Report 367
July 2023

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—Ronald G. Prinn,
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JULY 2023

Quantifying the recreation use value of New England natural lands

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Abstract: It is well recognized that natural land is of great importance, and measures of the value of natural lands are required when making data-driven policy decisions between land development and land preservation. One of the most important values of natural land areas is the recreational services provided. In this study, we apply the travel cost method to estimate the recreation use value provided by the natural land in New England. Specifically, this study calculates the total consumer surplus for hunting, fishing, and wildlife-watching in the New England region. We also investigate whether and how people from households of different race and surroundings have different recreational habits. Using data from the National Survey of Fishing, Hunting, & Wildlife-Associated Recreation, we found that New England natural lands provide a remarkable amount of recreation use value—$88 billion per year to U.S. citizens who partake in wildlife-related activities, accordingly to the travel cost method. Our estimates can serve as input for economic projection and policy analysis models and allow more equitable and appropriate data-driven policy decisions.

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"There is a delight in the hardy life of the open. There are no words that can tell the hidden spirit of the wilderness that can reveal its mystery, its melancholy and its charm. The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value." (Roosevelt, 1910).

1. Background

It is well recognized that natural land is invaluable, both for the survival and prosperity of humanity, and for the maintenance of all terrestrial ecosystems (Food and Agriculture Organization of the United Nations & United Nations Environment Programme, 1992). Nonetheless, it is necessary to have an estimated measure of the value of natural lands when making policy decisions between land development and land preservation. One of the most important values of natural land areas is the recreational services provided, yet assessing this use can be challenging. In this study, we estimate the recreation use value of New England natural lands using the travel cost method.

The travel cost method is the most widely used method for valuing recreation uses of the environment (Parsons, 2003). This method was first suggested by Hotelling (1949) and later by Clawson (1959). It creates a demand model that relates the number of recreational trips with trip cost and other variables. This demand model can be used to calculate the difference between a person's total willingness to pay and the actual amount they paid (this difference is called the consumer surplus), which quantifies the value provided by the environment. The travel cost method has been applied extensively to estimate the recreation use value of individual recreation sites. In this study, we apply the travel cost method to estimate the recreation value provided by the natural land in a whole region. While we concentrate on the New England region, the same approach used in this study can be used for other regions as well.

2. Data

This study uses national survey data provided by the U.S. Census Bureau. The National Survey of Fishing, Hunting, & Wildlife-Associated Recreation (FHWAR) reports results from interviews with U.S. residents about their fishing, hunting, and wildlife-watching activities (U.S. Census Bureau, 2016). These data provide information on the number of participants, their personal information (e.g., household income, home region, age, race, sex, and education), where and how often they participated, the type of wildlife encountered, and the expenditures on wildlife-related recreation. Respondents were chosen from U.S. residents who were 16 years of age or older. All data is anonymous and publicly available.

The survey is conducted periodically, and the latest available data is from 2016. In the 2016 survey, the data are divided into two datasets: FH3 for fishing and hunting, and FH4 for wildlife-watching. Each dataset contains approximately 4000 respondents. In the datasets, each respondent has a sample weight that reflects the inverse of their probability of selection. Intuitively, the weight can be viewed as the number of population members this sample case represents (U.S. Census Bureau, 2019). Thus, to estimate the national or regional total of a quantity of interest, we can calculate the weighted total of the quantity of the sample points. For example, to estimate the total number of trip days to a site by everyone in the U.S., we sum up the product of each respondent's number of trip days to that site and their weight.

In the FHWAR survey, the U.S. states are grouped into nine divisions: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific (later we also refer to them as regions 1 through 9 in the above order). In this study, we focus on the New England division.

