Coastal Ecosystem Services of the Gulf of Mexico:
Does their Value Depend on the Providing Habitat?

Matthew G. Interis* and Daniel R. Petrolia

PO Box 5187
Department of Agricultural Economics
Mississippi State University
Mississippi State, MS 39762

Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2015 Annual Meeting, Atlanta, Georgia, January 31-February 3, 2015

* Contact Author. Matthew G. Interis is an Assistant Professor. *Phone:* (662)325-4787, *Email:* m.interis@msstate.edu. Daniel R. Petrolia is an Associate Professor. *Phone:* (662)325-8777, *Email:* d.petrolia@msstate.edu. This research was conducted under award NA10OAR4170078 to the Mississippi-Alabama SeaGrant Consortium by the NOAA Office of Ocean and Atmospheric Research, U.S. Department of Commerce, and was supported by the USDA Cooperative State Research, Education & Extension Service, Multistate Project W-3133 "Benefits and Costs of Natural Resources Policies Affecting Ecosystem Services on Public and Private Lands" (Hatch # MIS-033130).

Coastal Ecosystem Services of the Gulf of Mexico:
Does their Value Depend on the Providing Habitat?

Abstract

Our study is the first to test whether ecosystem service values depend on the providing habitat and is the first study using primary data to compare value estimates across locations which are *ex ante* more likely to yield similar value estimates than locations in existing studies. We find that about half of value estimate comparisons across locations result in a rejection of value equality when the providing habitat is held constant and that about one fourth of comparisons across habitats but within the same location result in a rejection of equality.

Introduction

The real-estate mantra “location, location, location” implies that the most important attribute determining real estate values is where the property is located, and so we should not be surprised to see two otherwise similar homes – but located in different markets – sell for different prices. In the same spirit, we might not be surprised to find that the value of a given ecosystem service differs across two otherwise similar ecosystems in different locations. Woodward and Wui (2001) argue that ecosystem service values tend to vary widely across populations and geographical locations, and the implications of this are especially important for benefit transfer, wherein the value of a given good or service estimated for one location is “transferred” and applied as an estimate of the same good or service provided in a different location. Although such an approach may be tempting in the face of project budget constraints, borrowing estimates based on studies of different locations can often lead to inefficient decision-making (Brander et al. 2006; Holland et al. 2010).

Several studies in the literature have in fact found results consistent with this expectation. Brander et al. (2006) find that total wetland values per hectare in Africa and Australasia statistically differ from those in North America, and Barrio and Loureiro (2010) find that studies in European countries provide different estimates from those in the United States. In these studies, where value estimates are compared across continents and/or very diverse nations, we might not be surprised to see such differences. However, finding differences among drastically dissimilar locations and contexts does not prove especially useful in considering whether ecosystem service value estimates differ, as a general rule, from one place and context to another. Rather, it would be more useful to test whether ecosystem service values differ even among reasonably similar locations and contexts. If value estimates are shown to differ even among very similar locations and contexts, then we would have evidence to support the claim that value estimates are unique to each location and context, giving us pause before presuming that one set of estimates can serve as reasonable approximations for other locations.

In the present study, we compare estimates of the value of incremental changes in four ecosystem services – water quality, fisheries support, flood protection, and bird habitat – across two different locations: Barataria-Terrebonne Estuary, Louisiana, and Mobile Bay, Alabama. Unlike in the studies cited above that compare ecosystem service values across locations where we might expect ecosystem service values to differ, the two locations used in our study are in relatively close proximity to each other. Furthermore, while acknowledging that the populations of Alabama and Louisiana are certainly unique, they are more likely to be similar to each other than, say, the populations of Africa and North America (as in Brander et al. 2006) or the populations of Europe and the United States (as in Barrio and Loureiro 2010). Choosing two locations which are relatively close to each other, both geographically and in population characteristics, should increase the likelihood of observing similar ecosystem value estimates across locations. Thus, one aim of our study is to compare value estimates across locations that are relatively more similar to each other than those examined in existing studies. We know of no other study comparing value estimates across locations which uses primary data and whose study design is carefully constructed to minimize differences in data collection methods across locations.

Because ecosystem services are provided by particular kinds of habitats, there is, potentially, an additional component to valuation beyond location. It is possible that ecosystem service values may differ *even in the same location* when provided by different habitats. The second aim of our study, then, is to compare ecosystem service value estimates in the same location provided by different habitats. Specifically, we estimate the value of the ecosystem services when provided by three distinct habitat types found along the northern coast of the Gulf of Mexico: oyster reefs, mangroves, and salt marsh. Each habitat provides, to varying degrees, all four of these ecosystem services (see Coen et al. 2007; Grabowski and Peterson 2007; Koch et al. 2009; Strange et al. 2002; Zedler and Kercher 2005). We know of no other study which compares ecosystem service values across habitats which provide the same ecosystem services holding location constant.

Values are estimated based on survey respondents' stated willingness to pay a one-time state tax to fund a program to construct additional acres of these habitats in either Barataria-Terrebonne Estuary, Louisiana, or Mobile Bay, Alabama. Residents of each state were asked about a habitat construction program in their respective state, and the surveys administered in each state were designed to be as similar to each other as possible.

Our analysis also incorporates two important developments in methodology. First, we restrict the domain of the bid parameter to be in the positive domain using an approach outlined in Carson and Czajkowski (2013), who argue that the typical practice of determining value estimate confidence intervals is incorrect because the domain of the parameter in the denominator spans zero; the mean and standard deviation of the derived distribution are therefore undefined. The approach they outline avoids this problem. Second we compare estimates across simulated distributions using the complete combinatorial approach of Poe et al. (2005). Despite value estimate distributions typically being skewed, researchers persist in conducting tests across distributions which rely on a normality assumption (Poe et al. 2005). The complete combinatorial approach avoids this assumption.

If we examine only mean willingness to pay estimates, we find that ecosystem service values do differ, across both location and habitat. Despite our two study areas being of similar size and composition, and in relatively close proximity to each other (and both bordering the same body of water, i.e., the Gulf of Mexico), we find that ecosystem service value estimates for the same habitat types, oyster reefs and salt marsh, differ substantially between these two locations, being twice as great in one location than in the other, depending on the specific service. Additionally, we find that ecosystem service value estimates can differ by as much as a factor of four when presented to respondents as being provided by one type of habitat compared to another, even when the geographic location of the proposed project is held constant. However, when dispersion of willingness to pay estimates is considered, we detect a statistical difference of willingness to pay distributions across a significant, but smaller, proportion of many of the same paired comparisons. These findings highlight the importance of context – population, location, and habitat type – in ecosystem service valuation, and make clear the need for care to be taken when transferring value estimates from one location – even over the same habitat type – to another, or from one habitat type – even in the same location – to another, such as is done with benefits transfer methods. They also underscore the need to examine both mean willingness to pay and the dispersion of willingness to pay distributions when comparing value estimates across locations or across habitats.

