Chapter D4: RUM Analysis

Introduction

This case study uses a random utility model (RUM) approach to estimate the effects of improved fishing opportunities due to reduced impingement and entrainment (I&E) in the Mid-Atlantic region. The Mid-Atlantic region, as defined by the National Marine Fisheries Service (NMFS), includes NMFS fishing intercept sites along the Atlantic coasts of New York, New Jersey, Delaware, Maryland and Virginia; Chesapeake Bay sites in Delaware, Virginia, and Maryland; and Delaware Bay sites in Delaware and New Jersey. The RUM includes anglers from Virginia, Maryland, Delaware, New Jersey, New York, the District of Columbia, and Pennsylvania.

Chapter Contents

Cooling Water Intake Structures (CWIS) withdrawing water in the Mid-Atlantic region impinge and entrain many of the species sought by recreational anglers. EPA included the following species and species groups in the model: striped bass, bluefish, flatfish, weakfish, small game fish, big game fish, bottom fish. Some of these species (e.g., weakfish, flatfish, striped bass) inhabit a wide range of coastal waters spanning several states (e.g., striped bass range from North Carolina to Maine). Therefore, increased fish mortality from I&E in the Mid-Atlantic region may affect recreational fishing from North Carolina to Maine.

The study's main assumption is that, all else being equal, anglers will get greater satisfaction, and thus greater economic value, from sites with a higher catch rate. This benefit may occur in two ways: first, an angler may get greater enjoyment from a given fishing trip with higher catch rates, yielding a greater value per trip; second, anglers may take more fishing trips when catch rates are higher, resulting in greater overall value for fishing in the region.

The following sections focus on the data set used in the Mid-Atlantic analysis and analytic results. Chapter A11 of this report provides a detailed description of the RUM methodology used in this analysis.

D4-1 Data Summary

EPA's analysis of improvements in recreational fishing opportunities in the Mid-Atlantic region relies on the NMFS Marine Recreational Fishery Statistics Survey (MRFSS), combined with the 1994 Add-on MRFSS Economic Survey (NMFS, 2003b; QuanTech, 1998).[1] The model of recreational fishing behavior relies on the subset that includes only single-day trips for boat and shore anglers. In addition, the sample excludes respondents missing data on key variables (e.g., home town). The Agency did not include charter boat anglers in the model. As explained further below, the welfare gain to charter boat anglers from improved catch rates is approximated based on the regression coefficients developed for the boat anglers. Additionally, values for single-day trips were used to value each day of a multi-day trip. The final sample used to estimate the RUM model includes 12,102 boat and shore anglers.

[1] For general discussion of the MRFSS, see Chapter A11 of the Regional Study Report or Marine Recreational Fisheries Statistics: Data User's Manual, http://www.st.nmfs.gov/st1/recreational/pubs/data_users/index.html (NMFS, 1999a).

D4-1.1 Summary of Anglers' Characteristics

a. Fishing modes and targeted species

A majority of the interviewed anglers (56 percent) fish from either a private or a rental boat (see Table D4-1). Approximately 23 percent fish from the shore; the remaining 21 percent fish from a party or charter boat. In addition to the mode of fishing, the MRFSS contains information on the specific species targeted on the current trip. Approximately 19 percent of anglers did not have a designated target species. The most popular species, targeted by 31 percent of anglers, is flatfish, which includes summer and winter flounder. The second most popular species, targeted by 14 percent of anglers, is striped bass. Of the remaining anglers, thirteen, eleven, six, four, and two percent target bottom fish, bluefish, other small game fish, weakfish, and big game fish, respectively.[2]

Table D4-1: Species Group Choice by Mode of Fishing

Species	All Modes		Private/Rental Boat		Party/Charter Boat		Shore	
	Frequency	Percent	Frequency	Percent by Mode	Frequency	Percent by Mode	Frequency	Percent by Mode
No Target	2,894	19.00%	1,423	16.58%	455	14.56%	1,016	28.89%
Striped Bass	2,066	13.57%	1,316	15.33%	291	9.31%	459	13.05%
Bluefish	1,634	10.73%	654	7.62%	488	15.61%	492	13.99%
Flatfish	4,786	31.43%	3,183	37.08%	665	21.27%	938	26.67%
Weakfish	561	3.68%	434	5.06%	47	1.50%	80	2.27%
Big Game Fish	296	1.94%	139	1.62%	157	5.02%	0	0.00%
Bottom Fish	2001	13.14%	1002	11.67%	629	20.12%	370	10.52%
Other Small Game Fish	988	6.49%	434	5.06%	394	12.60%	160	4.55%
All Species	15,228	100.00%	8,585	56.38%	3,126	20.53%	3,517	23.10%

Source: NMFS, 2003b.

The distribution of target species is not uniform by fishing mode. Flatfish is the most popular species group for all modes, targeted by 37 percent of private/rental boat anglers, 27 percent of shore anglers, and 21 percent of charter/party boat anglers. While 29 percent of shore anglers do not target a particular species, 17 percent of private/rental boat anglers did not target, and 15 percent of charter boat anglers did not target. The second most popular species for private/rental boat anglers is striped bass (targeted by 15 percent), followed by bottom fish (12 percent), bluefish (8 percent), other small game fish (5 percent), weakfish (5 percent), and big game fish (2 percent). Shore anglers' second favorite target species is bluefish (targeted by 14 percent), followed by striped bass (13 percent), bottom fish (11 percent), other small game fish (5 percent), and weakfish (2 percent). Twenty percent of charter boat anglers target bottom fish, followed by bluefish (16 percent), other small game fish (13 percent), striped bass (9 percent), big game fish (5 percent), and weakfish (2 percent).

b. Anglers' characteristics

This section presents a summary of angler characteristics for the Mid-Atlantic region, as defined above. For this data comparison, the study uses both the observations valid for the site choice model and those valid for the trip participation model. Those valid for the trip participation model include only anglers who responded to the economic add-on survey. The following trip profile information relies on the 12,102 site choice observations for boat and shore anglers, of which 3,779 responded to key questions in the economic add-on survey, and therefore are also valid for the trip participation model. Table

[2] Bottom fish includes dogfish sharks, catfish, white perch, white bass, black sea basses, scup, drums, spot, northern kingfish, Atlantic croaker, tautog, and codfish. Big game fish includes mako and blue sharks, dolphin, billfish, and tuna. Other small game fish include jacks, snappers, seatrout, mackerels, basses, and Atlantic bonito.

D4-2 summarizes characteristics of the sample of private/rental boat and shore anglers fishing at NMFS sites in the Mid-Atlantic region.

The average income of the respondent anglers was $47,992, with 88 percent having reported their household income. Ninety percent of the anglers are white, with an average age of about 46 years. Educational attainment information indicates that only 16 percent have a college degree. The average household size was 2.97 individuals. Twenty percent of the anglers are retired, while 73 percent are employed. Sixty-three percent of the anglers indicated that they had flexible time when setting their work schedule.

Table D4-2 shows that on average anglers spent 34 days fishing during the past year. The average duration of a fishing trip was 4.3 hours per day. Anglers made an average of 6.2 trips to the intercept site. The average round trip travel cost was $19.51 (1994$),[3] and the average travel time to and from the visited site was 1.6 hours. Fifty-nine percent of Mid-Atlantic anglers own their own boat. Finally, the average number of years of fishing experience was 24. This analysis does not include anglers under the age of 16, which may result in overestimation of the average age of recreational anglers and years of experience.