3. Methodology

The travel cost model is widely used to value recreational uses of the environment. Estimates of value from the model are commonly used in benefit-cost analyses and in natural resource damage assessments where recreation values play a role. For example, it may be used to value the recreation loss associated with a beach closure due to an oil spill or to value the recreation gain associated with improved water quality on a river (Parsons, 2003). Since the model is based on observed behavior, it is used to estimate use values only. Parsons (2003) gives a clear introduction to the travel cost method. Parsons (2003) also cites Sohngen, Lichtkoppler, and Bielen (1999) as an example of a practical application of the travel cost method. Our description of the travel cost approach closely follows these papers.

The travel cost model is useful when the goal is to estimate the total use or 'access value' of recreational services. It is a demand-based model for the use of recreation sites. The travel cost model works like a conventional downward-sloping demand function. The 'quantity demanded' for a person is the number of recreational trips taken in a year and the 'price' is the cost of a trip. The access value is the total consumer surplus under the demand function, or the difference between a person's total willingness to pay for trips and the actual trip cost incurred over a year.

This study seeks to calculate the total consumer surplus for hunting, fishing, and wildlife-watching in the New

England region. In the end, estimates of consumer surplus can provide guidance to policymakers on the value users place on these recreational resources, providing a rationale for protecting them.

3.1 The Model

In most modern travel cost model applications, the model is estimated as a count data model because the dependent variable (number of trips) is a nonnegative integer. The most common count data travel cost model is a Poisson regression, which is the model we use in this study. The probability of an individual taking *r* trips in 2016 to the New England region is

$$\Pr(r) = \frac{\exp(-\lambda)\cdot\lambda^{r}}{r!} \quad (1)$$

The parameter λ is the expected number of trips. To ensure λ is positive, λ is assumed to a log-linear form

$$ln(\lambda) = \beta_{tc}tc + \beta_{h}h + \beta_{z}z\ , \quad (2)$$

where *tc* is a person's average trip cost. Like any demand function, one expects a negative relationship between quantity demanded (trips *r*) and price (trip cost *tc*); that is, β_{tc} is expected to be negative. Next, *h* represents a person's home division (the division they reside in). In a typical travel cost method application, to model the number of trips to a recreational site, trip costs to alternative sites are included as one of the explanatory variables. This variable cannot be derived from our data. Hence, in this paper, we use the home division variable to account for trip costs to alternative regions. In addition, *z* is a vector of demographic variables hypothesized to influence the number of trips.

3.2 Average Trip Cost

A person's total travel cost in 2016 has two components: their expenditures related to their excursion (e.g., transportation, equipment, lodging), and the opportunity cost of time.

3.2.1 Expenditures

In the FHWAR datasets, expenditures are categorized into trip-related expenditures and equipment and other non-trip related expenditures. Trip-related expenditures encompass money spent on lodging, food, transportation, fees, and rentals. Examples of equipment and other non-trip related expenditures may include rifles for hunting, rods for fishing, and binoculars for wildlife-watching, along with the amount paid for off-the-road vehicles (such as snowmobiles, trail bikes, and dune buggies) in 2016. For trip-related expenditures, the datasets provide each respondent's expenses at each region. Hence, we can calculate the total expense incurred in New England for this study. However, for equipment and other non-trip related expenditures, the datasets only provide the division where each equipment was purchased, not where the equipment was used. Therefore, we allocate the equipment cost proportionally to different regions according to the number of trip days a respondent spent in each region.

3.2.2 Opportunity Cost of Time

A person's opportunity cost of time is calculated by multiplying the average American daily wage (or a fraction of it) and their total number of trip days. Data on the average American daily wage in 2016 is provided by the Social Security Administration (SSA, 2016). According to Parsons (2003), in wage-based applications, it is common to use some fraction of the imputed wage used to value time, anywhere from ⅓ of the wage to the full wage, as the value of time. The recreation literature has more or less accepted ⅓ as the lower bound and the full wage as the upper bound (De Steiguer, n.d.; Sohngen, Lichtkoppler, & Bielen 1999). In this study, the fraction of daily wage taken into account is one. However, we also present the results for different values of this fraction in the Appendix for a sensitivity analysis.

