Part F: The Great Lakes

Chapter F1: Background

Introduction

This chapter presents an overview of the potential Phase III existing facilities in the Great Lakes study region and summarizes their key cooling water and compliance characteristics. For further discussion of the technical and compliance characteristics of potential Phase III existing facilities, refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* and the *Technical Development Document for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a,c).

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F1-1   Facility Characteristics

The Great Lakes Regional Study includes 17 sample facilities that are potentially subject to the national standards for Phase III existing facilities. Figure F1-1 presents a map of these facilities. Thirteen of them are manufacturing facilities and four are electric generators. Industry-wide, these 17 sample facilities represent 43 facilities.[1]

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[1] EPA applied sample weights to the survey respondents to account for non-sampled facilities and facilities that did not respond to the survey. For more information on EPA's 2000 Section 316(b) Industry Survey, please refer to the Information Collection Request (U.S. EPA, 2000b).

Figure F1-1: Potential Existing Phase III Facilities in the Great Lakes Regional Study[a]
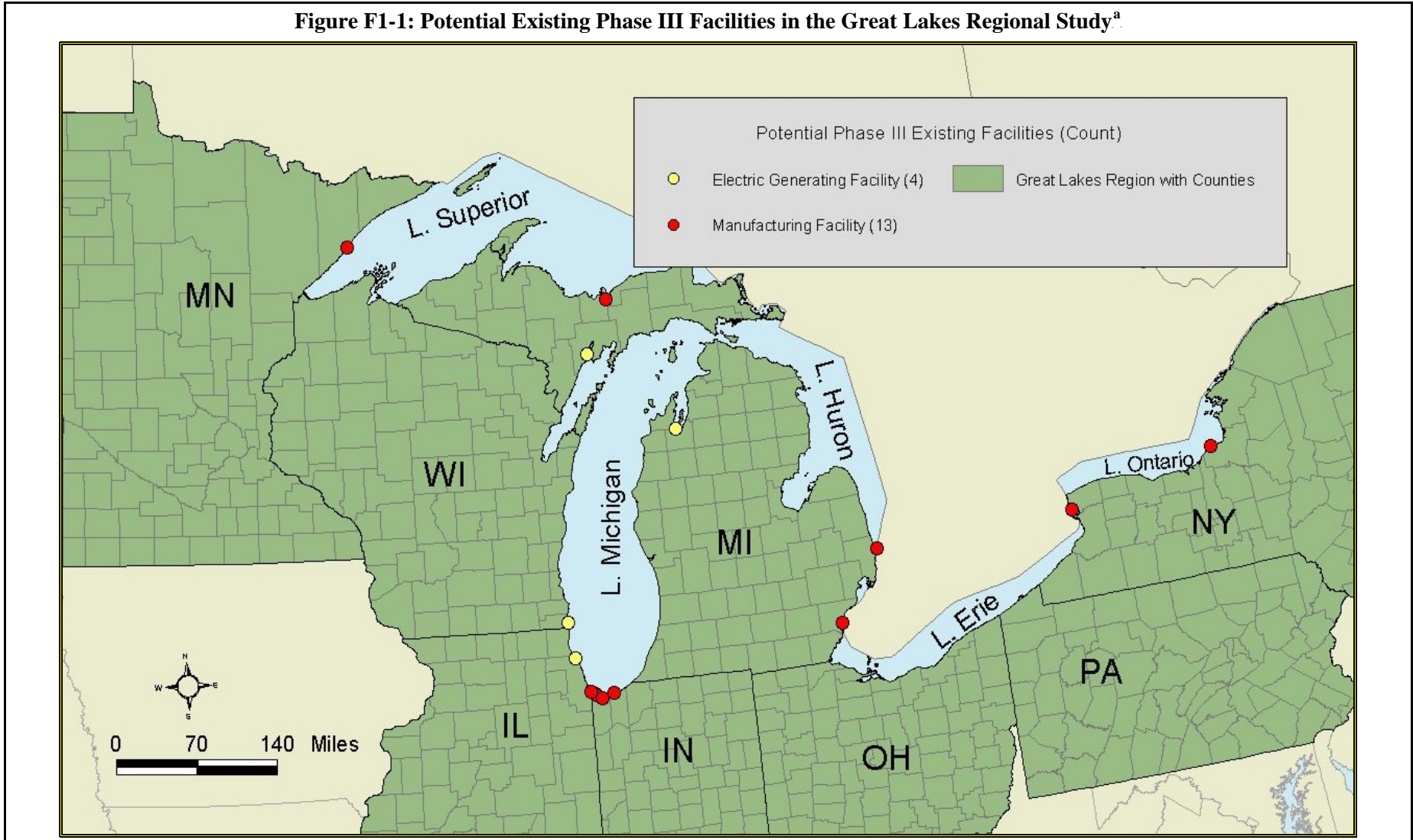
[a] The map includes locations of sample facilities only.

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

Table F1-1 summarizes key technical and compliance characteristics for all potentially regulated Phase III existing facilities in the Great Lakes study region for the regulatory options considered by EPA for this rule (the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option). Facilities with a design intake flow below the three applicability thresholds would be subject to permitting based on best professional judgment and are excluded from EPA's analyses.[2] Therefore, a different number of facilities is affected under each option.

Table F1-1 shows that 43 Phase III existing facilities in the Great Lakes study region would potentially be subject to the national requirements. Under the "50 MGD for All Waterbodies" option, the most inclusive of the regulatory options, 22 facilities would be subject to the national requirements for Phase III existing facilities. Under the less inclusive "200 MGD for All Waterbodies" option, nine facilities would be subject to the national requirement, and under the "100 MGD for Certain Waterbodies" option, eleven facilities would be subject to the national requirements. One facility in the Great Lakes study region has a recirculating system in the baseline.

Table F1-1: Technical and Compliance Characteristics of Existing Phase III Facilities (sample-weighted)				
	All Potentially Regulated Facilities	**Regulatory Options**		
		50 MGD All	**200 MGD All**	**100 MGD CWB**
Total Number of Facilities (sample-weighted) [a]	**43**	**22**	**9**	**11**
Number of Facilities with Recirculating System in Baseline	**1**	**-**	**-**	**-**
Design Intake Flow (MGD)	**2,610**	**2,421**	**w** [b]	**2,214**
Number of Facilities by Compliance Response				
Fine mesh traveling screens with fish H&R	5	5	4	5
Velocity cap	1	-	-	-
New larger intake structure with fine mesh and fish H&R	4	4	-	-
Passive fine mesh screens	11	9	3	4
None	21	4	1	1
Compliance Cost, Discounted at 3% [c]	$20.58	$9.74	$4.41	$5.28
Compliance Cost, Discounted at 7% [c]	$22.32	$9.84	$4.10	$4.99

[a] Total may not equal compliance response subtotal due to rounding.
[b] Data withheld because of confidentiality reasons.
[c] Annualized pre-tax compliance cost (2004$, millions).

Sources: U.S. EPA, 2000b; U.S. EPA analysis for this report.

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[2] Also excluded are facilities that are estimated to be baseline closures. For additional information on EPA's baseline closure analyses, please refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a).

Appendix F1: Life History Parameter Values Used to Evaluate I&E in the Great Lakes Region

The tables in this appendix summarize the life history parameter values used by EPA to calculate age-1 equivalents and fishery yield from impingement and entrainment (I&E) data for the Great Lakes region.

	Table F1-1: Alewife Life History Parameters			
Stage Name	**Instantaneous Natural Mortality (M)**	**Instantaneous Fishing Mortality (F)**	**Fraction Vulnerable to Fishery**	**Weight (lbs)**
Eggs	11.5	0	0	0.00000128
Larvae	5.50	0	0	0.00000141
Juvenile	6.21	0	0	0.00478
Age 1+	0.500	0	0	0.0160
Age 2+	0.500	0	0	0.0505
Age 3+	0.500	0	0	0.0764
Age 4+	0.500	0	0	0.0941
Age 5+	0.500	0	0	0.108
Age 6+	0.500	0	0	0.130
Age 7+	0.500	0	0	0.149

Sources: Spigarelli et al., 1981; PG&E National Energy Group, 2001; Froese and Pauly, 2003; and NMFS, 2003a.

Table F1-2: Bass Species (*Micropterus* spp.) Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000731
Larvae	2.70	0	0	0.0000198
Juvenile	0.446	0	0	0.0169
Age 1+	0.860	0	0	0.202
Age 2+	1.17	0.32	0.50	0.518
Age 3+	0.755	0.21	1.0	0.733
Age 4+	1.05	0.29	1.0	1.04
Age 5+	0.867	0.24	1.0	1.44
Age 6+	0.867	0.24	1.0	2.24
Age 7+	0.867	0.24	1.0	2.56
Age 8+	0.867	0.24	1.0	2.92
Age 9+	0.867	0.24	1.0	3.30

[a] Includes largemouth bass, smallmouth bass, and other sunfish not identified to species level.

Sources: Scott and Crossman, 1973; Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-3: Black Bullhead Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000312
Larvae	4.61	0	0	0.000186
Juvenile	1.39	0	0	0.00132
Age 1+	0.446	0	0	0.0362
Age 2+	0.223	0.22	0.50	0.0797
Age 3+	0.223	0.22	1.0	0.137
Age 4+	0.223	0.22	1.0	0.233
Age 5+	0.223	0.22	1.0	0.402
Age 6+	0.223	0.22	1.0	0.679
Age 7+	0.223	0.22	1.0	0.753
Age 8+	0.223	0.22	1.0	0.815
Age 9+	0.223	0.22	1.0	0.823

Sources: Carlander, 1969; Scott and Crossman, 1973; Geo-Marine, Inc., 1978; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-4: Black Crappie Life History Parameter

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.80	0	0	0.000000929
Larvae	0.498	0	0	0.00000857
Juvenile	2.93	0	0	0.0120
Age 1+	0.292	0	0	0.128
Age 2+	0.292	0.29	0.50	0.193
Age 3+	0.292	0.29	1.0	0.427
Age 4+	0.292	0.29	1.0	0.651
Age 5+	0.292	0.29	1.0	0.888
Age 6+	0.292	0.29	1.0	0.925
Age 7+	0.292	0.29	1.0	0.972
Age 8+	0.292	0.29	1.0	1.08
Age 9+	0.292	0.29	1.0	1.26

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-5: Bluegill Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.73	0	0	0.00000130
Larvae	0.576	0	0	0.00000156
Juvenile	4.62	0	0	0.00795
Age 1+	0.390	0	0	0.00992
Age 2+	0.151	0	0	0.0320
Age 3+	0.735	0.74	0.50	0.0594
Age 4+	0.735	0.74	1.0	0.104
Age 5+	0.735	0.74	1.0	0.189
Age 6+	0.735	0.74	1.0	0.193
Age 7+	0.735	0.74	1.0	0.209
Age 8+	0.735	0.74	1.0	0.352
Age 9+	0.735	0.74	1.0	0.393

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-6: Brown Bullhead Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000115
Larvae	4.61	0	0	0.0000192
Juvenile	1.39	0	0	0.00246
Age 1+	0.446	0	0	0.0898
Age 2+	0.223	0.22	0.50	0.172
Age 3+	0.223	0.22	1.0	0.278
Age 4+	0.223	0.22	1.0	0.330
Age 5+	0.223	0.22	1.0	0.570
Age 6+	0.223	0.22	1.0	0.582

Sources: Carlander, 1969; Geo-Marine, Inc., 1978; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-7: Bullhead Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000312
Larvae	4.61	0	0	0.000186
Juvenile	1.39	0	0	0.00132
Age 1+	0.446	0	0	0.0362
Age 2+	0.223	0.22	0.50	0.0797
Age 3+	0.223	0.22	1.0	0.137
Age 4+	0.223	0.22	1.0	0.233
Age 5+	0.223	0.22	1.0	0.402
Age 6+	0.223	0.22	1.0	0.679
Age 7+	0.223	0.22	1.0	0.753
Age 8+	0.223	0.22	1.0	0.815
Age 9+	0.223	0.22	1.0	0.823

[a] Includes black bullhead, stonecat, tadpole madtom, yellow bullhead, and other bullheads not identified to species level.

Sources: Carlander, 1969; Scott and Crossman, 1973; Geo-Marine, Inc., 1978; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-8: Burbot Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000154
Larvae	7.13	0	0	0.00000160
Juvenile	0.916	0	0	0.0154
Age 1+	0.562	0	0	0.129
Age 2+	0.562	0	0	0.513
Age 3+	0.562	0	0	0.842
Age 4+	0.562	0	0	1.23
Age 5+	0.562	0	0	1.99
Age 6+	0.562	0	0	2.68
Age 7+	0.562	0	0	2.97
Age 8+	0.562	0	0	3.35
Age 9+	0.562	0	0	3.57
Age 10+	0.562	0	0	4.09

Sources: Schram et al., 1998; Scott and Crossman, 1998; Snyder, 1998; and NMFS, 2003a.

Table F1-9: Carp Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000673
Larvae	4.61	0	0	0.0000118
Juvenile	1.39	0	0	0.0225
Age 1+	0.130	0	0	0.790
Age 2+	0.130	0	0	1.21
Age 3+	0.130	0	0	1.81
Age 4+	0.130	0	0	5.13
Age 5+	0.130	0	0	5.52
Age 6+	0.130	0	0	5.82
Age 7+	0.130	0	0	6.76
Age 8+	0.130	0	0	8.17
Age 9+	0.130	0	0	8.55
Age 10+	0.130	0	0	8.94
Age 11+	0.130	0	0	9.76
Age 12+	0.130	0	0	10.2
Age 13+	0.130	0	0	10.6
Age 14+	0.130	0	0	11.1
Age 15+	0.130	0	0	11.5
Age 16+	0.130	0	0	12.0
Age 17+	0.130	0	0	12.5

[a] Includes bowfin, carp, goldfish, and other similar carps not identified to species level.

Sources: Carlander, 1969; Geo-Marine, Inc., 1978; Wang, 1986; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-10: Carp/Minnow Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000115
Larvae	2.06	0	0	0.000375
Juvenile	2.06	0	0	0.00208
Age 1+	1.00	0	0	0.00585
Age 2+	1.00	0	0	0.0121
Age 3+	1.00	0	0	0.0171

[a] Includes bluntnose minnow, fathead minnow, hornyhead chub, lake chub, longnose dace, and other similar minnows not identified to species level.

Sources: Carlander, 1969; Froese and Pauly, 2001; NMFS, 2003a; and Ohio Department of Natural Resources, 2003.

Table F1-11: Crappie Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.80	0	0	0.000000929
Larvae	0.498	0	0	0.00000857
Juvenile	2.93	0	0	0.0120
Age 1+	0.292	0	0	0.128
Age 2+	0.292	0.29	0.50	0.193
Age 3+	0.292	0.29	1.0	0.427
Age 4+	0.292	0.29	1.0	0.651
Age 5+	0.292	0.29	1.0	0.888
Age 6+	0.292	0.29	1.0	0.925
Age 7+	0.292	0.29	1.0	0.972
Age 8+	0.292	0.29	1.0	1.08
Age 9+	0.292	0.29	1.0	1.26

[a] Includes white crappie and other crappies not identified to the species level.

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-12: Freshwater Catfish Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000539
Larvae	4.61	0	0	0.0000563
Juvenile	1.39	0	0	0.0204
Age 1+	0.410	0.41	0.50	0.104
Age 2+	0.410	0.41	1.0	0.330
Age 3+	0.410	0.41	1.0	0.728
Age 4+	0.410	0.41	1.0	1.15
Age 5+	0.410	0.41	1.0	1.92
Age 6+	0.410	0.41	1.0	2.41
Age 7+	0.410	0.41	1.0	3.45
Age 8+	0.410	0.41	1.0	4.01
Age 9+	0.410	0.41	1.0	5.06
Age 10+	0.410	0.41	1.0	8.08
Age 11+	0.410	0.41	1.0	8.39
Age 12+	0.410	0.41	1.0	8.53

[a] Includes channel catfish and flathead catfish.

