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Peter E T Edwards
George R Parsons, *University of Delaware*
Kelley A Myers, *University of Delaware*

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Peter E. T. Edwards [a b], George R. Parsons [c] & Kelley H. Myers [c]
[a] NOAA, National Marine Fisheries Service, Silver Spring, Maryland, USA
[b] I.M. Systems Group Inc, Rockville, Maryland, USA
[c] School of Marine Science and Policy, University of Delaware, Newark, Delaware, USA

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The Economic Value of Viewing Migratory Shorebirds on the Delaware Bay: An Application of the Single Site Travel Cost Model Using On-Site Data

PETER E. T. EDWARDS,[1,2] GEORGE R. PARSONS,[3] AND KELLEY H. MYERS[3]

[1]NOAA, National Marine Fisheries Service, Silver Spring, Maryland, USA
[2]I.M. Systems Group Inc., Rockville, Maryland, USA
[3]School of Marine Science and Policy, University of Delaware, Newark, Delaware, USA

We estimated a count data model of recreation demand using data from an on-site survey of recreational birders who had visited southern Delaware during the month–long annual horseshoe crab/shorebird spring migration in 2008. We analyzed daytrips only. Our estimates from the models ranged from $32 to $142/trip/household or about $131 to $582/season/household (2008$). The variation was due to differences in the value of time. The average household size was 1.66. We found that the valuation results were sensitive to the inclusion of covariates in the model. Our results are useful for damage assessments and benefit–cost analyses where birdwatching is affected.

Keywords recreational birding, economic value, shorebird migration, onsite sampling, endogenous stratification

Introduction

Each year from early May to the middle of June thousands of migratory shorebirds stopover on the Delaware Bay to feed on horseshoe crab eggs during the crab-spawning season. The eggs provide vital nutrition for the birds on their journey from South American to Canada. The migrating birds include, among others, the Red Knot, Ruddy Turnstone, Semi-Palmated Sandpiper, and Sanderling. Due to declining numbers in recent years, the Red Knot, probably the best known of the species, has become a candidate for listing as endangered.[1]

This article estimated the use value of these migratory shorebirds to recreational birders. Our goal was to provide a set of estimates that may be useful in damage assessment and benefit-cost analysis. We estimated a single-site travel cost model using data from an

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Address correspondence to Dr. George R. Parsons, School of Marine Science and Policy, Robinson Hall, University of Delaware, Newark, DE 19716, USA. E-mail: gparsons@udel.edu

on-site sample of recreational birders visiting the Delaware Bay in Delaware. We confined our analysis to daytrips and use the household as our unit of observation.[2] Our model was applied to birding during the horseshoe crab/shorebird migration in 2008. A viewing "season" is about 5 or 6 weeks long.

We estimated a negative-binomial count-data travel cost model. We were particularly interested in accounting for biases introduced by on-site sampling—endogenous stratification (over sampling frequent visitors) and truncation (only observing households making at least one trip during the season). Hellerstein (1991), Hellerstein and Mendelsohn (1993), and Creel and Loomis (1990) were the first to explore research on applications using count data models in recreation demand. Shaw (1988) was the first to design a correction for endogenous stratification and truncation due to on-site sampling. Shaw's correction applied to simple Poisson models. Englin and Shonkwiler (1995) later introduced an on-site correction for negative-binomial models. For some recent applications along these lines and similar to ours see Donovan and Champ (2009), Ovaskainen, Mikkola, and Pouta (2001), McKean, Johnson, and Walsh (1995), Englin, Holmes, and Sills (2003), and Martínez-Espiñeira and Amoako-Tuffour (2008).

