# Chapter F4: Value of I&E Losses at the Brayton Point Station Based on Benefits Transfer Techniques

This chapter presents the results of EPA's evaluation of the economic losses that are associated with I&E at the Brayton Point Station using benefits transfer techniques. Section F4-1 provides an overview of the valuation approach, Section F4-2 discusses the value of losses to recreational fisheries, Section F4-3 discusses the value of commercial fishery losses, Section F4-4 discusses values of forage losses, Section F4-5 discusses nonuse values, and Section F4-6 summarizes benefit transfer results.

CHAPTER CONTENTS



## F4-1 Overview of Valuation Approach

I&E at Brayton Point affect recreational and commercial fisheries as well as forage species that contribute to the biomass of fishery species. EPA evaluated all these species groups to capture the total economic impact of I&E at Brayton Point.

Recreational fishery impacts are based on benefits transfer methods, applying results from nonmarket valuation studies. Commercial fishery impacts are based on commodity prices for the individual species. The economic value of forage species losses is determined by estimating the replacement cost of these fish if they were to be restocked with hatchery fish, and by considering the foregone biomass production of forage fish resulting from I&E losses and the consequential foregone production of commercial and recreational species that use the forage species as a prey base. All of these methods are explained in further detail in Chapters A5 and A9 of this document.

Many of the I&E-impacted fish species at Brayton Point are harvested both recreationally and commercially. To avoid double-counting the economic impacts of I&E on these species, EPA determined the proportion of total species landings attributable to recreational and commercial fishing, and applied this proportion to the impacted fishery catch. For example, if 30 percent of the landed numbers of one species are harvested commercially at a site, then 30 percent of the estimated catch of I&E-impacted fish are assigned to the increase in commercial landings. The remaining 70 percent of the estimated total landed number of I&E-impacted adult equivalents are assigned to the recreational landings.

The National Marine Fisheries Service (NMFS) provides both recreational and commercial fishery landings data by state. To determine what proportions of total landings per state occur in the recreational or commercial fishery, EPA summed the landings data for the recreational and commercial fishery, and then divided by each category to get the corresponding percentage. The percentages applied in this analysis are presented in Table F4-1.

**Table F4-1: Percentages of Total Impacts in the Recreational and Commercial Fisheries of Selected Species at Brayton Point Station**

| Fish Species | Percent Impacts to Recreational Fishery | Percent Impacts to Commercial Fishery |
|---|---|---|
| Atlantic menhaden | 0 | 100 |
| Butterfish | 0 | 100 |
| Rainbow Smelt | 0 | 100 |
| Silver Hake | 0 | 100 |
| Tautog | 83 | 17 |
| Weakfish | 95 | 5 |
| White perch | 20 | 80 |
| Windowpane | 0 | 100 |
| Winter flounder | 8 | 92 |
| Scup | 45 | 55 |

Wed Feb 13 13:11:19 MST 2002; TableA:Percentages of total impacts occurring to the commercial and recreational fisheries of selected species; Plant: brayton.projected; Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableA.Perc.of total.impacts.brayton.projected.csv

As discussed in Chapter A5 of Part A of this document, the yield estimates in Chapter F3 represent the total pounds of foregone yield for both the commercial and recreational catch combined. For the economic valuation discussed in this chapter, Table F4-1 partitions total yield between commercial and recreational fisheries based on the landings in each fishery. Because the economic evaluation of recreational yield is based on numbers of fish rather than pounds, foregone recreational yield was converted to numbers of fish. This conversion was based on the average weight of harvestable fish of each species. Table F4-2 shows these conversions for the impingement data presented in Section F3-4 of Chapter F3 and Table F4-3 displays the conversions for entrainment data. Note that the numbers of foregone recreational fish harvested are typically lower than the numbers of age 1 equivalent losses, since the age of harvest of most fish is greater than age 1.

