Identifying which ecosystem services coastal residents actually value: A choice experiment survey of the Eastern Shore of Virginia regarding climate change adaptation

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Introduction

Human actions, motivated by behavior and choice, have greatly influenced environmental change by modifying ecosystem structure and function, generating disturbances that alter natural systems (Chapin et al. 2000, DeFries et al. 2004). With the growing awareness of this reality within the scientific community, much attention has been placed on understanding the feedback links between human and environmental systems. In the U.S., for instance, the National Science Foundation-funded Long Term Ecological Research (LTER) network has focused its latest Decadal Plan on understanding the factors that link ecosystem structure to human institutions, values, and decisions (U.S. LTER 2007).

One way in which these linkages have been examined by scientists and policy-makers alike has been through ecosystem services. Drawing on the terminology used by Fisher et al. (2009), we define ecosystem services in this paper as *naturally-occurring processes and goods that can be utilized (actively or passively) to produce human well-being*.

Ecosystem services differ based on the ecosystem and spatial scale considered. For example, in temperate or sub-tropical estuarine coastal environments, sea grasses can provide the ecosystem services of sediment stabilization and wildlife habitat provision; migrating coastal song birds can provide aesthetically pleasing sights and sounds and thus opportunities for recreational activity; and shellfish can help to filter excess nutrients from coastal waters, improving water quality (Barbier et al. 2011, Grabowski and Peterson 2007). Moreover, people may simultaneously benefit from ecosystem services, enjoying higher quality water for recreation as well as enjoying the existence of a better-functioning, healthier ecosystem in proximity to human communities (Krutilla 1967). Overall, these services provide a positive impact to a variety of sectors, ranging from seafood production to ecotourism to shoreline protection and management (Ruckelshaus et al. 2013).

Ecosystem services can be an impetus for encouraging people to see the immediate relevance of the environment to their lives. Ecosystem services, for example, can be readily used to frame environmental protection as a way to sustain the “natural capital” that contributes to a country’s economic growth (Daily et al. 2009, Liu et al. 2010). Furthermore, ecosystem services can be used as the baseline by which environmental managers are able to link conservation to development issues “that policy-makers and the majority of the general public care about” (Watson 2005).

From an environmental economics perspective, an ecosystem services framework provides an entry point into more fully examining the attitudes people hold towards the environment. Specifically, by understanding what ecosystem services people find valuable, we are able to parse out: (a) the motivations behind why people value the environment and (b) how such motivations impact people’s preferences for different environmental management and policy alternatives. These two ideas are explored further in the two sub-sections and provide the basis for the major research questions addressed in this paper.

What ecosystem services are "valuable"?

While the theoretical concept of ecosystem services can be used to enhance discussions about natural resource protection, the application of how these services fit into a practical management plan are less defined. For instance, different approaches to environmental management may emphasize some ecosystem services over others. This may raise such issues as whether a management plan should focus on protecting the maximum number of ecosystem services, those services deemed as the most ecologically "critical", or those services that may be of greatest value to vulnerable human populations (Ruckelshaus et al. 2013).

Ultimately, the question being asked is how one defines the value of an ecosystem service. The existing scientific literature is rich in its collection of studies focused on determining the monetary value of ecosystem services, Constanza et al. (1997) perhaps being the most notable. Despite the existence of such value metrics, however, an oft-neglect consideration by these studies is whether the existing ecosystem services are actually perceived as being "valuable" by those who benefit from them. In other words, does the presence of an ecosystem service mean that those benefiting from the service actually value it? Such an inquiry challenges notion of what it means for an ecosystem service to be deemed as "valuable".

As it turns out, this consideration is more than just a cognitive exercise. The literature has raised questions over how ecosystem services are actually perceived. One issue that has been explored is how local populations and technical experts may differ in their views of the benefits that ecosystem services provide. Sheil and Wunder (2002) have shown that environmental valuation based on local perceptions may prove scientifically-validated data to be of lesser relevance when it comes to environmental decision-making. Furthermore, Pearce (2007) has questioned to extent to which society values biodiversity conservation, given the dissonance between technical estimates of ecosystem service worth, stated willingness to pay for conservation, and actual expenditures for such conservation.

The literature has also spoken to how different stakeholders can perceive different benefits from the same ecosystem processes — sometimes complementary, sometimes competitive. These differences can be attributable to individual differences, such as perceptions, as well as larger divisions, such as the categorization of resources, property rights, and institutional arrangements (Dasgupta et al. 1999, Turner and Daily 2008). Differences in value can also be due to ecosystem benefits provided at different spatial and temporal scales. Hein et al. (2006) argue that stakeholder interest in ecosystem services differ greatly based on spatial scales, and thus scales of ecosystem services need to be accounted for when implementing ecosystem management plans. All in all, these studies point to the importance of considering the context of those on the receiving end of ecosystem service benefits when striving to determine the value of such services.

Ecosystem services and climate change

As previously mentioned, by understanding which ecosystem services people place value on, it is possible to parse out whether such values impact their preferences for how environmental management should be carried out. Environmental planning today is largely considered in the context of global climate change; such an approach is relevant to ecosystem services, as the supply of ecosystem services is expected to change with the climate (Schroter et al. 2005). Furthermore, human action can both exacerbate and mitigate the extent of such change.