There are a number of studies that have focused on the economic impact of recreational birding and ecotourism (Eubanks, Stoll, & Kerlinger, 2000; Glowinski, 2008) but only a few have estimated consumer surplus for use values of birdwatching (Eubanks, Stoll, & Ditton, 2004; Isaacs & Chi, 2005; Stoll, Ditton, & Eubanks, 2006). There are several estimates for broad categories such as nonconsumptive wildlife recreation (Rockel & Kealy, 1991) and wildlife viewing for other species such as elk (Donovan & Champ, 2009). There are also a number of studies that have estimated non-use values for endangered or threatened species of birds such as the Spotted Owl (Rubin, Helfand, & Loomis, 1991), the Red Cockaded Woodpecker (Reaves, Kramer & Holmes, 1999), and Canada geese (MacMillan, Hanley, & Daw, 2004). But, the published literature on use values for birdwatching remains sparse. A few other articles of note here include Hvenegaard, Bulter, and Krystofiak (1989), Lee, Lee, Mjelde, Scott, and Kim (2009), and U.S. Fish and Wildlife Service. (2001). Rosenberger and Loomis (2001) conducted a meta-analysis of a number of consumptive and nonconsumptive activities including a category identified as wildlife viewing. The wildlife viewing studies they considered reported values that ranged from \$2.36 to \$161.59 (1996 dollars) per day. They reported an expected value over all wildlife-viewing studies of \$29.57 (2001 dollars). In a benefit transfer application one might reasonably use these as values for birdwatching, but estimates for birdwatching directly would be desirable. Our application provides just such estimates.

Survey and Data

Our data come from an on-site survey of visitors to key shorebird viewing sites on the Delaware side of the Delaware Bay. The migration occurs from early to mid-May through early June. Our sampling was done in 2008 from May 17–June 6—respondents were asked to report actual trips since May 1 and expected trips to June 15. Birders were intercepted while they were birdwatching (usually after) at two selected sites in the area: Port Mahon and Mispillion Harbor Reserve. These sites are approximately 25 miles apart (Figure 1). Most people visiting the area to view the migration visited one of these sites as part of their trip and usually visited more than one site in the area on a trip. We, in effect, treated the entire area as a single site. The unit of analysis was a household. The average household size was 1.66.