[3] All costs are in 1994$ because that was the MRFSS survey year. All costs and benefits will be updated to 2002$ later in this analysis (i.e., for welfare estimation).

Table D4-2: Data Summary for the Mid-Atlantic Coast Anglers

Variable	All Modes					Private/Rental Boat					Shore				
	N	Mean[a]	Std Dev	Min	Max	N	Mean[a]	Std Dev	Min	Max	N	Mean[a]	Std Dev	Min	Max
Trip Cost	12,102	$19.51	$22.23	$0.29	$544.69	8,585	$19.49	$22.55	$0.29	$544.69	3,517	$19.56	$21.63	$0.29	$231.07
Travel Time	12,102	1.59	1.68	0	19.92	8,585	1.58	1.66	0	14.99	3,517	1.61	1.73	0	19.92
Visits	3,186	6.24	8.71	0	62	2,397	6.00	8.05	0	62	789	6.99	10.42	0	62
Hours Fished	12,093	4.30	2.08	0.5	24	8,577	4.52	1.92	0.5	20	4	3.76	2.34	0.5	24
Own a Boat	3,830	0.59	0.49	0	1	2,824	0.73	0.44	0	1	1,006	0.21	0.40	0	1
College Degree	3,800	0.16	0.37	0	1	2,801	0.16	0.37	0	1	999	0.16	0.37	0	1
Retired	3,817	0.20	0.40	0	1	2,817	0.19	0.39	0	1	1,000	0.22	0.41	0	1
Employed	3,817	0.73	0.44	0	1	2,817	0.75	0.43	0	1	1,000	0.67	0.47	0	1
Age	3,788	45.64	14.34	16	91	2,796	45.86	13.92	16	91	992	45.02	15.48	16	85
Years Fishing	3,925	23.96	15.78	1	99	2,900	24.63	15.53	1	88	1,025	22.07	16.32	1	99
Household Size	3,810	2.97	1.37	1	20	2,812	2.98	1.31	1	17	998	45.02	15.48	1	20
Flexible Time	2,749	0.63	0.48	0	1	2,090	0.64	0.48	0	1	659	0.62	0.49	0	1
Male	3,832	0.89	0.32	0	1	2,826	0.90	0.30	0	1	1,006	0.86	0.35	0	1
White	3,781	0.90	0.30	0	1	2,797	0.93	0.25	0	1	984	0.81	0.39	0	1
Household Income	3,391	$47,992	$27,169	$7,500	$165,000	2,488	$50,532	$27,358	$7,500	$165,000	903	$40,994	$25,372	$7,500	$165,000
Annual trips	12,102	34.30	45	1	365	8,585	32.16	37.58	0	301	3,517	39.53	58.34	0	365

[a] For dummy variables such as "Own a Boat" that take the value of 0 or 1, the reported value represents a portion of the survey respondents possessing the relevant characteristic. For example, 59 percent of the surveyed anglers own a boat.

Source: NMFS, 2003b.

D4-1.2 Recreational Fishing Choice Sets

The NMFS survey intercept sites included in the analysis are depicted in Chapter D1 of this report (see Figure D1-1). Table D4-3 summarizes the 790 NMFS intercept sites in the Mid-Atlantic region. For the RUM model, each angler's choice set included up to 74 sites: 37 boat sites and 37 shore sites.[4] Boat and shore sites were determined by whether boat or shore anglers had been intercepted at a particular site. Each angler's choice set included his chosen site, plus a randomly selected set of up to 73 additional sites within 120 miles of his home zip code. Distances from unique zip codes to each of the NMFS sites were estimated using ArcView 3.2a software. Anglers' complete choice sets were determined based on their geographical location, using the following criteria:[5]

- New York and New Jersey anglers were assumed to fish at sites in New York or New Jersey.
- Pennsylvania anglers were assumed to fish at any location in the region.
- Northern and central Delaware anglers were assumed to fish only in Delaware.
- Sussex County, Delaware anglers were assumed to fish in Delaware, the three southeastern Maryland counties, and the northern Virginia peninsula.
- Anglers from the eastern shore area of Maryland were assumed to fish at locations in the eastern shore region, Delaware, and the northern Virginia peninsula.
- Cecil County, Maryland anglers were assumed to fish at all sites except New York and New Jersey sites.
- Anglers from the three western Maryland shore counties, nine northern Virginia counties, and Washington, D.C. were assumed to fish along the western shore of the Chesapeake, two counties on the eastern shore in proximity to the Chesapeake Bay Bridge, Sussex County, Delaware, Worcester County Maryland, and anywhere in Virginia.
- Anglers from Maryland counties on the western shore of the Chesapeake were assumed to fish either in those Maryland counties or at sites in Virginia (excluding the northern peninsula).
- Anglers from the Virginia peninsula were assumed to fish at sites on the peninsula.
- Anglers from the 26 southeastern Virginia counties were assumed to fish anywhere in Virginia.
- Anglers from the remaining Virginia counties were assumed to fish only at mainland Virginia sites (excluding the peninsula).

The above criteria were developed based on the analysis of visited sites.

[4] The total number of sites per angler was restricted to 74 to be compatible with LIMDEP's model specifications.

[5] These criteria were developed based on where anglers in the data set actually fished and geographical restrictions (e.g., we assumed that anglers would not cross large water bodies such as Delaware Bay to fish).

Table D4-3: Number and Description of Sites (by State)

State of Intercept	County of Intercept	Waterbody[a]	Number of Sites	Number of Observations	Percent of Sample
New York	Kings County	Atlantic Coast	12	161	1.33
New York	Nassau County	Atlantic Coast	61	1,330	10.99
New York	Queens County	Atlantic Coast	7	76	0.63
New York	Richmond County	Atlantic Coast	12	131	1.08
New York	Suffolk County	Atlantic Coast	220	2,286	18.89
New York	Westchester County	Atlantic Coast	20	103	0.85
New Jersey	Atlantic County	Atlantic Coast	33	306	3.42
New Jersey	Cape May County	Atlantic Coast, Delaware Bay	48	503	5.63
New Jersey	Cumberland County	Delaware Bay	8	81	0.91
New Jersey	Hudson County	Hudson River, East River	2	24	0.27
New Jersey	Middlesex County	Chesapeake Bay	4	34	0.38
New Jersey	Monmouth County	Atlantic Coast	30	1026	11.48
New Jersey	Ocean County	Atlantic Coast	45	531	5.94
Delaware	Kent County	Atlantic Coast, Delaware Bay	7	364	4.07
Delaware	New Castle County	Delaware Bay	8	180	2.01
Delaware	Sussex County	Atlantic Coast, Delaware Bay	26	1051	11.75
Maryland	Anne Arundel County	Chesapeake Bay	7	368	4.12
Maryland	Baltimore County	Chesapeake Bay	11	364	4.07
Maryland	Calvert County	Chesapeake Bay	7	127	1.42
Maryland	Cecil County	Chesapeake Bay	7	16	0.18
Maryland	Charles County	Chesapeake Bay	5	2	0.02
Maryland	Dorchester County	Chesapeake Bay	5	38	0.43
Maryland	Harford County	Chesapeake Bay	11	32	0.36
Maryland	Queen Annes County	Chesapeake Bay	5	24	0.27
Maryland	Somerset County	Chesapeake Bay	8	75	0.84
Maryland	St Marys County	Chesapeake Bay	6	76	0.85
Maryland	Talbot County	Chesapeake Bay	10	54	0.6
Maryland	Wicomico County	Chesapeake Bay	3	30	0.34
Maryland	Worcester County	Atlantic Coast	18	181	2.02
Virginia	Accomack County	Atlantic Coast, Chesapeake Bay	30	235	2.63
Virginia	Essex County	Chesapeake Bay	3	27	0.3
Virginia	Gloucester County	Chesapeake Bay	4	205	2.29