Survey Design

We used a choice experiment (CE) survey to elicit choice responses and other information which were used in value estimation. In each choice set, the respondent was asked whether he was willing to pay a specified price for one of two proposed habitat construction projects, or if he would prefer neither be implemented and to pay nothing. The two construction projects differed in the amount of each ecosystem service they were predicted to deliver. The consideration of multiple competing project designs was justified by the fact that there is some flexibility in precise location (within each water body) of constructed habitat and in other design details and technology used to complete the project. An example choice question for an oyster reef construction project is shown in figure 1, where the blanks would be filled in with pre-specified values drawn from those in table 1.

Figure 1 about here

Table 1 about here

Table 2 about here

Table 2 presents a diagram of the treatments pertaining to the present study. There were two location treatments of the survey, each specifying a different location where a funded project would occur: the Barataria-Terrebonne Estuary in Louisiana (“LA” treatment) and Mobile Bay in Alabama (“AL” treatment). Each respondent was asked about a construction project involving one of the three targeted habitats (oyster reefs, mangroves, or salt marsh) depending upon which location treatment he was in. The habitat choices were limited by existing levels of the habitats in the location of interest. For example, in Mobile Bay, there are few mangroves to speak of so it was deemed unrealistic to propose constructing mangrove habitat where there currently was none. The Barataria-Terrebonne Estuary has all three habitats.

The CE design was developed using Ngene software, in which 24 choice sets were created in order to maximize D-efficiency (See Ngene 1.1.1 User Manual & Reference Guide 2012). Most respondents were asked a single choice question; however some were asked four choice questions, i.e., a repeated-choice format.[i]

To increase the perception that their responses would be meaningful in the sense that they could actually influence future policy (Carson and Groves 2007), respondents were told at the beginning of the survey that a large number of taxpayers would be taking the survey and that their responses would be shared with policy-makers and could affect how much they pay in taxes in the future. Respondents were then given some information about their assigned habitat including an explanation of some of the ecosystem services it provides. Then it was explained that policy-makers were considering implementing a habitat construction program and details were given about how such a program would be implemented, including how many acres of habitat would be created and when, where, and by whom they would be created.

Respondents were shown maps of candidate locations within each water body of where habitat could potentially be constructed, and where existing habitat is located already. An example map of the oyster construction project in Mobile Bay is shown in figure 2.

Figure 2 about here

The payment mechanism specified was a one-time payment collected on the respondent's state tax return filed the following year. It was stipulated that the tax revenue would partially cover the cost of an implemented program with the remainder of funds coming from existing tax dollars. It was explained that construction would commence the following year and take five years to complete. The expected benefits – the provided ecosystem services – were expected to last 30 years after completion.

To aid in the design of our survey instrument, we hired New South Research, based in Birmingham, AL to conduct two focus groups, one in Birmingham, Alabama (representing a non-coastal population), and one in Mobile, Alabama (representing a coastal population), in December of 2012. The primary output sought from the focus groups was information that would be helpful in designing a realistic hypothetical habitat construction scenario. To this end, much of the discussion centered on what kind of information people would like to know in order for them to be able to choose between competing construction programs, which benefits of habitat construction would be most important to them, and to critique the wording of portions of a draft survey we presented to them. We also asked open-ended willingness to pay questions for some candidate projects in order to hone the bid range used in the final survey. Based on the focus groups we decided to focus on the attributes, attribute levels, and prices listed in table 1.

Data Collection

The survey was administered by GfK Custom Research (formerly Knowledge Networks), which has a pre-recruited panel of households who have agreed to be contacted periodically to complete surveys online (known as Knowledge Panel®). Because we sought more observations than GfK had on their Alabama and Louisiana panels, GfK subcontracted out with some of their partner organizations to obtain extra observations in those states (we refer to these respondents as "off-panel"). It should be noted that while GfK is known for having a panel that is representative of the US population and its state populations, this representativeness does not necessarily carry over to the off-panel respondents.[ii] In April of 2013, an initial pretest of the survey was administered to 25 respondents to make sure the online survey was working properly and to elicit open-ended feedback about respondent understanding and ease of completion. The final survey was administered in May and June, 2013. Out of 8,573 respondents sampled, 5,366 (63%) completed the survey. The final sample of respondents includes 5,196 respondents with no missing values for the variables of interest.

In addition to answering the choice questions and standard demographic questions, respondents were asked to rate their confidence in federal, state, local and private agencies to implement projects like the ones proposed (no confidence, some confidence, a lot of confidence) in order to capture any perceived incompetence of one or more of the agencies involved in construction. To control for predisposition towards environmentally-focused projects, we asked respondents whether they had made no, minor, or major changes to their shopping choices and lifestyle over the last five years to help the environment.

We asked two questions in an attempt to better understand the perceived incentives faced by respondents. The first question asked what amount of influence the respondent believed the survey would have on actual habitat projects in the Gulf (no influence, a small influence, a large influence). This is our measure of perceived consequentiality. Carson and Groves (2007) argue that if respondents do not believe that their responses will have any effect on anything they care about, then applying standard economic theory to the data is inappropriate because any response to the choice question will yield the same expected utility. If we are to assume that respondents make choices to maximize their expected utility, it must be that respondents' choices actually affect their expected utility. The second question asked (yes or no) whether respondents believed their household would actually have to pay the specified tax for a project if it is actually implemented. Compelled payment is essential for incentive-compatibility in binary-choice questions (Carson and Groves 2007; Herriges et al. 2010) and, while it is well-known that multinomial choices cannot generally be made incentive compatible, compelled payment yet assures that the respondent considers the specified prices of the construction programs when casting his vote. We also asked whether respondents considered their budget when making their choice (Cameron and DeShazo 2013).