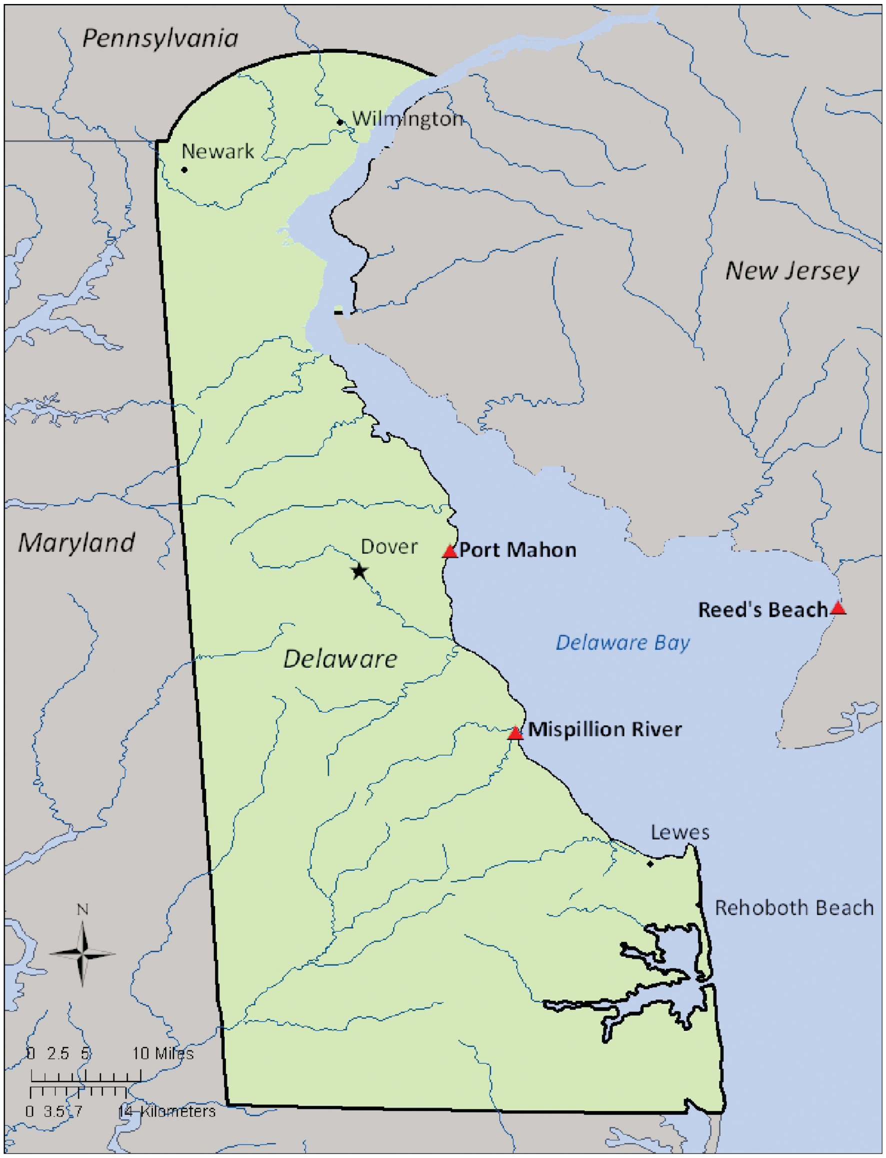

Figure 1. Data collection sites on the Delaware Bay: Port Mahon and Mispillion Harbor (color figure available online).

A team of interviewers intercepted birdwatchers over 11 different week and weekend days during the shorebird migration. The days were randomly drawn from 20 possible days. The sites were surveyed regardless of weather conditions and virtually every birder at a site was sampled during the sampling period, so we believe the sample is representative of the population. Visitors were informed about the study and then asked to take a packet that contained the questionnaire, complete it as soon as possible (preferably the same day), and mail it back using an enclosed envelop. Visitors were only handed a survey if the primary purpose of their trip was for birdwatching and only if they were on-site for at least 15 minutes. A total of 581 questionnaires were handed out with 376 returned (response rate = 65%).

The survey included questions on where their household birding day began and ended, home zip code, number of hours spent birding, visits to other birding sites, income, size and composition of travel party, activities during the birding trip, age, income, and other demographic information.

The mean age of the respondents was 58 years. Forty-two percent were women. Mean household income was $106,825 (2008$), mean education was about 14 years, and the mean value of birding equipment owned by respondents was $4,097/household. Finally, 55% reported being members of birding clubs or societies while 84% reported that they had previously made a least one visit to the Delaware Bay to view shorebirds in years prior to the intercept.[3]

Of the 376 people who returned a survey, 229 were either on a daytrip, had taken a daytrip earlier in the season, or were planning to take a daytrip later in the season. Of the 229, five reported having taken a day trip of longer than 300 miles. We decided to exclude these from the analysis. It is difficult to believe that a single round-trip daytrip of 600 miles (10 to 12 hours) plus time for birding is possible. Table 1 shows a frequency distribution of trips by distance. Over half of the households travel more than 150 miles for a daytrip. Table 2 show the median distance traveled per household by the number of trips taken.

Travel Cost Model in Negative Binomial Form

We estimated our travel cost model in a negative binomial form. Each household i's probability of taking x_i trips during the season *correcting for on-site sampling* is given by

$$pr(x_i|x_i > 0) = x_i \cdot \frac{\Gamma\left(x_i + \alpha^{-1}\right)}{\Gamma\left(x_i + 1\right) \cdot \Gamma\left(\alpha^{-1}\right)} \cdot \left(\alpha^{x_i}\lambda_i^{x_i-1}\right) \cdot (1 + \alpha\lambda_i)^{-(y_i+\alpha^{-1})}, \quad x_i = 1, 2, \ldots. \tag{1}$$

where Γ is a gamma distribution.[4] The parameter $\alpha \geq 0$ is a measure of dispersion. A large α indicates observations are over-dispersed with respect to the Poisson model. In some applications α is allowed to vary across respondents introducing heterogeneity. In our

Table 1
Distance traveled by household

Distance traveled one-way (miles)	Number of households	Cumulative percent of sample
< 10	10	4
10–20	15	11
21–40	13	17
41–50	16	24
51–80	17	32
81–100	13	38
101–150	24	48
151–200	31	62
201–300	85	100
Total	224	—

Table 2
Median distance traveled by number of trips taken[1]

Number of trips	Median distance traveled one-way (miles)
1	201
2	185
3	109
4	83
5	67
6	97
7	57
8	76
9	46
10	94
11	74
12	74
13–14	60
15–19	24
20–30	19
31–41	20

[1]Our 224 respondents took 905 trips.

model it is fixed. The expected number of trips taken by household i is given by λ_i in this model and has the form

$$E(x_i) = \lambda_i = \exp\left(\beta_{tc} tc_i + \beta_{tcs} tcs_i + \beta_z z\right). \quad (2)$$

Equation (2), in effect, serves as our travel cost recreation demand function where tc_i is the trip cost of traveling to a birding site on the Delaware Bay, tcs_i is the trip cost of reaching a site on the New Jersey side of the Delaware Bay which serves as our substitute site, and z_i is a vector of individual characteristics believed to influence a household's decision to take a birding trip.

