Demand for Diving on Large Ship Artificial Reefs*

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Abstract Using data drawn from a web-based travel cost survey, we jointly model revealed and stated preference trip count data in an attempt to estimate the recreational use value from diving the intentionally sunk *USS Oriskany*. Respondents were asked to report their: (1) actual trips from the previous year, (2) anticipated trip in the next year, and (3) anticipated trip next year assuming a second diveable vessel (a Spruance class destroyer) is sunk in the same vicinity. Results from several different model specifications indicate average per-person per-trip use values range from $480 to $750. The "bundling" of a second vessel in the area of the *Oriskany* to create a multiple-ship artificial reef area adds between $220 and $1,160 per diver per year in value.

Key words Artificial reefs, diving, recreation demand, combined revealed and stated preferences, non-market valuation.

JEL Classification Codes Q26, Q50.

***The views expressed in this paper are those of the authors and do not necessarily represent those of the US EPA. No Agency endorsement should be inferred.**

Introduction

On May 17, 2006, the ex-*USS Oriskany*, an Essex Class aircraft carrier was deliberately sunk off the coast of Pensacola, Florida to become "the world's largest artificial reef." The sinking was the culmination of two years of effort from a diverse set of individuals, institutions, and organizations. Its sinking created significant national media interest ranging from network coverage to a documentary film.[1] It was hoped that the new artificial reef would provide many of the same ecosystem services supplied by a natural reef including increased fish and sea-life habitat, improved fish stocks and angling quality, and new recreational diving opportunities (Adams, Lindberg, and Stevely 2006). If successful in providing these services, it is hoped the *Oriskany* will also relieve some of the use pressure on the area's other reefs. Although the *Oriskany*'s effect on fish stocks and angling are unclear at this time, there have been thousands of divers who have visited the site in the year since its sinking.

The purpose of this paper is twofold. First, we estimate the non-market value of recreational diving on the *Oriskany* artificial reef, and second, we explore the potential value of adding additional artificial reefs to the area. To accomplish these tasks, we estimate several count data travel cost models based on combined revealed and stated diving trip counts to the *Oriskany*. As part of our modeling efforts, we also investigate the consistency of revealed and stated preference trip count data under varying site quality assumptions. The results provide the first estimate of divers' willingness to pay for diving the *Oriskany* and should be transferable to other existing and potential large ship artificial reef sites. As the number of ships needing to be disposed of continues to increase, the value of creating artificial reefs and "bundling" additional vessels alongside existing artificial reefs to create multiple-ship reefs should also become increasingly important.

Data for the analysis are drawn from a web-based survey of individuals known to have dived the *Oriskany* in the year since its sinking. The survey asked respondents to report their: (1) actual *Oriskany* dive trips taken during the 2006 dive season, (2) expected 2007 dive season trips under 2006 conditions, and (3) expected 2007 trips assuming a second diveable warship is sunk in the vicinity of the *Oriskany*. Controlling for sampling method and diver characteristics, we combine the collected revealed and stated preference data and jointly estimate the relationship between trips demanded and travel cost and diver characteristics.

This paper proceeds as follows. First, we describe previous efforts to value recreational diving on artificial reefs. We then provide some background on the *Oriskany* and its sinking and describe our survey design and modeling strategy. Next we summarize our estimation data and present our results. We end with conclusions and recommendations for future work.

The Value of Recreational Diving

Despite the recent significant growth in the number and popularity of artificial reef dive sites, there have been relatively few studies that focus specifically on artificial reef recreational diving use values. Broadening the scope to encompass studies including any type of recreational diving valuation estimates increases the sample size, although a large %age of the estimates are from studies that group values from multiple activities (fishing, diving, boating, etc.) or multiple dive site types (natural and artificial reefs).[2] In many cases, the multiple-activity or multiple-dives site type estimates are not decomposable into accurate measures of divers' artificial reef valuations (Kildow 2006).

Roughly half of previous artificial reef valuation studies and reports of which we are aware focus on expenditure-driven economic impacts such as local output, employment, and labor income instead of on non-market recreational use values (Adams, Lindberg, and Stevely 2006). For valuation purposes, non-market estimates of dive site consumer surplus are theoretically preferred; however, the diving expenditure valuation literature does provide evidence suggesting the existence of substantial artificial reef recreational diving use values. For example, Bell, Bon, and Leeworthy (1998) estimate the economic impacts from fishing and diving artificial reefs along the five-county region of northwest Florida to be approximately $461 million.[3] Across the state in southeastern Florida, Johns *et al.* (2001) estimate that reef users spent approximately 10 million person-days using artificial reefs over a one-year period from 1997 to 1998, generating $2 billion in sales, $933 million in additional labor income, and 27,000 jobs in the region. Along the Texas coast, Ditton and Baker (1999) and Ditton *et al.* (2001) estimate that recreational expenditures of non-resident divers taking trips to the Flower Gardens Banks National Marine Sanctuary and other artificial reefs generated over $2.2 million in output at the local (coastal) level. Also in the Gulf of Mexico, Heitt and Milon (2002) estimate dives on oil and gas rigs result in total direct diving expenditures of $17.3 million and total economic activity of $32.5 million.

Most recently and closely related to the *Oriskany*, Leeworthy, Maher, and Stone (2006) investigate the economic and ecological impacts of the 2002 sinking of the ex-*USS Spiegel Grove* off Key Largo in southern Florida. The authors estimate a net change in total recreational expenditures from pre- to post-deployment of $3.1 million. These new expenditures are further found to generate an additional $3.2 million in total output, $1.1 million in local income, and 68 new jobs.