Table D4-3: Number and Description of Sites (by State)

State of Intercept	County of Intercept	Waterbody[a]	Number of Sites	Number of Observations	Percent of Sample
Virginia	Isle of Wight County	Chesapeake Bay	2	10	0.11
Virginia	James City County	Chesapeake Bay	3	14	0.16
Virginia	Lancaster County	Chesapeake Bay	2	3	0.03
Virginia	Mathews County	Chesapeake Bay	4	37	0.41
Virginia	Middlesex County	Chesapeake Bay	10	59	0.66
Virginia	Northampton County	Atlantic Coast, Chesapeake Bay	10	147	1.64
Virginia	Northumberland County	Chesapeake Bay	7	21	0.23
Virginia	Richmond County	Chesapeake Bay	3	12	0.13
Virginia	Suffolk City	Chesapeake Bay	4	20	0.22
Virginia	Surry County	Chesapeake Bay	5	17	0.19
Virginia	Virginia Beach City	Chesapeake Bay	6	967	10.82
Virginia	Westmoreland County	Chesapeake Bay	10	18	0.2
Virginia	York County	Chesapeake Bay	6	243	2.72
Virginia	Hampton City	Chesapeake Bay	10	374	4.18
Virginia	Newport News City	Chesapeake Bay	2	530	5.93
Virginia	Norfolk City	Chesapeake Bay	2	514	5.75
Virginia	Poquoson City	Chesapeake Bay	21	1	0.01

[a] Waterbody represents location of the sites included in each county: Atlantic Coast, Delaware Bay, or Chesapeake Bay. Some counties have sites at more than one waterbody.

Sources: NMFS, 2003b; and U.S. EPA analysis for this report.

D4-1.3 Site Attributes

This analysis assumes that the angler chooses between site alternatives based on catch rates at the sites. Catch rate is the most important attribute of a fishing site from the angler's perspective (McConnell and Strand, 1994; Haab et al., 2000). This attribute is also a policy variable of concern because catch rate is a function of fish abundance, which is affected by fish mortality due to I&E. The catch variable in the RUM therefore provides the means to measure baseline losses in I&E and changes in anglers' welfare attributed to changes from I&E due to the final section 316(b) rule.

To specify the fishing quality of the case study sites, EPA calculated historic catch rate based on the NMFS catch rates for the years 1990 to 1994 for recreationally important species: flatfish, striped bass, bluefish, and weakfish (McConnell and Strand, 1994). Other species of interest (e.g., white perch, Atlantic croaker, American shad, and spot) did not produce enough observations to permit a RUM analysis. EPA therefore bundled all other species into three aggregate groups — big game fish, bottom fish, and other small game fish — and calculated group-specific catch rates. No sample anglers targeted species in the "other fish" category (i.e., eel). The bottom fish, big game, and other small game groups include the following species:

- ***Bottom fish***: codfish, dogfish sharks, catfish, white perch, black sea basses, scup, drums, northern kingfish, tautog, Atlantic croaker, and spot;
- ***Big game***: mako shark, blue shark, bluefin and yellowfin tuna, billfish, and dolphin; and
- ***Other small game fish***: jacks, snappers, seatrout, mackerels, basses.

The catch rates represent the number of fish caught on a fishing trip divided by the number of hours spent fishing (i.e., the number of fish caught per hour per angler). The estimated catch rates are averages across all anglers in a given year over the five-year period.

The catch rate variables include total catch, including fish caught and kept and fish released. Some NMFS studies use the catch-and-keep measure as the relevant catch rate. Although a greater error may be associated with measured number of fish not kept, the total catch measure is most appropriate because a large number of anglers catch and release fish. The total catch rate variables include both targeted fish catch and incidental catch. For example, striped bass catch rates include fish caught by striped bass anglers and anglers who don't target any particular species. This method may underestimate the average historic catch rate for a given site because anglers not targeting particular fish species are usually less experienced and may not have the appropriate fishing gear. EPA considered using targeted species catch rates for this analysis, but discovered that this approach did not provide a sufficient number of observations per fishing zone to allow estimation of catch rates for all fishing sites included in the analysis.

For anglers who don't target any species, EPA used average catch rates for each site, for all species caught by no-target anglers, by mode, to characterize fishing quality. The MRFSS provided information on species caught for 3,820 no-target anglers. Of those, 56 percent caught bottom fish; 20 percent caught small game fish (i.e., striped bass, weakfish, bluefish, or other small game); 10 percent caught flatfish; and 1 percent caught big game fish. The remaining 13 percent caught other fish species.

Anglers who target particular species generally catch more fish in the targeted category because of specialized equipment and skills than anglers who don't target these species. Of the boat anglers who target particular species, bottom fish anglers catch the largest number of fish per hour, followed by anglers who catch flounder, bluefish, weakfish, striped bass, other small game fish, and big game fish. Of the shore anglers who target particular species, bottom fish anglers catch the largest number of fish per hour, followed by anglers who catch bluefish, striped bass, flounder or weakfish, other small game fish, and big game fish. Table D4-4 summarizes average catch rates by species for all sites in the study area.

Table D4-4: Average Catch Rate by Species/Species Group for the Mid-Atlantic Coast Sites by Mode of Fishing

Species/Species Group	Average Catch Rate (fish per angler per hour)			
	All Sites		Sites with Non Zero Catch Rates	
	Private/Rental Boat	Shore	Private/Rental Boat	Shore
Striped Bass	0.12	0.10	0.63	0.75
Weakfish	0.09	0.04	0.65	0.70
Flounder	0.27	0.12	0.84	0.70
Bluefish	0.20	0.25	0.75	1.30
Bottom Fish	0.41	0.32	1.15	1.31
Big Game Fish	0.04	N/A	0.39	N/A
Small Game Fish	0.07	0.04	0.58	0.59

Source: NMFS, 2002e.

Some RUM studies have used predicted, rather than actual, catch rates (Haab et al., 2000; Hicks et al., 1999; McConnell and Strand, 1994). This practice allows for individual characteristics to affect catch rates; for example, anglers with different levels of experience may have different catch rates. Haab et al. (2000) compared historic catch-and-keep rates to predicted catch-and-keep rates and found that historic catch-and-keep rates were a better measure of site quality. The authors also found that the choice of catch rate had little effect on the travel cost parameters. Hicks et al. (1999) found that using historic catch rates resulted in more conservative welfare estimates than predicted catch rate models. Consequently, EPA favored this more conservative approach.

