Measuring the Economic Value of Marine Recreational Angling: the U.S. Approach

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Abstract. The United States has been collecting supplemental economic information in addition to biological catch and effort data from saltwater recreational anglers. This supplemental information was collected to enable the estimation of travel cost models of recreation demand. This paper will discuss in detail the data that is available and the standard modeling approaches that can be undertaken given the data. Some results from the economic valuation surveys will be presented in order to characterize the types of information that can be learned from surveying recreational anglers.

Keywords: Recreational Angling Surveys, Recreational Valuation, Welfare Measurement, Recreational Angling, Random Utility Model.

Introduction[ii]

The economic value and economic impact of marine recreational fisheries in the United States is significant — how significant has been an issue of concern for the Agency and its constituents for many years because neither the data nor the appropriate analyses to measure them were available. The National Marine Fisheries Services' (NMFS) efforts over the last 6 years were meant to remedy this deficiency. The intent of the program is to continue a systematic collection and analysis of marine recreational economic data to support the assessment, implementation and monitoring of sustainable fisheries policies by collecting data on marine anglers from all coasts of the continental United States. This data will help provide basic estimates of the value of recreationally important fisheries (i.e., economic value). The data will be available for use in fisheries management decisions regarding allocation, changes in management strategies, (e.g., changes in bag limits) or changes in factors that affect catch rates and/or access to marine recreational species for fishing sites.

To achieve this, two rounds of surveys are being conducted in conjunction with the existing NMFS' Marine Recreational Fishing Statistics Survey (MRFSS). The first round of surveys is designed to: 1) provide baseline descriptive information on marine recreational participants (socio-demographic characteristics as well as factors that influence their fishing decisions); 2) estimate the net economic benefits of recreational fisheries, and 3) estimate the changes in net benefits to the Nation as a result of imposing or changing fishing regulations.

The second round of surveys will revisit the same regions, but will collect more data on fishing expenditures to assist the estimation of the distributional consequences of fishing regulations, and their impacts on regional economies. Data from this round will be used primarily in input/output (I/O) analyses. Table 1 shows the data collection efforts for the Northeast (NE), Southeast(SE), and the West Coast (WC).

Description of Surveys

The Marine Recreational Fisheries Statistics Survey (MRFSS)

NMFS has operated a comprehensive coast-wide survey of marine recreational anglers since 1979 through its Marine Recreational Fisheries Statistics Survey (MRFSS). The MRFSS is a

Table 1. NMFS' socio-economic data collection program for recreational fishing

	Valuation Surveys			Impact Surveys		
Year	NE	SE	WC	NE	SE	WC
1994	x					
1996	x*					
1997	x*	x				
1998	x*		x	x		
1999		x*			x	
2000			x*			x

*Denotes a short version of survey collecting minimum data elements long-term monitoring program that provides estimates of effort, participation, and finfish catch by recreational anglers. The MRFSS survey consists of two independent, but complementary, surveys: a random digit-dial telephone survey of households and an intercept survey of anglers at fishing access sites.

The intercept survey distinguishes between the mode of fishing (shore, private/rental boat, party/charter boat), and is designed to elicit information about fishing trips just completed by anglers. The basic intercept survey collects information about anglers' home zip code, the length of their fishing trip, the species they were targeting on that trip, and the number of times anglers have been fishing in the past two and twelve months. In addition to angler specific characteristics, the survey collects biological data on fish caught.

The random telephone survey is used to estimate recreational fishing effort (trips) on a two-month basis (as opposed to annual participation) for coastal households. The effort estimates are used in the economic valuation work to expand mean trip-level recreational fishing values to aggregate, population values for recreational fishing[iii].

The 1994 Northeast Economic Add-on to the MRFSS[iv]

NMFS collected additional socio-economic data from anglers in Maine through Virginia by supplementing the routine MRFSS in 1994. Economic questions were added to the intercept survey and a follow-up survey conducted over the telephone was designed to elicit additional socio-economic information from anglers who completed the add-on economic intercept survey.

The Intercept Survey

The economic field intercept survey of anglers solicited data about trip duration, travel costs, distance traveled, and on-site expenditures associated with the intercepted trip. All survey participants, with the exception of beach-bank shore anglers, must have completed their fishing for the day.