Table 3 displays the descriptive statistics of the variables used in the analysis. The variable *income* was measured in 19 categories where 1 indicates an annual income of less than $5K, and 19 indicates an annual income of greater than $175K. The category midpoints were used for categories 1 through 18, and $175K was used for category 19. Forty-eight percent of respondents were either looking for work or not working due to retirement or disability. The average respondent was less confident in the ability of the federal government than in state or local governments or in private companies, to implement the projects. Eighty percent of respondents believed the survey would have at least a small influence on future habitat construction projects in the gulf and 77% believed their household would actually have to pay the specified tax if a project was implemented. Notably, the proportion of male respondents is low (34%). This is due to our desire to have more observations than GfK had on its panel. While the proportion of male respondents who were on the GfK panel was a reasonable 43%, only 28% of off-panel respondents were male. GfK provides weights based on demographics in order to compensate for underrepresented subpopulations (DiSogra 2007) which we incorporate into our analysis.

Table 3 about here

Model specification and hypotheses

Model

We assume that within a choice set respondents choose the alternative (one of the two habitat construction projects presented or to implement neither) that will maximize their utility. Traditionally, the utility for individual *i* from alternative *j* in choice set *s* has been specified as

$$U_{ijs} = \alpha_j + \gamma t_{ijs} + \boldsymbol{\beta}'\boldsymbol{x}_{ijs} + \boldsymbol{\delta}_j'\boldsymbol{z}_i + \varepsilon_{ijs} \quad (1)$$

where α_j is an alternative-specific constant, γ is the coefficient on the price of the project, t_{ijs}, $\boldsymbol{\beta}$ is a vector of coefficients on alternative-specific attribute levels $\boldsymbol{x}_{ijs}$ (excluding price), $\boldsymbol{\delta}_j$ is a vector of alternative-specific coefficients on individual-specific characteristics $\boldsymbol{z}_i$, and ε_{ijs} is a disturbance term. Assuming an iid extreme value distribution for the disturbance terms, the parameters can be estimated using McFadden's (1974) conditional logit model, and the willingness to pay for an increase in an attribute is taken to be the attribute's coefficient divided by the price coefficient, β_k / γ. We make two adjustments to this traditional conditional logit specification.

First, it is well known (e.g. Fieller 1932) that the ratio of two normally distributed random variables has an undefined mean and standard deviation due to the distribution of the variable in the denominator spanning zero. In a recent working paper, Carson and Czajkowski (2013) propose specifying the price parameter as a random parameter (i.e. varying across respondents) with a log-normal distribution and restricting the standard deviation to be zero. In this way, the support of the price parameter is restricted to be in the positive domain and the resulting ratios of attribute parameters and the price parameters will have well defined moments. We adopt this approach which involves making only a slight change to the utility specification:

$$U_{ijs} = \alpha_j + \exp(\eta)t_{ijs} + \boldsymbol{\beta}'\boldsymbol{x}_{ijs} + \boldsymbol{\delta}_j{}'\boldsymbol{z}_i + \varepsilon_{ijs} \tag{2}$$

The coefficient on the project price is now exponentiated and the willingness to pay for a marginal increase in attribute *k* will now be $\beta_k / \exp(\eta)$ which is strictly positive (given $\beta_k > 0$). The mean and standard deviation of the willingness to pay distribution can now be determined in a standard approach such as Krinsky and Robb (1986) parametric bootstrapping. Carson and Cjakowski (2013) explain how to implement the alternative specification practically in various statistical software packages.

The second adjustment we make to the traditional conditional logit model involves the disturbance term. The conditional logit imposes the restrictive independence from irrelevant alternatives assumption (Greene 2012). To relax this assumption, we include additional error terms, ω_{ij}, which vary by individual and by alternative, but not by choice set. By allowing these terms to vary across alternatives, the independence from irrelevant alternatives assumption is relaxed and by not allowing them to vary across choice sets for a given individual, we account for possible correlation of responses made by a given individual. Because there is no inherent difference between the two proposed construction projects in each choice set other than in the attribute levels specified, we allow ω to differ between the proposed project alternatives and the status quo (neither) alternative, but not between the proposed project alternatives themselves. Our complete specification is thus:

$$U_{ijs} = \alpha_j + \exp(\eta) t_{ijs} + \boldsymbol{\beta}' \boldsymbol{x}_{ijs} + \boldsymbol{\delta}_j ' \boldsymbol{z}_i + \varepsilon_{ijs} + \omega_{ij} \quad (3)$$

The sampling weights provided by GfK enter the empirical model in the typical manner as multipliers of each respondent's contribution to the likelihood function (see Manski and Lerman 1977).

Willingness to pay hypotheses

Mean willingness to pay for an increase in attribute *k* provided by habitat *h* in location *l* is equal to its associated parameter divided by the corresponding price parameter for that habitat and location, or, $\beta_{khl} / \exp(\eta_{hl})$. We are interested in whether these mean willingness-to-pay values differ across habitats and across locations. We therefore test two null hypotheses:

Location hypotheses: $\beta_{khl} / \exp(\eta_{hl}) = \beta_{khm} / \exp(\eta_{hm})$ for $m \neq l, \forall k$

Habitat hypotheses: $\beta_{khl} / \exp(\eta_{hl}) = \beta_{kpl} / \exp(\eta_{pl})$ for $h \neq p, \forall k$

The alternative hypotheses are that the willingness-to-pay values specified in the null are not equal. The hypotheses are tested for each location pair (holding habitat constant) and each habitat pair (holding location constant) using tests over the simulated willingness-to-pay distributions, which are described in a later section.

Results

The regression results for each treatment are presented in table 4. Recall that in some treatments, respondents answered four choice questions (rather than a single choice question as in the other treatments), each between implementing one of two potential alternative projects or implementing neither. The number of observations specified, *N*, is therefore the number of unique choices in each location/habitat sub-sample.

Because of the Carson and Czajkowski transformation, the price coefficient requires a slightly different interpretation from what is typical. The estimates displayed in table 4 are estimates of η in equation 2. The estimate of the full coefficient of price is therefore $\exp(\eta)$ which of course is positive (that was our point in implementing the transformation of the coefficient in the first place). A negative and significant value for η, as seen in table 4, implies a price coefficient that is less than 1 but greater than 0.

Table 4 around here

Habitat Type: Oyster Reef

The first two columns of table 4 contain the parameter estimates from the oyster reef construction treatments in each state.[iii] The lowest level of each project attribute is omitted as the base level. All attribute coefficients are significant in both the LA and AL treatments. The action alternative dummy, which equals 1 if the alternative is one of the proposed project alternatives and 0 otherwise (i.e. if it is the "status quo" alternative), is significant and negative in both treatments.[iv] This indicates that respondents are more likely to choose the status quo alternative over an action alternative with attribute levels at the omitted base levels, all else equal.[v] Inherent respondent preference to maintain the status quo is well-documented in the literature (e.g. Adamowicz et al. 1998; Boxall, Adamowicz, and Moon 2009; Meyerhoff and Liebe 2009; Samuelson and Zeckhauser 1988), although its opposite, an inherent preference for taking action, has also been found (e.g. Patt and Zeckhauser 2000; Petrolia, Interis, and Hwang 2014).