D4-1.4 Travel Cost

EPA used ArcView 3.2a software to estimate distances from the household zip code to each NMFS fishing site in the individual opportunity sets. The Agency obtained fishing site locations from the Master Site Register supplied by NMFS. The Master Site Register includes both a unique identifier that corresponds to the visited site identifier used in the angler survey, and latitude and longitude coordinates. For some sites the latitude and longitude coordinates were missing or demonstrably incorrect, in which case the town point, as identified in the U.S. Geological Survey (USGS) Geographic Names Information System, was used as the site location if a town was reported in the site address. The program measured the distance in miles of the shortest route, using state and U.S. highways, from the household zip code to each fishing site, then added the distances from the zip code location to the closest highway and from the site location to the closest highway. The average one way distance to the visited site for boat and shore anglers is 32.4 miles. Private/rental boat anglers traveled an average of 32.2 miles to the chosen site, while shore anglers traveled an average of 32.8 miles.

EPA estimated trip "price" as the sum of travel costs plus the opportunity cost of time following the procedure described in Haab et al. (2000). Based on Parsons and Kealy (1992), this study assumed that time spent "on-site" is constant across sites and can be ignored in the price calculation. To estimate consumers' travel costs, EPA multiplied round trip distance by average motor vehicle cost per mile ($0.29, 1994 dollars).[6] To estimate the opportunity cost of travel time, EPA first divided round trip distance by 40 miles per hour to estimate trip time, and used the household's wage to yield the opportunity cost of time. EPA estimated household wage by dividing household income by 2,080 (i.e., the number of full time hours potentially worked).

Only those respondents who reported that they lost income during the trip (*LOSEINC*=1) are assigned a time cost in the trip cost variable. Information on the *LOSEINC* variable was available only for a subset of survey respondents who participated in the follow-up telephone interviews. Only 191 respondents reported that they lost income. Given that only a small number of survey respondents reported lost income, EPA assumed that the remaining 11,911 anglers did not lose income during the trip. EPA calculated visit price as:

$$Visit\ Price = \begin{cases} Round\ Trip\ Distance \times \$.29 + \dfrac{Round\ Trip\ Distance}{40\ mph} \times (Wage) & If\ LOSEINC = 1 \\ Round\ Trip\ Distance \times \$.29 & If\ LOSEINC = 0 \end{cases} \quad \text{(D4-1)}$$

For those respondents who do not lose income, the time cost is accounted for in an additional variable equal to the amount of time spent on travel. EPA therefore estimated time cost as the round trip distance divided by 40 mph:

$$Travel\ Time = \begin{cases} Round\ Trip\ Distance/40 & If\ LOSEINC = 0 \\ 0 & If\ LOSEINC = 1 \end{cases} \quad \text{(D4-2)}$$

EPA used a log-linear ordinary least square regression model to estimate wage rates for anglers who did not report their income. The estimated regression equation used in wage calculation is :

$$\begin{aligned} Ln(Income) = {} & 0.132 \times male + 0.179 \times white + 0.037 \times age - 0.0004 \times age^2 + 0.317 \times employed \\ & + 0.177 \times boatown - 0.222 \times low\text{-}ed + 0.263 \times high\text{-}ed + 0.883 \log(stinc) \end{aligned} \quad \text{(D4-3)}$$

where:

Income	=	the reported household income;
Male	=	1 for males;
White	=	1 for white;
Age	=	age in years;

[6] EPA used the 1994 government rate ($0.29) for travel reimbursement to estimate travel costs per mile traveled. This estimate includes vehicle operating cost only.

Employed = 1 if the respondent is currently employed and 0 otherwise;
Boatown = 1 if the respondent owns a boat;
Low-ed = 1 if the respondent had a high school education or less;
High-ed = 1 if the respondent graduated from college, or had a post-graduate degree; and
Stinc = the average income of residents in the corresponding states.

All variables in the estimated income regression are statistically significant at better than the 99th percentile.

D4-2 SITE CHOICE MODEL

The nature of the MRFSS data leads to the RUM as a means of examining anglers' preferences (Haab et al., 2000). Anglers arrive at each NMFS site by choosing among a set of feasible sites. Interviewers intercept individual anglers at marine fishing sites along the Mid-Atlantic coast, including Delaware Bay and Chesapeake Bay, and collect data on the anglers' origins and catch (including number and weight of species caught).

The RUM assumes that the individual angler makes a choice among mutually exclusive site alternatives based on the attributes of those alternatives (McFadden, 1981). The total number of sites in the study area is 790. Each angler's choice set was restricted, as described above, to a large set of feasible sites within 120 miles of the angler's home zip code.[7] This set of feasible sites was further restricted to up to 37 boat sites and 37 shore sites, for a total of up to 74 feasible choices (*J*).[8]
An angler's choice of mode and site is assumed to be based on utility maximization. An angler will choose mode k and site *j* if the utility (u_{jk}) from visiting site *j* and fishing with mode *k* is greater than that from visiting other sites (*h*) and fishing other modes *(m)*, such that:

$$u_{jk} > u_{hm} \;\; for\; h = 1, \ldots, J \; and \; h \neq j, for \; m = 1, \ldots, K \; and \; m \neq k \qquad \text{(D4-4)}$$

In addition to choosing a fishing mode and site, anglers choose the species to target. Available fishing modes include shore fishing, fishing from charter boats, or fishing from private or rental boats. EPA estimated the Mid-Atlantic RUM model using a nested logit, including boat and shore modes. Boat and shore sites were defined based on NMFS site descriptions, combined with availability of boat or shore catch rates for each site. EPA used values for boat anglers to value recreational benefits to charter anglers. EPA included the following species in the model: striped bass, bluefish, flounders, and weakfish. Additional species were grouped into the following categories: small game, big game, and bottom fish. Anglers may also choose not to target any particular species.

Recreational fishing models generally assume that anglers first choose a mode and species, and then a site. The nested logit model generally avoids the independence of relevant alternatives (IIA) problem, in which sites with similar characteristics that are not included in the model have correlated error terms. The nested structure based on mode/species and then site choice therefore assumes that sites selected for certain modes and/or species have similar characteristics.[9]

EPA used the following general model to specify the deterministic part of the utility function:[10]

$$v \; (site \; j, \; mode \; k) = f \; (TC_j, \; TT_j, \; SQRT(Q_{jks}) \times Flag(s)) \qquad \text{(D4-5)}$$

where:

v = the expected utility for site *j* and mode *k* (*j*=1,...,37; *k*=1,2);
TC_j = travel cost to site *j*;
TT_j = travel time to site *j* for survey respondents who cannot value the extra time according to the wage rate;

[7] Based on the 99th percentile for the distance traveled to a fishing site.

[8] The actual site fished was included, along with other sites that were randomly drawn from each angler's feasible choice set.

[9] See Chapter A11 of this report for greater detail.

[10] See Chapter A11 of this report for detail on model specification.

$SQRT(Q_{jks})$ = square root of the historic catch rate for species *s* and mode *k*, at site *j*;[11] and
Flag(s) = 1 if an angler is targeting this species; 0 otherwise;

The analysis assumes that each angler in the estimated model considers site quality based only on the catch rate for the targeted species. Theoretically, an angler may catch any of the available species at a given site (McFadden, 1981). If, however, an angler truly has a species preference, then including the catch variable for all species available at the site would inappropriately attribute utility to the angler for a species not pursued (Haab et al., 2000). To avoid this problem, the Agency used an interaction variable $SQRT(Q_{jks}) \times Flag(s)$, such that the catch rate variable for a given species is turned on only if the angler targets a particular species [*Flag (s)* =1]. Because no-target anglers catch all of the modeled species, EPA used average catch rates for all species caught by no-target anglers at a particular site to characterize a site's fishing quality for the no-target angler group.