A total of 33,117 economic intercepts were attempted in the Northeast Region. Of these, 22,594 (68%) economic intercepts were fully completed. Approximately 10 percent of the surveys (3,364) were terminated because of initial refusals or because interviewees were under the age of 16. The remaining 7,151 surveys were not completed because individuals refused to answer certain key questions. Thus, an overall completion rate of 53% was achieved.

The Telephone Follow-up Survey:

The telephone follow-up survey was designed to elicit additional socio-economic information from anglers who completed the add-on economics field survey. The telephone follow-up survey also solicited data and information about anglers' recreational fishing avidity, attitudes, and experience.

A total of 14,868 follow-up surveys were attempted in the Northeast Region, of which 8,226 (55%) were completed. Refusals, wrong numbers and households that could not be reached in four calls accounted for the 45% non-response rate. More extensive details regarding the final results of the intercept or telephone follow-up surveys, as well as survey instruments, can be found in Steinback and O'Neil (1998).

Figure 1

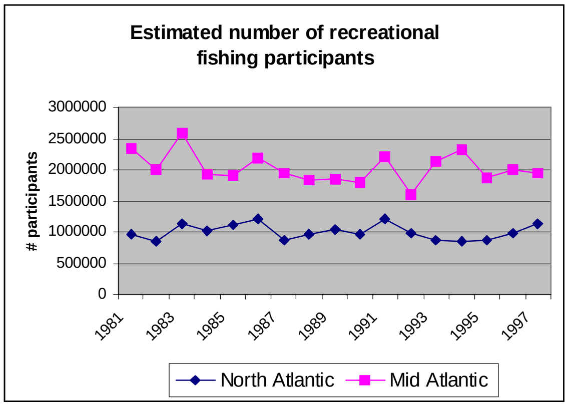
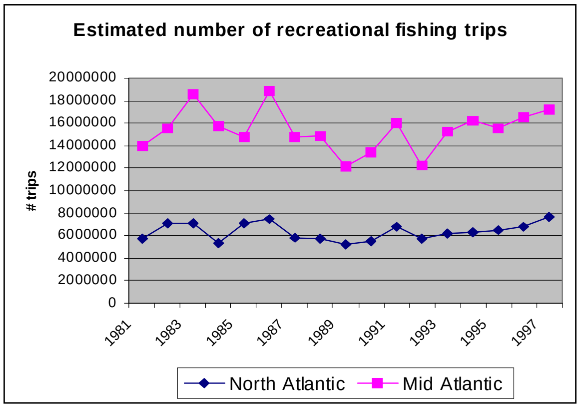


Figure 2



An overview of recreational fishing in the Northeast region

Marine recreational fishing is a popular outdoor recreational activity in the Northeast region of the U.S. In 1992, the lowest level of participation in the Northeast during the last ten years, approximately 2.57 million residents of Northeastern coastal states participated in marine recreational fishing in their own state[v]. Participation increased approximately five percent in 1993 (2.7 million) and increased another 14 percent in 1994 (3.1 million), exceeding the ten-year average of 2.9 million. However, participation in 1994 remains the highest level, for the nineteen-nineties, estimated through 1997 (Figure 1.1); after dropping 15% in 1995, the estimated number of anglers in the Northeast increased by only 8% and 3% in 1996 and 1997, respectively.

While participation has slowly increased since 1995 (Figure 1.1), the number of recreational fishing trips (Figure 1.2) increased approximately 13% between 1994 and 1997, with a high of 24.9 million trips taken in 1997. An estimated 22.5 million fishing trips were taken in 1994.

Figures 1.3 and 1.4 show the estimated number of fish caught[vi] for some important recreational species. Striped bass, scup, and bluefish were the most common recreationally caught species in 1994 in the North Atlantic. Together, these three species comprised roughly thirty percent of the total North Atlantic (Maine through Connecticut) recreational catch. In the Mid-Atlantic (New York through Connecticut), summer flounder, black sea bass, bluefish, and striped bass accounted for approximately thirty-seven percent of total recreational catches.