Finally, a person's average cost per trip is calculated by dividing their total cost in 2016 by the number of trips they took in 2016.

3.3 Model Estimation

Once the Poisson regression model and explanatory variables are specified, we can estimate the model coefficients using the glm (generalized linear model) function in R. In this study, we treat each recreational service (wildlife-watching, hunting, and fishing) separately, meaning that we estimate models for each service. When using the glm function to fit our model, we input the following:

```
glm(New_England_trips ~ New_England_cost +
factor(homeregion), family="poisson", data=ne,
weights=wt)
```
(3)

This study also estimates extended models that include the demographic variables mentioned earlier.

3.4 Total Consumer Surplus

Once the model coefficients are estimated, the average consumer surplus per trip (*t*) can be estimated by (equation 16 in Parsons, 2003)

$$\hat{t} = \frac{1}{-\hat{\beta}_{tc}}\ , \quad (4)$$

where β_{tc} is the estimated coefficient of the average trip cost variable in our model shown by equation (2).

To arrive at an aggregate consumer surplus for the New England region, we multiply the average consumer surplus per trip by the total number of trips taken to the region during 2016 by everyone in the U.S., which is estimated by the weighted total number of trips by everyone in the sample survey. This gives the total consumer surplus of recreational services in the New England region.

4. Data Summary

As shown in **Table 1**, the majority of the people in our samples did not take a recreational trip to New England in 2016. Only around 4% of people in the sample made at least one wildlife-watching trip to the region. Similarly, about 2% of the people in the sample made at least one hunting trip to the region, and about 5% made at least one fishing trip. In the following tables and scatter plots, we concentrate on the population who has made at least one recreational trip to New England in 2016.

Table 2 gives the estimated total number of people in the U.S. who made recreational trips to New England from different regions. These values are derived from the sample by summing up all of the weights of the respondents who have taken at least one trip to New England. Table 2 also gives the estimated total number of recreational trips to the New England region by different home regions. As expected, people who reside in New England take more recreational trips to New England than people from other regions. The long dashes in the table indicate that there was no one in the sample from that region that made trips to the New England region. The sample did not include anyone from the West North Central region, the East South Central region, the Mountain region, and the Pacific region that made any recreational trips to New England.

Additional data summary tables that give the estimated total number of people in the U.S. who made recreational trips to New England and their total number of trips, broken down by race and by the population density of their home location, are given in the Appendix.

Figure 1, **Figure 2**, and **Figure 3** present scatter plots with the relationship between the number of trips and average trip cost for the three different types of recreational activities (wildlife-watching, hunting, and fishing). In all of the three cases, we can observe a negative correlation between the number of trips and trip cost.

Table 1. The number and percentage of people in our samples who took at least one trip to New England (NE).

	Total samples	Visited NE	
		Number	% of total
Wildlife-watching	4018	159	3.96%
Hunting	3949	63	1.60%
Fishing	3949	211	5.34%

Table 2. The estimated number of people in the U.S. who made recreational trips to New England and the total number of trips they took, broken down by home region.

Home Region	Total Number of People (and Trips) in Thousands		
	Wildlife-watching	Hunting	Fishing
New England	1295.5 (18578.9)	267.5 (4764.3)	1262.4 (16863.2)
Middle Atlantic	66.7 (93.5)	–	53.5 (115.3)
East North Central	–	–	30.8 (30.8)
South Atlantic	128.5 (237.7)	–	48.2 (258.5)
West South Central	–	–	34.9 (34.9)