Based on post-estimation tests of equality of parameter means, the displayed fisheries support coefficients are not statistically different from each other (at the 10% level) within the AL treatment and neither are the displayed flood protection and bird population coefficients within the LA treatment. This indicates no marginal utility gain from increasing fisheries support beyond a 20% increase for residents of Alabama, and no marginal utility gain from increasing flood protection beyond 10% more homes or increasing the wading bird population beyond a 5% population increase for residents of Louisiana.

Although signs and significance of program attributes match closely in the two treatments, there is very little consistency of significant respondent-specific characteristics across the two location treatments. Each characteristic is interacted with the action alternative dummy and the sign of the resulting parameter estimate corresponds to the direction of the marginal effect of that characteristic on the probability of choosing a project alternative instead of the status quo, all else equal. Therefore a positive (negative) and significant coefficient indicates that a respondent with a higher individual-specific variable value is more (less) likely to choose a project alternative rather than the status quo than a respondent with a lower value of the same individual-specific variable. In the AL treatment, respondents who believe the survey will have at least a small influence on future habitat construction projects in the Gulf of Mexico, who consider their budget when making their choice, who have made more changes to their shopping choices and lifestyle for environmental reasons, who are younger, and who have greater income are more likely to choose an action alternative than to maintain the status quo. Of these variable coefficients, only that on income and on if the respondent believed the survey will influence policy are also significant in the LA treatment. In addition to these, respondents in Louisiana who believe their household will have to pay if a project is implemented, who have greater confidence in the state but less confidence in local entities to implement the project, who are women, and who are employed are more likely to choose an action alternative than the status quo.

Habitat type: Salt Marsh

The third and fourth columns of table 4 contain the parameter estimates for the salt marsh treatments in Alabama and Louisiana, respectively. While the signs and significance of the attributes align fairly closely across the two locations (with the exception of the 10% increase in flood protection not being significant in Alabama), once again there is little consistency across locations of the significant respondent-specific variables. In Alabama, the two water quality coefficients do not differ statistically from each other and neither do the two flood protection coefficients from each other. In Louisiana, the two fisheries support coefficients and the two bird population estimates do not statistically differ.

Location: Alabama

We now consider results from the perspective of comparing different habitat types within the same location. The first and third columns of table 4 contain the parameter estimates from the Alabama treatments for oyster reef and salt marsh construction, respectively. Signs and significance match closely except that the parameter on a 10% increase in flood protection is significant only in the oyster treatment. For respondent-specific characteristics, the parameter on age is significant only in the oysters treatment and the parameter on confidence in the federal government to implement the project is significant only in the salt marsh treatment.

Location: Louisiana

The second, fourth, and fifth columns of table 4 contain the parameter estimates from the Louisiana treatments of oyster reef, salt marsh, and mangrove construction, respectively. What stands out most is the lack of significance for some attribute levels in the mangrove treatment whereas all attributes are significant in the oyster reef and salt marsh treatments. Furthermore, only two respondent-specific characteristic parameters are significant in the mangroves treatment (with the exception of the binary variables controlling for the third and fourth questions). In the mangrove treatment, respondents who had made changes to their shopping choices and lifestyle in the past for environmental reasons were more likely to choose a project alternative, and respondents who considered their budget when making their choice were more likely to choose the status quo. In each of the Louisiana treatments, the parameters on the dummy variables indicating if the choice question was the third or fourth in the sequence are all negative and significant. This indicates that respondents were less likely to choose a project alternative in later choice situations.[vi]

Table 5 around here

Ecosystem Service Value Estimates

We cannot directly compare attribute coefficient magnitudes across treatments because of the indeterminacy of the scale parameter within the coefficient estimates (see Swait and Louviere 1993). However we can make direct comparisons between willingness to pay values across any two sub-samples because the scale parameter "drops out" when taking the ratio of attribute parameters to the price parameter (Greene 2012).

Table 5 displays the willingness to pay estimates for each attribute level (again, with the lowest level of each attribute as the omitted base).[vii] The confidence intervals were estimated using the Krinsky and Robb bootstrapping approach (see Haab and McConnell 2002) with 5000 draws. After exponentiating the price coefficient one can straightforwardly employ the Krinsky and Robb technique as moments of the willingness to pay distribution are now well-defined (Carson and Czajkowski 2013). The results of the hypotheses tests are displayed in tables 6 and 7. They were conducted using the complete combinatorial approach of Poe et al. (2005).[viii]

Table 6 displays the test results of whether value estimates for a particular incremental change in an attribute differ across the two locations, holding the providing habitat constant. For the oyster habitat, four of the eight attribute increment values statistically differ across the two locations at at least the 10% level. For the salt marsh habitat, three attribute increment values statistically differ. Thus, we cannot generally conclude that value estimates are the same across these two locations.

By comparing the test results in table 6 with the value estimates in table 5, one can see the importance of looking at the entire willingness to pay distributions rather than simply the means of the distributions. For example, in table 5, the estimated mean willingness to pay for a 5% increase in bird population is twice as large in Louisiana as it is in Alabama, but the test result in table 6 indicates a failure to reject equality of willingness to pay for that attribute level across the two locations.

Table 7 displays the test results of whether value estimates for a particular incremental change in an attribute differ across habitats, holding the location constant. Here we see limited evidence of statistical difference of distributions: in Alabama, three of eight willingness to pay measures statistically differ, and in Louisiana only one or two values differ across habitats for each comparison. Thus, although value estimates do not statistically differ in about three fourths of paired comparisons, there are still enough pairs in which value estimates do differ that we cannot conclude that estimates are generally equal across different habitats providing the same ecosystem services.[ix]

Discussion and Conclusions

Overall we find strong evidence in each treatment of positive marginal utility for increases in water quality, flood protection, fisheries support, and wading bird population along the Gulf of Mexico. However, mean willingness to pay values for these attribute increases differ greatly across locations for a given habitat and across habitat treatments within a location. In some cases, the mean value of an increase in a given ecosystem service can be about four times as large when provided by one habitat instead of another. Tests of differences in dispersion of welfare estimates, however, indicate that that only about half of the mean estimates are statistically different when comparing service values across locations for a given habitat, and only about one-quarter are statistically different when comparing service values across habitats for a given location.