Sources: Miller, 1966; Carlander, 1969; Geo-Marine, Inc., 1978; Wang, 1986; Saila et al., 1997; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-13: Freshwater Drum Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.27	0	0	0.00000115
Larvae	6.13	0	0	0.00000295
Juvenile	2.30	0	0	0.0166
Age 1+	0.310	0	0	0.0500
Age 2+	0.155	0.16	0.50	0.206
Age 3+	0.155	0.16	1.0	0.438
Age 4+	0.155	0.16	1.0	0.638
Age 5+	0.155	0.16	1.0	0.794
Age 6+	0.155	0.16	1.0	0.950
Age 7+	0.155	0.16	1.0	1.09
Age 8+	0.155	0.16	1.0	1.26
Age 9+	0.155	0.16	1.0	1.44
Age 10+	0.155	0.16	1.0	1.60
Age 11+	0.155	0.16	1.0	1.78
Age 12+	0.155	0.16	1.0	2.00

Sources: Scott and Crossman, 1973; Virginia Tech, 1998; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-14: Gizzard Shad Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.000000487
Larvae	6.33	0	0	0.00000663
Juvenile	0.511	0	0	0.0107
Age 1+	1.45	0	0	0.141
Age 2+	1.27	0	0	0.477
Age 3+	0.966	0	0	0.640
Age 4+	0.873	0	0	0.885
Age 5+	0.303	0	0	1.17
Age 6+	0.303	0	0	1.54

[a] Includes gizzard shad and other shad not identified to species level.

Sources: Wapora, 1979; Froese and Pauly, 2003; and NMFS, 2003a.

Table F1-15: Logperch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000260
Larvae	1.90	0	0	0.000512
Juvenile	1.90	0	0	0.00434
Age 1+	0.700	0	0	0.0132
Age 2+	0.700	0	0	0.0251
Age 3+	0.700	0	0	0.0377

Sources: Carlander, 1997; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-16: Pike Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.08	0	0	0.0000189
Larvae	5.49	0	0	0.0133
Juvenile	5.49	0	0	0.0451
Age 1+	0.150	0	0	0.365
Age 2+	0.150	0	0	1.10
Age 3+	0.150	0	0	1.53
Age 4+	0.150	0	0	2.72
Age 5+	0.150	0	0	6.19
Age 6+	0.150	0	0	7.02
Age 7+	0.150	0	0	8.92
Age 8+	0.150	0	0	12.3
Age 9+	0.150	0	0	13.9
Age 10+	0.075	0.08	0.50	16.6
Age 11+	0.075	0.08	1.0	19.0
Age 12+	0.075	0.08	1.0	24.2
Age 13+	0.075	0.08	1.0	25.3
Age 14+	0.075	0.08	1.0	30.0
Age 15+	0.075	0.08	1.0	32.4
Age 16+	0.075	0.08	1.0	34.3
Age 17+	0.075	0.08	1.0	45.6
Age 18+	0.075	0.08	1.0	45.8
Age 19+	0.075	0.08	1.0	47.7
Age 20+	0.075	0.08	1.0	48.8
Age 21+	0.075	0.08	1.0	48.9
Age 22+	0.075	0.08	1.0	49.0
Age 23+	0.075	0.08	1.0	49.1
Age 24+	0.075	0.08	1.0	49.2
Age 25+	0.075	0.08	1.0	49.3
Age 26+	0.075	0.08	1.0	49.4
Age 27+	0.075	0.08	1.0	49.4

[a] Includes grass pickerel, muskellunge, and northern pike.

Sources: Carlander, 1969; Pennsylvania, 1999; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-17: Rainbow Smelt Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	11.5	0	0	0.000000990
Larvae	5.50	0	0	0.00110
Juvenile	0.916	0	0	0.00395
Age 1+	0.400	0	0	0.0182
Age 2+	0.400	0.03	0.50	0.0460
Age 3+	0.400	0.03	1.0	0.0850
Age 4+	0.400	0.03	1.0	0.131
Age 5+	0.400	0.03	1.0	0.180
Age 6+	0.400	0.03	1.0	0.228

Sources: Spigarelli et al., 1981; PG&E National Energy Group, 2001; Froese and Pauly, 2003; and NMFS, 2003a.

Table F1-18: Redhorse Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000115
Larvae	2.30	0	0	0.00000370
Juvenile	2.99	0	0	0.0267
Age 1+	0.548	0	0	0.0521
Age 2+	0.548	0	0	0.180
Age 3+	0.548	0	0	0.493
Age 4+	0.548	0	0	0.653
Age 5+	0.548	0	0	0.916
Age 6+	0.548	0	0	2.78
Age 7+	0.548	0	0	3.07

[a] Includes golden redhorse, shorthead redhorse, and silver redhorse.

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table F1-19: Salmonids Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000240
Larvae	8.20	0	0	0.000171
Juvenile	0.250	0	0	0.0117
Age 1+	0.250	1.0	0.50	0.705
Age 2+	0.250	1.0	1.0	1.27
Age 3+	0.250	1.0	1.0	2.32
Age 4+	0.250	1.0	1.0	2.85
Age 5+	0.250	1.0	1.0	3.52
Age 6+	0.250	1.0	1.0	4.09
Age 7+	0.250	1.0	1.0	4.76
Age 8+	0.250	1.0	1.0	5.70
Age 9+	0.250	1.0	1.0	5.73
Age 10+	0.250	1.0	1.0	5.85
Age 11+	0.250	1.0	1.0	6.10
Age 12+	0.250	1.0	1.0	6.83
Age 13+	0.250	1.0	1.0	7.11
Age 14+	0.250	1.0	1.0	7.29
Age 15+	0.250	1.0	1.0	7.32
Age 16+	0.250	1.0	1.0	8.66

[a] Includes bloater, brown trout, chinook salmon, coho salmon, lake herring, lake trout, lake whitefish, rainbow trout, round whitefish, and other salmonids not identified to species level.

Sources: Fish, 1932; Schorfhaar and Schneeberger, 1997; Scott and Crossman, 1998; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-20: Shiner Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000473
Larvae	4.61	0	0	0.000285
Juvenile	0.777	0	0	0.00209
Age 1+	0.371	0	0	0.00387
Age 2+	4.61	0	0	0.00683
Age 3+	4.61	0	0	0.0143

[a] Includes common shiner, emerald shiner, golden shiner, spotfin shiner, spottail shiner, and other shiners not identified to species level.

Sources: Fuchs, 1967; Wapora, 1979; Trautman, 1981; Froese and Pauly, 2003; and NMFS, 2003a.

Table F1-21: Spotted Sucker Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.79	0	0	0.00000115
Larvae	2.81	0	0	0.00000198
Juvenile	3.00	0	0	0.0213
Age 1+	0.548	0	0	0.0863
Age 2+	0.548	0	0	0.690
Age 3+	0.548	0	0	1.24
Age 4+	0.548	0	0	1.70
Age 5+	0.548	0	0	1.92
Age 6+	0.548	0	0	1.99

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table F1-22: Sucker Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.05	0	0	0.0000312
Larvae	2.56	0	0	0.0000343
Juvenile	2.30	0	0	0.000239
Age 1+	0.274	0	0	0.0594
Age 2+	0.274	0	0	0.310
Age 3+	0.274	0	0	0.377
Age 4+	0.274	0	0	0.735
Age 5+	0.274	0	0	0.981
Age 6+	0.274	0	0	1.10

[a] Includes carpsucker buffalo, lake chubsucker, longnose sucker, northern hog sucker, quillback, white sucker, and other suckers not identified to species.

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2003; and NMFS, 2003a.

Table F1-23: Sunfish Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.71	0	0	0.00000115
Larvae	0.687	0	0	0.00000123
Juvenile	0.687	0	0	0.000878
Age 1+	1.61	0	0	0.00666
Age 2+	1.61	0	0	0.0271
Age 3+	1.50	1.5	0.50	0.0593
Age 4+	1.50	1.5	1.0	0.0754
Age 5+	1.50	1.5	1.0	0.142
Age 6+	1.50	1.5	1.0	0.180
Age 7+	1.50	1.5	1.0	0.214
Age 8+	1.50	1.5	1.0	0.232

[a] Includes green sunfish, orange-spotted sunfish, pumpkinseed, rock bass, warmouth, and other sunfish not identified to species.

Sources: Carlander, 1977; Wang, 1986; PSE&G, 1999; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-24: Walleye Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.05	0	0	0.00000619
Larvae	3.55	0	0	0.0000768
Juvenile	1.93	0	0	0.0300
Age 1+	0.431	0	0	0.328
Age 2+	0.161	0.27	0.50	0.907
Age 3+	0.161	0.27	1.0	1.77
Age 4+	0.161	0.27	1.0	2.35
Age 5+	0.161	0.27	1.0	3.37
Age 6+	0.161	0.27	1.0	3.97
Age 7+	0.161	0.27	1.0	4.66
Age 8+	0.161	0.27	1.0	5.58
Age 9+	0.161	0.27	1.0	5.75

Sources: Carlander, 1997; Bartell and Campbell, 2000; Thomas and Haas, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table F1-25: White Bass Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.000000396
Larvae	4.61	0	0	0.00000174
Juvenile	1.39	0	0	0.174
Age 1+	0.420	0	0	0.467
Age 2+	0.420	0.70	0.50	0.644
Age 3+	0.420	0.70	1.0	1.02
Age 4+	0.420	0.70	1.0	1.16
Age 5+	0.420	0.70	1.0	1.26
Age 6+	0.420	0.70	1.0	1.66
Age 7+	0.420	0.70	1.0	1.68

Sources: Van Oosten, 1942; Geo-Marine, Inc., 1978; Carlander, 1997; Virginia Tech, 1998; McDermot and Rose, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table F1-26: White Perch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.75	0	0	0.000000330
Larvae	5.37	0	0	0.00000271
Juvenile	1.71	0	0	0.00259
Age 1+	0.693	0	0	0.0198
Age 2+	0.693	0	0	0.0567
Age 3+	0.693	0	0	0.103
Age 4+	0.689	0	0	0.150
Age 5+	1.58	0	0	0.214
Age 6+	1.54	0	0	0.265
Age 7+	1.48	0	0	0.356
Age 8+	1.46	0	0	0.387
Age 9+	1.46	0	0	0.516
Age 10+	1.46	0	0	0.619

Sources: Horseman and Shirey, 1974; PSE&G, 1999; and NMFS, 2003a.

Table F1-27: Yellow Perch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.75	0	0	0.000000655
Larvae	3.56	0	0	0.000000728
Juvenile	2.53	0	0	0.0232
Age 1+	0.361	0	0	0.0245
Age 2+	0.249	0	0	0.0435
Age 3+	0.844	0.36	0.50	0.0987
Age 4+	0.844	0.36	1.0	0.132
Age 5+	0.844	0.36	1.0	0.166
Age 6+	0.844	0.36	1.0	0.214

Sources: Wapora, 1979; PSE&G, 1999; Thomas and Haas, 2000; and NMFS, 2003a.

Table F1-28: Other Recreational Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0	0	0.000000716
Larvae	5.71	0	0	0.00000204
Juvenile	2.85	0	0	0.000746
Age 1+	0.450	0	0	0.0937
Age 2+	0.450	0.80	0.50	0.356
Age 3+	0.450	0.80	1.0	0.679
Age 4+	0.450	0.80	1.0	0.974
Age 5+	0.450	0.80	1.0	1.21
Age 6+	0.450	0.80	1.0	1.38

[a] Includes deepwater sculpin, mottled sculpin, slimy sculpin, and other sculpins not identified to species.

Sources: USFWS, 1978; Durbin et al., 1983; Ruppert et al., 1985; Able and Fahay, 1998; PSE&G, 1999; Entergy Nuclear Generation Company, 2000; ASMFC, 2001b; and NMFS, 2003a.

Table F1-29: Other Forage Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0	0	0.0000000186
Larvae	7.70	0	0	0.00000158
Juvenile	1.29	0	0	0.000481
Age 1+	1.62	0	0	0.00381
Age 2+	1.62	0	0	0.00496
Age 3+	1.62	0	0	0.00505

[a] Includes central mudminnow, chestnut lamprey, johnny darter, lake sturgeon, longnose gar, ninespine stickleback, pirate perch, sea lamprey, silver lamprey, and other forage fish not identified to species.

Sources: Derickson and Price, 1973; and PSE&G, 1999.

Chapter F2: Evaluation of Impingement and Entrainment in the Great Lakes Region

Background: The Great Lakes Fisheries

Great Lakes fisheries are among the most important in the world, providing $4 billion in landings and recreation for some 5 million recreational anglers (Great Lakes Fishery Commission, 2003). Historically, the top predators in the Great Lakes included lake trout (*Salvelinus namaycush*), sturgeon (*Acipenser fulvescens*), lake whitefish (*Coregonus clupeaformis*), northern pike (*Esox lucius*), walleye (*Sander vitreus*), and muskellunge (*Esox masquinongy*). Today, as a result of numerous stressors such as habitat destruction, damming, and the introduction of sea lamprey and other exotic species, dominant species are primarily non-native salmon sustained by hatcheries. Not all introductions have been harmful, however. For example, alewife (*Alosa pseudoharengus*) was introduced to provide forage for sport fish (Jude et al., 1987). Losses of alewife, emerald shiner (*Notropis atherinoides*), and other forage species to impingement and entrainment (I&E) at Great Lakes facilities are sometimes substantial. Impinged and entrained species of commercial and/or recreational importance include yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), gizzard shad (*Dorosoma cepedianum*), and walleye (*Sander vitreus*).

F2-1   I&E Species/Species Groups Evaluated

Table F2-1 provides a list of species/species groups that were evaluated in EPA's analysis of I&E in the Great Lakes.

Table F2-1: Species/Species Group Evaluated by EPA that are Subject to I&E in the Great Lakes Region

Species/Species Group	Recreational	Commercial	Forage
Alewife			X
Black bullhead		X	
Black crappie	X		
Bluegill	X		
Bluntnose minnow			X
Brown bullhead		X	
Bullhead species		X	
Burbot			X
Carp			X
Channel catfish	X	X	

Table F2-1: Species/Species Group Evaluated by EPA that are Subject to I&E in the Great Lakes Region

Species/Species Group	Recreational	Commercial	Forage
Chinook salmon			X
Crappie	X		
Darter species	X		
Emerald shiner			X
Freshwater drum		X	
Gizzard shad			X
Golden redhorse			X
Herrings			X
Logperch			X
Muskellunge	X		
Other (forage)			X
Other (recreational)	X		
Rainbow smelt	X	X	
Salmon	X		
Sculpins	X	X	
Shiner species			X
Smallmouth bass	X		
Smelt	X	X	
Spotted sucker			X
Sucker species			X
Sunfish	X		
Threespine stickleback			X
Walleye	X		
White bass	X	X	
White perch			X
Whitefish	X	X	
Yellow perch	X	X	

The life history data used in EPA's analysis and associated data sources are provided in Appendix F1 of this report.

F2-2   I&E Data Evaluated

Table F2-2 lists the facility I&E data evaluated by EPA to estimate current I&E rates for the region. See Chapter A1 of Part A for a discussion of the methods used to evaluate the I&E data. The facility studies used in EPA's analysis are provided in the 316(b) docket.