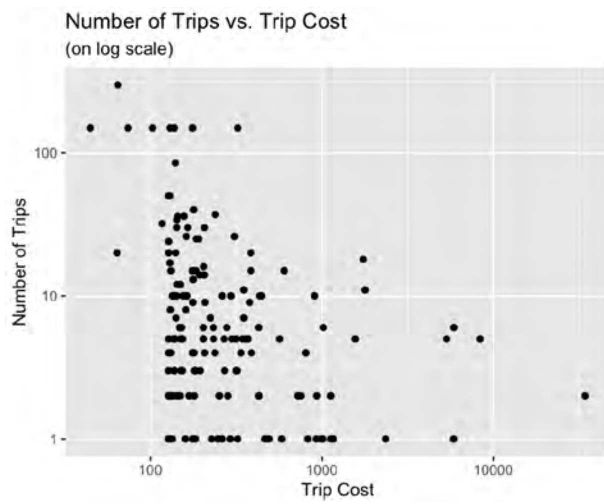

Figure 1. Scatter plot of the number of wildlife-watching trips vs. trip cost.

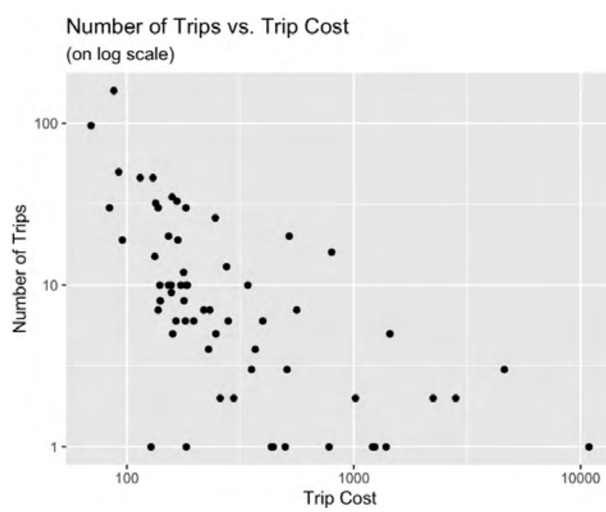

Figure 2. Scatter plot of the number of hunting trips vs. trip cost.

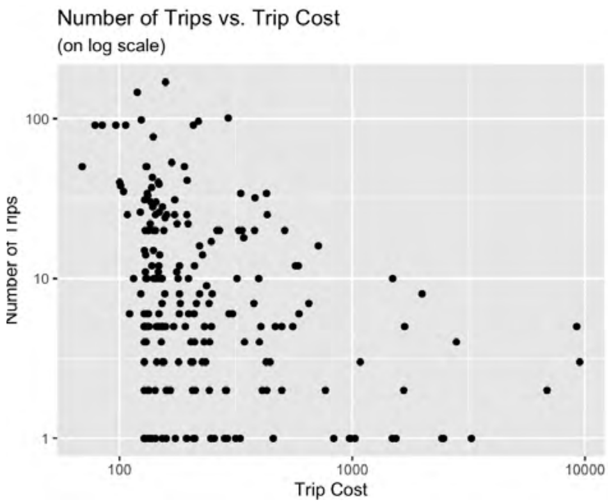

Figure 3. Scatter plot of the number of fishing trips vs. trip cost.

5. Results and Discussion

In a travel cost model, the main explanatory variable of interest is the trip cost. Trip costs to alternative sites are also typically included. In our model, we use a respondent's home region to account for trip costs to alternative regions. Thus, our base model has trip cost and home region as explanatory variables. We also look at extended models that include demographic variables believed to influence the number of trips taken. The demographic variables we include are helpwild (whether the respondent maintained any natural areas around their home for the primary purpose of benefiting fish or wildlife), race (coded as 1 for White, 2 for Black or African American, 3 for American Indian or Alaska Native, 4 for Asian, and 5 for Native Hawaiian or Other Pacific Islander), and population density (urban or rural). The household income variable is not included in our models because approximately 18% of the respondents in our datasets do not have valid input for the variable.

5.1 Wildlife-watching

The results for wildlife watching in the New England region are summarized in **Table 3**.