Measuring the value of fishing

The socio-economic surveys were designed to enable the estimation of models that yield (1) the value of access to fisheries (that is, what people are willing to pay for the opportunity to go recreational fishing in a particular area); and (2) the marginal value of catching fish (that is, what people are willing to pay to catch another fish). The models assume that anglers have decided to take a recreational fishing trip. Their next decision is what species of fish to target and which mode to use (e.g., to target striped bass from a private boat). Conditional on their species/mode choice, anglers then decide the site from which to fish. This kind of model is known as a nested random utility model (RUM) and it allows researchers to estimate the change in value to anglers when, for example, a fishing site is no longer available for fishing, or when the catch rate of a particular species changes. Estimates of the value of access by state and two-month period are provided, as are estimates of the value to anglers of a change in the catch rate for five species groups[vii].

Both pieces of information are valuable to fisheries managers. The first tells managers the worth of the recreational fishery under the current (in this case 1994) conditions, and the loss in value if fisheries were closed down for a period of time. The second piece of information tells managers how anglers will be affected by policies that change the catch rate, for example by enhancing the stock level or changing the allocation of fish between recreational and commercial fishermen. An important feature of the RUM model is that it implicitly acknowledges that anglers have substitutes and can substitute away from area closures and changes in catch rates by choosing to fish in

Figure 3.

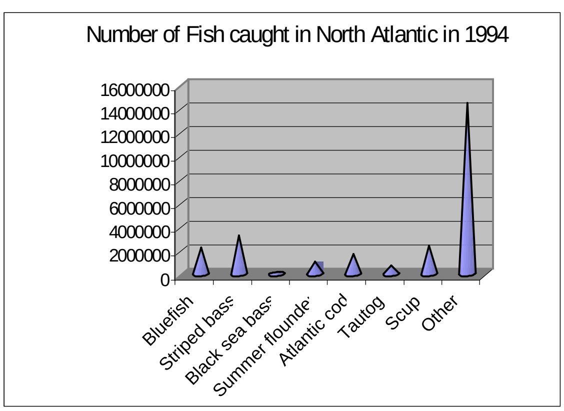


Figure 4.

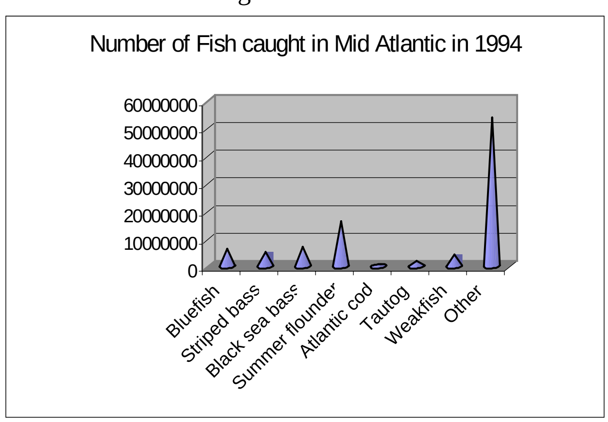


Table 2. Variables used in the analysis

Variable	**Definition**
TC	Travel Cost = $.30*distance + wage*time*interior Distance: roundtrip distance calculated from PC Miler Wage: income/2040 Interior: dummy equaling 1 if the person can work extra hours for extra pay, 0 otherwise Time: roundtrip travel time, predicted from self reported time and calculated travel time (distance/40)
TT	Travel Time = time*(1-interior)
$Q_{s,m,i}$	Expected catch for species group s, mode m, and site i
Ln(M)	Log of the number of NMFS interview sites in aggregated sites
PRDUM	Equals 1 if private/rental mode and individual owns a boat, otherwise zero
CPRDUM	Cold Private/Rental boat ownership dummy. Equals 1 if PRDUM=1 and wave=6, otherwise zero.

another area, choosing to target another species, or choosing to fish in a different mode.

The RUM as applied to the Northeast data requires a careful definition of the choice structure, which dictates the data requirements of the model. In this study, individuals are assumed to choose a mode/species to target and then conditional on that choice, they choose where to fish. Given the definition of mode, species, and sites[viii], an individual could be faced with deciding among 945 alternatives.

To properly apply the RUM model, data are needed for the actual choice made by the individual (choice of site, mode, and species) and for all other alternatives considered by the individual. Even after limiting the choice sets of individuals there are numerous alternatives open to them.

