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Diving Demand for Large Ship Artificial Reefs

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U.S. Environmental Protection Agency
National Center for Environmental Economics
1200 Pennsylvania Avenue, NW (MC 1809)
Washington, DC 20460
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Ash Morgan[a], D. Matthew Massey[b], and William L. Huth[a]

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[a] University of West Florida
Department of Marketing and Economics
11000 University Parkway
Pensacola, FL 32514
amorgan@uwf.edu
whuth@uwf.edu

[b] US EPA, National Center for Environmental Economics
1200 Pennsylvania Ave., NW
MC1809T
Washington, DC 20460
massey.matt@epa.gov

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Diving Demand for Large Ship Artificial Reefs

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 ex-USS Oriskany. Respondents were asked to report (1) their actual trips from the previous year, (2) their anticipated trip in the next year, and (3) their anticipated trip next year assuming a second dive-able destroyer were sunk in the same vicinity. Results from a single-site Poisson and negative binomial travel cost model indicate an annual use value of $1,215 per diver associated with current Oriskany-specific dive trips. Expected annual use value estimates then increase to $2,596 with the "bundling" of a second vessel alongside the Oriskany to create a multiple-ship artificial reef area.

Keywords: **Artificial reefs, diving, bundled public goods, recreation demand, non-market valuation**

Subject Area Classification: **Recreation/Travel Demand, Marine/Coastal Zone Resources**

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. It's sinking created significant national media interest ranging from network coverage to a documentary film.[1] It was hoped that the newly sunken 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 do this, we estimate both a single-site poisson and negative binomial travel cost model based on combined revealed and stated diving trip counts to the Oriskany. 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 "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 (1) their actual Oriskany dive trips taken during the 2006 dive season, (2) their expected 2007 dive season trips under 2006 conditions, and (3) their expected 2007 trips assuming a second dive-able 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 somewhat, although a large percentage 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). 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 have focused on expenditure-driven economic impacts such as local output, employment, and labor income instead of on non-market recreational use values. For valuation purposes, non-market estimates of dive site consumer surplus are theoretically preferred; however, the diving expenditure valuation literature does provided 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 between $700 million and $1.2 billion. Across the state in southeastern Florida, Johns et al. (2001) estimate that reef users spent approximately 10 million person-days using artificial reefs, generating $1.7 million in sales, $782 million in additional labor income, and 27,000 jobs to 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 $1.7 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 $13.2 million and total economic activity of $24.8 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 $2.6 million. These new expenditures are further found to generate an additional $2.7 million in total output, $962,000 in local income, and 68 new jobs.

The majority of the nonmarket 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. 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, Roberts, Thompson, and Pawlyk (1985), 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. 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 higher use WTP 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 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 found annual use values that range from $27 to $142. Johns et al. also utilizes 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.[2] Their 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 to a sample of local and non-local users, Leeworthy, Maher, and Stone estimate a total annual use value (not diving specific) of $19.7 million for artificial reef use across the Florida Panhandle region.[3]

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. 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 as well. 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 very 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 out to the Oriskany, on which divers provide email addresses.[6] From the diver release forms, 248 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. As an incentive to increase response rates, respondents 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. To estimate a balanced panel, 17 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.[8] Respondents were provided with the Destroyer's dimensions and proposed sinking depth and 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). This suggests an increase in demand for dive trips in the upcoming season, although part of this effect may also be attributed to hypothetical bias in the survey responses. Second, the expected number of dive trips doubles with the addition of the destroyer (TRP_SP_DESTR), from roughly 1.8 trips to 3.7 trips per year.

Insert Table 1 and 2 Here

The travel cost data show that, on average, divers incur approximately $551 in costs per trip to dive the Oriskany.[9] 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).[10] 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 percent of respondents are technical divers (TECH_DIVE) with the remaining 74 percent considered recreational divers.