The analysis tested various alternative model specifications, but the model presented here was the most successful at explaining the probability of selecting a site. For example, models that allowed for differences in value by waterbody (e.g., Chesapeake Bay and Atlantic Coast) did not produce significantly different results from those presented here.

The final model presented here is a site choice model that includes all fish species. The analysis therefore assumes that each angler has chosen a species followed by choosing a mode (boat or shore) and then a site based on the catch rates for that site, species, and mode. The model also allows for different coefficients on travel time for private/rental boat anglers and shore anglers, thus allowing the value of time spent traveling to vary by fishing mode.[12] Table D4-5 gives the parameter estimates for the RUM model.

Table D4-5: Estimated Coefficients for the Nested Logit Site Choice Model

Variable	Estimated Coefficient	t-statistic
TRIPCST	-0.020	-15.11
TIMECST-SHORE	-0.806	-42.58
TIMECST-BOAT	-0.699	-40.42
$SQRT (Q_{weakfish})$	2.448	19.93
$SQRT (Q_{striped\ bass})$	2.202	26.40
$SQRT (Q_{bluefish})$	0.991	10.28
$SQRT (Q_{flounder})$	1.210	22.44
$SQRT (Q_{bottom})$	0.736	13.20
$SQRT (Q_{big\ game})$	3.852	16.20
$SQRT (Q_{small\ game})$	1.013	13.83
$SQRT (Q_{notarget})$	1.038	19.71
IV-SHORE	0.840	19.56
IV-BOAT	1.112	26.41

Source: EPA analysis for this report.

[11] The analysis used the square root of the catch rate to allow for decreasing marginal utility of catching fish (McConnell and Strand, 1994).

[12] EPA estimated all RUM and Poisson models with LIMDEP™ software (Greene, 1995).

One disadvantage of the specified model is that the model looks at site and mode choice without regard to species. Once an angler chooses a target species, no substitution is allowed across species (i.e., the value of catching, or potentially catching, a different species is not included in the calculation). Therefore, improvements in fishing circumstances related to other species will have no effect on anglers' choices. This limitation, however, is unlikely to have a significant effect on welfare estimates, because most anglers tend to fish for the same target species on most of their trips (Haab et al., 2000).

Table D4-5 shows that all coefficients have the expected signs and are statistically significant at the 95th percentile. Travel cost and travel time have a negative effect on the probability of selecting a site, indicating that anglers prefer to visit sites closer to their homes (other things being equal). Boat anglers have a smaller negative value for travel time than shore anglers, indicating that, on average, boat anglers are willing to travel farther than shore anglers. The probability of a site visit increases as the historic catch rate for fish species increases.

Generally, the coefficient on the inclusive value is expected to fall between 0 and 1. As shown in Table D4-5, the coefficient on the inclusive value for the boat mode is greater than one in the estimated model. Kling and Herriges (1995) show that it is possible to have a coefficient greater than one that is still consistent with utility theory. The necessary condition for consistency is satisfied if the following inequality holds:

$$\theta_k \leq \frac{1}{1 - Q_k(v)} \qquad \text{(D4-6)}$$

where:

θ_k = the coefficient on the inclusive value for mode *k*; and
$Q_k(v)$ = the probability of selecting mode *k*.

EPA conducted this test for each angler in the model, and found that the test condition held for all anglers. Therefore, the inclusive value coefficient for boat mode is consistent with utility maximization.

D4-3 TRIP FREQUENCY MODEL

EPA also examined effects of changes in fishing circumstances on an individual's choice concerning the number of trips to take during a recreation season. EPA used the negative binomial form of the Poisson regression model to estimate the number of fishing trips per recreational season. The participation model relies on socio-economic data and estimates of individual utility (the inclusive value) derived from the site choice model (Parsons et al., 1999; Feather et al., 1995). EPA estimated a combined participation model for the North Atlantic and Mid-Atlantic regions.[13] This section discusses results from the Poisson model of recreational fishing participation, including statistical and theoretical implications of the model. A detailed discussion of the Poisson model is presented in Chapter A11 of this report.

The dependent variable, the number of recreational trips within the past 12 months, is an integer value ranging from 1 to 365. To avoid over-prediction of the number of fishing trips, EPA set the number of trips for anglers reporting over 125 trips per year to 125 in the model estimation.[14] The Agency first tested the data on the number of fishing trips for overdispersion to determine whether to use the Poisson model or the negative binomial model. If the dispersion parameter is equal to zero, then the Poisson model is appropriate; otherwise the negative binomial is more appropriate. The analysis found that the overdispersion parameter is significantly different from zero and therefore the negative binomial model is the most appropriate for this analysis.

Independent variables of importance include gender, ethnicity, education, household size, hourly wage, whether the angler targets a species, whether the angler fishes from shore or from a boat, whether the angler is employed, whether the angler is self-employed, and whether the angler owns a boat. The model also includes a dummy variable to indicate whether the angler is from the North Atlantic region. Variable definitions for the trip participation model are:

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[13] EPA combined data for the North and Mid-Atlantic regions, as these regions are part of a single NMFS data set, to estimate the model. The Agency calculated separate estimates of participation and changes in participation for each region, based on average values of variables for that region.

[14] The number of trips was truncated at the 95th percentile, 125 trips per year.

- Constant: a constant term;
- IVBASE: the inclusive value estimated using the coefficients from the site choice model;
- HIGH_ED: equals 1 if the individual completed college or an advanced degree, 0 otherwise;
- HH_SIZE: household size;
- EMPLYED: equals 1 if the individual is employed; 0 otherwise;
- SELFEMP: equals 1 if the individual is self-employed; 0 otherwise;
- MALE: equals 1 if the individual is male; 0 if female;
- WHITE: equals 1 if the individual is white; 0 otherwise;
- OWNBT: equals 1 if individual owns a boat, 0 otherwise;
- NOTARG: equals 1 if the individual did not target a particular species; 0 otherwise;
- SHORE: equals 1 if the individual fished from shore; 0 if the individual fished from a boat;
- WAGE: household hourly wage (household income divided by 2,080);
- N_ATL: equals 1 if the individual fished in the North Atlantic region; and
- α (alpha): overdispersion parameter estimated by the negative binomial model.

Table D4-6 presents the results of the trip participation model. Where a particular sign is expected, all estimated parameters have the expected signs. The model shows that the most significant determinants of the number of fishing trips taken by an angler are region (N_ATL), whether the angler fishes from shore (SHORE), whether the angler targets a species (NOTARG), boat ownership (OWNBT), whether the angler is male (MALE), whether the angler is employed (EMPLOYED), and the perceived quality of fishing sites (IVBASE).