Table F2-2: Facility I&E Data Evaluated for the Great Lakes Region

Facilities	Phase	Years of Data
Bailly Generating Station	II	1975
D.H. Mitchell Station	II	1975
DC Cook Nuclear Power Plant	II	1975-1982
J.P. Pulliam Power Plant	II	1975
J.R. Whiting Power Plant	II	1978-1991
Monroe Power Plant	II	1974-1985
Pleasant Prairie Power Plant	III	1980
Port Washington Power Plant	II	1975-1980
Silver Bay Power Plant	III	1981
South Oak Creek	II	1975
U.S. Steel Corporation Gary Works	III	1977

F2-3   EPA's Estimate of Current I&E at Phase III Facilities in the Great Lakes Region Expressed as Age-1 Equivalents and Foregone Yield

Table F2-3 provides EPA's estimate of the annual age-1 equivalents and foregone fishery yield resulting from the impingement of aquatic species at facilities located in the Great Lakes region. Table F2-4 displays this information for entrainment. Note that in these tables, "total yield" includes direct losses of harvested species and the yield of harvested species that is lost due to losses of forage species (trophic transfer).

Table F2-3: Estimated Current Annual Impingement at Phase III Facilities in the Great Lakes Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Alewife	31,600	<1
Black bullhead	14,300	1,130
Black crappie	74	12
Bluegill	33	1
Bluntnose minnow	533	<1
Brown bullhead	344	28
Bullhead species	676	55
Burbot	612	<1
Carp	5,720	<1

Table F2-3: Estimated Current Annual Impingement at Phase III Facilities in the Great Lakes Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Channel catfish	2,070	429
Chinook salmon	364	<1
Crappie	165	28
Darter species	463	<1
Emerald shiner	3,030,000	<1
Freshwater drum	43,500	10,500
Gizzard shad	16,300,000	<1
Golden redhorse	19	<1
Herrings	<1	<1
Logperch	31,700	<1
Muskellunge	6	23
Other (forage)	10,400	<1
Other (recreational)	7,610	1,500
Rainbow smelt	59,400	221
Salmon	668	2,820
Sculpins	252	17
Shiner species	7,310,000	<1
Smallmouth bass	434	18
Smelts	577,000	14,300
Spotted sucker	<1	<1
Sucker species	948	<1
Sunfish	14,700	11
Threespine stickleback	4,470	<1
Trophic transfer.[a]	<1	145,000
Walleye	4,550	4,060
White bass	167,000	51,200
White perch	156,000	<1
Whitefish	30,200	27,100
Yellow perch	182,000	2,530

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

**Table F2-4: Estimated Current Annual Entrainment at Phase III Facilities in the
Great Lakes Region Expressed as Age-1 Equivalents and Foregone Fishery Yield**

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Alewife	777	<1
Black bullhead	380	30
Black crappie	<1	<1
Bluegill	30	1
Bluntnose minnow	4,590	<1
Brown bullhead	<1	<1
Bullhead species	<1	<1
Burbot	362	<1
Carp	327,000	<1
Channel catfish	22,800	4,730
Chinook salmon	<1	<1
Crappie	3,780	637
Darter species	<1	<1
Emerald shiner	55,500	<1
Freshwater drum	16,500	3,980
Gizzard shad	1,750,000	<1
Golden redhorse	<1	<1
Herrings	6,540	<1
Logperch	34,800	<1
Muskellunge	<1	<1
Other (forage)	160,000	<1
Other (recreational)	130	26
Rainbow smelt	22,100	82
Salmon	172	726
Sculpins	2,720	182
Shiner species	80,800	<1
Smallmouth bass	23,600	957
Smelts	1,650	41
Spotted sucker	<1	<1
Sucker species	14,300	<1
Sunfish	658,000	475
Threespine stickleback	284	<1
Trophic transfer[a]	<1	41,100
Walleye	2,510	2,240
White bass	183,000	56,000
White perch	<1	<1
Whitefish	15	14
Yellow perch	152,000	2,110

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

F2-4   Reductions in I&E at Phase III Facilities in the Great Lakes Region Under Alternative Options

Table F2-5 presents estimated reductions in I&E under the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option. Reductions under all other options are presented in Appendix F2.

Table F2-5: Estimated Reductions in I&E Under Three Alternative Options		
Option	**Age-1 Equivalents (#s)**	**Foregone Fishery Yield (lbs)**
50 MGD All Option	13,300,000	160,000
200 MGD All Option	9,650,000	119,000
100 MGD Option	11,600,000	141,000

F2-5   Assumptions Used in Calculating Recreational and Commercial Losses

In order to estimate the economic value of these losses, total yield was partitioned between commercial and recreational fisheries based on the landings in each fishery. Table F2-6 presents the percentage impacts for each species/species group. Commercial and recreational fishing benefits are presented in Chapters F3 and F4.

Table F2-6: Percentage of Total Impacts Occurring to the Commercial and Recreational Fisheries and Commercial Value per Pound for Species Impinged and Entrained at Great Lakes Facilities		
Species/Species Group	**Percent Impact to Recreational Fishery[a,b]**	**Percent Impact to Commercial Fishery[a,b]**
American shad	100.0%	0.0%
Bigmouth buffalo	100.0%	0.0%
Black bullhead	0.0%	100.0%
Black crappie	100.0%	0.0%
Bluegill	100.0%	0.0%
Brown bullhead	0.0%	100.0%
Bullhead species	0.0%	100.0%
Channel catfish	50.0%	50.0%
Crabs (commercial)	0.0%	100.0%
Crappie	100.0%	0.0%
Darter species	100.0%	0.0%
Flounders	1.0%	99.0%
Freshwater drum	0.0%	100.0%
Menhaden species	0.0%	100.0%
Muskellunge	100.0%	0.0%
Other (commercial)	0.0%	100.0%
Other (recreational and commercial)	50.0%	50.0%

Table F2-6: Percentage of Total Impacts Occurring to the Commercial and Recreational Fisheries and Commercial Value per Pound for Species Impinged and Entrained at Great Lakes Facilities

Species/Species Group	Percent Impact to Recreational Fishery[a,b]	Percent Impact to Commercial Fishery[a,b]
Other (recreational)	100.0%	0.0%
Paddlefish	100.0%	0.0%
Pink shrimp	0.0%	100.0%
Rainbow smelt	50.0%	50.0%
River carpsucker	100.0%	0.0%
Salmon	100.0%	0.0%
Sauger	100.0%	0.0%
Sculpins	85.0%	15.0%
Sea basses (recreational)	100.0%	0.0%
Smallmouth bass	100.0%	0.0%
Smelts	6.2%	93.8%
Striped bass	100.0%	0.0%
Striped killifish	100.0%	0.0%
Sturgeon species	100.0%	0.0%
Sunfish	100.0%	0.0%
Trophic transfer[c]	64.0%	36.0%
Walleye	100.0%	0.0%
White bass	50.0%	50.0%
Whitefish	50.0%	50.0%
Yellow perch	50.0%	50.0%

[a] Based on opinion of local experts and comments received at proposal. EPA collected recreational landings data by species from State fisheries experts. However, these data were limited to a few broad species groups and were not sufficient to calculate more accurate values.
[b] Calculated using 1993-2001 commercial landings data from NMFS (2003a, http://www.st.nmfs.gov/commercial/landings/annual_landings.html).
[c] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

See Chapter F3 for results of the commercial fishing benefits analysis and Chapter F4 for recreational fishing results. As discussed in Chapter A8, benefits were discounted to account for (1) the time to achieve compliance once a Phase III final regulation for existing facilities would have become effective, and (2) the time it takes for fish spared from I&E to reach a harvestable age.

Appendix F2: Reductions in I&E Under Supplemental Policy Options

Table F2-1: Estimated Reductions in I&E in the Great Lakes Region Under Eight Supplemental Options

Option	Age-1 Equivalents (#s)	Foregone Fishery Yield (lbs)
Electric Generators 2-50 MGD		
I-only Everywhere	303,000	2,820
I&E like Phase II	327,000	3,610
I&E Everywhere	331,000	3,740
Manufacturers 2-50 MGD		
I-only Everywhere	698,000	6,510
I&E like Phase II	732,000	7,580
I&E Everywhere	764,000	8,620
Manufacturers 50+ MGD		
I-only Everywhere	11,700,000	109,000
I&E Everywhere	13,400,000	161,000

Chapter F3: Commercial Fishing Benefits

Introduction

This chapter presents the results of the commercial fishing benefits analysis for the Great Lakes region. The chapter presents EPA's estimates of baseline (i.e., current) annual commercial fishery losses from impingement and entrainment (I&E) at potentially regulated facilities in the Great Lakes region and annual reductions in these losses under the regulatory options for Phase III existing facilities[1]:

- ▸ the "50 MGD for All Waterbodies" option,
- ▸ the "200 MGD for All Waterbodies" option, and
- ▸ the "100 MGD for Certain Waterbodies" option.

The chapter then presents the estimated benefits to commercial fisheries from eliminating baseline losses from I&E, and the expected benefits under the regulatory options.

Chapter A4, "Methods for Estimating Commercial Fishing Benefits," details the methods used by EPA to estimate the commercial fishing benefits of reducing and eliminating I&E losses.

EPA considered a wide range of policy options in developing this regulation. In addition to the regulatory options, EPA evaluated several supplemental options. Appendix F3 presents results of the commercial fishing benefits analysis for the supplemental options. For additional information on the options, please see the TDD.

F3-1   Baseline Commercial Losses

Table F3-1 provides EPA's estimate of the value of gross revenues lost in commercial fisheries resulting from the impingement of aquatic species at facilities in the Great Lakes region. Table F3-2 displays this information for entrainment. Total annualized revenue losses are approximately $100,153 (undiscounted).

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[1] See the Introduction to this report for a description of the primary analysis options.

Table F3-1: Annualized Commercial Fishing Gross Revenues Lost due to Impingement at Facilities in the Great Lakes Region

Species[a]	Estimated Pounds of Harvest Lost	Commercial Value per Pound (2004$)	Estimated Value of Harvest Lost (2004$) Undiscounted
Black bullhead	1,132	$0.52	$591
Brown bullhead	28	$0.52	$15
Bullhead species	55	$0.52	$29
Channel catfish	215	$0.52	$112
Freshwater drum	10,475	$0.15	$1,557
Rainbow smelt	110	$0.64	$70
Sculpins	3	$2.68	$7
Smelts	13,425	$0.28	$3,783
White bass	25,603	$0.89	$22,879
Whitefish	13,554	$0.88	$11,928
Yellow perch	1,265	$2.23	$2,816
Trophic transfer[b]	52,256	$0.40	$21,084
Total	**118,121**		**$64,871**

[a] Species included are only those that have baseline losses greater than $1.
[b] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

Table F3-2: Annualized Commercial Fishing Gross Revenues Lost due to Entrainment at Facilities in the Great Lakes Region

Species[a]	Estimated Pounds of Harvest Lost	Commercial Value per Pound (2004$)	Estimated Value of Harvest Lost (2004$) Undiscounted
Black bullhead	30	$0.52	$16
Channel catfish	2,364	$0.52	$1,234
Freshwater drum	3,979	$0.15	$592
Rainbow smelt	41	$0.64	$26
Sculpins	27	$2.68	$73
Smelts	38	$0.28	$11
White bass	27,982	$0.89	$25,005
Whitefish	7	$0.88	$6
Yellow perch	1,053	$2.23	$2,345
Trophic transfer[b]	14,806	$0.40	$5,974
Total	**50,327**		**$35,282**

[a] Species included are only those that have baseline losses greater than $1.
[b] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

F3-2   Expected Benefits Under Regulatory Analysis Options

As described in Chapter A4, EPA estimates for Great Lakes that, depending on species, 0 to 29% of the gross revenue losses represent surplus losses to producers, assuming no change in prices or fishing costs. Earlier EPA analysis assumed a rate of 40%. The 0% estimate, of course, results in loss estimates of $0.

The expected reductions in I&E attributable to changes at facilities required by the "50 MGD for All Waterbodies" option (50 MGD All option) are 42.4% for impingement and 45.3% for entrainment; the expected reductions for the "200 MGD for All Waterbodies" option (200 MGD All option) are 30.4% for impingement and 36.2% for entrainment; and the expected reductions for the "100 MGD for Certain Waterbodies" option (100 MGD CWB option) are 36.7% for impingement and 40.9% for entrainment. Total annualized benefits are estimated by applying these estimated reductions to the annual baseline producer surplus loss. As presented in Tables F3-3, F3-4, and F3-5, this results in total annualized benefits of up to approximately $10,610 for the 50 MGD All option, $7,873 for the 200 MGD All option, and $9,340 for the 100 MGD CWB option, assuming a 3% discount rate and a species-specific net benefits ratio.[2]

F3-2.1   Commercial Fishing Benefits of the "50 MGD for All Waterbodies" Option

Table F3-3 shows EPA's analysis of the commercial benefits of the "50 MGD for All Waterbodies" option for the Great Lakes region. The table shows that this option, assuming a species-specific net benefits ratio, will result in undiscounted total annualized commercial benefits of approximately $12,612. When evaluated at 3% and 7% discount rates, the annualized commercial benefits are $10,610 and $8,516, respectively.

Table F3-3: Annualized Commercial Fishing Benefits Attributable to the 50 MGD All Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	42.4%	45.3%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$12,612
3% discount rate			$10,610
7% discount rate			$8,516

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

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[2] The net benefits ratio is the fractional share of gross revenue associated with net benefits, by gear and vessel type. See Chapter A4, section A4-10, for a description of the species-specific net benefits ratios and how they are calculated.

F3-2.2 Commercial Fishing Benefits of the "200 MGD for All Waterbodies" Option

Table F3-4 shows EPA's analysis of the commercial benefits of the "200 MGD for All Waterbodies" option for the Great Lakes region. The table shows that this option, assuming a species-specific net benefits ratio, will result in undiscounted total annualized commercial benefits of approximately $9,410. When evaluated at 3% and 7% discount rates, the annualized commercial benefits are $7,873 and $6,275, respectively.

Table F3-4: Annualized Commercial Fishing Benefits Attributable to the 200 MGD All Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	30.4%	36.2%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$9,410
3% discount rate			$7,873
7% discount rate			$6,275

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

F3-2.3　Commercial Fishing Benefits of the "100 MGD for Certain Waterbodies" Option

Table F3-5 shows EPA's analysis of the commercial benefits of the "100 MGD for Certain Waterbodies" option for the Great Lakes region. The table shows that this option, assuming a species-specific net benefits ratio, will result in undiscounted total annualized commercial benefits of approximately $11,107. When evaluated at 3% and 7% discount rates, the annualized commercial benefits are $9,340 and $7,494, respectively.

Table F3-5: Annualized Commercial Fishing Benefits Attributable to the 100 MGD CWB Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	36.7%	40.9%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$11,107
3% discount rate			$9,340
7% discount rate			$7,494

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Appendix F3: Commercial Fishing Benefits Under Supplemental Policy Options

Introduction

Chapter F3 presents EPA's estimates of the commercial benefits of the regulatory options for the section 316(b) rule for Phase III facilities in the Great Lakes region. To facilitate comparisons among the options, this appendix presents estimates of the commercial fishing benefits of several supplemental options that EPA evaluated in preparation for this rule:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option;
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option;
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option;
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option; and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

Commercial fishing benefits presented in this chapter were estimated using the benefit transfer approach discussed in Chapter F3 and in Chapter A4, "Methods for Estimating Commercial Fishing Benefits." For more information on the options, please see the TDD.

F3-1   Commercial Fishing Benefits of the Supplemental Options

Tables F3-1 through F3-8 present EPA's estimates of the annualized commercial benefits of the supplemental options in the Great Lakes region.