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 a proxy for quantity demanded and the travel cost for accessing the site is interpreted as the price. Price variation comes from sampling respondents traveling to the Oriskany site from different origins (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 investigate two different count data specifications in our attempt to estimate the travel cost relationship.

Following Haab and McConnell (2003), the basic models 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 may 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, a, and site quality measure q.

The y vector is constructed by stacking 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)).

Realizing that because we only survey past participants our revealed choice data is truncated at zero, the probability that an individual will take y trips is first assumed to take the truncation corrected Poisson form

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

where the parameter λ is the expected number of trips and is assumed to be a function of the variables specified in the model. Usually, λ takes a log-linear form to ensure nonnegative trip counts and may be written

$$\ln(\lambda)=\beta_{TC_y}TC_y+\beta_{TC_{SUB}}TC_{SUB}+\beta_{INC}INC+\beta_{SP}SP+\beta_z z+\beta_q q\ . \tag{3}$$

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.

Combining equations (2) and (3) then allows us to define the truncation corrected Poisson likelihood function

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

where n indexes individuals (n = 1 … N).[11] Because the model does not allow for correlation in a given individual's responses across the different count measures the model essentially treats a single person's three responses (one for each count) as coming from three identical but unrelated people. 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 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 linear model, consumer surplus can be calculated as

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

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.

One potentially undesirable characteristic of the Poisson model is that it assumes that the conditional mean of the dependent variable, λ, is equal to the conditional variance. In a recreation demand framework, this can be a limiting assumption as the variance in trips is often greater than the mean. Greater variance implies overdispersion in the data, which causes the standard errors in the Poisson model to be underestimated. When faced with overdispersion, the negative binomial model (our second model) is a natural alternative since it allows for differences in the mean and variance and tests for overdispersion.

The zero-truncated negative binomial model probability function with a gamma distributed error term in the mean for an individual can be expressed

$$\Pr(y|y>0,x) = \frac{\Gamma(y+\frac{1}{\alpha})}{\Gamma(y+1)\Gamma\left(\frac{1}{\alpha}\right)}(\alpha\lambda)^{y}(1+\alpha\lambda)^{-(y+1/\alpha)}\left[\frac{1}{1-(1+\alpha\lambda)^{(-1/\alpha)}}\right] \tag{6}$$

where Γ denotes a gamma distribution and α is the overdispersion parameter. As with the Poisson model, equations (3) and (6) may then be combined to specify a likelihood function which is then maximized to recover parameter estimates. Consumer surplus is computed analogously to the Poisson model.

For completeness, we estimate and present the results of both models. We then use estimated coefficients from both models to report welfare estimates for (1) the value of trips taken to the Oriskany and (2) the expected value of bundling a second ship with the Oriskany to create a multiple-ship reefing site.

Estimation Results

Table 3 provides the estimates of the stacked Poisson and negative binomial models. While estimates from both models are very similar, the positive and significant alpha value indicates that there is overdispersion present in the data. This overdispersion means that the Poisson model is misspecified due to its constraining assumption that the conditional mean equals the conditional variance. As such, the standard errors in the Poisson model will be underestimated and the negative binomial model is more appropriate of the two.

Even with the misspecification in the Poisson model, results across the two models are largely consistent. For example, the size and significance of the travel cost variable is the same across model specifications. 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.

Insert Table 3 here

Turning to the diver-related characteristics, TECH_DIVE is positive and significant in both models 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 probably 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 in the negative binomial model. AGE is significant only in the negative binomial model and is 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 across both model specifications. 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. Although it is not certain, it is likely that at least a portion of this increase in expected trips may be due to hypothetical response bias often prevalent in the stated preference methodology. Similarly, the DESTR coefficient further indicates that adding a second destroyer in the vicinity of the Oriskany would cause an increase in the number of expected trips. The SP variable should account for any stated preference bias in the stated destroyer trip predictions and therefore allow the DESTR variable to solely isolate the effect of creating a multi-ship reef on expected trips.