We defined trip cost as the sum of round trip travel and time cost. It has the following form

$$tc_i = (.20 \cdot dist_i) + \left(v.\frac{income_i}{2040} \cdot time_i\right) \quad (3)$$

where $dist_i$, is the round trip distance to the birding sites, $time_i$, is the round trip time to the sites, and $income_i$, is household income. We let $v = 0, .33, \text{and} 1$ for sensitivity analysis on the value of time. Given the measurement uncertainty and importance of trip cost, we felt sensitivity analysis would be important in any applications that might use these values. We used Google Maps© to calculate time and distance and we used the site where the household was intercepted as the destination site in this calculation. For travel cost, we used the Automobile Association of America's (AAA) cost of operating a vehicle in the summer of 2008 (20 cents/mile).[5] We use household income divided by the number of working hours in a year (2040) as a proxy for wage and then one-third of that wage as a proxy for opportunity cost of time. The substitute site price was calculated in the same way for each household. We used Reeds Beach in New Jersey as the substitute. Reeds Beach is one of the largest and most popular sites in New Jersey for viewing shorebirds including the Red Knot.

The vector z_i includes household income and a set of variables intended to capture intensity of interest in birding. This includes the current market value of birding equipment owned, membership in a birding club, and whether or not the respondent made a trip to view the wood sandpiper. In May of 2008, the wood sandpiper was spotted on the Delaware coast, making this its third appearance in the United States since 1907. The Wood Sandpiper is typically found in Siberia and parts of Australia, so its presence in the Delaware Bay area was extremely rare. Of all the birders we intercepted, we thought that birders who made a specific trip to see this species might be among the more avid birders. We present descriptive statistics for all of the variables used in the model in Table 3.

Consumer surplus (or access value) per season (CS_i) and per trip (cs_i) in this model are given by

$$CS_i = \frac{\hat{\lambda}_i}{\hat{\beta}_{tc}} \text{ and } cs_i = \frac{\hat{\lambda}_i}{\hat{\beta}_{tc}} \frac{1}{\hat{\lambda}_i} = \frac{1}{\hat{\beta}_{tc}} \tag{4}$$

where $\hat{\lambda}_i$ and $\hat{\beta}_{tc}$ are estimates from the model. $\hat{\beta}_{tc}$ is the parameter estimate on trip cost.[6]

Results and Conclusions

Our estimation results are shown in Table 4 using time costs at zero, one-third, and full wage. As expected, the coefficient on trip cost was negative and statistically significant in all models. The coefficient on trip cost to the substitute site was positive but insignificant. Two of the three birding intensity variables, viewing the wood sandpiper and the market value of household birding equipment, had positive and significant coefficients. Club

Table 3
Summary of the variables used in the econometric model ($n = 224$)

Variable	Mean	*SD*	Description
Day Trips	4.04	5.20	Visit on which a person leaves and returns home on the same day
Trip Cost	\$115.38	109.78	Round trip travel plus time cost using 1/3 wage. See Equation 3. (2008\$)
Substitute Site Trip Cost	\$204.55	109.83	Round trip travel plus time cost using 1/3 wage. See Equation 3. (2008\$)
Membership in a Birding Club	0.55	0.50	1 = yes, 0 = no
Made a Trip to View the Wood Sandpiper	0.13	0.34	1 = yes, 0 = no
Household Income	\$106,508	65,512	2008\$
Equipment Value	\$3,914	6,422	2008\$

Table 4
Estimation results for negative binomial model correcting for on-site data collection (*t*-statistics in parenthesis)