**Table F4-2: Summary of Brayton Point's Mean Annual Impingement of Fishery Species**

| Species | Impingement Count (#) | Age 1 Equivalents (#) | Total Catch (#) | Total Yield (lb) | Commercial Catch (#) | Commercial Yield (lb) | Recreational Catch (#) | Recreational Yield (lb) |
|---|---|---|---|---|---|---|---|---|
| Atlantic menhaden | 2,076 | 2,623 | 851 | 308 | 851 | 308 | 0 | 0 |
| Butterfish | 176 | 278 | 25 | 7 | 25 | 7 | 0 | 0 |
| Rainbow smelt | 870 | 1,278 | 20 | 2 | 20 | 2 | 0 | 0 |
| Silver hake | 4,900 | 5,773 | 848 | 2,196 | 848 | 2,196 | 0 | 0 |
| Tautog | 1,131 | 1,230 | 127 | 548 | 22 | 93 | 105 | 455 |
| Weakfish | 503 | 600 | 124 | 419 | 6 | 21 | 118 | 398 |
| White perch | 1,723 | 2,297 | 79 | 25 | 63 | 20 | 16 | 5 |
| Windowpane | 1,094 | 1,320 | 582 | 122 | 582 | 122 | 0 | 0 |
| Winter flounder | 9,048 | 13,601 | 867 | 1,465 | 798 | 1,347 | 69 | 117 |
| Total | 21,521 | 28,999 | 3,522 | 5,091 | 3,214 | 4,116 | 308 | 975 |

**Table F4-3: Summary of Brayton Point's Mean Annual Entrainment of Fishery Species**

| Species | Entrainment Count (#) | Age 1 Equivalents (#) | Total Catch (#) | Total Yield (lb) | Commercial Catch (#) | Commercial Yield (lb) | Recreational Catch (#) | Recreational Yield (lb) |
|---|---|---|---|---|---|---|---|---|
| Atlantic menhaden | 625,117,471 | 10,523 | 3,414 | 1,236 | 3,414 | 1,236 | 0 | 0 |
| Rainbow smelt | 3,340,371 | 49,506 | 766 | 56 | 766 | 56 | 0 | 0 |
| Scup | 2,851,071 | 509 | 46 | 54 | 25 | 29 | 21 | 24 |
| Silver hake | 43,450 | 2 | 0 | 1 | 0 | 1 | 0 | 0 |
| Tautog | 3,953,743,774 | 30,149 | 3,112 | 13,433 | 529 | 2,284 | 2,583 | 11,149 |
| Weakfish | 66,474,092 | 492 | 102 | 343 | 5 | 17 | 97 | 326 |
| White perch | 55,050 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Windowpane | 368,327,045 | 7,369 | 3,246 | 683 | 3,246 | 683 | 0 | 0 |
| Winter flounder | 795,883,100 | 507,114 | 32,331 | 54,605 | 29,745 | 50,237 | 2,587 | 4,368 |
| Total | 5,815,835,424 | 605,664 | 43,016 | 70,410 | 37,730 | 54,542 | 5,287 | 15,868 |

# F4-2 Economic Value of Average Annual Losses to Recreational Fisheries Resulting from I&E at Brayton Point Station

## F4-2.1 Economic Values of Recreational Fishery Losses from the Consumer Surplus Literature

There is a large literature that provides willingness-to-pay values for increases in recreational catch rates. These increases in value are benefits to the anglers, and are often referred to by economists as "consumer surplus." In applying this literature to value I&E impacts, EPA focused on changes in consumer surplus per additional fish caught.

When using values from the existing literature as proxies for the value of a trip or fish at a site not studied, it is important to select values for similar areas and species. Table F4-4 gives a summary of several studies that are closest to Mt. Hope Bay fisheries in geographic area and relevant species.