In Table 3, Model A is the base model, with explanatory variables trip cost and home region. Model B is an extended model of Model A, with the additional variable of helpwild. Model C further takes into account the variable of race, and Model D adds on the variable of population density. As we can observe, the estimated coefficients of the explanatory variables are relatively stable throughout the models. Additionally, all variable coefficients are highly significant.

In the wildlife-watching sample, only respondents from New England, Middle Atlantic, and South Atlantic participated in wildlife-watching in the New England region. Hence, only regions 2 (Middle Atlantic) and 5 (South Atlantic) show up in Table 3. Region 1 (New England) serves as the base region in the model in which other home regions are compared to. Hence, it is not surprising that the coefficients of other home regions are negative; this means that the people living outside of New England take less wildlife-watching trips to the region compared to the people who live within it.

As shown in Table 3, the coefficient of helpwild 1 is consistently greater than the coefficient of helpwild 0 across Models B to D (there are a small number of missing values for the helpwild variable, which is why both helpwild 0 and helpwild 1 show up in the models' estimates), indicating that people who actively strive to benefit wildlife generally make more wildlife-watching trips.

Table 3. Wildlife-watching: The estimated coefficients of the base model (Model A) and the extended models (Models B, C, and D).

	Model A	Model B	Model C	Model D
Intercept	2.738e+00 ***	1.650e+00 ***	1.643e+00 ***	1.654e+00 ***
Trip cost	-2.617e-04 ***	-3.100e-04 ***	-2.676e-04 ***	-3.331e-04 ***
Home region 2	-1.946e+00 ***	-2.018e+00 ***	-2.107e+00 ***	-2.133e+00 ***
Home region 5	-1.874e+00 ***	-2.115e+00 ***	-2.163e+00 ***	-1.844e+00 ***
Helpwild 0	–	1.065e+00 ***	1.157e+00 ***	1.067e+00 ***
Helpwild 1	–	1.472e+00 ***	1.465e+00 ***	1.142e+00 ***
Race 2	–	–	-1.584e+00 ***	-1.483e+00 ***
Race 3	–	–	-5.651e-02 ***	2.241e01 ***
Race 4	–	–	-4.612e-01 ***	-3.726e-01 ***
Rural	–	–	–	6.228e-01 ***
Total consumer surplus	$72,269,237,908	$61,002,206,166	$70,657,819,715	$56,765,835,681
Signif. codes: *** 0.001 ** 0.01 * 0.05				

The coefficients of the race variables in Table 3 are negative, with race 1 (White) as the base category. This means that compared to white people, people of other races are less likely to participate in wildlife-watching in the New England region.

For population density, the coefficient of rural is positive. This indicates that rural residents are more likely to use wildlife-watching services than urban residents.

Because all of the variable coefficients are highly significant throughout the models in Table 3, we can focus on the most complete model, Model D, when estimating the total consumer surplus. In this model, the variable of most interest to us, trip cost, has an estimated coefficient of -3.331e-04 with a standard error of 5.730e-07; this coefficient is highly significant with p-value less than 0.001. As explained earlier, we can use equation (4) to calculate the average consumer surplus per trip and subsequently derive the total consumer surplus. Hence, given the estimates in Model D, the estimated total consumer surplus for wildlife-watching in New England comes out to be about $57 billion.

5.2 Hunting

The results for hunting in the New England region are summarized in **Table 4**.

Table 4. Hunting: The estimated coefficients of the base model (Model A) and the extended model (Models B).

	Model A	Model B
Intercept	3.938e+00 ***	3.293e+00 ***
Trip cost	-4.449e-03 ***	-3.898e-03 ***
Rural	–	6.356e-01 ***
Total consumer surplus	$1,070,878,713	$1,222,103,296
Signif. codes: *** 0.001 ** 0.01 * 0.05		

In the hunting sample, only respondents from New England hunted in the New England region. Therefore, the variable home region is not included in the models in Table 4. Similarly, in our hunting sample, only people of race 1 (White) had made hunting trips in New England. Thus, the variable race is also not included in the models. Next, the hunting survey does not include a helpwild variable, so our explanatory variables are only trip cost and population density.