We deliberately designed our study to offer a better chance of observing similar welfare estimates in two locations by choosing two regions that, while different, are closer geographically and demographically than those in extant studies comparing welfare estimates across very diverse locations and contexts. Other than necessary changes to the survey to accommodate geographical differences, the survey instruments administered in the two locations were identical. Yet, we still find that, in some cases, welfare estimates can differ across locations. Other studies (e.g. Woodward and Wui 2001; Barrio and Loureiro 2010), largely relying on secondary data (e.g. meta-analyses), have reached this same conclusion. The novel, and perhaps more concerning finding, however, is that ecosystem service values estimates can differ even in the same location, depending on which habitat is providing the ecosystem services. In one fourth of our comparisons we observe large differences in the values of these ecosystem services depending upon the habitat providing them.

Our results have implications for both practitioners and non-practitioners of benefits transfer methods. For the former, our results underscore the importance of controlling for the providing habitat and for location characteristics when conducting benefits transfer analyses. Brander et al. (2006) and Moeltner and Woodward (2009) both control for habitat type when estimating wetland willingness to pay values in meta-regression analyses, and the former controls for location as well. In these studies the dependent variable was the value of the wetlands in their entirety, but our results would imply that controlling for providing habitat and location would also be necessary in benefits transfer studies which estimate values of particular ecosystem services. For valuation researchers in general who use stated preference surveys, our results imply that details provided to the respondent about the providing habitat are integral to the value estimates themselves. For example, stating only that certain ecosystem services might be provided by “wetlands” would not capture differences we might expect, as we see in our results, between ecosystem services provided by salt marsh and those provided by mangroves. Given these mixed results, our results imply that although in some cases value estimates do indeed differ, there were many cases where – either from one location to another for the same habitat or from one habitat to another in the same location – value estimates were the same, lending some level of added credence to the notion of benefit transfer, at least in cases where transfers are made across locations that are sufficiently similar and/or when transfers are made across habitats in the same location.

Works Cited

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere. 1998. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." *American Journal of Agricultural Economics* 80: 64-75.

Barrio, M., and M.L. Loureiro. 2010. "A Meta-Analysis of Contingent Valuation Forest Studies." *Ecological Economics* 69: 1023-30.

Brander, L., R. Florax, and J. Vermaat. 2006. "The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature." *Environmental and Resource Economics* 33: 223-50.

Boxall, P., W.L. Adamowicz, and A. Moon. 2009. "Complexity in choice experiments: choice of the status quo alternative and implications for welfare measurement." *The Australian Journal of Agricultural and Resource Economics* 53: 503-19.

Brown, C., K. Andrews, J. Brenner, J.W. Tunnell, C. Canfield, C. Dorsett, M. Driscoll, and E. Johnson, S. Kaderka. 2011. Strategy for Restoring the Gulf of Mexico (A cooperative NGO report). The Nature Conservancy. Arlington, VA. 23 pages.

Cameron, T. A., and J.R. DeShazo. 2013. "Demand for Health Risk Reductions." *Journal of Environmental Economics and Management* 56: 87-109.

Carson, R.T. and M. Czajkowski. 2013. "A New Baseline Model for Estimating Willingness to Pay from Discrete Choice Models." White Paper. <http://www.icmconference.org.uk/index.php/icmc/ICMC2013/paper/view/730/354> Accessed October 16, 2013.

Carson, R.T., and T. Groves. 2007. "Incentive and Informational Properties of Preference Questions." *Environmental & Resource Economics* 37: 181-210.

Coen, L.D., R.D. Brumbaugh, D. Bushek, R. Grizzle, M. W. Luckenbach, M.H. Posey, S.P. Powers, and S. G. Tolley. 2007. "Ecosystem Services Related to Oyster Restoration." *Marine Ecology Progress Series* 241: 303-07.

DiSogra, C. 2007. "Weight, Weight, Don't Tell Me!" Website article for GfK, Knowledge Networks. <http://www.knowledgenetworks.com/accuracy/summer2007/disogra.html> Accessed November 20, 2013.

Fieller, E.C. 1932. "The Distribution of the Index in a Normal Bivariate Population." *Biometrika* 24: 428-40.

Greene, W.H. 2012. *Econometric Analysis*. 7th ed. Boston: Prentice Hall.

Grabowski, J.H., and C.H. Peterson. 2007. "Restoring Oyster Reefs to Recover Ecosystem Services." *Theoretical Ecology Series* 4:281-98.

Haab, T.C. and K.E. McConnell. 2002. Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation. Northampton, MA: Edward Elgar.

Herriges, J., C. Kling, C. Liu, and J. Tobias. 2010. "What are the Consequences of Consequentiality?" *Journal of Environmental Economics and Management* 59: 67-81.

Holland, D.S., J.N. Sanchirico, R.J. Johnston, and D. Joglekar. 2010. *Economic Analysis for Ecosystem-Based Management: Applications to Marine and Coastal Environments.* Washington, DC: RFF Press.

Johnston, R.J., G. Magnusson, M.J. Mazzotta, and J.J. Opaluch. 2002. "Combining Economic and Ecological Indicators to Prioritize Salt Marsh Restoration Actions." *American Journal of Agricultural Economics* 84(no. 5): 1362-70.

Kim, S. and T.C. Haab. 2009. "Temporal Insensitivity of Willingness to Pay and Implied Discount Rates." *Resource and Energy Economics* 31:89-102.

Koch, E.W., E.B. Barbier, B.R. Silliman, D.J. Reed, G.M. Perillo, S.D. Hacker, E. F. Granek, J.H. Primavera, N. Muthiga, S. Polasky, B.S. Halpern, C.J. Kennedy, C.V. Kappel, and E. Wolanski. 2009. "Non-linearity in Ecosystem Services: Temporal and Spatial Variability in Coastal Protection." *Frontiers in Ecology and the Environment* 7(no.1): 29-37.

Krinsky, I., and A. L. Robb. 1986. "On Approximating the Statistical Properties of Elasticities." *The Review of Economics and Statistics* (68): 715-19.

Kroeger, T. 2012. Dollars and Sense: Economic Benefits and Impacts from two Oyster Reef Restoration Projects in the Northern Gulf of Mexico. Report for *The Nature Conservancy*. <http://www.nature.org/ourinitiatives/regions/northamerica/oyster-restoration-study-kroeger.pdf> Accessed October 1, 2013.