The majority of the non-market valuation consumer surplus estimates found in the diving literature use contingent valuation methods to elicit divers willingness to pay (WTP) for recreational diving opportunities, although several studies do employ travel cost models (Pendelton 2004). Both types of analysis may be seen in the handful of studies focusing explicitly on the recreational benefits of petroleum platforms. One of the first employs an iterative bidding process to estimate a mean WTP of $305 for an annual pass to dive petroleum rigs in the Gulf of Mexico (Roberts, Thompson, and Pawlyk 1985). Assuming an estimated diver population of 3,200, this implies a total annual use value of $976,000 for diving the rigs. Similarly, Ditton and Baker (1999) and Ditton *et al.* (2001) test open- and closed-ended contingent valuation questions to estimate WTP for recreational reef diving off the coast of Texas. Their estimates range from $383 to $646 per year depending on the disclosure mechanism, with the closed-ended questioning providing larger estimates. In another example, McGinnis, Fernandez, and Pomeroy (2001) use a travel cost model to estimate the value of recreational diving and fishing platform Grace, an oil rig off the southern California coast. They find a value of $68 per person per trip. With an average of three trips per year, the annual use value is $205 per person.

We are aware of only three studies that have focused specifically on artificial reefs. Milon (1989) and Johns *et al.* (2001) both use contingent valuation questions to elicit use value for creating new artificial reefs. Milon estimates WTP for a new marine artificial reef site using several alternative incentive mechanisms and finds annual use values that range from $27 to $142. Johns *et al.* also utilize a contingent valuation methodology to estimate reef users' value for maintaining artificial reefs in their existing condition and for investing and maintaining "new" artificial reefs. In the survey, respondents were informed of a proposed new artificial reef program with no specific mention of the vessels/infrastructure that constituted the new reef. Results indicate diminishing marginal returns to increasing the size of the artificial reef system with annual use values per person for maintaining the existing reef of $75, compared to $24 for creating new artificial reefs. Finally, using dichotomous choice question responses from a sample of local and non-local users, Bell, Bonn, and Leeworthy (2006) estimate a total annual use value (not diving specific) of $25.0 million for artificial reef use across the Florida Panhandle region.

The *Oriskany* Case Study

The national defense reserve fleet was established after World War II to serve as an inventory of vessels available for use in national emergencies and for national defense. At the end of 2005 there were approximately 255 vessels in the fleet. Vessels are periodically examined and reclassified. During that process some are moved into a "non-retention" status and targeted for disposal. According to the U.S. Department of Transportation Maritime Administration (MARAD 2007) vessel disposal program report, there were well over 100 obsolete vessels scheduled for future disposal. Over the period from 2001 through 2006 some 72 ships, including the *Oriskany* and several other warships, were disposed of.

There are a number of options available for ship disposal including vessel donation and sale, dismantling (domestic and foreign recycling/scrapping), sinking as an artificial reef, and deep-sinking in the U.S. Navy SINKEX Program.[4] Hess *et al.* (2001) examined the disposal options for the fleet of decommissioned vessels that were stored at various naval yards throughout the country at the time and concluded that reefing was the best option available. In particular, Hess *et al.* note that if one focuses on the costs and offsetting revenues associated with domestic recycling, international recycling, and reefing disposal options, reefing is "very promising" and one of the "least expensive" disposal options available to MARAD and the Navy. Hynes, Peters, and Rushworth (2004) reiterated the potential benefits from the reef disposal option and suggested that communities might be willing to cost share in the disposal process due to fiscal benefits from use after reef establishment.

The *Oriskany* was actually sunk in May of 2006 and commercial dive charters to the new reef began two days after the sinking.[5] The ship is now located 22 nautical miles (a nautical mile covers 1.151 statute miles) south of Pensacola and operators along a 60-mile stretch of the Florida Panhandle from Destin, FL, to Gulf Shores, AL, offer trips to the *Oriskany*.

Insert Figure 1 here

Most charter boat operators in the area run vessels that can take up to six divers, and a few run larger vessels capable of taking 16-20 divers at a time. There are also many private vessels that visit the reef for diving purposes. Given seas running up to about three feet, approximate travel times for a vessel out to the reef are between 90 to 150 minutes (a mean of about 2 hours). The *Oriskany* is sitting upright in about 215 feet of water and the bow of the vessel points due south. The flight deck is about 135 feet deep and the top of the island superstructure is about 70 feet deep.

Most divers that visit the *Oriskany* are recreational divers that stay within 130 feet of the surface within no decompression limits. Recreational divers usually stay in the vicinity of the vessel's island superstructure and make two dives on the *Oriskany* on a single trip. There is a large contingent of technical divers that visit the ship as well. These divers use dive profiles that involve greater depths, decompression, the breathing of various gas mixtures, specialized equipment, and penetration of the below flight deck interior. Technical diving is much more training and equipment-intensive than recreational diving, and all technical divers have a number of different advanced diving certifications. The ordinary recreational diver will usually have what is termed a basic or advanced open water certification, and some might be certified to dive simple nitrox gas mixes. Most operators require or recommend that the diver have at least the basic open water certification and a minimum number of dives before performing an advanced dive like the *Oriskany*.

Survey Design

Because no formal records are kept on the total number of private and commercial dive trips taken to the *Oriskany*, the only plausible method available to value the recreational opportunity is to survey a known sample of the divers about their past and expected future trips. To define our sample of *Oriskany* divers, we obtained diver liability release forms from one of the most active dive shops that charters trips to the *Oriskany*.[6] From the forms, 248 diver email addresses were identified. Each diver was sent an email describing the purpose of the study, the importance and confidentiality of all completed responses, and a link to a web-based survey instrument (see Little *et al.* 2006 and Champ 2003 for detailed discussions of web-based surveys).

As an incentive to increase response rates, survey recipients were informed that participants would be entered into a random drawing in which three individuals would win a $150 gift certificate to cover the charter boat fee for their next dive. Five days after sending the original email, individuals that had not yet done so were sent a reminder to complete the survey. In total, we received 177 responses (a 71% response rate). As the focus of this research is on day trips, 43 individuals that only took overnight trips were not included in the final data set. Seventeen respondents that did not complete all the questions in the survey were also excluded, leaving 127 complete and usable responses (a 51% response rate).