Table F3-1: Annualized Commercial Fishing Benefits Attributable to the "Electric Generators 2-50 MGD I-only Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	1%	0%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$203
3% discount rate			$168
7% discount rate			$132

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-2: Annualized Commercial Fishing Benefits Attributable to the "Electric Generators 2-50 MGD I&E like Phase II" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	1%	1%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$274
3% discount rate			$227
7% discount rate			$179

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-3: Annualized Commercial Fishing Benefits Attributable to the "Electric Generators 2-50 MGD I&E Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	1%	1%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$286
3% discount rate			$237
7% discount rate			$186

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-4: Annualized Commercial Fishing Benefits Attributable to the "Manufacturers 2-50 MGD I-only Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	2%	0%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$469
3% discount rate			$402
7% discount rate			$331

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-5: Annualized Commercial Fishing Benefits Attributable to the "Manufacturers 2-50 MGD I&E like Phase II" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	2%	1%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$566
3% discount rate			$486
7% discount rate			$400

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-6: Annualized Commercial Fishing Benefits Attributable to the "Manufacturers 2-50 MGD I&E Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	2%	2%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$660
3% discount rate			$567
7% discount rate			$467

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-7: Annualized Commercial Fishing Benefits Attributable to the "Manufacturers 50+ MGD I-only Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	42%	0%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$7,882
3% discount rate			$6,561
7% discount rate			$5,196

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Table F3-8: Annualized Commercial Fishing Benefits Attributable to the "Manufacturers 50+ MGD I&E Everywhere" Option at Facilities in the Great Lakes Region (2004$)[a]

	Impingement	Entrainment	Total
Baseline loss — gross revenue			
Undiscounted	$64,872	$35,281	$100,153
Producer surplus lost — 0%	$0	$0	$0
Producer surplus lost — (gross revenue * species-specific net benefits ratio)			
Undiscounted	$18,813	$10,231	$29,044
Expected reduction due to rule	42%	46%	
Benefits attributable to rule — 0%	$0	$0	$0
Benefits attributable to rule — species-specific net benefits ratio			
Undiscounted			$12,580
3% discount rate			$10,583
7% discount rate			$8,494

[a] Annualized benefits represent the value of all commercial benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a 30 year period. For a more detailed discussion of the discounting methodology, refer to Chapter A8, and see Chapter I1 for a timeline of benefits.

Chapter F4: Recreational Use Benefits

Introduction

This chapter presents the results of the recreational fishing benefits analysis for the Great Lakes region. The chapter presents EPA's estimates of baseline (i.e., current) annual recreational fishery losses from impingement and entrainment (I&E) at potentially regulated facilities in the Great Lakes region and annual reductions in these losses under the regulatory options for Phase III existing facilities[1]:

- the "50 MGD for All Waterbodies" option,
- the "200 MGD for All Waterbodies" option, and
- the "100 MGD for Certain Waterbodies" option.

The chapter then presents the estimated welfare gain to Great Lakes anglers from eliminating baseline recreational fishing losses from I&E and the expected benefits under the regulatory options.

EPA estimated the recreational benefits of reducing and eliminating I&E losses using a benefit transfer methodology based on a meta-analysis of the marginal value of catching different species of fish. This meta-analysis is discussed in detail in Chapter A5, "Recreational Fishing Benefits Methodology."

EPA considered a wide range of policy options in developing this regulation. In addition to the regulatory options, EPA evaluated several supplemental options. Appendix F4 presents results of the recreational fishing benefits analysis for the supplemental options. For additional information on the options, please see the TDD.

F4-1   Benefit Transfer Approach Based on Meta-Analysis

EPA estimated the recreational welfare gain from the reduction in annual I&E losses expected under the policy options, and the welfare gain from eliminating I&E at potentially regulated facilities, using a benefit transfer approach. As discussed in Chapter A5, the Agency used a meta-analysis regression equation to estimate the marginal recreational value per additional fish caught by anglers, for different species in different regions. Since I&E at potentially regulated facilities affects a variety of species, EPA assigned each species with I&E losses to one of the general species groups used in the meta-analysis. The Agency then calculated the economic value of reducing or eliminating baseline I&E losses, for each species group, by multiplying the value per fish for that species group by the number of fish in the group that are lost in the baseline or saved under the policy options.[2]

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[1] See the Introduction to this report for a description of the primary analysis options.

[2] The estimates of I&E presented in this chapter include only the fraction of impinged and entrained recreational fish that would be caught by anglers. The total amount of I&E of recreational species is actually much higher.

In general, the fit between the species with I&E losses and the species groups in the meta-analysis was good. However, EPA's estimates of baseline I&E losses and reductions in I&E under the policy options included losses of "unidentified" species. The "unidentified" group includes fish lost indirectly through trophic transfer, as well as species for which no species information was available.[3] Rather than using the meta-analysis regression to try to predict the value per fish for an "unidentified" species, EPA assumed that per-fish values for these species can be approximated by the weighted average value per fish for all species affected by I&E in the Great Lakes region.[4]

F4-1.1　Baseline Losses and Reductions in Recreational Fishery Losses Under the Regulatory Options

Table F4-1 presents EPA's estimates of baseline (i.e., current) annual recreational I&E losses at potentially regulated facilities and annual reductions in these losses under each of the regulatory options, in the Great Lakes region. The table shows that total baseline losses to recreational fisheries are 225.5 thousand fish per year. In comparison, the "50 MGD for All Waterbodies" option prevents losses of 96.7 thousand fish per year, the "200 MGD for All Waterbodies" option prevents losses of 72.1 thousand fish per year, and the "100 MGD for Certain Waterbodies" option prevents losses of 85.1 thousand fish per year. Of all the affected species, white bass and "unidentified" species have the highest losses in the baseline and the highest prevented losses under the regulatory options.

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[3] In addition to recreational fish that are lost because they are impinged or entrained, some recreational fish are lost because the forage fish that they feed on are impinged or entrained, and thus removed from the food chain. These trophic transfer losses of recreational species are included in EPA's estimates of total I&E losses. Since it is difficult to predict which recreational species would be affected by losses of forage fish, these losses are classified as "unidentified" recreational species. Also included in the "unidentified" group are losses of fish that were reported by facilities without information about their exact species.

[4] EPA used the estimated level of baseline recreational losses for each species group as a weighting factor.

Table F4-1: Baseline Recreational Fishing Losses from I&E at Potentially Regulated Phase III Facilities and Reductions in Recreational Losses Under the Regulatory Options in the Great Lakes Region

Species[a]	Baseline Annual Recreational Fishing Losses (# of fish)	Annual Reductions in Recreational Fishing Losses (# of fish)		
		50 MGD All	200 MGD All	100 MGD CWB
Salmon	160.6	68.2	50.0	59.7
Total (salmon)	**160.6**	**68.2**	**50.0**	**59.7**
Northern pike	0.7	0.3	0.2	0.3
Walleye	2,003.4	859.2	641.3	756.8
Total (walleye/pike)	**2,004.2**	**859.5**	**641.5**	**757.1**
Smallmouth bass	1,167.4	521.1	415.9	471.6
White bass	57,737.6	25,030.5	19,038.1	22,214.0
Total (bass)	**58,905.0**	**25,551.6**	**19,454.0**	**22,685.6**
Black crappie	19.0	7.9	5.7	6.9
Bluegill	11.9	5.1	3.9	4.6
Channel catfish	2,082.7	925.8	734.2	835.8
Crappie	1,008.9	449.7	358.1	406.6
Rainbow smelt	1,085.6	463.0	342.2	406.2
Sculpin	1,279.0	568.5	450.7	513.1
Smelts	1,877.8	786.8	562.9	681.6
Sunfish	7,816.4	3,488.0	2,783.2	3,156.7
Yellow perch	18,422.2	7,951.5	6,002.2	7,035.3
Total (panfish)	**33,603.4**	**14,646.5**	**11,243.0**	**13,046.8**
Whitefish[b]	9,236.8	3,869.9	2,767.4	3,351.7
Total (trout)	**9,236.8**	**3,869.9**	**2,767.4**	**3,351.7**
Total (unidentified)	**121,540.8**	**51,655.7**	**37,934.5**	**45,206.6**
Total (all species)	**225,450.8**	**96,651.4**	**72,090.5**	**85,107.4**

[a] EPA assigned each species with I&E losses to one of the species groups used in the meta-analysis. The "unidentified" group includes fish lost indirectly through trophic transfer and fish reported lost without information about their species.

[b] EPA included whitefish in the "trout" category because its physical characteristics are similar to trout, and lake whitefish are prized for their meat. Therefore, valuing them in the panfish category would be inappropriate.

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

F4-1.2 Recreational Fishing Benefits from Eliminating Baseline I&E Losses

Table F4-2 shows the results of EPA's analysis of the welfare gain to recreational anglers from eliminating baseline recreational fishery losses at potentially regulated facilities in the Great Lakes region. The table presents baseline annual recreational I&E losses, the estimated value per fish, and the monetized annual welfare gain from eliminating recreational losses, for each species group. Total baseline recreational fishing losses for the Great Lakes region are 225.5 thousand fish per year. The undiscounted annual welfare gain to the Great Lakes anglers from eliminating these losses is $1,180.6 thousand (2004$), with lower and upper bounds of $810.2 thousand and $1,730.9 thousand. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain of eliminating these losses is $1,145.2 thousand and $1,102.8 thousand, respectively. The majority of monetized recreational losses from I&E under baseline conditions are attributable to losses of species in the bass and "unidentified" species groups.

Table F4-2: Recreational Fishing Benefits from Eliminating Baseline I&E at Potentially Regulated Phase III Facilities in the Great Lakes Region (2004$)

Species Group	Baseline Annual Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Benefits from Eliminating Recreational Fishing Losses (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Salmon	0.2	$8.42	$11.17	$14.83	$1.4	$1.8	$2.4
Trout	9.2	$5.87	$7.94	$10.79	$54.2	$73.4	$99.7
Walleye/pike	2.0	$2.12	$3.46	$5.69	$4.3	$6.9	$11.4
Bass	58.9	$4.90	$7.21	$10.64	$288.8	$424.5	$626.5
Panfish	33.6	$0.74	$1.12	$1.72	$24.8	$37.5	$57.8
Unidentified	121.5	$3.59	$5.24	$7.68	$436.8	$636.5	$933.1
Total (undiscounted)	**225.5**				**$810.2**	**$1,180.6**	**$1,730.9**
Total (evaluated at 3% discount rate)	**225.5**				**$785.9**	**$1,145.2**	**$1,678.9**
Total (evaluated at 7% discount rate)	**225.5**				**$756.8**	**$1,102.8**	**$1,616.7**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.
[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[c] Monetized benefits are calculated by multiplying baseline losses by the estimated value per fish.
[d] Annualized values represent the total welfare gain over the time frame of the analysis from eliminating recreational losses, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

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

F4-1.3 Recreational Fishing Benefits of the "50 MGD for All Waterbodies" Option

Table F4-3 shows the results of EPA's analysis of the recreational benefits of the "50 MGD for All Waterbodies" option for the Great Lakes region. The table presents the annual reduction in recreational I&E losses expected under this option, the estimated value per fish, and annual monetized recreational welfare gain from this option, by species group. The table shows that this option reduces recreational losses by 96.7 thousand fish per year, resulting in an undiscounted welfare gain to recreational anglers of $505.5 thousand (2004$), with lower and upper bounds of $346.8 thousand and $741.2 thousand. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain from this reduction in recreational losses is $425.3 thousand and $341.3 thousand, respectively. The majority of benefits result from reduced losses of species in the bass and "unidentified" species groups.

Table F4-3: Recreational Fishing Benefits of the "50 MGD for All Waterbodies" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Recreational Fishing Benefits (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Salmon	0.1	$8.42	$11.17	$14.83	$0.6	$0.8	$1.0
Trout	3.9	$5.87	$7.94	$10.79	$22.7	$30.7	$41.8
Walleye/pike	0.9	$2.12	$3.46	$5.69	$1.8	$3.0	$4.9
Bass	25.6	$4.90	$7.21	$10.64	$125.3	$184.1	$271.8
Panfish	14.6	$0.74	$1.12	$1.72	$10.8	$16.4	$25.2
Unidentified	51.7	$3.59	$5.24	$7.68	$185.6	$270.5	$396.6
Total (undiscounted)	**96.7**				**$346.8**	**$505.5**	**$741.2**
Total (evaluated at 3% discount rate)	**96.7**				**$291.8**	**$425.3**	**$623.5**
Total (evaluated at 7% discount rate)	**96.7**				**$234.2**	**$341.3**	**$500.5**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.
[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[c] Monetized benefits are calculated by multiplying the annual reduction in recreational losses by the estimated value per fish.
[d] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

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

F4-1.4 Recreational Fishing Benefits of the "200 MGD for All Waterbodies" Option

Table F4-4 shows the results of EPA's analysis of the recreational benefits of the "200 MGD for All Waterbodies" option for the Great Lakes region. The table presents the annual reduction in recreational I&E losses expected under this option, the estimated value per fish, and annual monetized recreational welfare gain from this option, by species group. The table shows that this option reduces recreational losses by 72.1 thousand fish per year, resulting in an undiscounted welfare gain to recreational anglers of $376.2 thousand (2004$), with lower and upper bounds of $258.0 thousand and $551.7 thousand. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain from this reduction in recreational losses is $314.7 thousand and $250.8 thousand, respectively. The majority of benefits result from reduced losses of species in the bass and "unidentified" species groups.

**Table F4-4: Recreational Fishing Benefits of the "200 MGD for All Waterbodies" Option
in the Great Lakes Region (2004$)**

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Recreational Fishing Benefits (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Salmon	0.1	$8.42	$11.17	$14.83	$0.4	$0.6	$0.7
Trout	2.8	$5.87	$7.94	$10.79	$16.2	$22.0	$29.9
Walleye/pike	0.6	$2.12	$3.46	$5.69	$1.4	$2.2	$3.7
Bass	19.5	$4.90	$7.21	$10.64	$95.4	$140.2	$206.9
Panfish	11.2	$0.74	$1.12	$1.72	$8.3	$12.6	$19.3
Unidentified	37.9	$3.59	$5.24	$7.68	$136.3	$198.7	$291.2
Total (undiscounted)	**72.1**				**$258.0**	**$376.2**	**$551.7**
Total (evaluated at 3% discount rate)	**72.1**				**$215.9**	**$314.7**	**$461.6**
Total (evaluated at 7% discount rate)	**72.1**				**$172.1**	**$250.8**	**$367.9**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.

[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[c] Monetized benefits are calculated by multiplying the annual reduction in recreational losses by the estimated value per fish.

[d] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

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

F4-1.5 Recreational Fishing Benefits of the "100 MGD for Certain Waterbodies" Option

Table F4-5 shows the results of EPA's analysis of the recreational benefits of the "100 MGD for Certain Waterbodies" option for the Great Lakes region. The table presents the annual reduction in recreational I&E losses expected under this option, the estimated value per fish, and annual monetized recreational welfare gain from this option, by species group. The table shows that this option reduces recreational losses by 85.1 thousand fish per year, resulting in an undiscounted welfare gain to recreational anglers of $444.7 thousand (2004$), with lower and upper bounds of $305.1 thousand and $652.1 thousand. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain from this reduction in recreational losses is $374.0 thousand and $300.0 thousand, respectively. The majority of benefits result from reduced losses of species in the bass and "unidentified" species groups.