Manski, C.F., and S.R. Lerman. 1977. "The Estimation of Choice Probabilities from Choice Based Samples." *Econometrica* 45 (no. 8): 1977-88.

McFadden, D. 1974. "Conditional Logit Analysis of Qualitative Choice Behavior." in P. Zarembka, ed. Frontiers in Econometrics. New York: Academic Press.

Mendoza-Gonzalez, G., M.L. Martinez, D. Lithgow, O. Perez-Maqueo, and P. Simonin. 2012. "Land Use Change and its Effects on the Value of Ecosystem Services Along the Coast of the Gulf of Mexico." *Ecological Economics* 82: 23-32.

Meyerhoff, J. and U. Liebe. 2009. "Status Quo Effect in Choice Experiments: Empirical Evidence on Attitudes and Choice Task Complexity." *Land Economics* 85(3): 515-28.

Moeltner, K. and R. Woodward. 2009. “Meta-Functional Benefit Transfer ofr Wetland Valuation: Making the Most of Small Samples.” *Environmental and Resource Economics* 42: 89-108.

Ngene 1.1.1 User Manual & Reference Guide. 2012. Version 16/02/2012. ChoiceMetrics Pty Ltd.

Patt, A. and R. Zeckhauser. 2000. “Action Bias and Environmental Decisions.” *Journal of Risk and Uncertainty* 21(1): 45-72.

Petrolia, D. R., M. G. Interis, and J. Hwang. 2014. “America’s Wetland? A National Survey of Willingness to Pay for Restoration of Louisiana’s Coastal Wetlands.” *Marine Resource Economics* 29(1): 17-37.

Poe, G., K. Giraud, and J. Loomis. 2005. “Computational Methods for Measuring the Difference of Empirical Distributions.” *American Journal of Agricultural Economics* 87(2): 353-65.

Samuelson, W. and R. Zeckhauser. 1988. “Status Quo Bias in Decision Making.” *Journal of Risk and Uncertainty* 1: 7-59.

Strange, E., H. Galbraith, S. Bickel, D. Mills, D. Beltman, and J. Lipton. 2002. “Determining Ecological Equivalence in Service-to-Service Scaling of Salt Marsh Restoration.” *Environmental Management* 29(no.2): 290-300.

Swait, J. and J. Louviere. 1993. “The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models.” *Journal of Marketing Research* 30 (no.3): 305-14.

Wells, S., C. Ravilious, and E. Corcoran. 2006. In the Front Line. Shoreline Protection and Other Ecosystem Services from Mangroves and Coral Reefs. United Nations, Cambridge, United Kingdom.

Woodward, R.T. and Y. Wui. 2001. “The Economic Value of Wetland Services: a Meta-analysis.” *Ecological Economics* 37: 257-70.

Zedler, J.B. and S. Kercher. 2005. “Wetland Resources: Status, Trends, Ecosystem Services, and Restorability.” *Annual Review of Environment & resources* 30(no.1): 75-115.

Figure 1. Example choice question.

The table below shows the expected outcomes for two project options, labeled “Option A” and “Option B”, as well as the expected outcomes of not taking any action (No Action). If these were the only 3 options available, which would you prefer most?

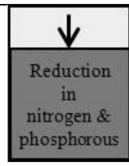
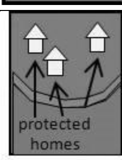
		Option A: 1,500 oyster reef acres constructed.	**Option B:** 1,500 oyster reef acres constructed.	**No Action:** No oyster reef acres constructed.
Increased water quality		__% reduction in nitrogen and phosphorus	__% reduction in nitrogen and phosphorus	No reduction in nitrogen and phosphorus.
Improved flood protection		__% increase in the number of homes protected.	__% increase in the number of homes protected.	No increase in the number of homes protected.
Increased commercial fisheries support		__% increase in annual seafood catch	__% increase in annual seafood catch	No increase in annual seafood catch.
Increased wading bird population		__% increase in wading bird population	__% increase in wading bird population	No increase in wading bird population.
Total one-time cost to your household:	**$**	$__	$__	$0
I most prefer:				

Table 1. Attribute levels

Habitat construction program attribute	Levels
Increased water quality	(No, 10%, or 20%) reduction in nitrogen and phosphorus.
Improved flood protection	(5%, 10%, or 15%) increase in the number of homes protected.
Increased commercial fisheries support	(10%, 20%, or 30%) increase in annual seafood catch.
Increased wading bird population	(No, 5%, or 10%) increase in wading bird population.
Total one-time cost to your household	($5, $10, $25, $50, $75, $100, $150, $200)

Table 2. Diagram of Treatments

<table>
<tr><td>Region:</td><td colspan="5">LA</td><td colspan="2">AL*</td></tr>
<tr><td>Habitat:</td><td colspan="2">Oysters</td><td>Mangroves</td><td colspan="2">Salt Marsh</td><td>Oysters</td><td>Salt Marsh</td></tr>
<tr><td>Question Format:</td><td>Single</td><td>Repeated</td><td>Repeated</td><td>Single</td><td>Repeated</td><td>Single</td><td>Single</td></tr>
</table>

*Alabama does not contain mangroves in any significant quantity.