Along with some basic demographic and diver experience questions, the survey asked respondents three trip-count related questions – one revealed preference and two stated preference questions. The initial revealed preference (TRP_RP) question asked respondents to report the actual number of single day dive trips taken to the *Oriskany* in the year since its sinking.[7] Following the question on past trips, individuals were asked to provide their expected number of trips to dive the *Oriskany* in the upcoming 2007 dive season (TRP_SP). Finally, respondents were presented with a description of a potential ship/artificial reef bundling scenario. Respondents were told that the U.S. Maritime Administration has a number of out-of-service military ships of various types that are being considered for use as artificial reefs in a variety of locations in U.S. coastal waters and that one possible scenario for reefing the ships was to create a "multiple-ship reefing area" by sinking a Spruance class destroyer in the permit area with the *Oriskany*. Respondents were provided with the Destroyer's dimensions and proposed sinking depth and could choose to view a map of the proposed sinking location if they desired. They were further informed that charter boats would pass close by the destroyer on their way out to, and back from, the *Oriskany*. This would create the option to dive the *Oriskany* on the first dive, and then during the surface interval travel to the new destroyer and dive it before returning to port. Respondents were asked: "If the new destroyer was sunk and available to dive today, do you think it would change the number of diving trips you expect to take to the *Oriskany* site (now including the additional destroyer) in 2007?" If respondents select "yes," they were prompted to select how many more or less trips they would take in 2007. This selection was then used to define the number of trips they would expect to take in 2007 given the presence of the second bundled destroyer (TRP_SP_DESTR).

Tables 1 and 2 provide the definitions and descriptive statistics for the variables collected in the survey and used in the analysis. Several trip count characteristics immediately stand out. First, the average number of trips divers are expecting to take in the upcoming dive season (TRP_SP) exceed the average number of trips taken in the previous year (TRP_RP). Second, the expected number of dive trips nearly doubles with the addition of the destroyer (TRP_SP_DESTR), from slightly over two trips to almost four trips per year. The increases in both expected trip counts suggests an increase in demand for dive trips in the upcoming season. The sheer size of the *Oriskany* dive site, especially with the addition of a second ship, may lead divers to feel that multiple trips may be necessary to fully explore the vessels. However, portions of the expected trip increases may also be due to either hypothetical bias in the survey's stated preference responses or habit formation among divers. Within the stated preference literature, hypothetical bias is a widely recognized issue. For example, two summary meta-analyses studies focusing on hypothetical bias by List and Gallet (2001) and Murphy *et al.* (2005) have found evidence that values for non-market goods derived from stated preference survey techniques often significantly exceed the values derived from revealed preference methods. Similarly, a number of recreation demand studies focusing on recreator experience and habit formation have shown that past visits or experience have a positive effect on the probability of choosing to visit a site again in future choice occasions (Adamowicz 1994; Provencher and Bishop 1997; Moeltner and

Englin 2004). Because the sample used in this study consists of divers who have previously dived the *Oriskany*, they may be more likely than the general diving public to dive the *Oriskany* in a future season.

Insert Table 1 and 2 Here

The travel cost data show that, on average, divers incur approximately $531 in costs per trip to dive the *Oriskany*.[8] These costs may seem high but they include significant diving-specific fees in the form of access and equipment rental or purchase. For example, the average charter boat fee to take a diver out to the *Oriskany* is reported to be $174 (including tip).[9] Travel costs to the substitute site (TC_{SUB}) are significantly higher, representing the lack of notable close substitutes to diving the *Oriskany*. Consideration of the socio-demographic data indicates that the average diver in the sample is 43 years of age, earns close to $100,000 per year in household income, and has over 11 years of diving experience. Finally, in our sample, 26 % of respondents are technical divers (TECH_DIVE), with the remaining 74 % considered recreational divers.[10]

Estimation Methodology

As is standard when valuing outdoor recreational trips at a specific definable site such as the *Oriskany*, this study relies on demand-based, single-site travel cost models. Travel cost models exploit the tradeoffs recreators make between site quality and visitation costs when choosing where, and how often, to recreate. In the model, the number of trips taken in the season is the quantity demanded. The travel cost for accessing the site is interpreted as the price (see Parsons 2003) for a detailed discussion of travel cost models). Because the dependent variable, actual/expected trips (y), is a nonnegative integer with a high frequency of small numbers, we rely on several count data model specifications in our attempt to estimate the travel cost relationship.

Following Haab and McConnell (2003), the basic model may be written:

$$\begin{aligned} y &= f(x) \\ &= f(TC_y, TC_{SUB}, INC, SP, z, q), \end{aligned} \qquad (1)$$

where the number of trips taken by an individual in a season to the site, y, is assumed to be a function of a vector of personal and site characteristic explanatory variables, x. These explanatory variables include the travel cost to access the site, TC_y; a vector of trip costs to potential substitute sites, TC_{SUB}; individual's income, INC; a vector of socio-demographic and dive experience variables, z, believed to influence the number of trips, and a site quality or site attribute measure, q. In this study, the z vector is assumed to include the AGE, YRS_DIVE, and TECH_DIVE variables, and the site quality or attribute measure, q, is assumed to include the DESTR variable.

The y vector is constructed by pooling the three trip count measures (TRP_RP, TRP_SP, and TRP_SP_DESTR). The joint estimation of revealed and stated preferences has the advantage of allowing the estimation of preferences for situations outside of historical experience, while anchoring the stated preference responses to actual behavior. The presence of the stated preference elicitation dummy, SP, should account for and measure any hypothetical bias present in the stated preference trip counts (Egan and Herriges 2006; Whitehead 2005).

Because we only survey past participants, our revealed choice data are truncated at zero.[11] We do not believe that endogenous stratification is an issue in our sample since the sample was derived from diver liability waivers collected over a full dive season. Unlike a typical onsite sampling strategy that collects information on only one (or a few) day(s) over the course of a season thereby likely under-sampling those individuals who visit infrequently, our sample is effectively collected on every day of the season and therefore correctly samples all avidity levels.