The Model

For each fishing trip, the fisherman chooses the best fishing alternative by comparing his indirect utility function for each alternative and choosing the one that maximizes his utility. Let the indirect utility function for site a, mode m, and species s be given by

$$V_{ams} = \beta z_{ams} + \gamma w_{ms} + \varepsilon_{ams}$$

The individual's indirect utility function has several components: z_{ams} is a vector of attributes that is specific to area, mode, and species, while w_{ms} contains variables which are specific to only mode and species. The indirect utility function also contains parameter vectors, β and γ, and an error component ε_{ams}. This error is part of the individual's indirect utility function not observed by the researcher. The model presented above is consistent with the nested logit model with appropriate restrictions on the error term (see Domencich and McFadden, 1975, and McFadden, 1978).

Given the nested structure of the individual's choice set, the probability of an individual choosing site *a* conditional on the mode/species choice ms is

$$P(a \mid ms) = \frac{\exp\left(\dfrac{\beta z_{ams}}{(1-\sigma)}\right)}{\sum_{b \in A} \exp\left(\dfrac{\beta z_{bms}}{(1-\sigma)}\right)}$$

The probability of choosing the mode/species combination ms is then

$$P(ms) = \frac{\exp(\gamma w_{ms} + (1-\sigma) I_{ms})}{\sum_{ij \in A} \exp(\gamma w_{ij} + (1-\sigma) I_{ij})}$$

where

$$I_{ms} = \ln\left(\sum_{b \in A} \exp\left(\frac{\beta z_{bms}}{(1-\sigma)}\right)\right).$$

The term I_{ms} is called the inclusive value for mode/species choice ms, and captures information about the sites conditional on the choice of ms.

Estimating the model

A limited information maximum likelihood technique is employed that estimates the conditional site utility model and the mode/species choice model in a sequential manner. The choice structure chosen for this analysis follows McConnell and Strand (1994). The variables used in the analysis are given in Table 2. Because there is probable heterogeneity among the different species groups, a different catch coefficient is estimated for each group. This allows the marginal utility of catching an additional fish to vary with species groups. For example, one might expect the marginal utility of catching an additional big game fish to be greater than that from catching an additional flatfish.

Also included in the utility functions are variables describing costs to the individual of participating in the recreation trip. These costs can be broken into two components: travel costs and time costs. It is hypothesized that all other things equal, an individual will choose a site with a lower travel cost. Additionally, time is valuable to individuals. By choosing to participate in a recreational fishing trip, an individual is foregoing additional wages or some other leisure activity. The specification of travel cost and travel time takes into account the opportunity cost of time, and distinguishes between those persons having a flexible work schedule (who can trade time-off for foregone wages) and those with fixed schedules (see Bockstael, Hanemann, and Strand, 1986).

The other variable in the conditional site utility model describes the number of MRFSS intercept sites contained within the aggregate sites. This variable is included to account for possible aggregation bias. All other things equal, a person may be more likely to visit a county if there are more recreation sites within that county.

Two variables are included to explain how individuals choose among the mode/species combinations. First, individuals who own boats may be more likely to choose any of the private/rental modes. This variable (PRDUM) is then interacted with a variable that indicates if the fishing activity is occurring during the cold months (November-December). This cold variable (CPRDUM) is likely to dampen the effect of owning a boat and choosing the private rental mode. The probability model also requires the estimation of an inclusive value parameter, $(1-\sigma)$, that describes how information in the

Table 3. Parameter Estimates.

Variable	**Mean of Variable**	**Estimate (t-ratio)**
Conditional Site Choice Model		
Travel Cost (Dollars)	61.84	-.036 (-10.46)
Travel Time (Hours)	3.69	-1.141 (-16.12)
Ln(M)	3.11	1.247 (33.99)
Big Game Catch	.003	.974 (2.69)
Small Game Catch	.39	.579 (8.68)
Bottomfish Catch	.19	.572 (100.68)
Flatfish Catch	.26	.665 (58.23)
Non-seeking Catch	.20	.324 (15.23)
χ^2 (all parameters=0)		2780.15
Mode/Species Choice Model		
Inclusive Value	4.90	.612 (19.99)
Private Rental Dummy	.15	2.490 (42.02)
Cold*Private Rental Dummy	.020	-.553 (-4.08)
χ^2 (all parameters=0)		2172.46

conditional site choice utility model influences the choice of mode/species. A priori, it is expected that individuals will prefer mode/species combinations with a higher expected utility from the conditional site utility model, all other things equal.