Figure 2. Example habitat map shown to respondents

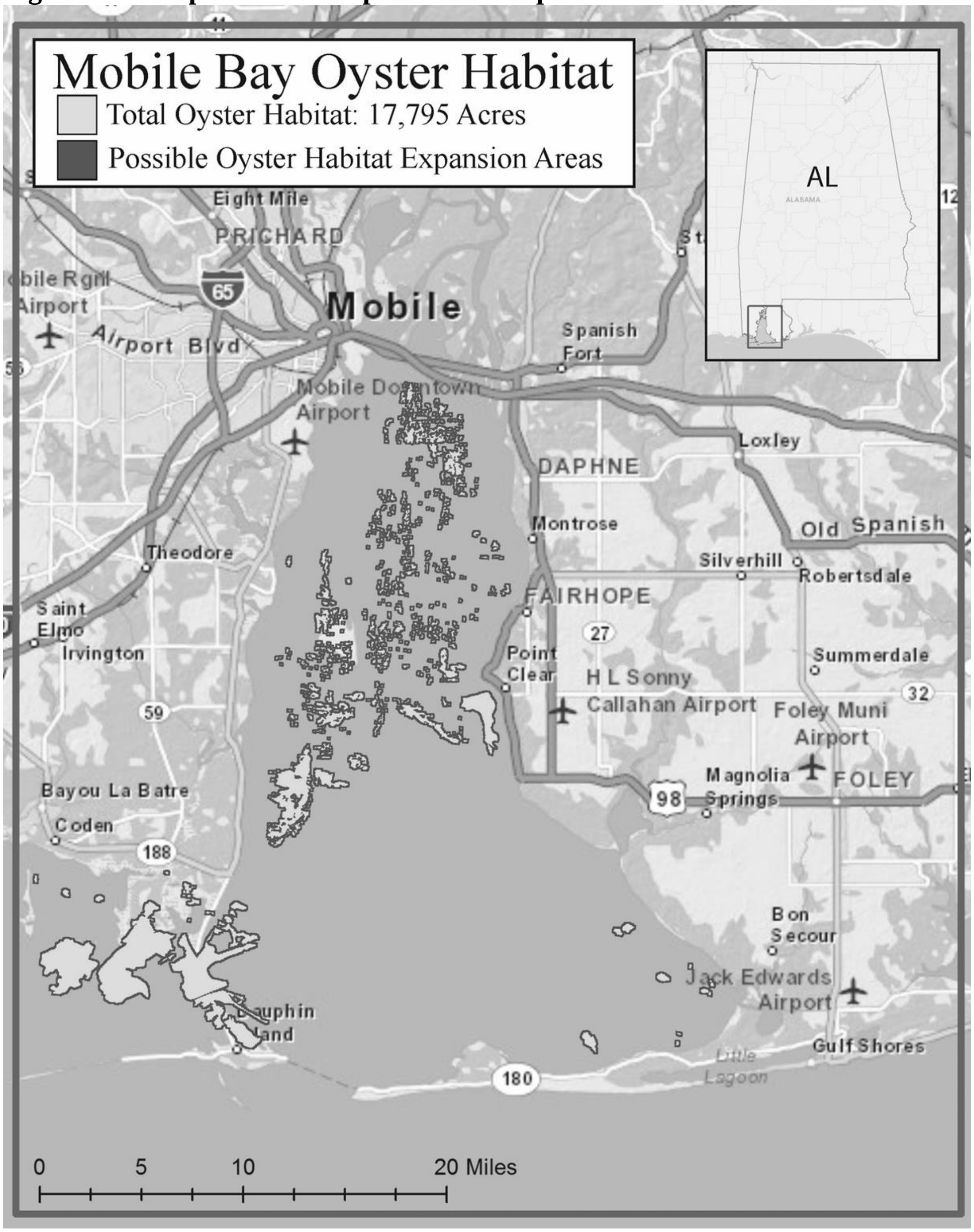


Table 3. Variable Descriptive Statistics

Variable	N	Mean	Std Dev	Min	Max
age	5348	49.58	15.59	18	89
is male	5333	0.34	0.47	0	1
income (1000s of $)	5348	58.42	40.88	2.5	175
is unemployed	5348	0.48	0.50	0	1
changes to shopping choices and lifestyle	5319	0.92	0.65	0	2
confidence in federal govt.	5328	0.70	0.64	0	2
confidence in state govt.	5321	1.02	0.60	0	2
confidence in local govt.	5325	1.08	0.65	0	2
believes survey will have at least a small influence on projects in the Gulf	5348	0.80	0.40	0	1
believes household will have to pay if a project is implemented	5310	0.77	0.42	0	1
considered budget when making choice	5315	0.77	0.42	0	1

Table 4. Regression Results

	Oysters in AL			*Oysters in LA*			*Salt Marsh in AL*			*Salt Marsh in LA*			*Mangroves in LA*		
	N=1396			*N=1253*			*N=493*			*N=1021*			*N=488*		
	Coef.		SE	Coef.		SE	Coef.		SE	Coef.		SE	Coef.		SE
Price	-4.62	***	0.09	-4.43	***	0.08	-4.62	***	0.18	-4.80	***	0.11	-4.73	***	0.19
Water quality (10%)	0.70	***	0.11	0.49	***	0.13	0.73	***	0.21	0.48	***	0.14	1.07	***	0.23
Water quality (20%)	0.94	***	0.13	0.73	***	0.14	0.65	***	0.22	0.80	***	0.14	1.12	***	0.26
Flood protection (10%)	0.28	***	0.10	0.69	***	0.12	0.28		0.20	0.57	***	0.14	0.77	***	0.22
Flood protection (15%)	0.54	***	0.13	0.93	***	0.15	0.62	**	0.27	0.96	***	0.15	0.71	**	0.28
Fisheries support (20%)	0.27	**	0.11	0.34	***	0.12	0.60	***	0.20	0.31	**	0.13	0.04		0.23
Fisheries support (30%)	0.37	***	0.10	0.74	***	0.12	0.95	***	0.20	0.38	***	0.13	0.39	*	0.23
Bird population (5%)	0.24	**	0.11	0.63	***	0.13	0.91	***	0.24	0.39	***	0.14	0.40	*	0.22
Bird population (10%)	0.52	***	0.11	0.55	***	0.12	1.30	***	0.22	0.63	***	0.12	0.29		0.19
Action alternative dummy	-6.71	**	2.82	-4.18	*	2.32	-4.97	***	1.30	-6.63	***	1.55	2.73		3.90
Variables interacted with the action alternative dummy															
Survey will influence policy	6.04	**	2.88	9.63	***	2.65	1.58	***	0.56	4.21	***	0.82	1.36		2.10
Household will have to pay	0.67		0.75	4.00	***	1.52	0.23		0.38	1.96	***	0.71	0.37		1.67
Considered budget	2.62	*	1.34	-0.82		1.36	1.17	**	0.48	-0.85		0.74	-3.63	*	1.88
Shopping & lifestyle changes	2.00	**	0.99	1.25		0.79	0.93	***	0.36	0.73	*	0.41	1.60	*	0.95
Confidence (federal)	1.43		0.88	0.27		0.90	-0.81	**	0.34	0.76		0.53	-2.02		1.65
Confidence (state)	0.54		0.70	2.61	*	1.50	0.24		0.40	-0.43		0.63	0.44		1.21
Confidence (local)	1.29		0.88	-2.93	**	1.32	0.52		0.35	1.08	*	0.57	0.85		1.18
Age	-0.07	*	0.04	0.02		0.03	-0.02		0.01	0.03		0.02	0.06		0.06
Male	0.71		0.72	-2.56	**	1.17	0.39		0.36	0.19		0.59	0.42		1.26
Income	0.24	*	0.13	0.30	**	0.13	0.16	**	0.06	0.15	**	0.08	-0.12		0.19
Unemployed	0.58		0.65	-2.66	**	1.35	0.25		0.42	1.35	*	0.69	-1.44		1.38
2nd Choice Question	--			-0.96		1.10	--			-0.88		0.69	-1.04		0.71
3rd Choice Question	--			-2.54	**	1.00	--			-2.13	***	0.62	-1.52	*	0.87
4th Choice Question	--			-2.41	**	1.07	--			-2.24	***	0.63	-2.17	***	0.74
Latent random effects parameters (ω)															