The probability that an individual will take y trips is first assumed to take the truncation at zero corrected Poisson form:

$$\Pr(y|y>0,x)=\frac{\exp(-\lambda)(\lambda)^{y}}{y!(1-\exp(-\lambda))}, \tag{2}$$

where the parameter λ is the expected number of trips and is assumed to be a function of the variables specified in the model. A detailed discussion of truncated count models may be found in Creel and Loomis (1990) and Haab and McConnell (2002). Usually, λ takes a log-linear form to ensure nonnegative trip counts and may be written:

$$\begin{aligned}\ln(\lambda) = {} & \beta_{CONSTANT}CONSTANT + \beta_{TC_Y}TC_y + \\ & \beta_{SP}SP + \beta_{DESTR}DESTR + \beta_{TC_{SUB}}TC_{SUB} + \beta_{INC}INC + \beta_{AGE}AGE + \\ & \beta_{YRS\_DIVE}YRS\_DIVE + \beta_{TECH\_DIVE}TECH\_DIVE,\end{aligned} \tag{3}$$

where the β's are the coefficients to be estimated. To simplify estimation, we assume that respondents are using temporally constant preference parameters and decision criteria when making trip choices and that there is no correlation between individuals' choices across the different count methods and scenarios.[12] Combining equations (2) and (3) allows us to define the truncation corrected Poisson likelihood function

$$L = \prod_{n=1}^{N} \frac{\exp(-\lambda_n)(\lambda_n)^y}{y!(1-\exp(-\lambda))}, \tag{4}$$

where n indexes individuals (n = 1 … N). This likelihood function is then maximized to recover estimates of the β parameters.

Using the estimated coefficients, an average per-person, per-trip access value, or consumer surplus, for a trip to the site can be estimated. Consumer surplus, or CS, represents a measure of the value a diver places on diving the *Oriskany* and is the difference between total willingness to pay for the trips and total trip cost. From our log-linear model, consumer surplus can be calculated as:

$$Per\,Trip\,CS = \int_{TC_y^{0}}^{TC_y^{choke}} f(TC_y, TC_{SUB}, inc, z, sp, q)\,dTC_y = \frac{1}{-\beta_{TC_Y}}, \tag{5}$$

where TC_y^0 is the individual's trip cost, and TC_y^{choke} is the choke price that at which the number of trips declines to zero. Annual per-person consumer surplus values are calculated by multiplying the per-trip consumer surplus value by the average number of predicted trips per year, λ. It is also possible to calculate the change in consumer surplus due to a change in site quality (i.e., the addition of a destroyer to the site). For example, the annual marginal value of a change in site quality may be found by:

$$Annual\,Change\;in\,CS = \frac{\lambda^*}{-\beta^*_{TC_Y}} - \frac{\lambda}{-\beta_{TC_Y}}, \tag{6}$$

where λ^* is expected trips with the quality change, and $\beta^*_{TC_y}$ the estimated travel cost parameter associated with the new quality conditions.

One potentially undesirable characteristic of the Poisson model is its restriction that the conditional mean and variance of the dependent variable, λ, are equal. In a recreation demand framework, this can be a limiting assumption as data on trips taken commonly exhibit overdispersion (i.e., the variance in trips is often greater than the mean). Ignoring overdispersion in estimation can lead to inefficiency due to the underestimation of standard errors. When dealing with truncated at zero data, the truncated Poisson model's assumptions may be even more troublesome because the truncated model's conditional mean is actually larger than the conditional variance. Therefore, if the underlying distribution is incorrectly assumed to be truncated Poisson, it can lead to both inefficient and inconsistent parameter estimates (Cameron and Trivedi 1998).

When faced with overdispersion, the negative binomial model is a natural alternative since it allows for differences in the mean and variance and tests for overdispersion. The truncated at zero negative binomial model probability function, which results from a gamma distributed error term in the mean for an individual, can be expressed:

$$\Pr(y|y>0,x) = \frac{\Gamma(y+\frac{1}{\alpha})}{\Gamma(y+1)\Gamma\left(\frac{1}{\alpha}\right)}(\alpha\lambda)^{y}(1+\alpha\lambda)^{-(y+1/\alpha)}\left[\frac{1}{1-(1+\alpha\lambda)^{(-1/\alpha)}}\right], \qquad (7)$$

where Γ denotes a gamma distribution and α is the overdispersion parameter. As with the Poisson model, equations (3) and (7) may be combined to specify a likelihood function which is then maximized to recover parameter estimates. Consumer surplus is computed analogously to the Poisson model.

Estimation Results

Columns one and two of table 3 provide the truncated at zero stacked Poisson and negative binomial models estimation results for our Model 1 specification (Equation 3). Model 1 is our most basic and restrictive model specification because it assumes that the pooled data can be described by a single set of parameters. While estimates from the Poisson and negative binomial models are very similar, the negative binomials model's positive and significant alpha value indicates that there is overdispersion present in the data. This overdispersion means that the Poisson model is misspecified, and the negative binomial model is the more appropriate of the two. Estimation results are presented for both models to illustrate their similarity, but all results are discussed in terms of the negative binomial model in the following sections.

Insert Table 3 here

As expected, TC_y is negative indicating that divers living farther from the site and facing higher travel costs take fewer visits. The size of TC_y implies that every dollar increase in the price of the trip to dive the *Oriskany* leads to a 1% decrease in expected trips. The positive, but insignificant, coefficient of the substitute site travel cost parameter, TC_{SUB}, signals that Key Largo is at best a weak substitute for the *Oriskany* artificial reef. A lack of good substitutes might be expected given the *Oriskany*'s status as the world's largest artificial reef.

Turning to the diver-related characteristics, TECH_DIVE is positive and significant indicating that technical divers take more *Oriskany* dive trips than recreational divers. This makes sense for two reasons. First, the *Oriskany* is probably a more attractive dive to technical divers as they can reach the large flight deck level and below flight deck interior providing more opportunities for exploration. Second, all else equal, technical divers also take more aggregate dives per year in order to gain and maintain a “technical” rating. Results also suggest that trips increase with YRS_DIVE and INC, although the relationships are not statistically significant. AGE is significant and negatively correlated with the number of trips, signaling that older divers take fewer trips.