**Table F4-4: Selected Valuation Studies for Estimating Changes in Catch Rates**

| Authors | Study Location and Year | Item Valued | Value Estimate ($2000) | |
|---|---|---|---|---|
| McConnell and Strand (1994) | Mid- and south Atlantic coast, anglers targeting specific species, 1988 | Catch rate increase of 1 fish per trip, values used are for NY[a] | Small game fish<br>Bottom fish<br>Flatfish | $9.54<br>$2.54<br>$5.35 |
| Hicks et al. (1999) | Mid-Atlantic coast, 1994 | Catch rate increase of 1 fish per trip, from historical catch rates at all sites, weighted average of MA and RI | Small game fish<br>Bottom fish<br>Flatfish | $3.61<br>$2.40<br>$5.04 |
| Agnello (1989) | Atlantic coast, 1981 | Mean value per fish caught, for the Atlantic coast[b] | Weakfish | $2.72 |
| Tudor et al. (2002)[c] | Delaware Estuary, 1994-98 | Willingness to pay for an additional fish caught per trip | Bottom fish (weakfish)<br>Small game fish (striped bass)<br>Flatfish (flounder) | $11.50<br>$18.14<br>$3.92 |

[a] Value was reported as "two month value per angler for a half fish catch increase per trip." From 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S. DOI, 1997), the average saltwater angler takes 1.5 trips in a 2 month period. Therefore, to convert to a "1 fish per trip" value EPA divided the 2 month value by 1.5 trips and then multiplied it by 2, assuming the value of a fish was linear.
[b] These values were reported as "consumer surplus for an 20 percent increase in catch rate for all fish." The average catch rate was 4.95 fish per trip, therefore a 20 percent increase in catch is equivalent to 1 more fish.
[c] Tudor et al. (2002) refers to this document; see Chapter B-5.

McConnell and Strand (1994) estimated fishery values for the mid- and south Atlantic states using data from the National Marine Fisheries Statistical Survey. They created a random utility model of fishing behavior for nine states, the northernmost being New York and the southernmost being eastern Florida. The New York values are used here, as they are the closest geographically to Brayton Point Station. In this model they specified four categories of fish: small gamefish (e.g., striped bass), flatfish (e.g., flounder), bottomfish (e.g., weakfish, spot, Atlantic croaker, perch), and big gamefish (e.g., shark). For each state and fish category, they estimated per angler values for access to marine waters and for an increase in catch rates.

Hicks et al. (1999) used the same methodology as McConnell and Strand (1994) but estimated values for a day of fishing and an increase in catch rates for the Atlantic states from Virginia north to Maine. Their estimates were generally lower than those of McConnell and Strand (1994) and may serve as a lower bound for the values of fish.

Agnello (1989) estimated one value for increased weakfish catch rates in all the Atlantic states. This study is useful because it values weakfish specifically, but the area considered ranges from Florida to Maine. This greater area may differ from Mount Hope Bay, where weakfish is a relatively important recreational species.

Tudor et al. (2002; See chapter B-5 of this document) applied a random utility model (RUM) to the recreational fishery impacts associated with I&E in the Delaware transitional estuary. The methods, data, and results of the Tudor et al. (2002; See chapter B-5 of this document) study are discussed in greater detail in Chapters A-10 and B-5 of this document. The willingness to pay (WTP) estimates derived by this study were not available at the time that the benefits transfer approach was applied to this case study, therefore the results developed below do not reflect these estimated values. However, the Tudor et al. (2002; See chapter B-5 of this document) values are consistent with – and for bottom fish and small game fish, somewhat higher than -- the other values cited from the literature and used in this benefits transfer analysis. The Tudor et al. values will be included in subsequent updates of this case study analysis.

## F4-2.2 Economic Values of Recreational Fishery Losses Resulting from I&E at Brayton Point Station

EPA estimated the average annual economic value of Brayton Point I&E impacts to recreational fisheries using the I&E estimates presented in Tables F4-2 and F4-3 and the economic values presented in Table F4-4. Since none of the studies in Table F4-4 consider fishing in Mount Hope Bay directly, EPA established a lower and upper value for each impacted recreational species to estimate a unit value for recreational landings. Results are displayed in Tables F4-5 and F4-6, for impingement and entrainment, respectively. The estimated total losses to the recreational fisheries range from $1,100 to $1,700 for impingement per year, and from $22,600 to $38,800 annually for entrainment.