Table F4-5: Recreational Fishing Benefits of the "100 MGD for Certain Waterbodies" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Recreational Fishing Benefits (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Salmon	0.1	$8.42	$11.17	$14.83	$0.5	$0.7	$0.9
Trout	3.4	$5.87	$7.94	$10.79	$19.7	$26.6	$36.2
Walleye/pike	0.8	$2.12	$3.46	$5.69	$1.6	$2.6	$4.3
Bass	22.7	$4.90	$7.21	$10.64	$111.2	$163.5	$241.3
Panfish	13.0	$0.74	$1.12	$1.72	$9.6	$14.6	$22.4
Unidentified	45.2	$3.59	$5.24	$7.68	$162.5	$236.7	$347.1
Total (undiscounted)	**85.1**				**$305.1**	**$444.7**	**$652.1**
Total (evaluated at 3% discount rate)	**85.1**				**$256.6**	**$374.0**	**$548.4**
Total (evaluated at 7% discount rate)	**85.1**				**$205.8**	**$300.0**	**$440.0**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.
[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[c] Monetized benefits are calculated by multiplying the annual reduction in recreational losses by the estimated value per fish.
[d] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

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

F4-2   Limitations and Uncertainty

The results of the benefit transfer based on a meta-analysis represent EPA's best estimate of the recreational benefits of the regulatory options. Nonetheless, there are a number of limitations and uncertainties inherent in these estimates. General limitations pertaining to the development of the meta-analysis model, the use of the model to estimate per-fish values, and the validity of the benefit transfer are discussed in section A5-3.3e and section A5-5.3 of Chapter A5. In addition to these general concerns about the analysis, there are some limitations and uncertainties that are specific to the Great Lakes region.

The main limitation of using the meta-analysis to calculate recreational benefits for the Great Lakes region is that EPA was unable to locate any studies that evaluated WTP for some Great Lakes species such as rainbow smelt and sculpin. However, the Agency believes that the per-fish values for these species can be approximated by the per-fish values for panfish.

Appendix F4: Recreational Use Benefits Under Supplemental Policy Options

Introduction

Chapter F4 presents EPA's estimates of the recreational benefits of the regulatory options for the section 316(b) rule for Phase III facilities in the Great Lakes region. To facilitate comparisons among the options, this appendix presents estimates of the recreational fishing benefits of several supplemental options that EPA evaluated in preparation for this rule:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option;
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option;
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option;
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option; and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

Recreational fishing benefits presented in this chapter were estimated using the benefit transfer approach discussed in Chapter F4 and in Chapter A5, "Recreational Fishing Benefits Methodology." For additional information on the options, please see the TDD.

F4-1   Recreational Fishing Benefits of the Supplemental Options

F4-1.1 Estimated Reductions in Recreational Fishing Losses Under the Supplemental Options

Table F4-1 presents EPA's estimates of the annual reduction in baseline (i.e., current) recreational fishing losses from impingement and entrainment (I&E) in the Great Lakes region under the supplemental options.

Table F4-1: Reductions in Recreational Fishing Losses from I&E Under the Supplemental Options in the Great Lakes Region

	Annual Reduction in Recreational Losses (# of fish)							
	Electric Generators 2-50 MGD			Manufacturers 2-50 MGD			Manufacturers 50+ MGD	
Species[a]	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E Everywhere
Salmon	1.4	1.6	1.6	3.2	3.5	3.8	53.5	68.6
Total (salmon)	**1.4**	**1.6**	**1.6**	**3.2**	**3.5**	**3.8**	**53.5**	**68.6**
Northern pike	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.3	0.3
Walleye	14.0	18.9	19.7	32.2	38.9	45.5	541.0	868.0
Total (walleye/pike)	**14.0**	**18.9**	**19.7**	**32.2**	**39.0**	**45.5**	**541.3**	**868.3**
Smallmouth bass	0.2	8.2	9.5	0.5	11.4	21.9	8.8	535.2
White bass	298.2	507.4	542.7	687.3	974.3	1,250.6	11,557.6	25,401.6
Total (bass)	**298.5**	**515.6**	**552.2**	**687.8**	**985.8**	**1,272.5**	**11,566.5**	**25,936.8**
Black crappie	0.2	0.2	0.2	0.5	0.5	0.5	7.9	7.9
Bluegill	0.1	0.1	0.1	0.2	0.2	0.3	2.6	5.2
Channel catfish	1.9	15.1	17.4	4.3	22.5	40.0	72.6	949.3
Crappie	0.5	7.2	8.3	1.1	10.3	19.1	17.7	461.6
Rainbow smelt	8.6	10.6	10.9	19.7	22.5	25.2	331.6	466.6
Sculpin	1.2	9.3	10.7	2.7	13.8	24.6	45.5	582.9
Smelts	20.2	20.3	20.3	46.6	46.7	46.7	784.5	786.9
Sunfish	1.8	54.9	63.8	4.2	77.0	147.1	71.4	3,582.2
Yellow perch	108.7	166.7	176.5	250.5	330.1	406.8	4,211.8	8,054.5
Total (panfish)	**143.1**	**284.4**	**308.2**	**329.8**	**523.7**	**710.3**	**5,545.6**	**14,897.2**
Whitefish	99.8	99.8	99.8	230.0	230.0	230.1	3,867.8	3,869.9
Total (trout)[b]	**99.8**	**99.8**	**99.8**	**230.0**	**230.0**	**230.1**	**3,867.8**	**3,869.9**
Total (unidentified)	**1,028.8**	**1,211.7**	**1,242.7**	**2,370.6**	**2,621.8**	**2,863.5**	**39,866.7**	**51,980.5**
Total (all species)	**1,585.5**	**2,132.0**	**2,224.4**	**3,653.5**	**4,403.8**	**5,125.8**	**61,441.4**	**97,621.2**

[a] EPA assigned each species with I&E losses to one of the species groups used in the meta-analysis. The "unidentified" group includes fish lost indirectly through trophic transfer and fish reported lost without information about their species.
[b] EPA included whitefish in the "trout" category because its physical characteristics are similar to trout, and lake whitefish are prized for their meat. Therefore, valuing them in the panfish category would be inappropriate.
[c] Denotes a non-zero value less than 0.5 fish.
Source: U.S. EPA analysis for this report.

F4-1.2 Recreational Fishing Benefits of the Supplemental Options

Tables F4-2 through F4-9 present EPA's estimates of the annualized recreational benefits of the supplemental options in the Great Lakes region.

Table F4-2: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I-only Everywhere" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	0.0[e]
Trout	0.1	$5.87	$7.94	$10.79	$0.6	$0.8	$1.1
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	0.0[e]	0.0[e]	$0.1
Bass	0.3	$4.90	$7.21	$10.64	$1.5	$2.2	$3.2
Panfish	0.1	$0.74	$1.12	$1.72	$0.1	$0.2	$0.2
Unidentified	1.0	$3.59	$5.24	$7.68	$3.7	$5.4	$7.9
Total (undiscounted)	**1.6**				**$5.9**	**$8.6**	**$12.5**
Total (evaluated at 3% discount rate)	**1.6**				**$4.9**	**$7.1**	**$10.3**
Total (evaluated at 7% discount rate)	**1.6**				**$3.8**	**$5.6**	**$8.1**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] Denotes a non-zero value less than 50 fish.
[e] Denotes a non-zero value less than $50.

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

Table F4-3: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I&E like Phase II" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	0.0[e]
Trout	0.1	$5.87	$7.94	$10.79	$0.6	$0.8	$1.1
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	0.0[e]	$0.1	$0.1
Bass	0.5	$4.90	$7.21	$10.64	$2.5	$3.7	$5.5
Panfish	0.3	$0.74	$1.12	$1.72	$0.2	$0.3	$0.5
Unidentified	1.2	$3.59	$5.24	$7.68	$4.4	$6.3	$9.3
Total (undiscounted)	**2.1**				**$7.7**	**$11.3**	**$16.5**
Total (evaluated at 3% discount rate)	**2.1**				**$6.4**	**$9.3**	**$13.6**
Total (evaluated at 7% discount rate)	**2.1**				**$5.0**	**$7.3**	**$10.7**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.

[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

[d] Denotes a non-zero value less than 50 fish.

[e] Denotes a non-zero value less than $50.

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

Table F4-4: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I&E Everywhere" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	0.0[e]
Trout	0.1	$5.87	$7.94	$10.79	$0.6	$0.8	$1.1
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	0.0[e]	$0.1	$0.1
Bass	0.6	$4.90	$7.21	$10.64	$2.7	$4.0	$5.9
Panfish	0.3	$0.74	$1.12	$1.72	$0.2	$0.3	$0.5
Unidentified	1.2	$3.59	$5.24	$7.68	$4.5	$6.5	$9.5
Total (undiscounted)	**2.2**				**$8.0**	**$11.7**	**$17.2**
Total (evaluated at 3% discount rate)	**2.2**				**$6.7**	**$9.7**	**$14.2**
Total (evaluated at 7% discount rate)	**2.2**				**$5.2**	**$7.6**	**$11.2**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] Denotes a non-zero value less than 50 fish.
[e] Denotes a non-zero value less than $50.

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

Table F4-5: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I-only Everywhere"
Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	0.0[e]
Trout	0.2	$5.87	$7.94	$10.79	$1.3	$1.8	$2.5
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	$0.1	$0.1	$0.2
Bass	0.7	$4.90	$7.21	$10.64	$3.4	$5.0	$7.3
Panfish	0.3	$0.74	$1.12	$1.72	$0.2	$0.4	$0.6
Unidentified	2.4	$3.59	$5.24	$7.68	$8.5	$12.4	$18.2
Total (undiscounted)	**3.7**				**$13.6**	**$19.7**	**$28.8**
Total (evaluated at 3% discount rate)	**3.7**				**$11.7**	**$16.9**	**$24.7**
Total (evaluated at 7% discount rate)	**3.7**				**$9.6**	**$13.9**	**$20.4**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] Denotes a non-zero value less than 50 fish.
[e] Denotes a non-zero value less than $50.

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

Table F4-6: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I&E like Phase II" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	$0.1
Trout	0.2	$5.87	$7.94	$10.79	$1.4	$1.8	$2.5
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	$0.1	$0.1	$0.2
Bass	1.0	$4.90	$7.21	$10.64	$4.8	$7.1	$10.5
Panfish	0.5	$0.74	$1.12	$1.72	$0.4	$0.6	$0.9
Unidentified	2.6	$3.59	$5.24	$7.68	$9.4	$13.7	$20.1
Total (undiscounted)	**4.4**				**$16.1**	**$23.4**	**$34.3**
Total (evaluated at 3% discount rate)	**4.4**				**$13.8**	**$20.1**	**$29.4**
Total (evaluated at 7% discount rate)	**4.4**				**$11.4**	**$16.6**	**$24.2**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] Denotes a non-zero value less than 50 fish.
[e] Denotes a non-zero value less than $50.

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

Table F4-7: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I&E Everywhere" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.0[d]	$8.42	$11.17	$14.83	0.0[e]	0.0[e]	$0.1
Trout	0.2	$5.87	$7.94	$10.79	$1.4	$1.8	$2.5
Walleye/pike	0.0[d]	$2.12	$3.46	$5.69	$0.1	$0.2	$0.3
Bass	1.3	$4.90	$7.21	$10.64	$6.2	$9.2	$13.5
Panfish	0.7	$0.74	$1.12	$1.72	$0.5	$0.8	$1.2
Unidentified	2.9	$3.59	$5.24	$7.68	$10.3	$15.0	$22.0
Total (undiscounted)	**5.1**				**$18.5**	**$27.0**	**$39.5**
Total (evaluated at 3% discount rate)	**5.1**				**$15.9**	**$23.2**	**$33.9**
Total (evaluated at 7% discount rate)	**5.1**				**$13.1**	**$19.1**	**$28.0**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] Denotes a non-zero value less than 50 fish.
[e] Denotes a non-zero value less than $50.

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

Table F4-8: Recreational Fishing Benefits of the "Manufacturers 50+ MGD I-only Everywhere" Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.1	$8.42	$11.17	$14.83	$0.5	$0.6	$0.8
Trout	3.9	$5.87	$7.94	$10.79	$22.7	$30.7	$41.7
Walleye/pike	0.5	$2.12	$3.46	$5.69	$1.1	$1.9	$3.1
Bass	11.6	$4.90	$7.21	$10.64	$56.7	$83.4	$123.0
Panfish	5.5	$0.74	$1.12	$1.72	$4.1	$6.2	$9.5
Unidentified	39.9	$3.59	$5.24	$7.68	$143.3	$208.8	$306.1
Total (undiscounted)	**61.4**				**$228.4**	**$331.5**	**$484.2**
Total (evaluated at 3% discount rate)	**61.4**				**$190.1**	**$276.0**	**$403.1**
Total (evaluated at 7% discount rate)	**61.4**				**$150.6**	**$218.6**	**$319.2**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

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

Table F4-9: Recreational Fishing Benefits of the "Manufacturers 50+ MGD I&E Everywhere"
Option in the Great Lakes Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Salmon	0.1	$8.42	$11.17	$14.83	$0.6	$0.8	$1.0
Trout	3.9	$5.87	$7.94	$10.79	$22.7	$30.7	$41.8
Walleye/pike	0.9	$2.12	$3.46	$5.69	$1.8	$3.0	$4.9
Bass	25.9	$4.90	$7.21	$10.64	$127.2	$186.9	$275.9
Panfish	14.9	$0.74	$1.12	$1.72	$11.0	$16.6	$25.6
Unidentified	52.0	$3.59	$5.24	$7.68	$186.8	$272.2	$399.1
Total (undiscounted)	**97.6**				**$350.1**	**$510.3**	**$748.3**
Total (evaluated at 3% discount rate)	**97.6**				**$294.5**	**$429.3**	**$629.5**
Total (evaluated at 7% discount rate)	**97.6**				**$236.4**	**$344.6**	**$505.3**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

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

F4-2   Comparison of Recreational Fishing Benefits by Option

Table F4-10 compares the recreational fishing benefits of the eight supplemental options.

Table F4-10: Annual Recreational Benefits of the Supplemental Options in the Great Lakes Region				
	Annual Reduction in Recreational Fishing Losses from I&E (thousands of fish)	**Undiscounted Recreational Fishing Benefits (thousands; 2004$)[a]**		
Policy Option		**Low**	**Mean**	**High**
Electric Generators 2-50 MGD				
I-only Everywhere	1.6	$5.9	$8.6	$12.5
I&E like Phase II	2.1	$7.7	$11.3	$16.5
I&E Everywhere	2.2	$8.0	$11.7	$17.2
Manufacturers 2-50 MGD				
I-only Everywhere	3.7	$13.6	$19.7	$28.8
I&E like Phase II	4.4	$16.1	$23.4	$34.3
I&E Everywhere	5.1	$18.5	$27.0	$39.5
Manufacturers 50+ MGD				
I-only Everywhere	61.4	$228.4	$331.5	$484.2
I&E Everywhere	97.6	$350.1	$510.3	$748.3

[a] These benefit estimates were calculated using the meta-analysis approach discussed in Chapter A5 and Chapter B4.

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

Chapter F5: Federally Listed T&E Species in the Great Lakes Region

This chapter lists current federally listed threatened and endangered (T&E) fish and shellfish species in the Great Lakes Region. This list does not address proposed or candidate species; In addition, fish and shellfish listed as cave species, marine mammals, reptiles, amphibians, and snails are not included in this chapter.

Table F5-1: Illinois Federally Listed T&E Fish and Shellfish		
Status	**Scientific Name**	**Common Name**
E	*Epioblasma torulosa torulosa*	Tubercled-blossom pearlymussel: entire range, except where listed as experimental populations
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel (= catspaw): entire range, except where listed as experimental populations
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range, except where listed as experimental populations
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations
E	*Potamilus capax*	Fat pocketbook mussel
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table F5-2: Indiana Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations
E	*Pleurobema plenum*	Rough pigtoe mussel
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel (= catspaw): entire range, except where listed as experimental populations
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range, except where listed as experimental populations
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Obovaria retusa*	Ring pink mussel
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Potamilus capax*	Fat pocketbook mussel

Source: USFWS, 2006a.

Table F5-3: Maine Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Salmo salar*	Atlantic salmon (Gulf of Maine Atlantic salmon DPS)

Source: USFWS, 2006a.

Table F5-4: Michigan Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations

Source: USFWS, 2006a.