To illustrate these points, take, for instance, the temperate or sub-tropical estuarine habitat considered earlier in this paper. The major climate change impacts on these environments are sea-level rise (SLR) and the increased frequency, intensity, and in-land reach of coastal storms. Saltmarsh is found in these estuarine environments and provides protection from erosion and inundation due to storm surge (Ruckelshaus et al. 2013). While saltmarsh is known to respond to SLR through the physiological process of accretion — marsh elevation building and in-land migration — the rate of accretion is highly dependent on sediment deposition rate, both for providing inorganic material for marsh to build upon and to enrich saltmarsh growth (Day et al. 2008, FitzGerald 2008, Najjar et al. 2000, Poff et al. 202, Wolanski et al. 2004). If the rate of SLR exceeds that of accretion, the viability of saltmarsh habitat is threatened (Kirwan et al. 2010). In combination with SLR, human development along the coastline could prevent the in-land migration of saltmarsh; this could ultimately result in the extinguishment of saltmarsh habitat (Burkett and Kusler 2000, Day et al. 2008, Kennedy et al. 2002, Michener et al. 1997). Furthermore, the enhanced severity of coastal storms could potentially increase the likelihood and incidence of saltmarsh damage or destruction (Day et al. 2008). This, along with any additional human-induced impacts to the nearshore coastal environment, could influence the damage done to the coastal environment (Ruckelshaus et al. 2013). The end result is a loss of ecosystem services, including the economic loss in recreation, tourism, fishing, and property values (Ruckelshaus et al. 2013).

It is not infeasible to imagine, therefore, that depending on the ecosystem services people hold to be important, preferences and priorities may differ in terms of environmental adaptation and management, especially as it relates to climate change.

Research Focus

Given the above context, we were broadly interested in understanding what ecosystem services coastal residents cared about and whether their affinity for certain services influenced their preferences for climate change adaptation measures that could influence the future availability of specific services. Notably, we aimed to gain this knowledge by posing these questions to coastal residents directly in a discrete choice, contingent valuation survey. Assessing ecosystem service value by surveying the beneficiaries of such services would provide a different approach to understanding ecosystem service value as compared to the valuation studies carried out by other studies in the scientific literature.

Our study site is the Eastern Shore of Virginia, 70-mile long region consisting of Accomack and Northampton Counties, the southernmost tip of the Delmarva Peninsula. The Eastern Shore is home to the Virginia Coast Reserve (VCR) LTER site, which funded our research as social science supplement to their ecological work.

The Eastern Shore provides a unique ecological environment to consider in terms of ecosystem services and climate change. The Shore encompasses 70 percent of Virginia's tidal wetlands; a National Wildlife Refuge that acts as "one of the most important avian migration funnels in North

America"; and the site of an ecologically-significant, restored sea grass habitat that was once thought to be extinct (U.S. FWS 2013, VCR 2012). These sites, among others, could be threatened under conditions of SLR and frequent storm damage. From a geological perspective, Accomack County, which makes up 18 percent of Virginia's dry land within two feet of tidal land, could be greatly at risk under conditions of SLR and frequent coastal storms (Titus et al. 2010). Furthermore, as the Eastern Shore's sole fresh water source is groundwater, SLR could threaten large-scale freshwater resources due to the potential for underground saltwater intrusion (Chang et al. 2011, Sanford et al. 2009). Anecdotal evidence gained from focus groups of Eastern Shore residents (discussed later in the paper) brought to light that many residents of the Eastern Shore — particularly those living along the coastline — have already perceived effects related to climate change.

The Eastern Shore is also an interesting cultural site to study. From our focus groups, it was revealed that a number of diverse populations call the Eastern Shore home. Historically, the Eastern Shore was largely inhabited by "watermen", traditional fishermen who trawl for crabs and oysters, as well as crop farmers — both of which rely on the natural environment for their livelihoods. The make-up Eastern Shore today still encompasses the watermen and farmers, but is now distinguished more between the "born heres", those who consider themselves "native" to the Eastern Shore, and the "come heres", transplants to the Shore whose population consists largely of retirees. Industry types has also shifted on the Shore, with the presence of poultry farms and a NASA flight facility adding to the aquaculture, agriculture, and ecotourism that have been mainstays for decades.

Given both the geographical and cultural context, we felt the Eastern Shore provided a unique environment to test these specific research questions:

1. Why do Eastern Shore residents care about the environment?
2. What ecosystem services do Eastern Shore residents value?
3. Do the answer to either of the above questions influence residents' preferences for climate change adaptation (specifically coastline protection)?

As noted briefly before, we addressed these questions through a discrete choice survey of the two counties. To our knowledge, we are among the first researchers to address these research questions. A similar study by Gordon et al. (2012), carried out in the Bay, Gulf, and Franklin counties of Florida, examined the trade-offs stakeholders, involved in or knowledgeable about sea level rise adaptation, and the general public are willing to make to reduce the risk of losing particular ecosystem services to SLR. Our study builds on the Gordon et al. (2012) study by framing our research question in the context of a discrete choice experiment, so that we may determine marginal utility values of attributes within the choice set. Our study analysis also accounts for population heterogeneity through the use of a latent class logit analysis. Our methodological analysis is described in more detail below.