**Table F4-5: Average Annual Impingement of Recreational Fishery Species at Brayton Point Station and Associated Economic Values Based on the Impingement Data in Table F4-2**

| Species | Loss to Recreational Catch from Impingement (# of fish) | Recreational Value/Fish | | Loss in Recreational Value from Impingement | |
|---|---|---|---|---|---|
| | | Low | High | Low | High |
| Tautog | 105 | $3.61 | $9.54 | $380 | $1,005 |
| Weakfish | 118 | $2.40 | $2.72 | $289 | $321 |
| White perch | 16 | $2.40 | $2.54 | $38 | $40 |
| Winter flounder | 69 | $5.04 | $5.35 | $350 | $371 |
| Total | 308 | | | $1,056 | $1,737 |

Wed Feb 13 13:11:28 MST 2002; TableB: recreational losses and value for selected species; Plant: brayton.projected; type: I
Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableB.rec.losses.brayton.projected.I.csv

**Table F4-6: Average Annual Entrainment of Recreational Fishery Species at Brayton Point Station and Associated Economic Values Based on the Entrainment Data in Table F4-3**

| Species | Loss to Recreational Catch from Entrainment (number of fish) | Recreational Value/Fish | | Annual Loss in Recreational Value from Entrainment ($2000) | |
|---|---|---|---|---|---|
| | | Low | High | Low | High |
| Scup | 20 | $2.40 | $2.54 | $49 | $52 |
| Tautog | 2,583 | $3.61 | $9.54 | $9,313 | $24,642 |
| Weakfish | 97 | $2.40 | $2.72 | $237 | $263 |
| Winter flounder | 2,586 | $5.04 | $5.35 | $13,041 | $13,838 |
| Total | 5,287 | | | $22,641 | $38,794 |

Wed Feb 13 13:11:34 MST 2002; TableB: recreational losses and value for selected species; Plant: brayton.projected; type: E
Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableB.rec.losses.brayton.projected.E.csv

# F4-3 Economic Value of Average Annual Commercial Fishery Losses Resulting from I&E at Brayton Point Station

## F4-3.1 Average Annual I&E Losses of Commercial Yield at Brayton Point and Economic Value of Losses

I&E losses to commercial catch (pounds) are presented in Tables F4-2 (for impingement) and F4-3 (for entrainment) based on the commercial and recreational splits listed in Table F4-1. EPA estimates of the economic value of these losses are displayed in Tables F4-7 and F4-8 for impingement and entrainment, respectively. Market values per pound are listed as well as the total market losses experienced by the commercial fishery. Values for commercial fishing are relatively straightforward because commercially caught fish are a commodity with a market price. The estimates of market loss to commercial fisheries are $2,700 for impingement per year, and $69,300 annually for entrainment.

**Table F4-7: Average Annual Impingement of Commercial Fishery Species at Brayton Point Station and Associated Economic Values Based on the Impingement Data in Table F4-2**

| Species | Loss to Commercial Catch from Impingement (lb of fish) | Commercial Value (lb of fish) | Annual Loss in Commercial Value from Impingement ($2000) |
|---|---|---|---|
| Butterfish | 7 | $0.66 | $5 |
| Atlantic menhaden | 308 | $0.04 | $14 |
| Rainbow smelt | 1 | $0.19 | $0 |
| Silver hake | 2,196 | $0.33 | $714 |
| Tautog | 93 | $0.71 | $66 |
| Weakfish | 21 | $0.75 | $16 |
| White perch | 20 | $1.39 | $28 |
| Windowpane | 122 | $0.56 | $68 |
| Winter flounder | 1,347 | $1.34 | $1,803 |
| Total | 4,116 | | $2,713 |

Wed Feb 13 13:11:29 MST 2002; TableC: commercial losses and value for selected species; Plant: brayton.projected; type: I
Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableC.comm.losses.brayton.projected.I.csv

