Introductions

Thank you all for taking time out of your busy days to participate in this discussion. As you know, we will be conducting a focus group, and I will be the moderator. First I want to introduce our group to everyone so you all know who we are.

[*Have group introduce themselves.*]

I already provided in my email a little background, but I'll go over it again for those of you who forgot. For our Social Science Surveys class, we are assigned a client, and we are tasked with designing, implementing, and analyzing a survey to a specific group of people about a specific environmental issue. At this step in the process, we have to conduct a focus group where you all will be helping us in the revision of the draft survey that will be giving to homeowners in the coming weeks.

I'll get into more of the details of the survey shortly, but first I need you all to quickly read through and sign the consent form I handed out. Does anyone have any questions about the consent form?

[*Collect forms.*]

As the form says, we will need to record the conversation for our reference purposes, but no one's names will be used in this study, and only our group members will listen to the recording. So if you can, please speak up when you're talking so that we can hear when we listen to the recording later.

Now I'll give you a little bit of background on the project. Holden Beach is a small town located on a barrier island in Brunswick County, about 15 miles from the South Carolina border. The town is currently planning to build a terminal groin in an effort to protect oceanfront houses that are threatened by erosion. For those of you who may not be familiar with the term terminal groin, they are hardened structures built perpendicular to the beach to control erosion by intercepting sand that naturally moves along the beach with the currents. Terminal groins do slow erosion immediately nearby but result in increased erosion elsewhere and affect habitat for wildlife like shorebirds and sea turtles. In addition, they are expensive. This survey of Holden Beach property owners will assess how much they understand the effects of terminal groins, and ask property owners to prioritize their erosion response projects.

So, without further adieu, let's begin our discussion. First, I know that you all know each other, but I'd like everyone to introduce themselves to the group. So if we could just go around and each state your name, how frequently you visit beaches, are you a property owner or renter, and which beaches you visit. Also, tell us something interesting about yourselves.

[*Introductions.*]

Next, we will go through each of the survey questions. I'm going to pass around packets with the surveys on them. I've taken out some of the demographic questions that aren't necessary for our purposes. As you read through each one, please consider the 7 questions that have been provided to you in your agendas.

[*Receive feedback on each question.*]

Thank you for that feedback, now, with the remaining time we have left, we are just going to open the floor for general discussion questions. Please don't be shy in providing your opinions. Everyone's input is welcomed and appreciated.

Discussion Questions

1. What can you tell me about your experience with erosion in your area(s)? What sort of issues are you currently facing or have previously faced?
2. Are you familiar with the terms terminal groin and beach nourishment? What do these terms mean to you?
3. How has erosion in your area(s) changed over time?
4. Are any of you concerned about the future of erosion in your area(s)?
5. Do you expect the next generation in your family to rent or own beach property?
6. Have you had experience with different erosion prevention projects in your area(s)?
7. Would you say that your experiences with these have been positive or negative?
8. What kinds of beach development issues are important for you or others your area(s)?
9. For people that you would call environmentalists, would tend to trust or not trust what they have to say? What about people affiliated with universities, Duke in particular?
10. How would you feel if you received this survey?

Suggestions

Now I'll just open the floor to suggestions you may have about any aspect of this survey, or any other questions you may have about this project.

Thank you!

APPENDIX D: Focus Group Agenda

Thursday Feb 25th, 11:45am
Central Park School for Children

Contact: Raenel Edmonds
Moderator: Melissa Whaling
Notetakers: Justin Pearce and Sara Cleaver
Other Group Members: Ashley Gordon, Emily Hall, and Hillary Smith

1. Group introductions and what our project is about:
Holden Beach is a small town located on a barrier island in Brunswick County, North Carolina. The Town is evaluating building a terminal groin in an effort to protect oceanfront houses threatened by erosion. Terminal groins slow erosion immediately down current, but result in increased erosion elsewhere and affect habitat for shorebirds and sea turtles. In addition, terminal groins are expensive, particularly given other pressing infrastructure and erosion response needs in coastal communities. This survey of Holden Beach property owners will assess understanding of the effects of terminal groins, and ask property owners to prioritize erosion response projects.

Research questions:
1. What do property owners in Holden Beach currently understand about the effects of terminal groins on beach erosion?
2. What are the property owners' relative preferences among different erosion interventions for Holden Beach?