Methodology

Focus Groups

The framing of the survey we implemented was primarily informed by five focus groups we facilitated on the Eastern Shore residents from the fall of 2012 through the summer of 2013. Focus group participants represented a diverse range of people from the Eastern Shore population in terms geographic residence, occupation, and ethnicity. These focus groups were an opportunity for us to learn about the cultural and environmental values of the region. We also used these focus groups to test draft versions of the survey for understandability and sociopolitical relevance.

To ensure our survey included workable and relatable attributes, we also consulted "experts" in the region — including a county planning director, administrators from the local community college, and scientific researchers working for or in collaboration with the VCR LTER — for survey content input and assessment.

Survey

Our survey consisted of three methods in three sections to analyze resident preferences and values.

In the first section, survey respondents were provided a series of 17 statements that related the Eastern Shore environment to the local economy, wildlife, natural resources, recreation, tourism, property and regional culture. Respondents were asked to rank how much they agreed with each statement on a Likert scale of 1 to 7 (strongly disagree to strongly agree). The intent of these questions was to determine, through the correlation of specific statements, the values or subjective attitudes each respondent held with regards to the Eastern Shore environment.

In the second section, respondents were provided with a list of statements. Respondents were asked to choose the statements that they felt were most and least important. Respondents repeated this process of choosing the most and least important statements twice, with each subsequent selection process only accounting for the statements that were not chosen in the previous selections. We provided respondents with two such lists. The first was a list of common reasons given by Eastern Shore residents as to why they believed the Eastern Shore environment should be protected. The second was a list of ecosystem services that could be attributable to the Eastern Shore environment. The intent of these questions was to determine which reasoning behind protecting the Eastern Shore environment resonated most with our respondents and what ecosystem services they valued the most.

Our third section consisted of a discrete choice experiment. Respondents were asked to make a choice between two publicly-funded (taxed) coastal protection plans and the option to take "no action" (Figure 1). The choice set scenario was the same for all questions in the section: that in 50 years, a certain number of acres of land in the respondent's county (4500 acres for Northampton, 9500 acres in Accomack) would likely flood as a result of climate change. These flooded acre values were determined using a rudimentary, "bathtub" GIS flood analysis using the conservative (4 mm/yr) and IPCC (6.5 mm/yr) SLR values used by the VCR LTER. For the choice question type relevant to this paper, each respondent was given four choice sets to answer.

Each of the two coastal protection plans in each choice set consisted of environmental and non-environmental attributes. The attributes included the total amount of land protected (1500 or 3000 acres for Northampton, 3000 or 6000 acres for Accomack), the protection type (conventional or alternative coastline protection), three ecosystem services (out of list of seven, all of which were noted in section two of the survey) that would be impacted by the coastal protection plan, and the cost of the plan in household taxes paid per year for five years ($15, $30, $45, $60, $75). Conventional coastline protection was defined as rock or concrete structures built along the coast that blocked waves and redirected water currents (e.g. seawalls). Alternative coastline protection was referenced in the context of "living shorelines", defined as a strategic combination of saltmarsh, sea grass beds, oyster reefs, and rock walls placed along the coast. When conventional coastline protection was indicated as the management option, the plan was said to "minimize the negative impacts on" the three ecosystem services noted. When alternative coastline protection was indicated as the management option, the plan was said to "enhance or strengthen" the three ecosystem services noted. The "no action" alternative indicated that no concerted county effort would be made to undertake a management plan and that all the acres expected to flood could potentially turn into saltmarsh, which in turn could provide any of the ecosystem services noted in section two of the survey. The intent of these questions was to parse out marginal utility values for each of the attributes present in any of the choice question sets.

There were 64 different choice questions (32 for each county) constructed use a fractional factorial man effects design designed by Don Anderson of StatDesign, LLC (Evergreen, CO). We adopted a six-part survey mailing sequence, based on the Dillman Total Design Survey Method (Dillman 1978), to ensure the best response rate. We launched the mailing sequence in the fall of 2013, sending out surveys to 1000 households in each of Northampton and Accomack Counties. Of the 1000 surveys sent to Northampton County, 759 surveys were sent to addresses from the county's latest voter registration list, 151 to members of a citizen's group or outdoors club in the Eastern Shore region, and 90 to a small community group. Of the 1000 surveys sent to Accomack County, 700 surveys were sent to addresses from the county's latest voter registration list and 300 to members of the same citizen's group or outdoors club. The reason for this distribution of surveys was two-fold: first, we wanted to see if the preferences among members of specific groups on the Eastern Shore differed from those in the general voting population, and secondly, given the poor survey response rate of past survey studies carried out by the two-county planning commission (< 10%), we wanted to ensure a response rate that would allow us to carry out statistically meaningful analysis.