**Table F4-8: Average Annual Entrainment of Commercial Fishery Species at Brayton Point Station and Associated Economic Values Based on the Entrainment Data in Table F4-3**

| Species | Loss to Commercial Catch from Entrainment (lb of fish) | Commercial Value (lb of fish) | Annual Loss in Commercial Value from Entrainment ($2000) |
|---|---|---|---|
| Atlantic menhaden | 1,236 | $0.04 | $55 |
| Rainbow smelt | 56 | $0.19 | $11 |
| Scup | 29 | $0.81 | $24 |
| Silver hake | 1 | $0.33 | $0 |
| Tautog | 2,284 | $0.71 | $1,614 |
| Weakfish | 17 | $0.75 | $13 |
| Windowpane | 683 | $0.56 | $382 |
| Winter flounder | 50,237 | $1.34 | $67,222 |
| Total | 54,542 | | $69,321 |

Wed Feb 13 13:11:34 MST 2002; TableC: commercial losses and value for selected species; Plant: brayton.projected; type: E
Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableC.comm.losses.brayton.projected.E.csv

## F4-3.2 Economic Surplus Impacts of Commercial Landings Losses

EPA expressed changes to commercial activity thus far as changes from dockside market landings. However, to determine the total impact on economic surplus from changes to the commercial fishery, EPA determined the losses experienced by producers wholesalers, retailers, and consumers.

The total social benefits (economic surplus) are greater than the increase in dockside landings, because the increased landings by commercial fishermen contribute to economic surplus in each of a multi-tiered set of markets for commercial fish. The total economic surplus impact thus is valued by examining the multi-tiered markets through which the landed fish are sold, according to the methods and data detailed in Chapter A9.

The first step of the analysis involves a fishery-based assessment of I&E-related changes in commercial landings (pounds of commercial species as sold dockside by commercial harvesters). The results of this dockside landings value step are described above. The next steps then entail tracking the anticipated additional economic surplus generated as the landed fish pass from dockside transactions to other wholesalers, retailers and, ultimately, consumers. The resulting total economic surplus measures include producer surplus to the watermen who harvest the fish, as well as the rents and consumer surplus that accrue to buyers and sellers in the sequence of market transactions that apply in the commercial fishery context.

To estimate producer surplus from the landings values, EPA relied on empirical results from various researchers that can be used to infer producer surplus for watermen based on gross revenues (landings times wholesale price). The economic literature (Huppert, 1990; Rettig and McCarl, 1985) suggests that producer surplus values for commercial fishing ranges from 50 to 90 percent of the market value. In assessments of Great Lakes fisheries, an estimate of approximately 40% has been derived as the relationship between gross revenues and the surplus of commercial fishermen (Cleland and Bishop, 1984, Bishop, personal communication, 2002). For the purposes of this study, EPA believes producer surplus to watermen is probably in the range of 40% to 70% of dockside landings values.

Producer surplus is one portion of the total economic surplus impacted by increased commercial stocks — the total benefits are comprised of the economic surplus to producers, wholesalers, processors, retailers, and consumers. Primary empirical research deriving “multi-market” welfare measures for commercial fisheries have estimated that surplus accruing to commercial anglers amount to approximately 22% of the total surplus accruing to watermen, retailers and consumers combined (Norton et al., 1983; Holt and Bishop, 2002). Thus, total economic surplus across the relevant commercial fisheries multi-tiered markets can be estimated as approximately 4.5 times greater than producer surplus alone (given that producer surplus is roughly 22% of the total surplus generated). This relationship is applied in the case studies to estimate total surplus from the projected changes in commercial landings.

Applying this method, estimates of the economic loss to commercial fisheries resulting from I&E at Brayton Point Station ranges from $4,900 to $8,600 per year for impingement and from $126,000 to $220,600 per year for entrainment.

## F4-4 Economic Value of Forage Fish Losses

Many species affected by I&E are not commercially or recreationally fished. For the purposes in this study, EPA referred to these species as forage fish. Forage fish are species that are prey for other species and are important components of aquatic food webs. Table F4-9 summarizes impingement losses of forage species at Brayton Point Station and Table F4-10 summaries entrainment losses. The following sections discuss the economic valuation of these losses using two alternative valuation methods.