The coefficients on the variables controlling for elicitation method and quality changes are also positive and highly significant. The coefficient on SP indicates expected trip totals for the upcoming season collected through stated preference questions tend to be larger than past year revealed trip totals. The size of the increase in expected trips suggests that it is likely due to hypothetical response bias often prevalent in the stated preference methodology, although diver habit formation created by previous dives on the *Oriskany* could also be an influence. The positive DESTR coefficient indicates that diver preferences are sensitive to the scope of the dive sites and that adding a destroyer in the vicinity of the *Oriskany* would cause an increase in the number of expected trips. As pointed out by Boyle (2003), scope is generally not a problem in use value estimates such as recreation demand.

Because welfare estimates are directly related to a model's estimated travel cost coefficient, and previous studies have found that assuming a single preference structure when combining revealed and stated preference data embodying large changes in site attributes and quality can lead to biased estimates (Huang, Haab, and Whitehead 1997), we also estimate two additional negative binomial model specifications that allow travel cost preferences to vary across the different trip counts. The first additional model (Model 2) tests whether travel cost preferences vary across the revealed (RP) and stated (SP) preference counts by including a term interacting travel costs and the stated preference dummy variable. The model is formally written:

$$\begin{aligned}\ln(\lambda) = {} & \beta_{CONSTANT} CONSTANT + \beta_{TC_Y} TC_y + \beta_{TC_Y}^{SP} TC * SP + \\ & \beta_{SP} SP + \beta_{DESTR} DESTR + \beta_{TC_{SUB}} TC_{SUB} + \beta_{INC} INC + \beta_{AGE} AGE + \\ & \beta_{YRS\_DIVE} YRS\_DIVE + \beta_{TECH\_DIVE} TECH\_DIVE,\end{aligned} \tag{8}$$

where $\beta_{TC_Y}^{SP}$ is the marginal effect of the stated preference elicitation method on baseline (revealed) travel cost preferences. Similarly, we also test whether travel cost preferences change when a destroyer is added to the *Oriskany* dive site (Model 3). The model is given by:

$$\begin{aligned}\ln(\lambda) = {} & \beta_{CONSTANT} CONSTANT + \beta_{TC_Y} TC_y + \beta_{TC_Y}^{DESTR} TC * DESTR + \\ & \beta_{SP} SP + \beta_{DESTR} DESTR + \beta_{TC_{SUB}} TC_{SUB} + \beta_{INC} INC + \beta_{AGE} AGE + \\ & \beta_{YRS\_DIVE} YRS\_DIVE + \beta_{TECH\_DIVE} TECH\_DIVE,\end{aligned} \tag{9}$$

where $\beta_{TC_Y}^{DESTR}$ is the marginal effect on baseline (no additional destroyer) preferences due to the addition of a destroyer.

Results for the varying travel cost models are presented in the last two columns of table 3. Two main results stand out. First, the travel cost and stated preference interaction is not significant in Model 2, suggesting that respondents are using the same travel cost preferences when evaluating revealed and stated preference trips. The SP dummy variable does, however, remain positive and significant in all models, implying that stated preference elicitation has a positive effect on total trips taken. Second, the travel cost and additional destroyer interaction is positive and significant in Model 3, signaling that when a major change in the scope or quality of a site occurs, such as the addition of a destroyer, it can affect the magnitude of the travel cost preference parameters recreators use to determine their expected number of trips. In this case, the addition of the second destroyer makes the *Oriskany* dive site more attractive and lessens the disutility associated with travel to reach it. Log likelihood ratio tests confirm that Model 3 is preferred to Model 1 with at least 97.5% certainty and preferred to Model 2 with at least 95% certainty. [13]

Lastly, we turn out attention to the consumer surplus estimates. Using the estimated parameters from Models 1 through 3, we first calculate the average predicted trip totals for existing baseline conditions (without the additional destroyer) and potential improved conditions (with the additional destroyer). For each scenario, estimates corrected for potential hypothetical stated preference bias are also derived (i.e. with SP=0). Next, we use the estimated travel cost parameters and the average predicted trip total to calculate the per-person, per-trip and per-person annual consumer surplus values associated with existing baseline conditions at the *Oriskany*. Finally, the marginal per-trip and annual consumer surplus gains from sinking an additional destroyer are also calculated. All mean welfare estimates are presented with 95% confidence intervals constructed using the Krinsky and Robb procedure (Creel and Loomis 1991). Results are presented in table 4.

Insert Table 4 here

Several main findings are evident from the results. Most importantly, explicitly accounting for differences in with destroyer travel cost preferences produces significantly lowers baseline per trip and annual consumer surplus values compared to the other models. In fact, the mean per trip consumer surplus values from Models 1 and 2 fall outside of Model 3's 95 % confidence interval in every case except Model 2's hypothetical bias corrected estimate. Results also show that (when possible) correcting for hypothetical bias lowers the consumer surplus estimates of all three models and brings them much closer in value. Model 2 is the only model that allows for a per trip hypothetical bias correction of travel cost preferences (TC_{SP}), although the effect is insignificant and relatively small. All three models correct for hypothetical bias in their annual baseline consumer surplus estimates through reductions in predicted trips when SP is set equal to zero. On average correcting for hypothetical bias reduces predicted trips roughly 50%.