	Model with value of time set = 0	Model with value of time = 1/3 wage	Model with value of time = Full wage
Trip Cost	−0.0316 (7.9)	−0.0157 (6.6)	−0.00704 (5.6)
Substitute Site Trip Cost	0.0015 (0.6)	0.0003 (0.2)	−0.0002 (0.2)
Bird Club	−0.051 (0.3)	−0.131 (0.7)	−0.204 (1.1)
View Wood Sandpiper	0.544 (2.4)	0.527 (2.2)	0.550 (2.3)
Income ($10,000)	−0.0226 (1.5)	0.035 (1.7)	0.056 (2.2)
Equipment ($1,000)	0.052 (3.6)	0.054 (3.3)	0.053 (3.0)
Constant	0.448 (0.7)	−0.766 (0.5)	−3.23 (0.2)
$\ln(\alpha)$	1.323 (1.7)	2.230 (1.5)	4.598 (0.3)
Log-Likelihood	−444.37	-452.15	−458.52
χ^2	132.09	105.23	86.15
Sample Size	224	224	224
Per Trip Per Household Access Values (2008$)	$31.65	$63.69	$142.05
95% CI rounded	($18−45)	($39−94)	($86−221)
Per Trip Per Household Access Values From Same Model estimated without Covariates (2008$)	$39.17	$86.13	$215.39
95% CI rounded	($31−48)	($63−110)	($105−325)

membership, on the other hand, was statistically insignificant. Income was also a poor predictor of choice as is often the case in recreation demand models. Our parameter estimates for ln(α) also suggest that our data had some over-dispersion but the statistical significance is not large.[7]

Table 4 also presents the welfare estimates along with sensitivity analysis over opportunity cost of time and inclusion of covariates. Using one-third of the wage instead of the full wage gave welfare estimates (access values) that are 45% of the full wage values. Using no time cost gave estimates that are 22% of the full wage value. The exclusion of covariates from the model caused values to increase by 23% in the no-wage model, 35% in the 1/3 wage model, and 52% in the full wage model. The trip cost coefficient in all cases dropped by more than we had anticipated. This implies that we are controlling for some important influences in our covariate selection and that some are correlated with trip cost. Our final values range from \$32 to \$215/trip/household. If one accepts 1/3 the wage as the appropriate measure for the value of time, as seems to be the norm in the literature, our best estimate is \$64/trip/household (or about \$262/season/household).

Rosenberger and Loomis' (2001) value for wildlife viewing converted to 2008\$ ranges from \$3 to \$221/trip/person with a mean of \$41. Our estimated values (after adjusting from household to person) range from \$19 to \$130/trip/person.[8] Using 1/3 the wage and the model with all covariates, our best estimate is \$38/trip/person. All wildlife viewing, of course, is not the same. It varies by place, time, and type of wildlife. Methods and data used in the studies are quite variable. Nevertheless, our results are some validation for their widely used estimates. Our results also highlight the importance of the value of time and covariates a researcher chooses to include in a model. The former is well known, the latter less so.

Finally, in a companion study covering the same sample of users we ask a simple contingent valuation question: "Suppose the cost to you to make this trip possible had been \$XX more than it actually cost. Would you still have made this trip?" The best estimate of the value of a day trip from that study was \$40–\$60 per person (Myers, Parsons, & Edwards, 2010). So, our travel cost estimates are on the lower end of that range. We also predicted total visitation for a season in that analysis at about 3,363 households (or 5,583 persons). This gives and annual birdwatching use value using the travel cost model of \$215,000. This estimate, of course, ignores nonuse values and values related to other uses of the resource.

Notes

1. See http://www.ceoe.udel.edu/horseshoecrab/Shorebird/index.html for more on the horseshoe crab/shorebird migration.
2. We chose to focus on daytrips to avoid the complications of multiple-purpose trips, calculation of overnight expenses, and endogenous on-site time (different number of days by different respondents).
3. The numbers reported here vary somewhat from those reported in Table 3 because they pertain to the entire day and overnight trip sample. Table 3 pertains to the observations used in estimation.
4. This is the NB2 version of the Negative Binomial (see Cameron and Trivedi, 1998, p. 70). We used STATA code from Hilbe and Martínez-Espiñeira (2005) to estimate our model.
5. Our estimate of travel cost includes gas plus half of the AAA depreciation costs. These are incremental costs associated with the trip. Our use of half of the depreciation costs is arbitrary but using the full depreciation would be in error since some is due simply to aging. Our data are from http://www.aaaexchange.com/Assets/Files/20084141552360.DrivingCosts2008.pdf
6. See Englin and Shonkwiler (1995, p. 109) for compensating and equivalent variation measures.

7. We also estimated our model in Poisson form and considered versions of both Poisson and Negative Binomial that ignored truncation and on-site sampling and that accounted for truncation but ignored on-site sampling. Since our reported model clearly dominates all of these, they were not included here.
8. Average household size was 1.66 in our sample.

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