Question #5

Suppose that, according to the best scientific data available, there is expected be an increase in the frequency, intensity, and inland reach of coastal floods over the next 50 years. If this holds true, **9,500 acres** of sea side coastal land in your county would most likely flood and potentially turn into saltmarsh over 50 years. *Suppose* that to manage this flooding, your county will enact a management plan to protect a portion of the county's mainland coast on the sea side.

Suppose your county has proposed two management plans for you to vote on. Please read the information about both plans below and indicate which plan, if either, you would vote to implement if they were the only choices:

	PLAN A	PLAN B	NO ACTION
Total area of coastal land managed to help protect against likely flooding:	6,000 out of 9,500 acres (63% of coastal land expected to be flooded)		No management plan is undertaken. 9,500 acres are expected to flood and will potentially turn into saltmarsh over 50 years. Saltmarsh could provide shoreline protection, wildlife habitat, and/or any of the other benefits listed on page 4 of this survey.
Your county would manage this area of land, along the coastline, by…	…building alternative protection — like "living shorelines"	…building alternative protection — like "living shorelines"	
Managers would choose the locations of coastal land to manage specifically to…	**…enhance or strengthen** these environmental benefits: **(1)** Stabilization of sediments that cloud coastal waters **(2)** Nature's protection against destructive waves and salt spray **(3)** Undeveloped landscape views for local quality of life	**…enhance or strengthen** these environmental benefits: **(1)** Removal of excess nutrients from coastal waters **(2)** Stabilization of sediments that cloud coastal waters **(3)** Saltmarsh buildup to combat coastal flooding	
Cost to your family, in new taxes, to pay the County's share of the expenses for this plan: **(Your taxes are 100% guaranteed to pay for this plan)**	$60 per year for 5 years ($300 total)	$30 per year for 5 years ($150 total)	
Acc Eco V #1 Q #5	☐ I would vote for **Plan A** and pay **$60** in additional taxes per year for five years (**$300 total**).	☐ I would vote for **Plan B** and pay **$30** in additional taxes per year for five years (**$150 total**).	☐ I would **not** vote for **either** Plan A or Plan B and pay **$0** in additional taxes.

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Figure 1. Example choice question for a respondent living in Accomack County, VA

Theoretical Framework: Factor Analysis

The analysis of our Likert-scale questions in section one of our survey utilizes a principal component factor analysis and subsequent varimax rotation. The intent of this was to identify latent variables that indicate correlation between the responses given to the 17 Likert-scale questions. Similar analysis was performed by Purdy and Decker (1989) to determine their Wildlife Attitudes and Values Scale and by McGonagle and Swallow (2005) to determine their Coastal Attitudes and Values Scale.

Theoretical Framework: Latent Class Analysis

The analysis of choice experiments is based on Random Utility Theory (RUT), as developed by McFadden (1974) and described in detail by Hensher et al. (2005) and . In short, RUT claims that the utility gained by a person making a certain choice is an unobservable quantity that exists within the mind of the decision-maker. By observing the choices made by respondents, researchers are able to decompose the factors that drive the decision-making and subsequently estimate partial values of the attributes that make up each choice alternative. The individual's latent utility consists of two components: the systematic (or explainable) component V and the random (or non-explainable) component ε.

$$U_{in} = V(X_i, Z_n) + \varepsilon_{in}$$

where

$X_i = characteristics\ of\ choice\ alternative\ i$

$Z_n = characteristics\ of\ the\ individual\ n$

Since utility is stochastic, we can predict the probability of individual n choosing alternative i (over alternative j):

$$\mathbb{P}\mathrm{r}_n(i) = \mathbb{P}\mathrm{r}[(V_{in} + \varepsilon_{in}) > Max(V_{jn} + \varepsilon_{jn})]\ \forall\ j$$

To account for heterogeneity, we utilize a latent class logit model, a semi-parametric variant of the multinomial logit, to analyze our choice question responses. This analysis is described in detail by Green and Hensher (2003) and Scarpa and Thiene (2005). In short, the underlying theory of latent class modeling is that choice behavior depends on observable attributes and unobserved variables that cause latent heterogeneity (Phillips 2011). The model uses a class probability equation, consisting of observed, individual-specific variables, to predict the probability of individuals falling into different classes with different preferences (and thus different utility equations parameters).

The latent class probability equation is:

$$\mathbb{P}\mathrm{r}_n(i|q) = \frac{\exp(\beta_q X_i)}{\sum_{k=1}^{K} \exp(\beta_q X_k)}$$

where

$q = specific\ class$

The resulting conditional indirect utility equation is:

$$v_{in} = \sum_{q=1}^{Q} \mathbb{P}\mathrm{r}_n(q) \cdot \left(\beta_q X_i + \gamma_q C_i\right)$$

where

$Q = total\ number\ of\ classes$

$\gamma = cost\ coefficient$

$C = cost$

Our study follows similar methods as Kafle et al. (2011).

Preliminary Results

Of the 1000 surveys mailed out to each county, a total of 298 usable surveys were received from Accomack County and 285 from Northampton County.