Results further suggest that the addition of a destroyer to the area will lead to large gains in consumer surplus. In terms of the per trip marginal value of an additional destroyer, Model 3 predicts that an additional destroyer would almost double the value of a trip. Only Model 3 is able to predict a change per trip value because it is the only model that allows travel cost preferences to vary between baseline and with destroyer conditions. All three models predict significant increases in the numbers of expected trips taken with the additional destroyer, which translate into large annual marginal consumer surplus values from the addition of the destroyer. In Models 1 and 2, the annual marginal consumer surplus values are roughly 60 % of the baseline annual consumer surplus values in the uncorrected cases and 48 % of the baseline annual values in the corrected cases. Because the annual marginal consumer surplus value from the destroyer in Model 3 is made up of a per trip increase and an expected trip increase, it is two to three and a half times the size of the comparable estimates from Models 1 and 2, and nearly twice the size of predicted annual consumer surplus under existing baseline conditions.

To come up with a rough estimate of the aggregate Pensacola area diver consumer surplus, we use the 4,029 reported total diver trips chartered by all dive shops in the area in the year since its sinking as a conservative estimate of the diver population. Multiplying our estimated baseline annual per diver consumer surplus estimates by our assumed diver population gives us a range of values from $1.2 to $3.5 million. The addition of a destroyer adds a marginal value between $900,000 and $4.7 million indicating there is a significant economic value in bundling vessels to create large ship reefing areas. It is important to note that the 4029 trip total does not account trips made in private boats or trips made from other ports, which means our estimate almost certainly underestimates the true total annual consumer surplus.

Although not directly comparable to other existing use value estimates because different reef systems are being valued, it is interesting to note that the estimates of this study are of roughly the same magnitude as a number of other estimates. For example, Johns (2004) estimates the annual value of $3.6 million associated with existing artificial reef use in Martin County, Florida and Bell, Bon, and Leeworthy (1998) results indicate a total annual value of $2.2 million for artificial reef use across the Florida Panhandle region. In term of adding additional reefs, Johns *et al.* (2001) estimate a total willingness to pay of $4 million in southeast Florida.

Conclusions

This paper employs a web-based travel cost survey of divers to provide the first estimate of the diving demand for the Ex-*USS Oriskany*. Respondents were asked to report both actual trips taken to the *Oriskany* in the year since it sinking and anticipated trips in the following dive season both with and without with the addition of a Spruance Class Destroyer to create a multiple-ship artificial reef. We jointly model stated and revealed preference trip count data using Poisson and negative binomial models controlling for sampling method and diver characteristics.

The study finds that in this case revealed and stated preferences are suitable for combination, although care must be taken before assuming that stated and revealed preferences can be described by a single set of parameters. We find consistent evidence a significant hypothetical bias effect through a stated preference dummy, but also find that travel cost preferences do not vary significantly between stated and revealed counts. Large site quality changes, such as the addition of a destroyer to the dive area, are found to alter the preferences used to evaluate trip choices.

Results also indicate that there are significant welfare benefits to divers from *Oriskany*-specific dive trips. The addition of a second destroyer to create a multi-ship artificial reef is found to add a significant amount of value and improve the desirability of the site. As MARAD seeks to dispose of more decommissioned vessels from its large inventory, the results of this study suggest that reefing is a valuable alternative and that bundling ships could provide extra value and disposal opportunities.

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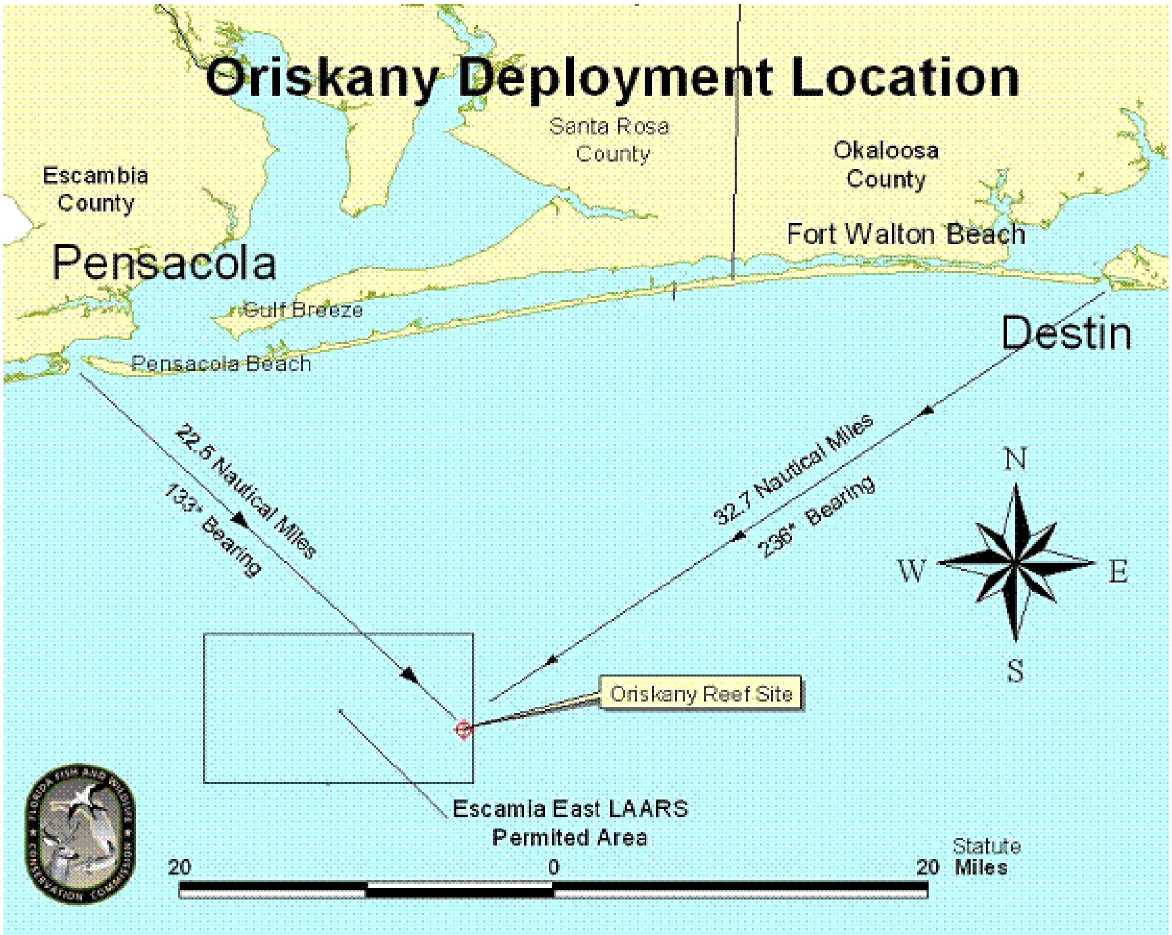