Based on the large stated preference fixed effect, we also estimate a second set of Poisson and negative binomial models that allow preferences for TC_y, YRS_DIVE, and TECH_DIVE to vary for revealed and stated preference responses. As can be seen in Table 4, the changes in model specifications have a relatively limited effect on the model's results, and because of overdispersion, the negative binomial model is again preferred. The travel cost coefficients do not differ substantially between revealed and stated preferences, but there is limited evidence of variation in other parameters. For example, the difference in coefficient values for the interactive terms $TECH\_DIVE_{RP}$ and $TECH\_DIVE_{SP}$ suggest that Oriskany technical divers actual trips exceeded their anticipated trips. Diver experience had only has a significant positive effect on stated preference responses in the Poisson model.

Insert Table 4 here

Next we turn out attention to the consumer surplus measures. Using the estimated travel cost parameter from the zero-truncated negative binomial model presented in Table 3 and the average trip totals from each trip count we calculate a number of different welfare measures. Because we assumed that travel cost preferences were equal across counts, per person per trip consumer surplus is also constant across counts at roughly $700. While it may seem high, the magnitude of the per person per trip consumer surplus value from diving the Oriskany is likely indicative of its unique status among the diving community.

Insert Table 5 here

The average annual consumer surpluses per person from diving the Oriskany are calculated by multiplying the per person per trip consumer surplus estimate by the average number of trips in each count, and range from $705 in 2006 to nearly $2600 in 2007. The expected 2007 trips average per person annual consumer surplus estimates are higher than the revealed 2006 estimate because respondents indicated they planned to take more trips in 2007. It is also interesting to note that the addition of the destroyer increases annual per person consumer surplus by roughly $1350.

We also calculate the total annual consumer surplus according to each count in our data set in order to provide numbers roughly comparable to the values most previous valuation and expenditure studies have reported. Because we do not know the true total number of divers who have visited the Oriskany in 2006, we use the 4,209 total trips chartered by all dive shops in the area in the year since its sinking as a conservative estimate. Multiplying the total trips estimate by annual consumer surplus generates total annual consumer surplus estimates ranging from $4.4 to $5.2 million under current conditions. The addition of the destroyer is estimated to bring total annual consumer surplus into the range of $10.9 million indicating there is a significant economic value in bundling vessels to create large ship reefing areas.

Although not directly comparable to other existing use value estimates because different reef systems are being valued, it is interesting to note that our estimates are within roughly a factor of two or less. For example, Johns (2004) estimated 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. Again, our estimates might be slightly higher because of the uniqueness and size of the Oriskany site.