A summary of our respondent demographics are noted in Table 1 below:

	Northampton	Accomack	Overall
Mean Age (Std. Dev.)	62.4 (13.4)	62.3 (14.6)	62.4 (14.0)
County of Residence	48%	52%	—
% Female	47%	41%	44%
Race/Ethnicity			
White	76%	86%	81%
Black/African-Amer.	10%	5%	7%
Other or Multiracial	5%	4%	4%
Prefer not to Say	10%	6%	8%
Education			
≤ High School	21%	22%	22%
Some College	26%	27%	27%
Bachelor's Degree	27%	20%	23%
Advanced Degree	27%	30%	29%
Income			
≤ $25,000	7%	6%	6%
$25,000 – $49,999	18%	20%	19%
$50,000 – $74,999	18%	19%	19%
$75,000 – $99,999	13%	14%	14%
≥ $100,000	23%	23%	23%
Prefer not to say	20%	18%	19%

Table 1. Respondent demographics

The results of our principal components factor analysis generated four latent variables that represent attitudinal scales. After examining the Likert-scale questions that most highly correlate with each of the four latent variables, we determined the following descriptors for each factor:

- *Factor #1: Cultural Heritage* – Those "scoring" highly for this factor demonstrated a preference for protecting the Eastern Shore environment for the sake of sustaining the historical culture of the Eastern Shore. This "score" reflects a preference for both preserving the historical physical landscape (undeveloped land) and a historical way of life (such as occupations, like farming or "watermen").
- *Factor #2: Resource Protection* – Those "scoring" highly for this factor demonstrated a preference for protecting the Eastern Shore environment for the sake of protecting resources that aided human livelihood. This "score" reflects a preference for both protecting personal property (such as housing along the coastline) and natural resources, such as groundwater.
- *Factor #3: Wildlife Conservation* – Those "scoring" highly for this factor demonstrated a preference for protecting the Eastern Shore environment for the sake of preserving wildlife. This "score" reflects a preference for both preserving wildlife habitat as well as a positive attitude towards environmental protection programs.
- *Factor #4: Economic Development* – Those "scoring" highly for this factor demonstrated a preference for protecting the Eastern Shore environment for the sake of sustaining natural-resource-based economic development. This "score" reflects a preference for protecting environmental services that contribute to ecotourism and aquaculture.

The results of the first ranking list (from section two of the survey), in which respondents indicated their most and least important reasons for protecting the Eastern Shore environment, are noted in Table 2.

	Northampton		Accomack		Overall	
	% Top 2	% Bott 2	% Top 2	% Bott 2	% Top 2	% Bott 2
Wildlife conservation	36%	14%	39%	10%	38%	12%
Economic contribution	44%	18%	33%	28%	38%	23%
Undeveloped landscape	27%	25%	34%	20%	31%	22%
Sustain E.S. culture	13%	56%	7%	60%	10%	58%
Recreational activity	13%	35%	22%	24%	18%	29%
Property protection	26%	43%	24%	45%	25%	44%
Groundwater protection	45%	10%	44%	13%	45%	12%

Table 2. The percentage of time a respondent listed each reason for protecting the Eastern Shore environment among their two most important and two least important

The results of the second ranking list (from section two of the survey), in which respondents indicated their most and least preferred ecosystem services on the Eastern Shore, are noted in Table 3.

	Northampton		Accomack		Overall	
	% Top 3	% Bott 3	% Top 3	% Bott 3	% Top 3	% Bott 3
Wildlife/habitat sustainment	78%	2%	75%	2%	77%	2%
Water nutrient removal	44%	6%	49%	6%	47%	6%
Sediment stabilization	17%	20%	12%	18%	14%	19%
Shoreline protection	43%	6%	44%	11%	44%	9%
Saltmarsh accretion	40%	8%	50%	7%	45%	7%
Economy: rec. & tourism	21%	17%	23%	17%	22%	17%
Economy: aquaculture	34%	8%	27%	10%	30%	9%
Landscape: Personal views	6%	41%	7%	43%	6%	42%
Landscape: Draw for devt.	4%	83%	1%	87%	2%	85%
Sustaining E.S. culture	10%	48%	6%	44%	8%	46%
Personal satisf. for conserv.	7%	64%	10%	60%	9%	61%

Table 3. The percentage of time a respondent listed each Eastern Shore ecosystem service among their two most important and two least important

We carried out a latent class analysis for each of the two counties, generating a two-class model. The results for Accomack County are noted in Table 4. The results for Northampton County are noted in Table 5. The reason we used a two-class model is that, based on discussion in our focus groups, we believed there existed a population among our survey respondents that demonstrated a high level of distrust for the government and thus would be opposed to any tax-funded plan. We wished to parse the group out in our analysis. Furthermore, the Bayesian Information Criteria supported a 2-class model. We attempted to run a 3-class model, to further parse out our heterogeneous population, but the Hessian matrix consistently came out singular and thus would not estimate the model.

In both tables, for the utility equation, *land* is the total amount of land protected in the management plan, all the *eco*-prefixed variables are dummies that take a value of 1 if that specific ecosystem service is present in the management plan, all the *ls*-prefixed variables are the associated *eco*-prefixed variables interacted with a dummy that takes the value of 1 if the management type is alternative coastline protection, and *cost* is the annual cost of the management plan (the yearly tax rate for five years). The seven ecosystem services, respectively, are wildlife and habitat provision for future generations, removal of excess nutrients from coastal waters, stabilization of sediments that cloud coastal waters, protection by nature against destructive waves and salt spray, saltmarsh accretion (natural marsh buildup) to combat coastal flooding, undeveloped landscape views that contribute to local quality of life, and maintenance of the historic Eastern Shore culture.