Figure 1 – *Oriskany* Permit Area
Courtesy of Florida Fish and Wildlife Conservation Commission

Table 1 – Variable Definitions

TRP_RP	Number of actual dive trips taken to the *Oriskany* during the 2006-2007 dive season
TRP_SP	Number of dive trips respondents expect to take to the *Oriskany* during the 2007-2008 dive season
TRP_SP_DESTR	Number of dive trips respondents would expect to take to the *Oriskany* if a second destroyer was available for diving nearby
TC_y	Per person travel cost necessary for each respondent to dive the *Oriskany* = ((round trip distance in miles * $.48 per mile)/size of traveling party + charter fees + equipment costs) + (1/3 * (round trip travel time in hours * average wage per hour))
AGE	Age of respondent
INC	Income of respondent
YRS_DIVE	Number of years of diving experience
TECH_DIVE	Certified as a technical diver (0/1)
TC_{SUB}	Per person travel cost to a substitute site (Key Largo, FL, Location of the USS Spiegel Grove)
SP	Dummy variable denoting the trip count was elicited through a stated preference question (0/1)
DESTR	Dummy variable denoting trip counts elicited under the assumption that a second Spruance class destroyer would be sunk in the vicinity of the *Oriskany* (0/1)

Table 2 – Descriptive Statistics

	Full Sample (N = 127)			
Variable	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
TRP_RP	1.49	1.23	1.00	12.00
TRP_SP*	2.19	1.71	1.00	10.00
TRP_SP_DEST**	3.75	2.94	1.00	15.00
TC_y	$531.34	$457.43	$10.36	$2,674.88
AGE	43.35	10.51	16.00	66.00
INC	$99,527.24	$54,141.50	$15,000.00	$225,000.00
YRS_DIVE	11.33	9.47	1.00	41.00
TECH_DIVE	0.26	0.44	0.00	1.00
TC_s	$1,110.77	$599.38	$233.02	$3,419.48

	Technical Divers (N = 33)		Recreational Divers (N = 94)	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
TRP_RP	2.06	2.10	1.29	0.62
TRP_SP	2.42	2.54	1.52	1.33
TRP_SP_DEST	5.00	5.47	3.21	2.71
TC_y	$681.39	$602.10	$453.22	$348.82
AGE	45.00	10.41	42.77	10.56
INC	$98,939.40	$53,535.30	$99,733.60	$54,636.20
YRS_DIVE	16.88	10.76	9.38	8.18
TC_s	$1,312.61	$796.86	$1,039.91	$498.72

* Twenty five zero observations were excluded from the data leaving 102 TRP_SP observations.
** Nine zero observations were excluded from the data leaving 118 TRP_SP_DEST observations.

Table 3 – Truncation at Zero Corrected Poisson and Negative Binomial Models[a]

Variable	Model 1		Model 2	Model 3
	Poisson	NB	NB	NB
TC_y	-0.0015	-0.0014	-0.0018	-0.0021
	(0.0002)*	(0.0002)*	(0.0004)*	(0.0003)*
TC_{SP}			0.0005	
			(0.0004)	
TC_{DESTR}				0.0010
				(0.0003)*
CONSTANT	0.2165	-.09035	0.0728	0.1518
	(0.2125)	(0.3244)	(0.3555)	(0.3347)
SP	0.7370	0.8324	0.6466	0.8315
	(0.1450)*	(.01925)*	(0.2409)*	(0.1992)*
DESTR	0.7846	0.8907	0.8877	0.5027
	(0.0965)*	(0.1572)*	(0.1560)*	(0.1987)*
AGE	-0.0119	-0.0130	-0.0129	-0.0124
	0.0045)	(0.0068)*	(0.0068)**	(0.0068)**
INC[b]	0.0180	0.0096	0.0094	0.0099
	(0.0086)**	(0.0143)	(0.0142)	(0.0143)
YRS_DIVE	0.0171	0.0150	0.0151	0.0154
	(0.0053)*	(0.0088)	(0.0088)**	(0.0089)**
TECH_DIVE	0.6904	0.7825	0.7813	0.7833
	(0.0874)*	(0.1436)*	(0.1431)*	(0.1421)*
TC_{SUB}	0.0001	0.0003	0.0003	0.0002
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Alpha		0.3794	0.3776	0.3673
		(0.1235)*	(0.1241)*	(0.1177)*
LOG LIK	-519.9754	-493.5160	-493.0939	-490.9389

[a] The top number in each cell is the estimated coefficient and the bottom number in parenthesis is the estimated standard error estimate

[b] Income is scaled by 10,000.

* Significant at a 99% level.

** Significant at a 95% level.

Table 4 – Per Person Consumer Surplus

	Model 1		Model 2		Model 3	
	Pooled	**SP = 0**	**Pooled**	**SP = 0**	**Pooled**	**SP = 0**
Predicted Trips (λ):						
Baseline Conditions (DESTR = 0)	1.15	0.63	1.15	0.63	1.16	0.64
With Addition of Destroyer	1.86	0.94	1.86	0.94	1.86	0.94
Value Per Trip:*						
Baseline Conditions (DESTR = 0)	$717.73 ($354, $1073)	$717.73 ($354, $1073)	$749.93 ($562, $1116)	$545.90 ($378, $1000)	$479.94 ($372, $668)	$479.94 ($372, $668)
Marginal Destroyer Value	$0	$0	$0	$0	$422.90 ($156, $1168)	$422.90 ($156, $1168)
Annual Value:						
Baseline Conditions (DESTR = 0)	$827.58 ($629, $1203)	$453.57 ($345, $660)	$865.62 ($648, $1314)	$344.73 ($241, $617)	$556.22 ($430, $788)	$305.09 ($237, $426)
Marginal Destroyer Value	$505.35 ($384, $731)	$219.82 ($167, $317)	$526.20 ($394, $798)	$165.85 ($115, $299)	$1,158.56 ($637, $2479)	$562.49 ($307, $1127)

* The top number in each cell is the mean welfare value and the numbers in parenthesis below the mean is a 95% confidence interval.