Model estimates are reported in Table 3. The signs of all of the parameters met with prior expectations. Anglers preferred sites with smaller time and travel cost components holding all other things equal. Similarly, anglers preferred sites with higher expected catch rates regardless of what species group was targeted. Only the parameter on expected big game catch is not significant at the 5% level.

Welfare estimation

The above results can be used to describe how an angler's behavior might change with an incremental change in any of the variables in the utility function given above. The flexibility of the model allows the estimation of welfare changes from policies that may close a fishery or improve the expected catch rates, for example. Welfare measures can be valuable information because they describe how potential policy measures benefit or cost recreational anglers. By considering the welfare of anglers before enacting policy measures in a fishery, managers can make informed decisions to meet biological management objectives while maximizing the net benefits to the nation, as required by law.

Two policy changes are considered in this report. First, all sites in a state are closed to measure the of all fishing sites within a state. Second, the expected catch rate is increased by 1 for all anglers to measure the marginal willingness to pay for an increase in the expected catch. Define the expected utility under situation P^t as

$$V(P^t) = \ln\left[\sum_{ij\in A}\left\{\sum_{b\in A}\exp\left(\frac{V^t_{bij}}{(1-\sigma)}\right)\right\}^{1-\sigma}\right],$$

where

$$V^t_{bij} = \beta_1 TC_b{}^t + \beta_2 TT_b{}^t + \beta_3 \ln(M_b)^t + \beta_i Q_{bij}^{1/2\,t} + \beta_4 PRDUM_{ij}{}^t + \beta_5 CPRDUM_{ij}{}^t$$

Using this notation, the welfare change from situation 0 to 1 can be written as

$$W = \frac{V(P^0) - V(P^1)}{\beta_1}.$$

The measure given above describes changes in well-being relative to other substitutes open to the individual. For example, if the person's choice set is small it is likely that closing a state will impact him significantly, and he would have a relatively large willingness to pay for fishing in the state[ix].

Table 4 shows, on average, what anglers are willing to pay for a one-day fishing trip, by state and wave. Values derived in this table were calculated for for all anglers in the NE data regardless of state of intercept. The value access value of fishing in the state; that is, what an individual fishing in the Northeast United States would be willing to pay to avoid a closure estimates do show some seasonal variation, with the highest values tending to be during the fall months. On average, Virginia had the highest

Table 4. Mean Willingness to pay for a one-day fishing trip, 1994

State	May-June	July-Aug.	Sep.-Oct.	Nov.- Dec.	Mean for All Waves	% Change in Choice Set
Virginia	$27.26	$35.12	$41.66	$86.24	$42.33	- 15%
Maryland	13.63	11.53	14.06	7.36	12.09	- 12
Delaware	1.81	1.60	0.83	1.43	1.43	- 07
New Jersey	16.68	13.54	13.73	11.84	14.12	- 13
New York	20.86	20.86	21.36	24.79	21.58	- 18
Connecticut	3.48	3.29	2.71	2.54	3.07	- 08
Rhode Island	3.82	4.51	4.73	3.42	4.23	- 08
Massachusetts	8.54	8.58	9.90	5.04	8.38	- 11
New Hampshire	1.11	1.07	0.78	0.01	0.85	- 02
Maine	7.90	8.06	6.47	0.00	6.40	- 05

willingness to pay, with New York following behind.

Table 5. Aggregate Willingness to pay for a one-day fishing trip, 1994 (Total Trips by wave x per trip access value). 1000 dollars

State Closed	May-June	July-Aug.	Sep.-Oct.	Nov.- Dec.	All Waves
Virginia	$ 144,369	$ 331,989	$ 213,841	$ 128,584	$ 904,719
Maryland	72,184	108,993	72,170	10,974	258,400
Delaware	9,586	15,125	4,260	2,132	30,563
New Jersey	88,337	127,994	70,476	17,653	301,787
New York	110,475	197,190	109,641	36,962	461,229
Connecticut	18,430	31,100	13,910	3,787	65,615
Rhode Island	20,231	42,633	24,279	5,099	90,408
Massachusetts	45,228	81,107	50,817	7,515	179,106
New Hampshire	5,879	10,115	4,004	15	18,167
Maine	41,838	76,191	33,211	0	136,787

The relative magnitude of the values in Table 4 reflect both the relative fishing quality of a state and the ability of anglers to choose substitute sites. Closures of large states will tend to lead to large welfare estimates, since anglers residing in that state may need to travel significant distances to visit alternative sites. For example, the sample of New York anglers contained a large number of people living on Long Island. These anglers incur large travel costs to fish in other states. Consequently, the value of a one-day fishing trip in New York is relatively high.