Conclusion

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. Results and consumer surplus estimates indicate significant welfare benefits to divers from Oriskany-specific dive trips. Findings also illustrate a significant benefit to divers from "bundling" a second vessel alongside the Oriskany to create a multiple-ship artificial reef area. 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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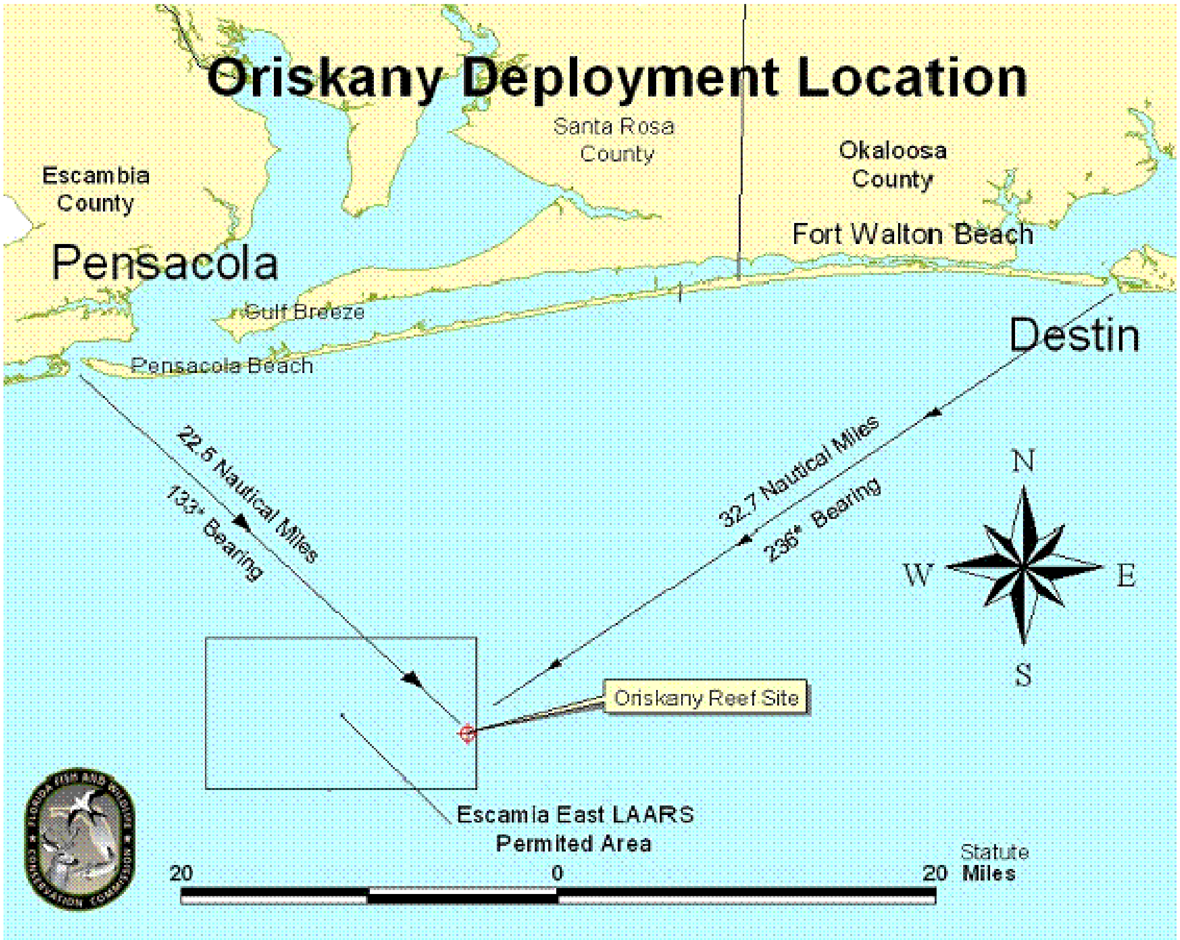

Figure 1 – Oriskany Permit Area
Courtesy of Florida Fish and Wildlife Conservation Commission

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[15] = ((round trip distance in miles * $.48 per mile)/size of traveling party + charter fees + equipment costs) + (1/3 * (round trip travel time in hours * 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

Variable	Mean	Std. Dev.	Minimum	Maximum
TRP_RP	1.49	1.23	1.00	12.00
TRP_SP	1.76	1.76	1.00	10.00
TRP_SP_DEST	3.68	3.69	0.00	28.00
TC_y	$551.86	$467.10	$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	$1,100.77	$599.38	$233.02	$3,419.48

Table 3 – Day-trip Travel Cost – Poisson and Negative Binomial Models[a]

Variable	Poisson Model		Negative Binomial Model	
	Coefficient	Standard Error	Coefficient	Standard Error
TC_y	-0.0014**	0.0001	-0.0014**	0.0002
AGE	-0.0085	0.0034	-0.0135**	0.0047
INC	0.0188*	0.0085	0.0085	0.0138
YRS_DIVE	0.0141**	0.0050	0.0136	0.0084
TECH_DIVE	0.7215**	0.0875	0.8057**	0.1397
TC_{SUB}	0.0001	0.0001	0.0002	0.0002
SP	0.8259**	0.1330	0.8261**	0.1792
DESTR	0.7845**	0.0965	0.8869**	0.1549
Alpha			0.3562**	0.1055
LOG LIK	-512.5		-487.5	

* Significant at 5% level.
** Significant at 1% level.
[a] Income is scaled by 10,000.