Table F5-5: Minnesota Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Leptodea leptodon*	Scaleshell mussel
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Notropis topeka*	Topeka shiner
E	*Quadrula fragosa*	Winged mapleleaf mussel

Source: USFWS, 2006a.

Table F5-6: New Hampshire Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table F5-7: New York Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel
E	*Acipenser brevirostrum*	Shortnose sturgeon

Source: USFWS, 2006a.

Table F5-8: Ohio Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Noturus trautmani*	Scioto madtom
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Leptodea leptodon*	Scaleshell mussel: entire range except where listed as experimental populations
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Potamilus capax*	Fat pocketbook mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Pleurobema clava*	Clubshell mussel

Source: USFWS, 2006a.

Table F5-9: Pennsylvania Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Pleurobema clava*	Clubshell mussel: entire range except where listed as experimental populations
E	*Cyprogenia stegaria*	Fanshell mussel
E	*Lampsilis abrupta*	Pink mucket pearlymussel
E	*Pleurobema plenum*	Rough pigtoe pearlymussel
E	*Plethobasus cooperianus*	Orange-foot pimpleback pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table F5-10: Vermont Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table F5-11: Wisconsin Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel

Sources: USFWS, 2006a,b.

Part G: The Inland Region

Chapter G1: Background

Introduction

This chapter presents an overview of the potential Phase III existing facilities in the Inland study region and summarizes their key cooling water and compliance characteristics. For further discussion of the technical and compliance characteristics of potential Phase III existing facilities, refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* and the *Technical Development Document for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a,c).

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G1-1 Facility Characteristics

The Inland Regional Study includes 274 sample facilities that are potentially subject to the national standards for Phase III existing facilities. Figure G1-1 presents a map of these facilities. One hundred and seventy-two facilities are manufacturing facilities and 102 are electric generators. Industry-wide, these 274 sample facilities represent 541 facilities.[1]

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[1] EPA applied sample weights to the survey respondents to account for non-sampled facilities and facilities that did not respond to the survey. For more information on EPA's 2000 Section 316(b) Industry Survey, please refer to the Information Collection Request (U.S. EPA, 2000b).

Figure G1-1: Potential Existing Phase III Facilities in the Inland Regional Study[a]
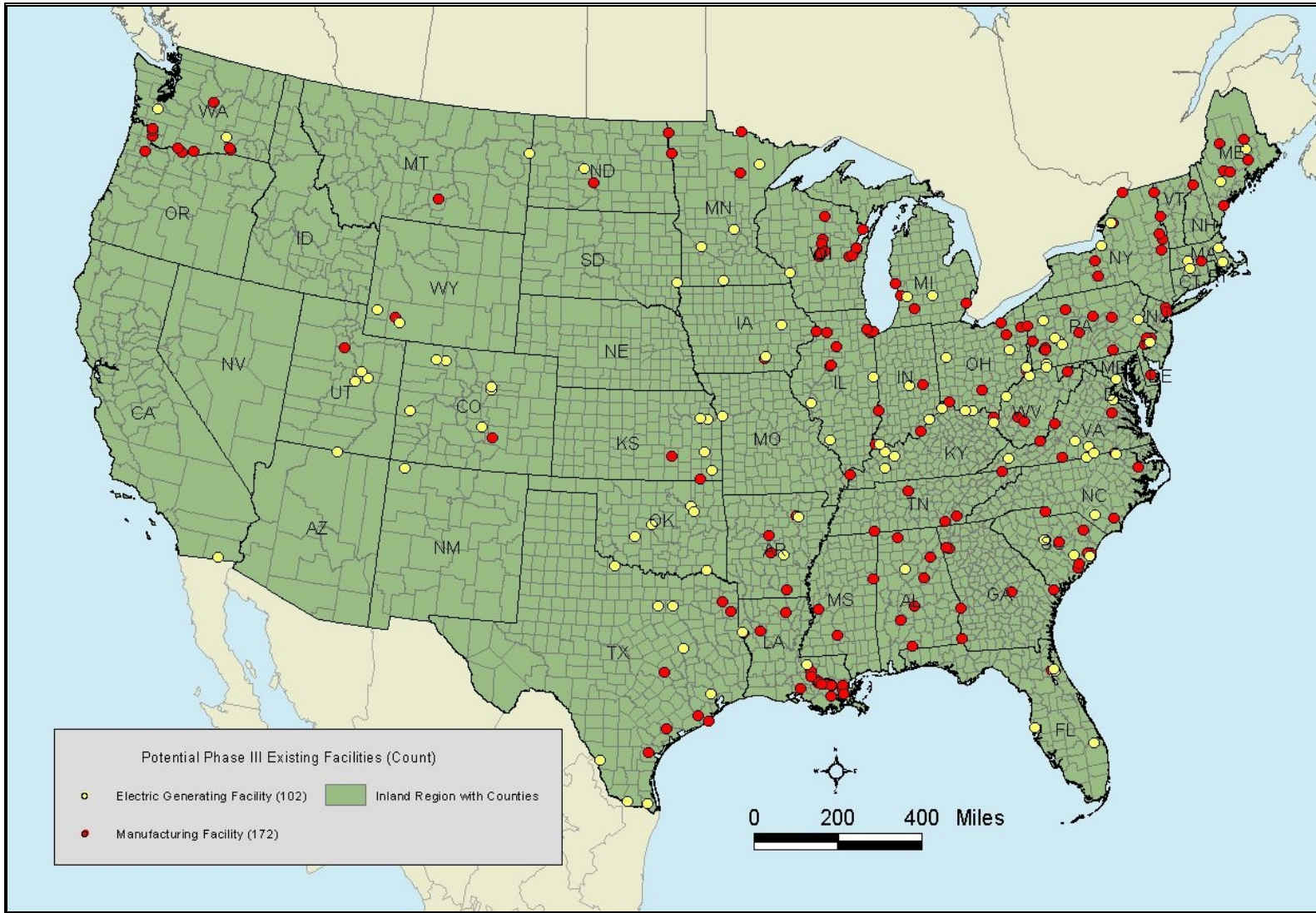
[a] The map includes locations of sample facilities only.

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

Table G1-1 summarizes key technical and compliance characteristics for all potentially regulated Phase III existing facilities in the Inland study region for the regulatory options considered by EPA for this rule (the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option). Facilities with a design intake flow below the three applicability thresholds would be subject to permitting based on best professional judgment and are excluded from EPA's analyses.[2] Therefore, a different number of facilities is affected under each option.

Table G1-1 shows that 541 Phase III existing facilities in the Inland study region would potentially be subject to the national requirements. Under the "50 MGD for All Waterbodies" option, the most inclusive of the regulatory options, 107 facilities would be subject to the national requirements for Phase III existing facilities. Under the less inclusive "200 MGD for All Waterbodies" option, 16 facilities would be subject to the national requirements, and under the "100 MGD for Certain Waterbodies" option, no facilities would be subject to the national requirements. One hundred and seventy-eight facilities in the Inland study region have a recirculating system in the baseline.

Table G1-1: Technical and Compliance Characteristics of Existing Phase III Facilities (sample-weighted)				
	All Potentially Regulated Facilities	**Regulatory Options**		
		50 MGD All	**200 MGD All**	**100 MGD CWB**
Total Number of Facilities (sample-weighted)[a]	**541**	**107**	**16**	**-**
Number of Facilities with Recirculating System in Baseline	**178**	**5**	**1**	**-**
Design Intake Flow (MGD)	**17,704**	**13,276**	**8,732**	**-**
Number of Facilities by Compliance Response				
Fish H&R	58	50	4	-
Velocity cap	9	8	-	-
Fine mesh traveling screens with fish H&R	13	12	4	-
Double-entry, single-exit with fine mesh, and fish H&R	3	3	2	-
Passive fine mesh screens	10	5	3	-
None	448	30	3	-
Compliance Cost, Discounted at 3%[b]	$35.42	$17.49	$10.11	$0.00
Compliance Cost, Discounted at 7%[b]	$35.86	$18.28	$11.25	$0.00

[a] Total may not equal compliance response subtotals due to rounding.
[b] Annualized pre-tax compliance cost (2004$, millions).

Sources: U.S. EPA, 2000b; U.S. EPA analysis for this report.

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[2] Also excluded are facilities that are estimated to be baseline closures. For additional information on EPA's baseline closure analyses, please refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a).

Appendix G1: Life History Parameter Values Used to Evaluate I&E in the Inland Region

The tables in this appendix summarize the life history parameter values used by EPA to calculate age-1 equivalents and fishery yield from impingement and entrainment (I&E) data for the Inland region.

	Table G1-1: Alewife Life History Parameters			
Stage Name	**Instantaneous Natural Mortality (M)**	**Instantaneous Fishing Mortality (F)**	**Fraction Vulnerable to Fishery**	**Weight (lb)**
Eggs	11.5	0	0	0.00000128
Larvae	5.50	0	0	0.00000141
Juvenile	6.21	0	0	0.00478
Age 1+	0.500	0	0	0.0160
Age 2+	0.500	0	0	0.0505
Age 3+	0.500	0	0	0.0764
Age 4+	0.500	0	0	0.0941
Age 5+	0.500	0	0	0.108
Age 6+	0.500	0	0	0.130
Age 7+	0.500	0	0	0.149

Sources: Spigarelli et al., 1981; PG&E National Energy Group, 2001; Froese and Pauly, 2003; and NMFS, 2003a.

Table G1-2: American Shad Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.496	0	0	0.000000716
Yolksac larvae	0.496	0	0	0.000000728
Post-yolksac larvae	2.52	0	0	0.00000335
Juvenile	7.40	0	0	0.000746
Age 1+	0.300	0	0	0.309
Age 2+	0.300	0	0	1.17
Age 3+	0.300	0	0	2.32
Age 4+	0.540	0.21	0.45	3.51
Age 5+	1.02	0.21	0.9	4.56
Age 6+	1.50	0.21	1.0	5.47
Age 7+	1.50	0.21	1.0	6.20
Age 8+	1.50	0.21	1.0	6.77

Sources: USFWS, 1978; Able and Fahay, 1998; PSE&G, 1999; and Froese and Pauly, 2001.

Table G1-3: Bass Species (*Micropterus* spp.) Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000731
Larvae	2.70	0	0	0.0000198
Juvenile	0.446	0	0	0.0169
Age 1+	0.860	0	0	0.202
Age 2+	1.17	0.32	0.5	0.518
Age 3+	0.755	0.21	1.0	0.733
Age 4+	1.05	0.29	1.0	1.04
Age 5+	0.867	0.24	1.0	1.44
Age 6+	0.867	0.24	1.0	2.24
Age 7+	0.867	0.24	1.0	2.56
Age 8+	0.867	0.24	1.0	2.92
Age 9+	0.867	0.24	1.0	3.30

[a] Includes largemouth bass, red bass, smallmouth bass, spotted bass, and other sunfish not identified to species.

Sources: Scott and Crossman, 1973; Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-4: Black Bullhead Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000312
Larvae	4.61	0	0	0.000186
Juvenile+	1.39	0	0	0.00132
Age 1+	0.446	0	0	0.0362
Age 2+	0.223	0.22	0.50	0.0797
Age 3+	0.223	0.22	1.0	0.137
Age 4+	0.223	0.22	1.0	0.233
Age 5+	0.223	0.22	1.0	0.402
Age 6+	0.223	0.22	1.0	0.679
Age 7+	0.223	0.22	1.0	0.753
Age 8+	0.223	0.22	1.0	0.815
Age 9+	0.223	0.22	1.0	0.823

Sources: Carlander, 1969; Scott and Crossman, 1973; Geo-Marine, Inc., 1978; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-5: Black Crappie Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.80	0	0	0.000000929
Larvae	0.498	0	0	0.00000857
Juvenile	2.93	0	0	0.0120
Age 1+	0.292	0	0	0.128
Age 2+	0.292	0.29	0.50	0.193
Age 3+	0.292	0.29	1.0	0.427
Age 4+	0.292	0.29	1.0	0.651
Age 5+	0.292	0.29	1.0	0.888
Age 6+	0.292	0.29	1.0	0.925
Age 7+	0.292	0.29	1.0	0.972
Age 8+	0.292	0.29	1.0	1.08
Age 9+	0.292	0.29	1.0	1.26

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-6: Blueback Herring Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lb)
Eggs	0.558	0	0	0.000000716
Larvae	3.18	0	0	0.00000204
Juvenile	6.26	0	0	0.000746
Age 1+	0.300	0	0	0.0160
Age 2+	0.300	0	0	0.0905
Age 3+	0.300	0	0	0.204
Age 4+	0.900	0	0	0.318
Age 5+	1.50	0	0	0.414
Age 6+	1.50	0	0	0.488
Age 7+	1.50	0	0	0.540
Age 8+	1.50	0	0	0.576

[a] Includes blueback herring and other herrings not identified to the species.

Sources: USFWS, 1978; Able and Fahay, 1998; PSE&G, 1999; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-7: Bluegill Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.73	0	0	0.00000130
Larvae	0.576	0	0	0.00000156
Juvenile	4.62	0	0	0.00795
Age 1+	0.390	0	0	0.00992
Age 2+	0.151	0	0	0.0320
Age 3+	0.735	0.74	0.50	0.0594
Age 4+	0.735	0.74	1.0	0.104
Age 5+	0.735	0.74	1.0	0.189
Age 6+	0.735	0.74	1.0	0.193
Age 7+	0.735	0.74	1.0	0.209
Age 8+	0.735	0.74	1.0	0.352
Age 9+	0.735	0.74	1.0	0.393

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-8: Brown Bullhead Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000115
Larvae	4.61	0	0	0.0000192
Juvenile	1.39	0	0	0.00246
Age 1+	0.446	0	0	0.0898
Age 2+	0.223	0.22	0.50	0.172
Age 3+	0.223	0.22	1.0	0.278
Age 4+	0.223	0.22	1.0	0.330
Age 5+	0.223	0.22	1.0	0.570
Age 6+	0.223	0.22	1.0	0.582

[a] Includes brown bullhead, stonecat, yellow bullhead, and other bullheads not identified to the species.

Sources: Carlander, 1969; Geo-Marine, Inc., 1978; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-9: Carp Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000673
Larvae	4.61	0	0	0.0000118
Juvenile	1.39	0	0	0.0225
Age 1+	0.130	0	0	0.790
Age 2+	0.130	0	0	1.21
Age 3+	0.130	0	0	1.81
Age 4+	0.130	0	0	5.13
Age 5+	0.130	0	0	5.52
Age 6+	0.130	0	0	5.82
Age 7+	0.130	0	0	6.76
Age 8+	0.130	0	0	8.17
Age 9+	0.130	0	0	8.55
Age 10+	0.130	0	0	8.94
Age 11+	0.130	0	0	9.76
Age 12+	0.130	0	0	10.2
Age 13+	0.130	0	0	10.6
Age 14+	0.130	0	0	11.1
Age 15+	0.130	0	0	11.5
Age 16+	0.130	0	0	12.0
Age 17+	0.130	0	0	12.5

[a] Includes carp, goldfish, and other minnows not identified to species.

Sources: Carlander, 1969; Geo-Marine, Inc., 1978; Wang, 1986; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-10: Carp/Minnow Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000115
Larvae	2.06	0	0	0.000375
Juvenile	2.06	0	0	0.00208
Age 1+	1.00	0	0	0.00585
Age 2+	1.00	0	0	0.0121
Age 3+	1.00	0	0	0.0171

[a] Includes bluntnose minnow, central stoneroller, creek chub, fathead minnow, silver chub, silverjaw minnow, and other minnows not identified to species.

Sources: Carlander, 1969; Froese and Pauly, 2001; NMFS, 2003a; and Ohio Department of Natural Resources, 2003.