Because the valuation estimates are contingent upon the remaining substitutes in the model, there are several factors that should be considered when examining the values in Table 4. Note that Maine and Virginia have relatively high willingness to pay estimates given their relative size and fishing quality characteristics. These states define the maximum geographic boundaries for a person's choice set, a definition that is arbitrary in nature. For example, an angler in southern Virginia is likely to have a choice set that contains sites in North Carolina and an angler in northern Maine may consider sites in Canada. The regional focus of the survey effort ignores these potential substitutes and therefore the valuation estimates for these states may be biased upward.
Table 5 shows the aggregate access values by state and by wave. The table also reports a total aggregate value for each state. The results indicate that Virginia has the highest aggregate value followed again by New York.

Also reported are the per trip and aggregate values from increasing the expected catch rate by 1 fish per trip across all sites and modes for each species group. The values are calculated across all persons in the sample regardless of the state in which they were intercepted. The per trip values (Table 6) vary little over the two-month periods within species groups, while differences in the aggregate values (reported in Table 7) are being driven largely by differences in participation. The highest willingness to pay is for the big game group followed by flat fish.

Table 6. Mean Willingness to pay for a 1 fish increase in the expected catch rate

State	Big Game	Small Game	Bottom Fish	Flat Fish
Virginia	$4.57	$2.46	$1.79	$3.36
Maryland	6.51	3.44	2.44	5.30
Delaware	5.58	3.00	2.06	4.24
New Jersey	5.03	2.69	1.73	3.48
New York	4.61	2.43	1.63	3.10
Connecticut	5.99	3.29	2.25	4.43
Rhode Island	5.73	3.13	2.11	4.40
Massachusetts	5.91	3.09	2.04	4.33
New Hampshire	6.20	3.25	2.14	4.77
Maine	6.61	3.74	2.62	5.75
All States	5.39	2.89	1.97	4.01

Table 7. Aggregate Willingness to pay for a 1 fish increase in the expected catch rate, by wave, 1994 (Total Trips by wave x average per trip value).

Species	$'s per choice occasion Mean	Aggregate ($1000's) Total Trips x Mean
Big Game	$ 5.39	$ 115,200
Small Game	2.89	61,768
Bottom Fish	1.97	42,105
Flat Fish	4.01	85,706

Conclusions

The National Marine Fisheries Service, in 1994, began a systematic data collection effort of saltwater recreational fishers. This paper briefly introduces NMFS's data collection program and outlines the types of socio-economic analysis that will be performed with the data. To demonstrate the feasibility of these types of analysis, a case study is presented here.

This paper demonstrates that recreational fishing in the Northeastern United States is a very valuable resource. The results show that aggregate access values for states such as Massachusetts, New York, New Jersey, Maryland, and Virginia reach the hundreds of millions of dollars. Even states with relatively small numbers of sites such as Rhode Island, Connecticut, New Hampshire, and Delaware have aggregate access values that can be in the tens of millions of dollars range. The results also show that changes in catch per trip can also have large impacts on anglers.

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[ii] The economic valuation estimates presented in this paper are reproduced from Hicks et. al.
[iii] More details about the intercept and the random phone surveys can be found in the MRFSS Procedures Manual (NOAA, 1997).
[iv] The Northeast region, for the purposes of the 1994 survey, covered the states of Maine, New Hampshire, Massachussetts, Rhode Island,

Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia.

[v] All recreational catch, effort and participation data used in this report were obtained through personal communication, NMFS's Division of Fishery Statistics and Economics.

[vi] Catch estimates include the number of fish released alive by anglers.

[vii] Data constraints required that the model be based upon five aggregate species groups: big game, small game, bottom fish, flat fish, and other/non-target. For more detail on these species groups, consult Hicks et. al.

[viii] Due to data limitations, the recreation sites (for this model) are defined by counties. For more detail, please see Hicks et. al.

[ix] Because the RUM model measures well-being relative to remaining substitutes, the model is not equipped to handle policy changes that might eliminate all fishing alternatives for individuals. Consequently, the total value of sportfishing for the Northeast United States cannot be measured with this model.