Table D4-6: Trip Participation Model (Negative Binomial Model)

Variable	Coefficient	t-statistic
Constant	2.428	32.48
IVBASE	0.167	18.26
HIGH_ED	-0.146	-3.96
HH_SIZE	-0.033	-3.27
EMPLYD	-0.210	-5.84
SELFEMP	0.137	3.44
MALE	0.221	5.46
WHITE	0.124	2.64
OWNBT	0.379	11.78
NOTARG	-0.391	-11.43
SHORE	0.400	11.23
WAGE	0.003	2.40
N_ATL	-0.685	-18.29
α (alpha)	1.034	38.02

Source: U.S. EPA analysis for this report.

The positive coefficient on the inclusive value index (IVBASE) indicates that the quality of recreational fishing sites has a positive effect on the number of fishing trips per recreational season. EPA therefore expects improvements in recreational fishing opportunities, such as an increase in fish abundance and catch rate, to result in an increase in the number fishing trips to the affected sites.

The model shows that anglers in the North Atlantic region take less fishing trips than those in the Mid-Atlantic region. Anglers who completed college or an advanced degree tend to take less fishing trips than those with less education. Anglers with larger households take fewer trips than those with smaller households, and those who are employed take fewer trips than those who are retired or otherwise not employed. However, self-employed anglers take more trips than those who are not self-employed. Male anglers fish more frequently than female anglers, and white anglers take more trips than non-white anglers. Anglers who own boats, those who target a specific species, those with higher incomes, and those who fish from shore take more trips each year.

D4-4 WELFARE ESTIMATES

This section presents estimates of welfare losses to recreational anglers from fish mortality due to I&E, and potential welfare gains from improvements in fishing opportunities due to reduced fish mortality stemming from the final section 316(b) rule.

D4-4.1 Estimating Changes in the Quality of Fishing Sites

To estimate changes in the quality of fishing sites under different policy scenarios, EPA relied on the recreational fishery landings data by state and the estimates of recreational losses from I&E corresponding to different technology options. The NMFS provided recreational fishery landings data for the Mid-Atlantic region. EPA estimated the losses to recreational fisheries using the physical impacts of I&E on the relevant fish species, and the percentage of total fishery landings attributed to recreational fishing, as described in Chapter D2 of this document. I&E affects recreational species in two ways: by directly killing recreational species, and by killing forage species, thus indirectly affecting recreational species through the food chain. The indirect effects on recreational species were calculated in two steps. First, EPA estimated the total number of fish lost due to forage fish losses. Second, EPA allocated this total number of fish among recreational species according to each species' percent of total recreational landings.

The Agency estimated changes in the quality of recreational fishing sites under different policy scenarios in terms of the percentage change in the historic catch rate. EPA assumed that catch rates will change uniformly across all marine fishing sites in the Mid-Atlantic region, because species considered in this analysis (i.e., weakfish, striped bass, bottom fish, and flatfish) inhabit a wide range of states (e.g., from North Carolina to Massachusetts).[15] EPA used five-year recreational landing data (1997 through 2001) for state waters to calculate average landings per year for striped bass, weakfish, bottom fish, flatfish, and all species combined.[16,17] EPA then divided losses to the recreational fishery from I&E by the total recreational landings for the region to calculate the percent change in historic catch rate from eliminating I&E completely. Table D4-7 presents results of this analysis. EPA estimated that compliance with the Phase II rule would reduce impingement by 53.5 percent, and entrainment by 47.9 percent. Table D4-7 also presents the reductions in I&E effects that would occur with installation of the CWIS technology due to the final section 316(b) rule.

[15] Fish lost to I&E are most often very small fish, which are too small to catch. Because of the migratory nature of most affected species, by the time these fish have grown to catchable size, they may have traveled some distance from the facility where I&E occurs. Without collecting extensive data on migratory patterns of all affected fish, it is not possible to evaluate whether catch rates will change uniformly or in some other pattern. Thus, EPA assumed that catch rates will change uniformly across the entire region.

[16] State waters include sounds, inlets, tidal portions of rivers, bay, estuaries, and other areas of salt or brackish water, plus ocean waters to three nautical miles from shore (NMFS, 2003b).

[17] EPA used average landings for all species to calculate changes in catch rates for no-target anglers.

Table D4-7: Estimated Changes in Historical Catch Rates From Eliminating and Reducing I&E in the Mid-Atlantic Region

Species	Total Recreational Landings 5 States (fish per year)[a]	Baseline		Final Section 316(b) Rule	
		Total Recreational Fishery Losses From I&E (number of fish)	Percent Increase in Recreational Catch From Eliminating I&E	Estimated Reduction in I&E (number of fish)	Percent Increase in Recreational Catch
Striped Bass	7,024,788	540,816	7.70%	262,141	3.73%
Flatfish	20,734,405	1,024,608	4.94%	497,762	2.40%
Bottom Fish	39,234,599	17,910,330	45.65%	8,746,693	22.29%
Weakfish	4,798,238	648,727	13.52%	317,158	6.61%
Small Game	7,335,013	344,059	4.69%	166,580	2.27%
No Target[b]	79,198,440	20,468,540	25.87%	9,990,333	12.63%

[a] Total recreational landings are calculated as a five year average (1997-2001) for sites in state waters.
[b] All species were summed to calculate percent change in catch rates for no-target anglers.

Sources: NMFS, 2002e; and U.S. EPA analysis for this report.

D4-4.2 Estimating Losses from I&E in the Mid-Atlantic Region

The recreational behavior model described in the preceding sections provides a means for estimating the economic effects of changes in recreational fishery losses from I&E in the Mid-Atlantic region. First, EPA estimated welfare gain to recreational anglers from eliminating fishery losses due to I&E. This estimate represents economic damages to recreational anglers from I&E of recreational fish species in the region under the baseline scenario. EPA then estimated benefits to recreational anglers from installing the CWIS technology due to the final section 316(b) rule.

EPA estimated anglers' willingness-to-pay (WTP) for improvements in the quality of recreational fishing by first calculating an average per-day welfare gain based on the expected changes in catch rates from eliminating I&E, and from reducing I&E by installing the CWIS technology due to the final section 316(b) rule. Table D4-8 presents the compensating variation per day (averaged over all anglers in the sample) associated with reduced fish mortality from eliminating and reducing I&E for each fish species of concern.[18,19]

Table D4-8 also reports the willingness-to-pay for a one-unit increase in historic catch rate by fishing mode and species for anglers targeting these species. The estimated values are consistent with those available from previous studies (McConnell and Strand, 1994).[20] In general, boat and shore anglers have similar values, and target anglers have higher values than no-target anglers. No-target anglers have higher values than anglers who target bottom fish, and shore anglers who target small game fish. Because no-target anglers catch a variety of species, including some of the higher-valued species, it makes sense that their value, on average, is higher than the values for the lowest-valued targeted species. Target anglers who fish from boats value an additional big game fish the most, followed by striped bass, weakfish, flatfish, other small game fish, bluefish, and bottom fish. Target anglers who fish from shore value an additional striped bass the most, followed by weakfish, bluefish, bottom fish and other small game fish.

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[18] A compensating variation equates the expected value of realized utility under the baseline and post-compliance conditions. For more detail, see Chapter A11 of this report.

[19] As the RUM model estimated values for single-day trips, the per-day value is equal to a per-trip value.