Table G1-11: Crappie Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.80	0	0	0.000000929
Larvae	0.498	0	0	0.00000857
Juvenile	2.93	0	0	0.0120
Age 1+	0.292	0	0	0.128
Age 2+	0.292	0.29	0.50	0.193
Age 3+	0.292	0.29	1.0	0.427
Age 4+	0.292	0.29	1.0	0.651
Age 5+	0.292	0.29	1.0	0.888
Age 6+	0.292	0.29	1.0	0.925
Age 7+	0.292	0.29	1.0	0.972
Age 8+	0.292	0.29	1.0	1.08
Age 9+	0.292	0.29	1.0	1.26

[a] Includes white crappie and other crappies not identified to the species.

Sources: Carlander, 1977; Wang, 1986; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-12: Darter Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000619
Larvae	1.95	0	0	0.0000497
Juvenile	1.95	0	0	0.000490
Age 1+	0.700	0	0	0.00161
Age 2+	0.700	0	0	0.00321
Age 3+	0.700	0	0	0.00496

[a] Includes fantail darter, river darter, tessallated darter, and other darters not identified to species.

Sources: Carlander, 1997; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table G1-13: Freshwater Catfish Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.0000539
Larvae	4.61	0	0	0.0000563
Juvenile	1.39	0	0	0.0204
Age 1+	0.410	0.41	0.50	0.104
Age 2+	0.410	0.41	1.0	0.330
Age 3+	0.410	0.41	1.0	0.728
Age 4+	0.410	0.41	1.0	1.15
Age 5+	0.410	0.41	1.0	1.92
Age 6+	0.410	0.41	1.0	2.41
Age 7+	0.410	0.41	1.0	3.45
Age 8+	0.410	0.41	1.0	4.01
Age 9+	0.410	0.41	1.0	5.06
Age 10+	0.410	0.41	1.0	8.08
Age 11+	0.410	0.41	1.0	8.39
Age 12+	0.410	0.41	1.0	8.53

[a] Includes blue catfish, channel catfish, flathead catfish, white catfish, and other catfish not identified to the species.

Sources: Miller, 1966; Carlander, 1969; Geo-Marine, Inc., 1978; Wang, 1986; Saila et al., 1997; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-14: Freshwater Drum Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.27	0	0	0.00000115
Larvae	6.13	0	0	0.00000295
Juvenile	2.30	0	0	0.0166
Age 1+	0.310	0	0	0.0500
Age 2+	0.155	0.16	0.50	0.206
Age 3+	0.155	0.16	1.0	0.438
Age 4+	0.155	0.16	1.0	0.638
Age 5+	0.155	0.16	1.0	0.794
Age 6+	0.155	0.16	1.0	0.950
Age 7+	0.155	0.16	1.0	1.09
Age 8+	0.155	0.16	1.0	1.26
Age 9+	0.155	0.16	1.0	1.44
Age 10+	0.155	0.16	1.0	1.60
Age 11+	0.155	0.16	1.0	1.78
Age 12+	0.155	0.16	1.0	2.00

[a] Includes freshwater drum and other drum not identified in species.

Sources: Scott and Crossman, 1973; Virginia Tech, 1998; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-15: Gizzard Shad Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.000000487
Larvae	6.33	0	0	0.00000663
Juvenile	0.511	0	0	0.0107
Age 1+	1.45	0	0	0.141
Age 2+	1.27	0	0	0.477
Age 3+	0.966	0	0	0.640
Age 4+	0.873	0	0	0.885
Age 5+	0.303	0	0	1.17
Age 6+	0.303	0	0	1.54

[a] Includes gizzard shad, threadfin shad, and other shad not identified to species.

Sources: Wapora, 1979; Froese and Pauly, 2003; and NMFS, 2003a.

Table G1-16: Killifish Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.0000180
Larvae	3.00	0	0	0.0000182
Juvenile	0.916	0	0	0.000157
Age 1+	0.777	0	0	0.0121
Age 2+	0.777	0	0	0.0327
Age 3+	0.777	0	0	0.0551
Age 4+	0.777	0	0	0.0778
Age 5+	0.777	0	0	0.0967
Age 6+	0.777	0	0	0.113
Age 7+	0.777	0	0	0.158

[a] Includes eastern banded killifish.

Sources: Carlander, 1969; Stone & Webster Engineering Corporation, 1977; Meredith and Lotrich, 1979; Able and Fahay, 1998; and NMFS, 2003a.

Table G1-17: Logperch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000260
Larvae	1.90	0	0	0.000512
Juvenile	1.90	0	0	0.00434
Age 1+	0.700	0	0	0.0132
Age 2+	0.700	0	0	0.0251
Age 3+	0.700	0	0	0.0377

Sources: Carlander, 1997; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-18: Paddlefish Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.0000434
Larvae	3.23	0	0	0.0000816
Juvenile	3.23	0	0	0.0578
Age 1+	0.570	0	0	0.453
Age 2+	0.285	0.29	0.50	7.10
Age 3+	0.285	0.29	1.0	16.3
Age 4+	0.285	0.29	1.0	27.4
Age 5+	0.285	0.29	1.0	31.6
Age 6+	0.285	0.29	1.0	37.3
Age 7+	0.285	0.29	1.0	41.6
Age 8+	0.285	0.29	1.0	43.7
Age 9+	0.285	0.29	1.0	49.2
Age 10+	0.285	0.29	1.0	51.9
Age 11+	0.285	0.29	1.0	54.6
Age 12+	0.285	0.29	1.0	60.6
Age 13+	0.285	0.29	1.0	63.5
Age 14+	0.285	0.29	1.0	68.1
Age 15+	0.285	0.29	1.0	72.7
Age 16+	0.285	0.29	1.0	75.5
Age 17+	0.285	0.29	1.0	80.8
Age 18+	0.285	0.29	1.0	82.6
Age 19+	0.285	0.29	1.0	85.4
Age 20+	0.285	0.29	1.0	87.9
Age 21+	0.285	0.29	1.0	96.2
Age 22+	0.285	0.29	1.0	102

Sources: Carlander, 1969; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-19: Pike Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.08	0	0	0.0000189
Larvae	5.49	0	0	0.0133
Juvenile	5.49	0	0	0.0451
Age 1+	0.150	0	0	0.365
Age 2+	0.150	0	0	1.10
Age 3+	0.150	0	0	1.53
Age 4+	0.150	0	0	2.72
Age 5+	0.150	0	0	6.19
Age 6+	0.150	0	0	7.02
Age 7+	0.150	0	0	8.92
Age 8+	0.150	0	0	12.3
Age 9+	0.150	0	0	13.9
Age 10+	0.075	0.08	0.50	16.6
Age 11+	0.075	0.08	1.0	19.0
Age 12+	0.075	0.08	1.0	24.2
Age 13+	0.075	0.08	1.0	25.3
Age 14+	0.075	0.08	1.0	30.0
Age 15+	0.075	0.08	1.0	32.4
Age 16+	0.075	0.08	1.0	34.3
Age 17+	0.075	0.08	1.0	45.6
Age 18+	0.075	0.08	1.0	45.8
Age 19+	0.075	0.08	1.0	47.7
Age 20+	0.075	0.08	1.0	48.8
Age 21+	0.075	0.08	1.0	48.9
Age 22+	0.075	0.08	1.0	49.0
Age 23+	0.075	0.08	1.0	49.1
Age 24+	0.075	0.08	1.0	49.2
Age 25+	0.075	0.08	1.0	49.3
Age 26+	0.075	0.08	1.0	49.4
Age 27+	0.075	0.08	1.0	49.4

[a] Includes grass pickerel, muskellunge, and northern pike.

Sources: Carlander, 1969; Pennsylvania, 1999; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-20: Rainbow Smelt Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	11.5	0	0	0.000000990
Larvae	5.50	0	0	0.00110
Juvenile	0.916	0	0	0.00395
Age 1+	0.400	0	0	0.0182
Age 2+	0.400	0.03	0.50	0.0460
Age 3+	0.400	0.03	1.0	0.0850
Age 4+	0.400	0.03	1.0	0.131
Age 5+	0.400	0.03	1.0	0.180
Age 6+	0.400	0.03	1.0	0.228

Sources: Spigarelli et al., 1981; PG&E National Energy Group, 2001; Froese and Pauly, 2003; and NMFS, 2003a.

Table G1-21: Redhorse Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000115
Larvae	2.30	0	0	0.00000370
Juvenile	2.99	0	0	0.0267
Age 1+	0.548	0	0	0.0521
Age 2+	0.548	0	0	0.180
Age 3+	0.548	0	0	0.493
Age 4+	0.548	0	0	0.653
Age 5+	0.548	0	0	0.916
Age 6+	0.548	0	0	2.78
Age 7+	0.548	0	0	3.07

[a] Includes golden redhorse, river redhorse, shorthead redhorse, silver redhorse, and other redhorses not identified to species.

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table G1-22: River Carpsucker Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.05	0	0	0.0000312
Larvae	2.56	0	0	0.0000343
Juvenile	2.30	0	0	0.000239
Age 1+	0.548	0	0	0.0594
Age 2+	0.548	0	0	0.310
Age 3+	0.548	0	0	0.377
Age 4+	0.548	0	0	0.735
Age 5+	0.548	0	0	0.981
Age 6+	0.548	0	0	1.10

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table G1-23: Sauger Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.05	0	0	0.00000619
Larvae	3.55	0	0	0.00000681
Juvenile	1.62	0	0	0.0341
Age 1+	0.230	0.05	0.50	0.505
Age 2+	0.230	0.05	1.0	1.03
Age 3+	0.230	0.05	1.0	1.53
Age 4+	0.230	0.05	1.0	2.19
Age 5+	0.230	0.05	1.0	2.27
Age 6+	0.230	0.05	1.0	3.82
Age 7+	0.230	0.05	1.0	4.65
Age 8+	0.230	0.05	1.0	4.80

[a] Includes sauger and walleye.

Sources: Carlander, 1997; Bartell and Campbell, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-24: Shiner Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.00000473
Larvae	4.61	0	0	0.000285
Juvenile	0.777	0	0	0.00209
Age 1+	0.371	0	0	0.00387
Age 2+	4.61	0	0	0.00683
Age 3+	4.61	0	0	0.0143

[a] Includes bigeye shiner, common shiner, emerald shiner, golden shiner, mimic shiner, river shiner, rosyface shiner, sand shiner, spotfin shiner, spottail shiner, and other shiners not identified to species.

Sources: Fuchs, 1967; Wapora, 1979; Trautman, 1981; Froese and Pauly, 2003; and NMFS, 2003a.

Table G1-25: Skipjack Herring Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.0000227
Larvae	4.25	0	0	0.000381
Juvenile	4.25	0	0	0.0572
Age 1+	0.700	0	0	0.301
Age 2+	0.700	0	0	0.833
Age 3+	0.700	0	0	1.74

Sources: Trautman, 1981; Wallus et al., 1990; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-26: Spotted Sucker Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.79	0	0	0.00000115
Larvae	2.81	0	0	0.00000198
Juvenile	3.00	0	0	0.0213
Age 1+	0.548	0	0	0.0863
Age 2+	0.548	0	0	0.690
Age 3+	0.548	0	0	1.24
Age 4+	0.548	0	0	1.70
Age 5+	0.548	0	0	1.92
Age 6+	0.548	0	0	1.99

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table G1-27: Striped Bass Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.39	0	0	0.000000224
Larvae	7.32	0	0	0.00000606
Juvenile	3.29	0	0	0.0109
Age 1+	1.10	0	0	0.485
Age 2+	0.150	0.31	0.06	2.06
Age 3+	0.150	0.31	0.20	3.31
Age 4+	0.150	0.31	0.63	4.93
Age 5+	0.150	0.31	0.94	6.50
Age 6+	0.150	0.31	1.0	8.58
Age 7+	0.150	0.31	0.90	12.3
Age 8+	0.150	0.31	0.90	14.3
Age 9+	0.150	0.31	0.90	16.1
Age 10+	0.150	0.31	0.90	18.8
Age 11+	0.150	0.31	0.90	19.6
Age 12+	0.150	0.31	0.90	22.4
Age 13+	0.150	0.31	0.90	27.0
Age 14+	0.150	0.31	0.90	34.6
Age 15+	0.150	0.31	0.90	41.5

Sources: Bason, 1971; PSE&G, 1999; and NMFS, 2003a.

Table G1-28: Sucker (*Ictiobus* spp.) Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.87	0	0	0.00000390
Larvae	1.73	0	0	0.00214
Juvenile	2.98	0	0	0.00851
Age 1+	0.548	0	0	1.14
Age 2+	0.548	0	0	1.82
Age 3+	0.548	0	0	2.63
Age 4+	0.548	0	0	3.48
Age 5+	0.548	0	0	4.64
Age 6+	0.548	0	0	5.04
Age 7+	0.548	0	0	11.1
Age 8+	0.548	0	0	12.7
Age 9+	0.548	0	0	16.8
Age 10+	0.548	0	0	27.8
Age 11+	0.548	0	0	28.0
Age 12+	0.548	0	0	36.1
Age 13+	0.548	0	0	36.2
Age 14+	0.548	0	0	36.3
Age 15+	0.548	0	0	36.5

[a] Includes bigmouth buffalo and smallmouth buffalo.

Sources: Carlander, 1969; Bartell and Campbell, 2000; Kleinholz, 2000; and NMFS, 2003a.

Table G1-29: Sucker Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.05	0	0	0.0000312
Larvae	2.56	0	0	0.0000343
Juvenile	2.30	0	0	0.000239
Age 1+	0.274	0	0	0.0594
Age 2+	0.274	0	0	0.310
Age 3+	0.274	0	0	0.377
Age 4+	0.274	0	0	0.735
Age 5+	0.274	0	0	0.981
Age 6+	0.274	0	0	1.10

[a] Includes carpsuckers, highfin carpsucker, northern hog sucker, quillback, white sucker, and other suckers not identified to species.

Sources: Carlander, 1969; Bartell and Campbell, 2000; Froese and Pauly, 2003; and NMFS, 2003a.

Table G1-30: Sunfish Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.71	0	0	0.00000115
Larvae	0.687	0	0	0.00000123
Juvenile	0.687	0	0	0.000878
Age 1+	1.61	0	0	0.00666
Age 2+	1.61	0	0	0.0271
Age 3+	1.50	1.5	0.50	0.0593
Age 4+	1.50	1.5	1.0	0.0754
Age 5+	1.50	1.5	1.0	0.142
Age 6+	1.50	1.5	1.0	0.180
Age 7+	1.50	1.5	1.0	0.214
Age 8+	1.50	1.5	1.0	0.232

[a] Includes green sunfish, longear sunfish, pumpkinseed, redear sunfish, rock bass, warmouth, and other sunfish not identified to species.

Sources: Carlander, 1977; Wang, 1986; PSE&G, 1999; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-31: Walleye Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.05	0	0	0.00000619
Larvae	3.55	0	0	0.0000768
Juvenile	1.93	0	0	0.0300
Age 1+	0.431	0	0	0.328
Age 2+	0.161	0.27	0.50	0.907
Age 3+	0.161	0.27	1.0	1.77
Age 4+	0.161	0.27	1.0	2.35
Age 5+	0.161	0.27	1.0	3.37
Age 6+	0.161	0.27	1.0	3.97
Age 7+	0.161	0.27	1.0	4.66
Age 8+	0.161	0.27	1.0	5.58
Age 9+	0.161	0.27	1.0	5.75

Sources: Carlander, 1997; Bartell and Campbell, 2000; Thomas and Haas, 2000; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

Table G1-32: White Bass Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0	0	0.000000396
Larvae	4.61	0	0	0.00000174
Juvenile	1.39	0	0	0.174
Age 1+	0.420	0	0	0.467
Age 2+	0.420	0.70	0.50	0.644
Age 3+	0.420	0.70	1.0	1.02
Age 4+	0.420	0.70	1.0	1.16
Age 5+	0.420	0.70	1.0	1.26
Age 6+	0.420	0.70	1.0	1.66
Age 7+	0.420	0.70	1.0	1.68

[a] Includes white bass and temperate bass not identified to species.