In both tables, for the class probability equation, the *f*-prefixed variables are the factor scores #1-3, *czgrp* is a dummy that takes the value of 1 if the respondent was part of the previously-mentioned citizen's group or outdoors club, *eslive* is the number of years the respondent has lived on the Eastern Shore, *native* is a dummy that takes the value of 1 if the respondent believed themselves to be a "native" of the Eastern Shore, and *flood* is the likelihood score in percent (0, 10, 20, 50, 100) that the respondent gave for the likelihood of their house being flooded each year. The factor variables were included The variables *eslive* and *native* were meant to potential distinguish "born heres" from "come heres", while the *flood* variable was intended to see if those whose homes are more prone to yearly floods value ecosystem services and certain coastline protection plans differently. The fourth factor score was not included in the analysis, because its removal from the class probability equation did not significantly change the results of the model, as verified by a log-likelihood ratio test based on the chi-square distribution. We also felt the fourth factor was not re

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+---------------------------------------------+
| Latent Class Logit Model                    |
| Maximum Likelihood Estimates                |
| Dependent variable               CHOICE     |
| Weighting variable                 None     |
| Number of observations             1134     |
| Iterations completed                 57     |
| Log likelihood function       -914.3375     |
| Number of parameters                 40     |
| Info. Criterion: AIC =          1.68313     |
|   Finite Sample: AIC =          1.68578     |
| Info. Criterion: BIC =          1.86068     |
| Info. Criterion:HQIC =          1.75020     |
| Restricted log likelihood     -1245.826     |
| McFadden Pseudo R-squared      .2660795     |
| Chi squared                    662.9776     |
| Degrees of freedom                   40     |
| Prob[ChiSqd > value] =         .0000000     |
| Constants only.  Must be computed directly. |
|                  Use NLOGIT ;...; RHS=ONE $ |
| At start values  -1053.7841  .13233 ******* |
| Response data are given as ind. choice.     |
+---------------------------------------------+
+---------------------------------------------+
| Notes No coefficients=> P(i,j)=1/J(i).      |
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|       Constants only => P(i,j) uses ASCs    |
|         only. N(j)/N if fixed choice set.   |
|         N(j) = total sample frequency for j |
|         N    = total sample frequency.      |
|       These 2 models are simple MNL models. |
|       R-sqrd = 1 - LogL(model)/logL(other)  |
|       RsqAdj=1-[nJ/(nJ-nparm)]*(1-R-sqrd)   |
|         nJ   = sum over i, choice set sizes |
+---------------------------------------------+
+---------------------------------------------+
| Latent Class Logit Model                    |
| Number of latent classes =    2             |
| Average Class Probabilities                 |
|   .633  .273                                |
| ------------------------------------------- |
| LCM model with panel has  298 groups.       |
| Fixed number of obsrvs./group=       4      |
| Discrete parameter variation specified.     |
| ------------------------------------------- |
| Number of obs.=  1192, skipped  58 bad obs. |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+--------------+----------------+--------+--------+
---------+Utility parameters in latent class -->> 1
 LAND|1  |    -.00012894     .820491D-04    -1.571   .1161
 ECO_WD|1|     .67016079       .22410608     2.990   .0028
 ECO_NU|1|     .33712205       .23178602     1.454   .1458
 ECO_SE|1|     .39671421       .22315477     1.778   .0754
 ECO_PR|1|     .87694287       .20461142     4.286   .0000
 ECO_AC|1|     .99796473       .21918972     4.553   .0000
 ECO_VI|1|     .29027623       .23718429     1.224   .2210
 ECO_CL|1|    -.37497174       .23129671    -1.621   .1050
 LS_WDL|1|     .73122155       .24328452     3.006   .0027
 LS_NUT|1|     .62562992       .27713177     2.258   .0240
 LS_SED|1|     .12436901       .22390965      .555   .5786
 LS_PRO|1|     .05133022       .23085402      .222   .8240
 LS_ACC|1|     .19667246       .22470704      .875   .3814
 LS_VIE|1|    -.12090050       .23563413     -.513   .6079
 LS_CLT|1|     .82883632       .26141859     3.171   .0015
 COST|1  |    -.00536177       .00299114    -1.793   .0730
---------+Utility parameters in latent class -->> 2
 LAND|2  |     .00040700       .00011154     3.649   .0003
 ECO_WD|2|   -2.05054482       .45216760    -4.535   .0000
 ECO_NU|2|   -2.21517950       .49959523    -4.434   .0000
 ECO_SE|2|    -.90063808       .42547984    -2.117   .0343
 ECO_PR|2|    -.58240031       .37152681    -1.568   .1170
 ECO_AC|2|    -.93965428       .41455849    -2.267   .0234
 ECO_VI|2|   -2.40470506       .50502332    -4.762   .0000
 ECO_CL|2|   -1.59613637       .45020234    -3.545   .0004
 LS_WDL|2|    1.05079810       .52585755     1.998   .0457