[20] Note that WTP for a one-unit increase in historical catch rates reported in Hicks et al. (1999) is lower compared to the values presented in Table D4-8. However, the values presented in the Hicks et al. study are not directly comparable with the values presented in Table D4-8. The values from the Hicks et al. study represent an average WTP for a one-unit increase in historical catch rates over all anglers while the values presented in Table D4-8 represent an average WTP for a one-unit increase in historical catch rates over anglers targeting a given species/species group.

Table D4-8: Per-Day Welfare Gain from Eliminating and Reducing I&E in the Mid-Atlantic Region, and Willingness-to-Pay per Additional Fish (2002$)

Targeted Species	Per-Day Welfare Gain (2000$)				WTP for an Additional Fish per Trip (2002$)	
	Baseline I&E		Reduced I&E			
	Boat Mode	Shore Mode	Boat Mode	Shore Mode	Boat Mode	Shore Mode
Striped Bass	$5.03	$4.59	$2.44	$2.23	$15.23	$15.19
Bottom Fish	$12.17	$13.46	$6.09	$6.67	$4.60	$4.66
Flatfish	$1.65	$1.72	$0.80	$0.84	$8.37	$8.57
Weakfish	$7.43	$8.21	$3.63	$4.02	$14.01	$14.58
Small Game Fish[a]	$1.46	$1.40	$0.71	$0.68	$6.50	$4.58
No Target	$7.86	$7.52	$3.88	$3.71	$5.71	$5.58
Big Game Fish[b]	N/A	N/A	N/A	N/A	$20.53	N/A
Bluefish[a]	N/A	N/A	N/A	N/A	$6.19	$6.28

[a] I&E welfare estimates for bluefish are included with small game fish.
[b] Shore anglers do not target big game fish.

Source: U.S. EPA analysis for this report.

The per-day values for changes in I&E are based on both the value of the species to anglers, and the expected percent change in catch. Bottom fish species have the highest per-day welfare gain, due to the large estimated change in catch rate from elimination of I&E (45.6 percent). No-target anglers receive the second highest per-day gain, mainly driven by the large expected change in catch rates (25.9 percent). Weakfish has the third highest change in per-day value, and striped bass has the fourth highest change. Both species are relatively valuable to anglers, and catch rates are expected to increase by significant amounts for both (13.5 percent for weakfish and 7.7 percent for striped bass). Flatfish, which are moderately valuable and have a moderate change in catch rates, have the fifth highest welfare gain. Finally, small game fish anglers have the lowest welfare gain, primarily due to the relatively low expected change in catch rates.

EPA calculated the total economic value of eliminating I&E in the Mid-Atlantic region by combining the estimated per-day welfare gain with the total number of fishing days at Mid-Atlantic sites. The Agency assumed that the welfare gain per day of fishing is independent of the number of days fished per trip and therefore equivalent for both single- and multiple-day trips.[21] Each day of a multiple-day trip is valued the same as a single-day trip. NMFS provided information on the total number of fishing trips by fishing mode; this total number of fishing days includes both single- and multiple-day trips. Table D4-9 presents the NMFS number of fishing days by fishing mode. Per-day welfare gain differs across recreational species and fishing mode.[22,23] EPA therefore estimated the number of fishing trips associated with each species of concern and the number of trips taken by no-target anglers. EPA used the MRFSS sample to calculate the proportion of recreational fishing trips taken by no-target anglers and anglers targeting each species of concern, and applied these percentages to the total number of trips to estimate species-specific participation. Table D4-9 shows the calculation results.

[21] See section D4-5.1 for limitations and uncertainties associated with ths assumption.

[22] EPA used the per-day values for private/rental boat anglers to estimate welfare gains for charter boat anglers.

[23] NMFS reports the total days of fishing, including days fished on both single- and multiple-day trips. The Agency assumed that the welfare gain per day of fishing is independent of the number of days fished per trip and therefore equivalent for both single- and multiple-day trips.

Table D4-9: Recreational Fishing Participation by Species and Fishing Mode

Species	Mode: Private Rental Boats Number of Fishing Days	Mode: Shore Number of Fishing Days	Mode: Charter Boat Number of Fishing Days	Total for all Modes [a]
No Target	1,864,425	2,282,545	117,321	4,264,291
Striped Bass	1,723,862	1,031,056	75,018	2,829,936
Flatfish	4,169,655	2,107,147	171,389	6,448,191
Weakfish	568,998	179,349	12,087	760,434
Small Game Fish[a]	1,461,853	1,469,552	227,310	3,158,715
Big Game Fish	172,049	N/A	40,450	212,499
Bottom Fish	1,286,431	826,425	162,123	2,274,979
Total[b]	11,247,273	7,896,075	805,698	19,949,046

[a] Includes bluefish.
[b] Sum of individual values may not add up to totals due to the rounding error.

Sources: NMFS, 2002d; and U.S. EPA analysis for this report.

Anglers targeting flatfish account for the largest number of fishing days at Mid-Atlantic NMFS sites (6.4 million). No-target anglers, small game anglers, and anglers targeting striped bass rank second, third, and fourth, fishing 4.3 million, 3.2 million, and 2.8 million days per year, respectively. Anglers targeting big game species fish the least days per year (about 212,000).

The estimated number of trips represents the baseline level of participation. Anglers may take more fishing trips as recreational fishing circumstances change. EPA used the trip participation model to estimate the percentage increase in the number of trips due to the elimination and reduction of I&E. These changes are reported in Table D4-10. For baseline I&E, the estimated percentage increase ranges from 0.4 percent for anglers who target small game fish to 3.6 percent for anglers targeting bottom fish. EPA calculated the number of recreational fishing trips under each I&E scenario by applying the estimated percentage increase to the baseline number of trips. The estimated increase in the total number of recreational fishing days ranges from 12,678 days for anglers who target small game fish to 80,720 days for anglers who target bottom fish. The estimated aggregate increase in the number of fishing days is 271,104.

Tables D4-11 and D4-12 provide total welfare estimates for two policy scenarios. Table D4-11 presents losses to recreational anglers from baseline I&E. Table D4-12 presents the welfare gains that would result from installing the CWIS technology at all plants subject to final section 316(b) rule in the Mid-Atlantic region. EPA calculated the total welfare estimates by multiplying the estimated values per day (Table D4-8) by the number of fishing days (Tables D4-9 and D4-10).[24] These values were discounted, to reflect the fact that fish must grow to a certain size before they will be caught by recreational anglers. EPA calculated discount factors separately for I&E of each species (see Chapter D2 for details). To estimate discounted total benefits for the Mid-Atlantic, EPA calculated weighted averages of these discount factors, and applied them to estimated willingness-to-pay values. Discount factors were calculated for both a 3 percent discount rate and a 7 percent discount rate. For the final rule policy scenario, an additional discount factor was applied to account for the one-year lag between the date when costs are incurred and the installation of the required cooling water technology is completed.

Table D4-11 presents annual losses to recreational anglers from baseline I&E effects in the Mid-Atlantic region. Total recreational losses (2002$) to Mid-Atlantic anglers, before discounting, from I&E of striped bass, bottom fish, flatfish, weakfish, small game fish, and to no-target anglers, are $95.7 million per year. Total discounted baseline losses are $89.6 million, discounted using a 3 percent discount rate; and $82.5 million, discounted using a 7 percent discount rate.

[24] EPA averaged the initial number of days (Table D4-9) and the predicted increased number of days (Table D4-10) to estimate total welfare (Bockstael, et al., 1987).