**Table F4-9: Summary of Brayton Point's Mean Annual Impingement of Forage Species**

| Species | Impingement Count (#) | Age 1 Equivalents (#) | Production Forgone (lb) |
|---|---|---|---|
| Alewife | 5,998 | 8,855 | 168 |
| Atlantic silverside | 4,784 | 9,113 | 2 |
| Bay anchovy | 3,350 | 6,090 | 1 |
| Hogchoker | 6,984 | 12,968 | 6 |
| Striped killifish | 418 | 572 | 4 |
| Threespine stickleback | 1,697 | 2,732 | 1 |
| Total | 23,231 | 40,330 | 181 |

**Table F4-10: Summary of Brayton Point's Mean Annual Entrainment of Forage Species**

| Species | Entrainment Count (#) | Age 1 Equivalents (#) | Production Foregone (lb) |
|---|---|---|---|
| Alewife | 1,076,500 | 460 | 584 |
| American sand lance | 84,520,243 | 453,236 | 1,737 |
| Atlantic silverside | 18,759,840 | 7,999 | 8,748 |
| Bay anchovy | 10,214,225,528 | 1,231,050 | 1,501,808 |
| Hogchoker | 106,615,903 | 34,148 | 81,576 |
| Seaboard goby | 462,170,823 | 1,513,836 | 894 |
| Threespine stickleback | 16,750 | 653 | 28 |
| Total | 10,887,385,587 | 3,241,381 | 1,595,375 |

### Replacement cost of fish

The replacement value of fish can be used in several instances. First, if a fish kill of a fishery species is mitigated by stocking of hatchery fish, then losses to the commercial and recreational fisheries would be reduced, but fish replacement costs would still be incurred and should be accounted for. Second, if the fish are not caught in the commercial or recreational fishery, but are important as forage or bait, the replacement value can be used as a lower bound estimate of their value (it is a lower bound because it would not consider how reduction in their stock may affect other species' stocks). Third, where there are not enough data to allow calculation of value losses to the recreational and commercial fisheries, replacement cost can be used as a proxy for lost fishery values. Typically the consumer or producer surplus is greater than fish replacement costs, and replacement costs typically omit problems associated with restocking programs (e.g., limiting genetic diversity).

The cost of replacing forage fish lost to I&E has two main components. The first component is the cost of raising the replacement fish. Table F4-11 displays the replacement costs of two of the forage fish species known to be impinged or entrained at Brayton Point. The costs are average costs to fish hatcheries across North America to produce different species of fish for stocking. The second component of replacement cost is the transportation cost, which includes costs associated with vehicles, personnel, fuel, water, chemicals, containers, and nets. The AFS (1993) estimates these costs at approximately

$1.13 per mile, but does not indicate how many fish (or how many pounds of fish) are transported for this price. Lacking relevant data, EPA does not include the transportation costs in this valuation approach.

Table F4-11 also presents the computed values of the annual average forage replacement cost losses. The value of the losses of forage species using the replacement cost method is $400 per year for impingement and $17,900 per year for entrainment.

**Table F4-11: Replacement Cost of Various Forage Fish Species at Brayton Point Station**

| Species | Hatchery Costs[a] ($/lb) | Annual Cost of Replacing Forage Losses ($2000) | |
|---|---|---|---|
| | | Impingement | Entrainment |
| Alewife | 0.34[b] | $133 | $7 |
| American sand lance | 0.34[b] | $0 | $591 |
| Atlantic silverside | 0.34[b] | $64 | $56 |
| Bay anchovy | $3.51 | $79 | $16,004 |
| Hogchoker | 0.34[b] | $50 | $131 |
| Seaboard goby | 0.34[b] | $0 | $1,055 |
| Striped killifish | 0.34[b] | $7 | $0 |
| Threespine stickleback | $2.58 | $65 | $15 |
| Total | | $398 | $17,860 |