 LS_NUT|2|     .89666442       .59900565     1.497   .1344
 LS_SED|2|    -.81486892       .49002757    -1.663   .0963
 LS_PRO|2|     .27610481       .49618605      .556   .5779
 LS_ACC|2|   -1.40036781       .55284109    -2.533   .0113
 LS_VIE|2|     .63407037       .52056408     1.218   .2232
```

LS_CLT|2|	.79048137	.50429628	1.567	.1170
COST|2 |	-.00867980	.00593843	-1.462	.1438
---------+This is THETA(1) in class probability model.				
Constant|	.92411814	.23686052	3.902	.0001
_F1_CL|1|	-.57755500	.16098477	-3.588	.0003
_F2_PR|1|	.17198265	.16510925	1.042	.2976
_F3_CO|1|	.40639943	.15004779	2.708	.0068
_CBES|1 |	.22826122	.32950471	.693	.4885
_ESLIV|1|	-.00030977	.00096804	-.320	.7490
_NATIV|1|	.00672180	.01581333	.425	.6708
_FLOOD|1|	.00013062	.00103847	.126	.8999
---------+This is THETA(2) in class probability model.				
Constant|	.000000	......(Fixed Parameter).......		
_F1_CL|2|	.000000	......(Fixed Parameter).......		
_F2_PR|2|	.000000	......(Fixed Parameter).......		
_F3_CO|2|	.000000	......(Fixed Parameter).......		
_CZGRP|2|	.000000	......(Fixed Parameter).......		
_ESLIV|2|	.000000	......(Fixed Parameter).......		
_NATIV|2|	.000000	......(Fixed Parameter).......		
_FLOOD|2|	.000000	......(Fixed Parameter).......		

Table 4. Latent class logit results for Accomack County

```
+---------------------------------------------+
| Latent Class Logit Model                    |
| Maximum Likelihood Estimates                |
| Dependent variable               CHOICE     |
| Weighting variable                 None     |
| Number of observations             1086     |
| Iterations completed                 61     |
| Log likelihood function       -790.2111     |
| Number of parameters                 40     |
| Info. Criterion: AIC =          1.52893     |
|   Finite Sample: AIC =          1.53182     |
| Info. Criterion: BIC =          1.71274     |
| Info. Criterion:HQIC =          1.59851     |
| Restricted log likelihood     -1193.093     |
| McFadden Pseudo R-squared      .3376785     |
| Chi squared                    805.7637     |
| Degrees of freedom                   40     |
| Prob[ChiSqd > value] =         .0000000     |
| Constants only.  Must be computed directly. |
|                  Use NLOGIT ;...; RHS=ONE $ |
| At start values   -963.7852  .18010 ******* |
| Response data are given as ind. choice.     |
+---------------------------------------------+
+---------------------------------------------+
| Notes No coefficients=> P(i,j)=1/J(i).      |
|       Constants only => P(i,j) uses ASCs    |
|         only. N(j)/N if fixed choice set.   |
|         N(j) = total sample frequency for j |
|         N    = total sample frequency.      |
|       These 2 models are simple MNL models. |
|       R-sqrd = 1 - LogL(model)/logL(other)  |
|       RsqAdj=1-[nJ/(nJ-nparm)]*(1-R-sqrd)   |
```

```
|         nJ   = sum over i, choice set sizes |
+---------------------------------------------+
+---------------------------------------------+
| Latent Class Logit Model                    |
| Number of latent classes =    2             |
| Average Class Probabilities                 |
|   .336  .538                                |
| ------------------------------------------- |
| LCM model with panel has  285 groups.       |
| Fixed number of obsrvs./group=       4      |
| Discrete parameter variation specified.     |
| ------------------------------------------- |
| Number of obs.=  1140, skipped  54 bad obs. |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+-------------+----------------+--------+--------+
---------+Utility parameters in latent class -->> 1
 LAND|1  |     .00022831       .00029053      .786   .4320
 ECO_WD|1|    -.81936769       .60866838    -1.346   .1782
 ECO_NU|1|    -.94134425       .60481167    -1.556   .1196
 ECO_SE|1|   -1.33275298       .59631405    -2.235   .0254
 ECO_PR|1|    -.90077971       .48287084    -1.865   .0621
 ECO_AC|1|    -.24954174       .54214060     -.460   .6453
 ECO_VI|1|   -1.80255246       .74895722    -2.407   .0161
 ECO_CL|1|   -1.07219090       .62385943    -1.719   .0857
 LS_WDL|1|     .25873007       .69930739      .370   .7114
 LS_NUT|1|    -.06103165       .74307058     -.082   .9345
 LS_SED|1|     .82205291       .72686414     1.131   .2581
 LS_PRO|1|     .23517150       .66607398      .353   .7240
 LS_ACC|1|    -.19016580       .66315226     -.287   .7743
 LS_VIE|1|     .20107209       .83004274      .242   .8086
 LS_CLT|1|    -.03025607       .70341749     -.043   .9657
 COST|1  |    -.01131202       .00909689    -1.244   .2137
---------+Utility parameters in latent class -->> 2
 LAND|2  |   -.912402D-05      .00012297     -.074   .9409
 ECO_WD|2|     .66226889       .17223222     3.845   .0001
 ECO_NU|2|     .28099411       .17961025     1.564   .1177
 ECO_SE|2|     .48921817       .16791727     2.913   .0036
 ECO_PR|2|     .23641263       .16252932     1.455   .1458
 ECO_AC|2|     .77144951       .15078851     5.116   .0000
 ECO_VI|2|     .12728830       .18325787      .695   .4873
 ECO_CL|2|    -.19955942       .17017329    -1.173   .2409
 LS_WDL|2|     .33307061       .19671784     1.693   .0904
 LS_NUT|2|     .85128062       .24189538     3.519   .0004
 LS_SED|2|    -.00841904       .17744546     -.047   .9622
 LS_PRO|2|     .49806237       .18203364     2.736   .0062
 LS_ACC|2|    1.11741920       .19007615     5.879   .0000
 LS_VIE|2|     .25107954       .19702228     1.274   .2025
 LS_CLT|2|    1.03496482       .23020259     4.496   .0000
 COST|2  |    -.01761533       .00249192    -7.069   .0000
---------+This is THETA(1) in class probability model.
 Constant|    -.47871881       .29220898    -1.638   .1014
 _F1_CL|1|     .39240938       .16794657     2.337   .0195
 _F2_PR|1|     .09912311       .15053055      .658   .5102
 _F3_CO|1|    -.49186791       .17201919    -2.859   .0042
 _CBES|1 |   -1.15055655       .40478819    -2.842   .0045
```