Table 4 – Day-trip Travel Cost with Revealed and Stated Preference Interactions – Poisson and Negative Binomial Models[b]

Variable	Poisson Model		Negative Binomial Model	
	Coefficient	Standard Error	Coefficient	Standard Error
TC_{RP}	-0.0018**	0.0004	-0.0020**	0.0004
TC_{SP}	-0.0014**	0.0002	-0.0013**	0.0002
AGE	-0.0102*	0.0040	-0.0118*	0.0052
INC	0.0178*	0.0085	0.0091	0.0140
YRS_DIVE_{RP}	0.0088	0.0129	0.0024	0.0191
YRS_DIVE_{SP}	0.0153**	0.0052	0.0144	0.0087
$TECH\_DIVE_{RP}$	1.4018**	0.2577	1.4353**	0.3343
$TECH\_DIVE_{SP}$	0.6308**	0.0933	0.6645**	0.1544
TC_{SUB}	0.0001	0.0001	0.0003	0.0002
SP	0.9239**	0.1796	0.7611**	0.2419
DESTR	0.7807**	0.0965	0.8718**	0.1491
Alpha			0.3562**	0.1055
LOG LIK	-512.5		-487.5	

* Significant at 5% level.
** Significant at 1% level.
[b] Income is scaled by 10,000.

Table 5 – Consumer Surplus Measures

	2006 Trips	2007 Trips	2007 Trips With Destroyer
Average per Person Per Trip Consumer Surplus	$705.43	$705.43	$705.43
Average Annual Consumer Surplus	$1,215.10	$1,241.56	$2,596.00
Total Annual Consumer Surplus	$4,424,067	$5,225,744	$10,926,555

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] Respondents were informed of a proposed new artificial reef program with no specific mention of the vessels/infrastructure that constituted the new reef.

[3] Adams, Lindberg, and Stevely (2006) provide a more detailed review of the expenditure based literature and Pendleton (2004) provide a general overviews of the expenditure and nonmarket value literature.

[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 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 Ex-Oriskany was initially towed from Corpus Christi, TX to Pensacola, FL where additional work was performed but due to delays and the threat of the 2005 hurricane season the vessel was towed to Beaumont, TX where it rode out Hurricane Rita. The Ex-Oriskany was towed back to Pensacola in March of 2006 and two months later it was sunk.

[6] The authors would like to thank the Scuba Shack, Pensacola, for their cooperation, time, and effort in allowing us access to their dive records.

[7] The Oriskany was sunk on May 17th, 2006. The calendar year after its sinking runs through May 16th, 2007. We refer to this as the 2006 dive season.

[8] Respondents could click to see a locator map of the permit area and the proposed location of the Destroyer.

[9] 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/Portal/gsa/ep/contentView.do?P=MTT&contentId=9646&contentType=GSA_BASIC. These estimates are comparable to the per mile driving cost estimates produced by AAA

[10] While some equipment will be used across several trips and so, amortized over the life of the equipment, other equipment will be bought or rented for the specific trip. One approach, as suggested by Parsons (2003) is to use the equipment rental fee as a proxy for the equipment cost fee even though this will invariably result in an overestimate. We use respondents' reported breathing gas costs and gear rentals incurred on their last trip in calculating total trip costs in an effort to avoid the amortization issue. To dive the Oriskany, divers typically need, at the very least, to be equipped with a wet suit, tanks, a regulator, pressure gauge, mask, fins etc.

[11] We do not believe that endogenous stratification is an issue in our sample because 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) days 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 therefore correctly sampling all avidity levels.