Table D4-10: Increased Recreational Fishing Participation by Species and Fishing Mode from Eliminating or Reducing I&E in the Mid-Atlantic Region

Species	Predicted Percent Change in Annual Fishing Trips		Private/Rental Mode		Shore Mode		Party/Charter Mode	
	Baseline I&E	Reduced I&E	Baseline	Reduced	Baseline	Reduced	Baseline	Reduced
Striped Bass	1.38%	0.67%	1,747,618	1,735,352	1,045,265	1,037,928	76,052	75,518
Bottom Fish	3.55%	1.75%	1,332,076	1,309,000	855,748	840,924	167,875	164,967
Flatfish	0.46%	0.23%	4,188,977	4,179,061	2,116,912	2,111,901	172,183	171,776
Weakfish	2.13%	1.03%	581,091	574,879	183,160	181,202	12,344	12,212
Small Game Fish	0.40%	0.19%	1,464,833	1,463,293	1,472,547	1,470,999	227,774	227,534
No Target	2.17%	1.07%	1,904,940	1,884,290	2,332,146	2,306,866	119,871	118,571
Totals			11,219,535	11,145,875	8,005,778	7,949,820	776,099	770,578

Source: U.S. EPA analysis for this report.

Table D4-11: Total Estimated Annual Baseline Losses from I&E for the Mid-Atlantic Region (2002$)

Species	Total Losses Before Discounting	Total Losses with 3% Discounting	Total Losses with 7% Discounting
Striped Bass	$13,864,218	$12,494,295	$10,965,862
Bottom Fish	$29,263,408	$27,729,976	$25,929,253
Flatfish	$10,783,335	$9,962,389	$9,010,383
Weakfish	$5,850,688	$5,529,514	$5,150,443
Small Game Fish	$2,815,749	$2,602,073	$2,353,597
No Target	$33,093,917	$31,264,188	$29,122,581
Total Recreational Use	$95,671,315	$89,582,435	$82,532,119

Source: U.S. EPA analysis for this report.

Table D4-12 presents the annual reduction in losses resulting from installation of the CWIS technology for each facility subject to final section 316(b) rule in the region. Total undiscounted recreational losses are reduced by $47.7 million under the final section 316(b) rule. Using a 3 percent discount rate, total losses are reduced by $43.4 million. Using a 7 percent discount rate, total losses are reduced by $38.5 million.

Table D4-12: Total Estimated Annual Welfare Gain from Reducing I&E Losses Under the Final Section 316(b) Rule in the Mid-Atlantic Region (2002$)

Species	Total Losses Before Discounting	Total Losses with 3% Discounting	Total Losses with 7% Discounting
Striped Bass	$6,711,814	$5,873,610	$4,963,735
Bottom fish	$14,458,662	$13,308,866	$11,987,589
Flatfish	$5,252,221	$4,712,489	$4,104,589
Weakfish	$2,845,927	$2,612,885	$2,344,593
Small Game	$2,195,124	$1,969,986	$1,715,870
No target	$16,227,901	$14,891,846	$13,362,426
Total recreational use losses	$47,691,649	$43,369,682	$38,478,802

Source: U.S. EPA analysis for this report.

D4-5 Limitations and Uncertainties

D4-5.1 Extrapolating Single-Day Trip Results to Estimate Benefits from Multiple-Day Trips

Use of per-day welfare gain estimated for single-day trips to estimate per-day welfare gain associated with multiple-day trips can either understate or overstate benefits to anglers taking multiple-day trips. Inclusion of multi-day trips in the model of recreational anglers' behavior can be problematic because multi-day trips are frequently multi-activity trips. An individual might travel a substantial distance and participate in several recreational activities such as shopping and sightseeing, all as part of one trip. Recreational benefits from improved recreational opportunities for the primary activity are overstated if all travel costs are treated as though they apply to the one recreational activity of interest. EPA therefore limited the recreational behavior model to single-day trips only and then extrapolated single-day trip results to estimate benefits to anglers taking multiple-day trips.

There is evidence that multi-day trips are more valuable than single-day trips. McConnell and Strand (1994) estimated a random utility model (RUM) using the NMFS data for New England and the Mid-Atlantic. Their study was intended to supplement the RUM study of single-day trips for the same region conducted by Hicks et al. (1999). The reported values for a catch rate increase of one fish are consistently higher for overnight trips than for single-day trips. Lupi and Hoehn (1998) compared values for single- and multi-day fishing trips. Their comparison is based on a RUM for the Great Lakes, with single- and multiple-day trips treated as distinct alternatives in the choice set, with separate parameters for different length trips. They found that multiple-day trips are less responsive to changes in travel cost, and thus relatively more valuable than single-day trips. Their case study results found that "over half the value of an across the board marginal change in catch rates was due to multiple-day trips even though multiple-day trips represent less than one fourth of the trips in the sample (p. 45)."

D4-5.2 Considering Only Recreational Values

This study understates the total benefits of improvements in fishing site quality because estimates are limited to recreational use benefits. Many other forms of benefits, such as habitat values for a variety of species (in addition to recreational fish), non-use values, etc., are also likely to be important.

D4-5.3 Species Substitution

EPA's estimated RUM model does not allow for anglers to substitute between species. The analysis therefore assumes that each angler has chosen a species before choosing a mode followed by a site based on the catch rates for that site and species. Once an angler chooses a target species and mode, no substitution is allowed across species (i.e., the value of catching, or potentially catching, a different species is not included in the calculation). Therefore, improvements in fishing circumstances related to other species will have no effect on anglers' choices, and thus will not be accounted for in the welfare estimates.

D4-5.4 Charter Anglers

EPA's model does not include charter boat anglers. Instead, the Agency used values for private/rental boat anglers to estimate values for charter anglers. It is not clear whether this will result in an overestimate or underestimate of per-day values for charter boat anglers.

D4-5.5 Potential Sources of Survey Bias

The survey results could suffer from bias, such as recall bias and sampling effects.

a. Recall bias

Recall bias can occur when respondents are asked, such as in the MRFSS, the number of their recreation days over the previous season. Some researchers believe that recall bias tends to lead to an overstatement of the number of recreation days, particularly by more avid participants. Avid participants tend to overstate the number of recreation days because they count days in a "typical" week and then multiply them by the number of weeks in the recreation season. They often neglect to consider days missed due to bad weather, illness, travel, or when fulfilling "atypical" obligations. Some studies also found that the more salient the activity, the more "optimistic" the respondent tends to be in estimating the number of recreation days.

Individuals also have a tendency to overstate the number of days they participate in activities that they enjoy and value. Taken together, these sources of recall bias may result in an overstatement of the actual number of recreation days.

b. Sampling effects

Recreational demand studies frequently face observations that do not fit general recreation patterns, such as observations of avid participants. These participants can be problematic because they claim to participate in an activity an inordinate number of times. This reported level of activity is sometimes correct but often overstated, perhaps due to recall bias. Even where the reports are correct, these observations tend to be overly influential (Thomson, 1991). EPA set the upper limit of the number of fishing trips per year to 180 days to correct for potential bias caused by these observations when estimating trip participation models. Instead of dropping four survey observations with the number of annual trips reported as greater than 180, the Agency set the number of annual trips to the upper bound (i.e., 180 trips).