```
 _ESLIV|1|     .00814024       .00984613      .827   .4084
 _NATIV|1|    -.10081631       .48765100     -.207   .8362
 _FLOOD|1|    -.00012918       .00074646     -.173   .8626
---------+This is THETA(2) in class probability model.
 Constant|       .000000    ......(Fixed Parameter).......
 _F1_CL|2|       .000000    ......(Fixed Parameter).......
 _F2_PR|2|       .000000    ......(Fixed Parameter).......
 _F3_CO|2|       .000000    ......(Fixed Parameter).......
 _CZGRP|2|       .000000    ......(Fixed Parameter).......
 _ESLIV|2|       .000000    ......(Fixed Parameter).......
 _NATIV|2|       .000000    ......(Fixed Parameter).......
 _FLOOD|2|       .000000    ......(Fixed Parameter).......
```

Table 5. Latent class logit results for Northampton County

Discussion

The results from section two of the survey (Tables 2 and 3) indicate that, while there are common trends among the surveyed population, there is still heterogeneity present within the population. In Table 2, for instance, the three most popular reasons for protecting the Eastern Shore environment across both counties are the economic contributions of the environment (providing opportunities to pursue ecotourism, aquaculture, agriculture, and forestry), the provision of wildlife conservation, and the protection of the Eastern Shore's groundwater resource (the sole freshwater resource on the Shore). Yet, even though these trends exist, the variations of percentages across counties and the fact that no single reason for protecting the Eastern Shore environment dominates all responses still shows some sort of heterogeneity.

The same can be said, somewhat, with regards to Table 3. The general trend across both counties is that wildlife and habitat sustainment, excess nutrient removal from coastal waters, shoreline protection, and saltmarsh accretion are the most highly valued ecosystem services. While Table 3 shows stronger trends than Table 2, such as the ability to conclude that the ecosystem service for wildlife and habitat sustainment is highly valuable for the large majority of survey respondents, there still exists heterogeneity across respondents and counties. The results from Table 2 and 3, along with the presence of four attitudinal variables from the factor analysis seem to indicate that an analysis based on heterogeneous preferences, such as the latent class logit that we perform on the choice experiment questions, seems justified.

Examining the latent class logit results, we find, in both counties, two distinct classes. One class, regardless of the combinations of three ecosystem services for either of the two coastline protection types, always results in negative utility. This indicates a group of people in which taking "no action" always seems to provide greater utility than pursuing a coastline protection plan. The second class, on the other hand, generally results in positive utility for any management plan at a reasonable cost, as all the significant coefficients are positive.

In both counties, those with higher attitudinal scores for wildlife conservation were more likely to fall into the latent class that valued the presence of ecosystem services with non-negative marginal utility. This result is logical, as ecosystem services are generally seen as valuable by those that are environmentally prone. On the other hand, in both counties, those with higher attitudinal scores for cultural preservation were more likely to fall into the latent class that would find negative utility to take any action. This result could be explained by the fact that those who value cultural preservation may be those used to a historical way of life, associated with low government intervention. Thus, any kind of tax-based government intervention, even for the sake of coastal protection would be seen in a negative light. Therefore, any coastal protection plan, if implemented, would cause negative utility.

In Northampton County, members of the citizen's group or outdoors club tended to fall into the latent class that valued the presence of ecosystem services with non-negative marginal utility. These people are generally known around the shore to be more environmentally prone, so this is not a surprising result. The variables *eslive, native,* and *flood* did not have any significant impact in either county.

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