2. Introductions: Say who you are and how frequently you visit beaches. Are you a property owner? Which beach(es)?

3. Go through confusing and complex questions:
1. Are questions consistently understood?
2. Do you have enough information to answer each questions?
3. Do your answers accurately describe what you're trying to say?
4. Are the answer categories appropriate for what the question is trying to measure?
5. Can any questions be added or eliminated? Are any questions repetitive?
6. Have we asked all questions that will answer our research question?
7. How long do you think this survey would take you to complete?

4. Suggestions?
5. Thank you and closing.

Focus Group Statement of Informed Consent

You have been selected to participate in a focus group hosted by students in the Duke University course entitled Environ 557 "Social Science Survey Methods" on behalf of the Southern Environmental Law Center (SELC). The purpose of this discussion is to obtain your insights and opinions regarding beach erosion interventions as well as to obtain your feedback on a sample survey questionnaire that we have constructed.

The discussion will take approximately 60 minutes. During this discussion, you will be asked to share your opinions; there are no right or wrong answers.

In order to ensure your privacy, only first names will be used during this discussion and there will be no personal information associated with any information obtained from this focus group. If all group members consent, the discussion will be audio recorded in order to make a transcript of responses at a later time. The audio tape and transcript will only be used by the researchers. As soon as a written transcript is made of the tape, the tape will be destroyed.

Your participation in this focus group is entirely voluntary. You may decline to answer any question and you may leave at any time.

If you have any questions or concerns regarding this discussion, please ask now or at any time during or after the discussion. You may also contact Professor Randall Kramer at (919) 613-8072.

I agree to participate in this focus group and to be audio recorded.

_____
Print name

_____ _____
Signature Date

APPENDIX E: Email Used for Survey Implementation

Dear Holden Beach POA member,

As a homeowner in Holden Beach, you have direct experience with processes of beach erosion affecting your community. Your opinions about beach erosion are important when considering different solutions to these complex issues.

As Duke University students, we are conducting a survey to understand: 1) How property owners in Holden Beach perceive the effects of beach erosion, 2) Property owners' opinions about the potential benefits of different proposed solutions, and 3) Property owners' preferences for various erosion intervention solutions. We would greatly appreciate your participation in a brief 10-minute survey to help us answer these questions. Please click the link below to take our survey and help Duke students better understand issues facing your community. We greatly value your input and thank you for your time.

Sincerely,

_____

APPENDIX F: Regression Summary Statistics

Summary Statistics	*Support Groin*	*East End*	*Permanent Resident*	*Knowledge of Groins*	*Won't Prevent Erosion*	*Slow Erosion*	*Costly*	*Tourism*	
Minimum	0	0	0	0	0	0	0	0	0
Maximum	1	1	1	1	1	1	1	1	4
Mean	0.37	0.22	0.18	0.15	0.48	0.65	0.38	0.19	1.4
SD	0.48	0.414	0.39	0.35	0.5	0.48	0.49	0.4	1.3
N	274	274	274	274	274	274	274	274	274

APPENDIX G: Response Rates

Question	Response Rate (%)
1	100.00
2	99.64
3	100.00
4	99.64
5	99.64
6	98.91
7	99.64
8	99.64
9	100.00
10	100.00
11	98.18
12	96.72
13	96.35
14	94.53
15	96.35
16	96.35
17	94.53
18	94.89
19	73.72

APPENDIX H: Kruskal-Wallis Test Results

Comparison	Z	P.adj
a-b	1.91	0.84
a-c*	-9.38	9.71E-20
b-c*	-11.25	3.39E-28
a-d*	-9.13	1.02E-18
b-d*	-10.99	6.67E-27
c-d	0.17	1.00
a-e	-1.85	0.96
b-e*	-3.70	3.19E-03
c-e*	7.28	4.91E-12
d-e*	7.06	2.56E-11
a-f	-2.63	0.13
b-f*	-4.49	1.04E-04
c-f*	6.57	7.54E-10
d-f*	6.35	3.28E-09
e-f	-0.74	1.00

Kruskal-Wallis Test Results: Chi-squared=220.23, df=5, p-value <2.2 e-16

*Asterisk denotes significance according to the 0.05 threshold. The erosion intervention options are coded as follows: a=No Action, b=Abandon/Retreat, c=Beach Nourishment, d=Inlet Management and Beach Nourishment, e=Short Terminal Groin, and f=Intermediate Terminal Groin.

APPENDIX I: Word Cloud from Open-Ended Question