ω (action alternatives)	3.86	*	2.12	1.55		1.59	1.31		0.94	1.64		1.08	1.78		2.1
ω (status quo alternative)	5.24	*	2.85	8.93	***	2.39	0.03		1.41	3.44	***	0.80	4.08	***	1.6
Log-likelihood value	-1209.03			-912.88			-396.30			-842.55			-341.73		
Wald Chi-sq(23 for Al, 26 for LA)	700.25***			855.22***			260.06***			622.30***			291.96***		

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

[a] The estimates shown are of the log of the full price coefficient.

[b] In these treatments, *N* represents the number of unique choice situations as some respondents answered four choice questions.

Table 5. Mean WTP Values

	Oysters in AL	*Oysters in LA*	*Salt Marsh in AL*	*Salt Marsh in LA*	*Mangroves in LA*
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
Water quality (10%)	$71 (49, 96)	$41 (19, 62)	$75 (32, 126)	$59 (27, 96)	$120 (67, 190)
Water quality (20%)	$95 (67, 129)	$62 (38, 89)	$66 (21, 125)	$97* (61, 139)	$127 (65, 214)
Flood protection (10%)	$28 (9, 48)	$58 (39, 79)	$29 (-12, 69)	$70 (36, 105)	$87 (39, 156)
Flood protection (15%)	$54* (31, 78)	$78* (56, 101)	$63 (12, 109)	$117** (83, 154)	$80 (18, 151)
Fisheries support (20%)	$27 (5, 53)	$28 (7, 53)	$61 (18, 119)	$38 (8, 75)	$4 (-44, 70)
Fisheries support (30%)	$37 (17, 59)	$62** (42, 83)	$97 (56, 149)	$46 (14, 79)	$44 (-7, 100)
Bird population (5%)	$24 (2, 51)	$53 (31, 79)	$93 (40, 171)	$47 (14, 85)	$45 (-2, 120)
Bird population (10%)	$52* (30, 77)	$47 (26, 67)	$132 (80, 203)	$77 (46, 109)	$32 (-11, 88)

*,** indicate that WTP for the higher level of the attribute is statistically greater than WTP for the lower level of the same attribute within the treatment at the 10% and 5% levels, respectively. 1-sided test.

Table 6. Equality of Means Tests Across Location for a Given Habitat

	AL v LA	*AL v LA*
	Oysters	*Salt Marsh*
Water quality (10%)	*	=
Water quality (20%)	*	=
Flood protection (10%)	**	*
Flood protection (15%)	=	=
Fisheries support (20%)	=	=
Fisheries support (30)	*	*
Bird population (5%)	=	=
Bird population (10%)	=	*

*,** indicate statistical difference at the 10% and 5% levels, respectively.
= indicates failure to reject statistical equality. 2-sided test.

Table 7. Equality of Means Tests Across Habitats for a Given Location

	Alabama	*Louisiana*		
	Oysters v Salt Marsh	*Oysters v Salt Marsh*	*Oysters v Mangroves*	*Salt Marsh v Mangroves*
Water quality (10%)	=	=	***	*
Water quality (20%)	=	=	*	=
Flood protection (10%)	=	=	=	=
Flood protection (15%)	=	*	=	=
Fisheries support (20%)	=	=	=	=
Fisheries support (30%)	***	=	=	=
Bird population (5%)	**	=	=	=
Bird population (10%)	***	=	=	=

*,**,*** indicate statistical difference at the 10%, 5%, and 1% level, respectively.
= indicates failure to reject statistical equality. 2-sided test.

[i] The effects of question format on service values are examined more closely in (BLINDED FOR REVIEW).

[ii] We initially controlled for whether respondents were on-panel or off-panel. However, no significant difference between these respondents was detected.

[iii] Here and in following regressions, we also experimented with random coefficients on the attributes (see Greene 2012), but the resulting empirical evidence strongly suggested non-random attribute coefficients. Also, despite a potential relationship between being unemployed and income, removing the former from the model does not affect the significance of any parameter estimates, so we chose to leave it in the model as its coefficient is significant in two treatments.

[iv] Testing indicated a failure to reject the hypothesis of equal alternative-specific constants for each of the two action alternatives in every treatment. Hence we specify only a single constant for the action alternatives.

[v] This is true despite the fact that, due to our study design, an action alternative with no improvements beyond the omitted bases would still include a 5% increase in the number of homes protected from flooding and a 10% increase in annual seafood catch.

[vi] The parameters on the ωs are displayed in table 4 as well. A significant ω parameter indicates that there are individual-specific random effects. The parameter on the random element of the status quo alternative is significant in four of the five treatments, indicating that one should allow individual-specific error terms for the status quo alternatives. On the other hand, the parameter on the random element of the project alternatives is significant only in the Alabama oysters treatment, indicating that individual-specific error terms for the project alternatives are not necessary.

[vii] The study most comparable to our own is Petrolia et al. (2014). They estimate mean willingness to pay for a 30% increase in the number of homes protected from storms in Louisiana through the construction of coastal wetlands to be between $149 and $165, whereas our estimated willingness to pay for half that increase (15%) ranges from $78 to $117. Their estimates of willingness to pay for a 30% increase in fisheries productivity ($204-$210) is much higher than our estimate of the same however ($44-$62).

[viii] This approach involves subtracting each element of one simulated willingness to pay distribution from each element of the second simulated willingness to pay distribution and observing the proportion of observations that lie above or below zero.

[ix] We should point out that one would reach a much stronger (and erroneous) conclusion using only t-tests of the means and Kolmogorov-Smirnov tests of the variances across distributions; when we conduct these tests we find that the willingness to pay distributions are statistically different from each other for each attribute level, both across locations for a given habitat and across habitats for a given location. As Poe et al. (2005) point out, tests which assume normality can often lead to incorrect conclusions when conducted over distributions which are not normal (as willingness to pay distributions often are).