Footnotes

[1] The sinking of the *Oriskany* was featured in the documentary film "Sinking of an Aircraft Carrier" and debuted on the Discovery Channel on 9/26/06.

[2] For examples see Milon (1989), Bell, Bon, and Leeworthy (1998), Ditton and Baker (1999), Ditton, Thailing, Reichers and Osburn (2001), or Leeworthy, Maher, and Stone (2006).

[3] All monetary values in this study are reported in 2006 dollars.

[4] Under the SINKEX Program ships are cleaned to EPA deep water disposal standards and then sunk in a live fire exercise at least 50 miles off shore and in at least 6,000 feet of water.

[5] When the *Oriskany* became available for reefing in 2003 there were four applications from states to receive it: Florida, Texas, Mississippi, and a joint application from South Carolina and Georgia. From the list of applicants, the U.S. Navy announced the selection of Escambia County, Florida to receive the *Oriskany* in April of 2004. Horn, Dodrill and Mille (2006) document the administrative and operational aspects associated with the sinking. The two year wait period was a function of both the extensive environmental cleaning the ship underwent and delays caused by the 2005 hurricane season. The *Oriskany* was initially towed from Corpus Christi, TX to Pensacola, FL where additional work was performed but due to the threat of Hurricane Rita the vessel was towed to Beaumont, TX where it rode out the storm. The *Oriskany* was towed back to Pensacola in March of 2006 and two months later it was sunk on May 17th.

[6] At the time of the survey there were five dive shops operating charter trips to the *Oriskany* in the Pensacola area. All the dive shops were roughly the same size and catered to both recreational and technical divers. The small number and similar size of the dive shops suggests that there are not great differences between shops or the diving population that visits specific shops. We contacted all five dive shops during data collection efforts, and while we were able to collect the number of total divers taken to the *Oriskany* from each shop (4029 in total), only one shop, the

Scuba Shack, was willing to share its manifest data. The authors would like to thank the Scuba Shack for their cooperation, time, and effort in allowing us access to their dive records. A copy of the survey may be found at http://haas.uwf.edu/*Oriskany*/survey.html.

[7] The calendar year after the *Oriskany*'s sinking runs through May 16th, 2007. We refer to this as the 2006 dive season.

[8] Cost per mile estimates were set equal to US EPA's 2006 privately owned vehicle per mile reimbursement rates, which may be found at: http://www.gsa.gov/milage. These estimates are comparable to the per mile driving cost estimates produced by the Automobile Association of America.

[9] While some equipment will be used and amortized over multiple trips, other equipment will be bought or rented for a specific trip. One approach, as suggested by Parsons (2003), is to use the equipment rental fee as a proxy for the equipment cost fee. A drawback of this method is that it will invariably result in an overestimate of costs for some recreators. In this study, we take respondents' reported gear rental costs incurred on their last trip as an estimate of their per trip diving gear expenses when calculating total trip costs. If divers own all, or the majority, of their own gear, then it is possible that they reported incurring little or no rental expenses. As compared to Parson's suggested method, our method may lead to conservative estimates of those divers' per trip diving gear expenses. In regards to diving gas expenses, we assume that every diver must buy diving gas for each trip. Therefore, if a diver in our survey reported no diving gas expenses we assign them the sample average diving gas cost.

[10] We believe that our web-based diver sample is representative for several reasons. First, due to the high cost and travel intensive nature of scuba diving, it is expected that the diving population would have relatively higher incomes compared to the general population. Second, the parameters of our survey are also very similar to the diver sample collected by Ditton and Baker

(1999) in a mail survey of 528 Gulf of Mexico divers randomly drawn from the annual dive logs of multiple Texas dive shops. Ditton and Baker find that divers are relatively well educated (four or more years of college on average) and high income earners (median income of $80,500 in 2007 dollars). Although not reported in Table 2, almost 66% of our web-based sample had at least a four year bachelors degree.

[11] While it is possible for respondents to state they expect to take zero trips in the two stated preference counts, the stated preference counts do suffer from incidental truncation because they are derived from an over-sample of avid participators. Respondents who have taken trips in the past are more likely to take a trip in the future, which means that the average probability of expecting zero trips in 2007 is lower in our sample of participants than it is in the general population (including non-participants).

[12] It is important to note that our estimation strategy does not recognize the panel nature of our data. There are likely unobserved individual specific factors that are correlated across respondents' three responses that our data pooling estimation method does not account for. We are currently unaware of any existing panel count data model that accounts for our situation of (incidental) truncation without endogenous stratification. As the focus of this paper is on valuing the experience of diving the *Oriskany*, we follow the examples of Adamowicz, Louviere and Williams (1994) and Grijalva, Berrens, Bohara and Shaw (2002) by pooling our data without estimating a panel data model, and leave the development of a new estimation method to future authors.

[13] A model that incorporated a travel cost and stated preference dummy interaction (from Model 2) and a travel cost and additional destroyer dummy (from Model 3) was also estimated. Results were similar to the presented models in that the destroyer interaction was significant and the stated preference interaction was not. While not significant, the travel cost and stated preference

parameter did however unexpectedly change to a negative value signaling that stated preference elicitation methods had a negative effect on expected trips. This effect followed through to estimated welfare and produced the counter-intuitive result that correcting for stated preference/hypothetical bias significantly increased welfare estimates compared to the uncorrected situation. Results are available from the authors upon request.