In Table 4, Model A is the base model, with the explanatory variable trip cost. Model B is an extended model of Model A, with the additional variable of population density. Because all variable coefficients are highly significant throughout the models, we can focus on the most complete model, Model B, when estimating the total consumer surplus. In this model, the variable of most interest to us, trip cost, has an estimated coefficient of -3.898e-03 with a standard error of 4.887e-06; this coefficient is highly significant with p-value less than 0.001. Thus, given the estimates in Model B, the estimated total consumer surplus for hunting in New England comes out to be about $1.2 billion.

5.3 Fishing

The results for fishing in the New England region are summarized in **Table 5**.

In the fishing sample, only respondents from New England, Middle Atlantic, East North Central, South Atlantic, and West South Central fished in the New England region. Hence, only regions 2 (Middle Atlantic), 3 (East North Central), 5 (South Atlantic), and 7 (West South Central) show up in Table 5. Region 1 (New England) serves as the base region in the model in which other home regions are compared to. Not surprisingly, the coefficients of other home regions are negative; this means that the people living

Table 5. Fishing: The estimated coefficients of the base model (Model A) and the extended models (Models B and C).

	Model A	Model B	Model C
Intercept	2.749e+00 ***	2.656e+00 ***	2.774e+00 ***
Trip cost	-6.075e-04 ***	-5.078e-04 ***	-5.764e-04 ***
Home region 2	-1.337e+00 ***	-1.298e+00 ***	-1.379e+00 ***
Home region 3	-2.158e+00 ***	-2.162e+00 ***	-2.213e+00 ***
Home region 5	-5.750e-01 ***	-5.580e-01 ***	-6.090e-01 ***
Home region 7	-2.471e+00 ***	-2.423e+00 ***	-2.510e+00 ***
Race 2	–	-6.432e-02 ***	-1.683e-01 ***
Race 3	–	8.207e-01 ***	8.385e-01 ***
Race 4	–	-4.752e-02 ***	-1.387e-01 ***
Rural	–	–	-3.114e-01 ***
Total consumer surplus	$28,481,184,708	$34,074,325,786	$30,018,225,196
Signif. codes: *** 0.001 ** 0.01 * 0.05			

outside of New England take less fishing trips to the region compared to the people who live within it.

In Table 5, Model A is the base model, with explanatory variables trip cost and home region. Model B is an extended model of Model A, with the additional variable of race. Model C further takes into account the variable of population density. As we can observe, all of the variable coefficients are highly significant.

As shown in Table 5, the coefficients of race 2 and race 4 are negative, with race 1 (White) as the base category. This means that compared to white people, people of race 2 (Black or African American) and race 4 (Asian) are less likely to participate in fishing in the New England region. On the other hand, the coefficient of race 3 is positive, indicating that American Indians and Alaska Natives are more likely to partake in fishing trips.

Because all of the variable coefficients are highly significant throughout the models in Table 5, we can focus on the most complete model, Model C, when estimating the total consumer surplus. In this model, the variable of most interest to us, trip cost, has an estimated coefficient of -5.764e-04 with a standard error of 1.097e-06; this coefficient is highly significant with p-value less than 0.001. Hence, given the estimates in Model C, the estimated total consumer surplus for fishing in New England comes out to be about $30 billion.

6. Conclusion

One important source of the values provided by natural land areas is the recreational services. Using FHWAR data from the U.S. Census Bureau, we were able to estimate the recreation use value of New England natural lands. The travel cost method was applied to estimate the value provided by wildlife-watching, hunting, and fishing. Our results, based on this survey, show that the total consumer surplus for these recreation services was around $88 billion in 2016 (as noted in the Appendix, if we change the wage fraction used to calculate the opportunity cost of time, this estimate ranges from $56 billion to $88 billion). While we concentrated on the New England region in this study, the same approach used in this study can be used for the other regions of the United States as well. This will be done in future research.