[a] Values are from AFS (1993). These values were inflated to 2000$ from 1989$, but this could be imprecise for current fish rearing and stocking costs.
[b] Individual species value is not available and thus an average of all species is used.
Wed Feb 13 13:11:29 MST 2002; TableD: loss in selected forage species; Plant: brayton.projected; type: I Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableD.forage.eco.ter.repl.brayton.projected.I.csv

## Production foregone value of forage fish

This approach considers the foregone production of commercial and recreational fishery species resulting from I&E of forage species based on estimates of trophic transfer efficiency, as discussed in Chapter A5 of Part A of this document. The economic valuation of forage losses is based on the dollar value of the foregone fishery yield resulting from these losses. Results for impingement of forage species at Brayton Point range from $73 to $204, and results for entrainment range from $3,400 to $4,700 per year (Table F4-12). The values listed are obtained by converting the forage species into species that may be commercially or recreationally valued.

**Table F4-12: Mean Annual Value of Production Foregone of Selected Fishery Species Resulting From Entrainment of Forage Species at Brayton Point Station Based on the Entrainment Data in Table F4-10**

| Species | Annual Loss in Production Foregone Value from Entrainment of Forage Species ($2000) | |
|---|---|---|
| | Low | High |
| Atlantic menhaden | $1 | $1 |
| Rainbow smelt | $19 | $33 |
| Scup | $3,149 | $4,352 |
| Silver hake | $13 | $23 |
| Tautog | $1 | $2 |
| Weakfish | $1 | $1 |
| Windowpane | $16 | $27 |
| Winter flounder | $182 | $307 |
| Total | $3,381 | $4,747 |

Wed Feb 13 13:11:35 MST 2002; TableD: loss in selected forage species; Plant: brayton.projected; type: E Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableD.forage.eco.ter.repl.brayton.projected.E.csv

## F4-5 NONUSE VALUES

Recreational consumer surplus and commercial impacts are only part of the total losses that the public realizes from I&E impacts on fisheries. Nonuse or passive use impacts arise when individuals value environmental changes apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Using a "rule of thumb" that nonuse impacts are at least equivalent to 50 percent of the recreational use impact (see Chapter A9 for further discussion), EPA estimated nonuse values for baseline losses at Brayton to range from $500 to $900 per year for impingement and from $11,300 to $19,400 per year for entrainment.

## F4-6 SUMMARY OF MEAN ANNUAL ECONOMIC VALUE OF I&E AT BRAYTON POINT STATION

Table F4-13 summarizes the economic values associated with mean annual I&E at Brayton Point Station. Total impacts range from $6,500 to $11,600 per year for impingement and from $163,400 to $296,600 per year for entrainment.

**Table F4-13: Summary of Economic Valuation of Mean Annual I&E at Brayton Point Station ($2000)**

| | | Impingement | Entrainment | Total |
|---|---|---|---|---|
| Commercial: Total Surplus (Direct Use, Market) | Low | $4,934 | $126,039 | $130,973 |
| | High | $8,634 | $220,568 | $229,202 |
| Recreational (Direct Use, Nonmarket) | Low | $1,056 | $22,641 | $23,697 |
| | High | $1,737 | $38,794 | $40,531 |
| Nonuse (Passive Use, Nonmarket) | Low | $528 | $11,320 | $11,849 |
| | High | $869 | $19,397 | $20,266 |
| Forage (Indirect Use, Nonmarket) | | | | |
| Production Foregone | Low | $73 | $3,381 | $3,381 |
| | High | $204 | $4,747 | $4,747 |
| Replacement | | $398 | $17,860 | $18,257 |
| Total (Com + Rec + Nonuse + Forage)[a] | Low | $6,591 | $163,382 | $169,899 |
| | High | $11,637 | $296,620 | $308,257 |

[a] In calculating the total low values, the lower of the two forage valuation methods (production foregone and replacement) was used and to calculate the total high values, the higher of the two forage valuation methods was used.
Wed Feb 13 13:11:36 MST 2002; TableE.summary; Plant: brayton.projected; Pathname: P:/Intake/Brayton/Brayton_Science/scodes/tables.output.projected01/TableE.summary.brayton.projected.csv