The values presented in this paper are consumer surplus, which is the economic value above and beyond the actual dollars spent while recreating. Recreational value is an important component of overall economic value because it represents quality of life and leisure considerations rather than expenditures alone. Policymakers should take these values into account in order to make more equitable and appropriate data-driven policy decisions for the New England region.

It is worth noting that the value provided by natural land areas is not limited to the recreation use value studied in this paper. The value also encompasses other use values such as the value of market commodities (e.g., timber) and the option value (the willingness to pay by a person to guarantee that a resource would be available should they choose to use it in the future). Meanwhile, natural lands additionally have non-use values such as the bequest value (willingness to pay by a person so that a resource might be passed onto future generations) and the existence value (willingness to pay by a person so that a resource will continue to exist today even if he/she never uses the resource), (De Steiguer, n.d.). Forests and natural lands are also a stock of carbon kept out of the atmosphere, are stocks of biodiversity and provide important ecosystem services such as controlling erosion and helping to retain water on the land and in rivers, streams, and aquifers.

According to a report by Wildlands, Woodlands, Farmlands and Communities, the estimated cumulative federal and state contributions to land conservation in New England totaled approximately $973 million during the years 2004 to 2014 (Buchanan, 2016). This meager amount is dwarfed by the tremendous amount of value provided by natural land areas (as studied in this paper); therefore, it is clear that funding used for the maintenance of natural lands is well spent, and that policies regarding the funding of land preservation efforts should take the large recreational value of natural lands into account.

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APPENDIX A: Additional Data Summary Tables

Table A1 gives the estimated total number of people in the U.S. who made recreational trips to New England and their total number of trips, broken down by race. Next, **Table A2** gives the estimated total number of people in the U.S. who made recreational trips to New England and their total number of trips, broken down by different population densities (urban or rural).

Table A1. The estimated number of people in the U.S. who made recreational trips to New England and the total number of trips they took, broken down by race.

Race	Total Number of People (and Trips) in Thousands		
	Wildlife-watching	Hunting	Fishing
White	1329.9 (18062.0)	267.5 (4764.3)	1265.2 (14156.8)
Black or African American	128.0 (397.0)	–	10.3 (124.1)
American Indian or Alaska Native	25.9 (382.0)	–	71.2 (2117.1)
Asian	6.9 (69.0)	–	83.1 (904.7)

Table A2. The estimated number of people in the U.S. who made recreational trips to New England and the total number of trips they took, broken down by population density.

Population Density	Total Number of People (and Trips) in Thousands		
	Wildlife-watching	Hunting	Fishing
Urban	1280.6 (14206.7)	68.9 (513.9)	1005.6 (12466.0)
Rural	210.0 (4703.3)	198.6 (4250.4)	424.3 (4836.7)

APPENDIX B: Results for Different Values of Wage Fractions

When calculating the opportunity cost of time, it is common to use some fraction of the imputed wage used to value time. Anywhere from ⅓ of the wage to the full wage has been used as the value of time in recreation literature. While we use the full wage in our analysis, we present in **Table B1** the results for different fractions of wage as a sensitivity check.

It can be observed that as the wage fraction used increases from ⅓ to one, the consumer surplus estimate for wildlife-watching increases considerably from $19.0 billion to $56.8 billion, whereas for hunting and fishing, the consumer surplus estimates stay relatively stable. This is due to the different proportions of the opportunity cost of time in the total cost for the different types of recreational activities. In total, the consumer surplus ranges from $55.8 billion to $88.0 billion for wage fractions from ⅓ to one.

Table B1. The estimated consumer surpluses (in billions of dollars) calculated with different wage fractions.

	Wage fraction		
	⅓	⅔	1
Wildlife-watching	19.0	35.7	56.8
Hunting	1.8	1.4	1.2
Fishing	35.0	31.6	30.0
Total	55.8	68.7	88.0

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