Sources: Van Oosten, 1942; Geo-Marine, Inc., 1978; Carlander, 1997; Virginia Tech, 1998; McDermot and Rose, 2000; Froese and Pauly, 2001; and NMFS, 2003a.

Table G1-33: White Perch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lb)
Eggs	2.75	0	0	0.000000330
Larvae	5.37	0	0	0.00000271
Juvenile	1.71	0	0	0.00259
Age 1+	0.693	0	0	0.0198
Age 2+	0.693	0	0	0.0567
Age 3+	0.693	0.15	0.0008	0.103
Age 4+	0.689	0.15	0.027	0.150
Age 5+	1.58	0.15	0.21	0.214
Age 6+	1.54	0.15	0.48	0.265
Age 7+	1.48	0.15	0.84	0.356
Age 8+	1.46	0.15	1.0	0.387
Age 9+	1.46	0.15	1.0	0.516
Age 10+	1.46	0.15	1.0	0.619

Sources: Horseman and Shirey, 1974; PSE&G, 1999; and NMFS, 2003a.

Table G1-34: Yellow Perch Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.75	0	0	0.000000655
Larvae	3.56	0	0	0.000000728
Juvenile	2.53	0	0	0.0232
Age 1+	0.361	0	0	0.0245
Age 2+	0.249	0	0	0.0435
Age 3+	0.844	0.36	0.50	0.0987
Age 4+	0.844	0.36	1.0	0.132
Age 5+	0.844	0.36	1.0	0.166
Age 6+	0.844	0.36	1.0	0.214

Sources: Wapora, 1979; PSE&G, 1999; Thomas and Haas, 2000; and NMFS, 2003a.

Table G1-35: Other Recreational Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0	0	0.000000716
Larvae	5.71	0	0	0.00000204
Juvenile	2.85	0	0	0.000746
Age 1+	0.450	0	0	0.0937
Age 2+	0.450	0.80	0.50	0.356
Age 3+	0.450	0.80	1.0	0.679
Age 4+	0.450	0.80	1.0	0.974
Age 5+	0.450	0.80	1.0	1.21
Age 6+	0.450	0.80	1.0	1.38

[a] Includes banded sculpin, coho salmon, rainbow trout, and trout-perch.

Sources: USFWS, 1978; Durbin et al., 1983; Ruppert et al., 1985; Able and Fahay, 1998; PSE&G, 1999; Entergy Nuclear Generation Company, 2000; ASMFC, 2001b; and NMFS, 2003a.

Table G1-36: Other Forage Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0	0	0.0000000186
Larvae	7.70	0	0	0.00000158
Juvenile	1.29	0	0	0.000481
Age 1+	1.62	0	0	0.00381
Age 2+	1.62	0	0	0.00496
Age 3+	1.62	0	0	0.00505

[a] Includes American eel, chestnut lamprey, goldeye, longnose gar, madtoms, mooneye, silver lamprey, and other forage fish not identified to species.

Sources: Derickson and Price, 1973; and PSE&G, 1999.

Chapter G2: Evaluation of Impingement and Entrainment in the Inland Region

G2-1 I&E Species/Species Groups Evaluated

Table G2-1 provides a list of species/species groups that were evaluated in EPA's analysis of impingement and entrainment (I&E) in the Inland region. There is not a significant level of commercial fishing in the interior U.S. Therefore, EPA has assumed that all I&E losses in this region affect recreational fisheries only.

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Table G2-1: Species/Species Groups Evaluated by EPA that are Subject to I&E in the Inland Region

Species/Species Group	Recreational	Commercial	Forage
Alewife			X
American shad	X		
Bay anchovy			X
Bigmouth buffalo	X		
Black bullhead	X		
Black crappie	X		
Blue crab		X	
Blueback herring			X
Bluegill	X		
Bluntnose minnow			X
Brown bullhead	X		
Bullhead species	X		
Burbot			X
Carp			X
Channel catfish	X		
Crappie	X		
Darter species	X		
Emerald shiner			X
Freshwater drum	X		
Gizzard shad			X
Gobies			X

Table G2-1: Species/Species Groups Evaluated by EPA that are Subject to I&E in the Inland Region

Species/Species Group	Recreational	Commercial	Forage
Golden redhorse	X		
Herrings			X
Hogchoker			X
Logperch	X		
Menhaden species	X		
Muskellunge	X		
Other (forage)			X
Other (recreational and commercial)	X		
Other (recreational)	X		
Paddlefish	X		
Pallid sturgeon			X
Rainbow smelt	X		
River carpsucker	X		
Sauger	X		
Sea basses (recreational)	X		
Shiner species			X
Silversides			X
Skipjack herring			X
Smallmouth bass	X		
Smelts	X		
Spotted sucker	X		
Striped bass	X		
Striped killifish	X		
Sturgeon species	X		
Sucker species	X		
Sunfish	X		
Threespine stickleback			X
Walleye	X		
White bass	X		
White perch	X		
Whitefish	X		
Yellow perch	X		

The life history data used in EPA's analysis and associated data sources are provided in Appendix G1 of this report.

G2-2 I&E Data Evaluated

Table G2-2 lists Inland facility I&E data evaluated by EPA to estimate current I&E rates for the region. See Chapter A1 of Part A for a discussion of the methods used to evaluate the I&E data. The facility studies used for EPA's analysis are provided in the 316(b) docket.

Table G2-2: Facility I&E Data Evaluated for the Inland Region Analysis		
Facility	**Phase**	**Years of Data**
AES Cayuga	II	1976-1987
Albany Generating Station	II	1974-1984
Barry Steam Plant	II	1976
Black River Power LLC Electric Generation Facility (Fort Drum Cogeneration Fac)	III	1993
Braidwood Nuclear Generating Station	II	1988
Callaway	II	1984-1985
Cardinal Plant	II	1978
Clifty Creek Station	II	1977-1986
Cogentrix Roxboro	II	1980
Comanche	II	1993
Council Bluffs	II	1976
Dexter Corp./Nonwoven Div. (CT)	III	1990
Dickerson Generating Station	II	1978
Duane Arnold Nuclear Power Plant (IA)	III	1980
Eastman Chemical Company Arkansas Eastman Division (AR)	III	1980
Eckert Station	II	1975
Elrama Power Plant	II	1978
Erickson (MI)	III	1976
Finch, Pruyn, & Company Inc. (NY)	III	1993
Fort Drum HTW Cogenerational Facility	III	1993
G.G. Allen Steam Station	II	1973
Gorgas Steam Plant	II	1985
H B. Robinson	II	1973-1975
Hatfield's Ferry Power Station (PA)	III	1980
James H. Miller Jr. (AL)	III	1978-1986
Kammer Plant	II	1978
Kyger Creek Station	II	1978
Labadie	II	1974
Meramec	II	1974
Miami Fort Generating Station	II	1978
Newton	II	1983-1986
Oconee	II	1974-1976
Pearl Station (IL)	III	1977

Table G2-2: Facility I&E Data Evaluated for the Inland Region Analysis

Facility	Phase	Years of Data
Philip Sporn Plant	II	1978
Putnam	III	1979
Seminole (FL)	III	1979
Sherburne Co. (MN)	III	1974-1975
Tanners Creek Plant	II	1977
Three Mile Island	II	1977
W.H. Sammis Generating Station	II	1977
Wabash River Plant	II	1976
Walter C. Beckjord Generating Station	II	1977
Wateree Generating Station	II	1976
Winyah Generating Station (SC)	III	1981

G2-3   EPA's Estimate of Current I&E at Phase III Facilities in the Inland Region Expressed as Age-1 Equivalents and Foregone Yield

Table G2-3 provides EPA's estimate of the annual age-1 equivalents and foregone fishery yield resulting from the impingement of aquatic species at facilities located in the Inland region. Table G2-4 displays this information for entrainment. Note that in these tables, "total yield" includes direct losses of harvested species and the yield of harvested species that is lost due to losses of forage species (trophic transfer). As discussed in Chapter A1 of Part A of the section 316(b) Phase III Regional Benefits Assessment, the conversion of forage to yield contributes only a very small fraction to total yield.

Table G2-3: Estimated Current Annual Impingement at Phase III Facilities in the Inland Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Alewife	37,800	<1
American shad	7,030	1,730
Bay anchovy	2,880	<1
Bigmouth buffalo	873	<1
Black bullhead	1,120	88
Black crappie	1,990	335
Blue crab	<1	<1
Blueback herring	251,000	<1
Bluegill	285,000	5,520
Bluntnose minnow	6,350	<1
Brown bullhead	7,460	615
Bullhead species	8,980	736
Burbot	45	<1
Carp	14,400	<1
Channel catfish	219,000	45,400
Crappie	15,100	2,550

Table G2-3: Estimated Current Annual Impingement at Phase III Facilities in the Inland Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Darter species	41,000	<1
Emerald shiner	8,480,000	<1
Freshwater drum	93,600	22,500
Gizzard shad	10,100,000	<1
Gobies	<1	<1
Golden redhorse	1,550	<1
Herrings	11,400,000	<1
Hogchoker	2,090	<1
Logperch	1,330	<1
Menhaden species	138	27
Muskellunge	30	113
Other (forage)	7,730,000	<1
Other (recreational and commercial)	76	15
Other (recreational)	1,170	231
Paddlefish	1,420	7,430
Pallid sturgeon	9	<1
Rainbow smelt	4	<1
River carpsucker	1,380	<1
Sauger	12,900	3,520
Sea basses (recreational)	61	15
Shiner species	362,000	<1
Silversides	4,950	<1
Skipjack herring	7,650	<1
Smallmouth bass	31,100	1,260
Smelts	2	<1
Spotted sucker	47	<1
Striped bass	21,200	29,600
Striped killifish	165	<1
Sturgeon species	437	2,060
Sucker species	4,400	<1
Sunfish	2,680,000	1,930
Threespine stickleback	36	<1
Trophic transfer[a]	<1	127,000
Walleye	171	152
White bass	53,000	16,200
White perch	90,600	40
Whitefish	13	12
Yellow perch	180,000	2,510

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

Table G2-4: Estimated Current Annual Entrainment at Phase III Facilities in the Inland Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
American shad	<1	<1
Bigmouth buffalo	6,180	<1
Black bullhead	<1	<1
Black crappie	9	2
Blueback herring	1,210	<1
Bluegill	17,800	344
Bluntnose minnow	7,730,000	<1
Brown bullhead	11,000	909
Bullhead species	11,200	923
Burbot	31	<1
Carp	1,010,000	<1
Channel catfish	73,300	15,200
Crappie	133,000	22,400
Darter species	320,000	<1
Emerald shiner	512,000	<1
Freshwater drum	365,000	87,900
Gizzard shad	870,000	<1
Gobies	3,480	<1
Golden redhorse	1,430	<1
Herrings	879,000	<1
Logperch	30,200	<1
Muskellunge	<1	<1
Other (forage)	701,000	<1
Other (recreational and commercial)	<1	<1
Other (recreational)	3,440	679
Paddlefish	788	4,140
Pallid sturgeon	<1	<1
Rainbow smelt	2	<1
River carpsucker	4,050	<1
Sauger	192,000	52,000
Sea basses (recreational)	<1	<1
Shiner species	103,000	<1
Silversides	499	<1
Skipjack herring	417	<1
Smallmouth bass	268,000	10,800
Smelts	<1	<1
Spotted sucker	<1	<1
Striped bass	<1	<1

Table G2-4: Estimated Current Annual Entrainment at Phase III Facilities in the Inland Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Striped killifish	<1	<1
Sturgeon species	2,450	11,500
Sucker species	3,390,000	<1
Sunfish	6,210,000	4,480
Threespine stickleback	<1	<1
Trophic transfer[a]	<1	57,400
Walleye	70,800	63,200
White bass	15,100	4,630
White perch	35,700	16
Whitefish	<1	<1
Yellow perch	15,300	212

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

G2-4   Reductions in I&E at Phase III Facilities in the Inland Region Under Alternative Options

Table G2-5 presents estimated reductions in I&E under the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option. Reductions under all other options are presented in Appendix G2.

Table G2-5: Estimated Reductions in I&E Under Three Alternative Options

Option	Age-1 Equivalents (#s)	Foregone Fishery Yield (lbs)
50 MGD All Option	19,700,000	155,000
200 MGD All Option	12,700,000	107,000
100 MGD Option	0	0

G2-5   Assumptions Used in Calculating Recreational and Commercial Losses

Unlike the other regions, all losses in the Inland region are assumed to be to recreational fisheries. Therefore, it was not necessary to partition losses between commercial and recreational fisheries.

See Chapter G4 for results of the recreational fishing benefits analysis. As discussed in Chapter A8, benefits were discounted to account for (1) the time to achieve compliance once a Phase III final regulation for existing facilities would have become effective, and (2) the time it takes for fish spared from I&E to reach a harvestable age.

Appendix G2: Reductions in I&E Under Supplemental Policy Options

Table G2-1: Estimated Reductions in I&E in the Inland Region Under Eight Supplemental Options		
Option	**Age-1 Equivalents (#s)**	**Foregone Fishery Yield (lbs)**
Electric Generators 2-50 MGD		
I-only Everywhere	473,000	3,050
I&E like Phase II	509,000	3,590
I&E Everywhere	802,000	7,870
Manufacturers 2-50 MGD		
I-only Everywhere	3,320,000	21,400
I&E like Phase II	3,660,000	26,500
I&E Everywhere	4,880,000	44,300
Manufacturers 50+ MGD		
I-only Everywhere	16,200,000	105,000
I&E Everywhere	24,600,000	228,000

Chapter G3: Commercial Fishing Benefits

There is no significant level of commercial fishing in the interior United States. Therefore, EPA has assumed that all impingement and entrainment losses in this region affect recreational fisheries only. As a result, commercial fishing losses and benefits for the Inland region are assumed to be $0.

Appendix G3: Commercial Fishing Benefits Under Supplemental Policy Options

There is no significant level of commercial fishing in the interior United States. Therefore, EPA has assumed that all impingement and entrainment losses in this region affect recreational fisheries only. As a result, baseline commercial fishing losses and benefits for the Inland region are assumed to be $0. For additional information on the options, please see the TDD.

Chapter G4: Recreational Use Benefits

Introduction

This chapter presents the results of the recreational fishing benefits analysis for the Inland region. The chapter presents EPA's estimates of baseline (i.e., current) annual recreational fishery losses from impingement and entrainment (I&E) at potentially regulated facilities in the Inland region and annual reductions in these losses under the regulatory options for Phase III existing facilities[1]:

- ▸ the "50 MGD for All Waterbodies" option,
- ▸ the "200 MGD for All Waterbodies" option, and
- ▸ the "100 MGD for Certain Waterbodies" option.

The chapter then presents the estimated welfare gain to Inland anglers from eliminating baseline recreational fishing losses from I&E and the expected benefits under the regulatory options.

EPA estimated the recreational benefits of reducing and eliminating I&E losses using a benefit transfer methodology based on a meta-analysis of the marginal value of catching different species of fish. This meta-analysis is discussed in detail in Chapter A5, "Recreational Fishing Benefits Methodology."

EPA considered a wide range of policy options in developing this regulation. In addition to the regulatory options, EPA evaluated various supplemental options. For additional information on the options, please see the TDD. Appendix G4 presents results of the recreational fishing benefits analysis for the supplemental options.

G4-1 Benefit Transfer Approach Based on Meta-Analysis

EPA estimated the recreational welfare gain from the reduction in annual I&E losses expected under the policy options, and the welfare gain from eliminating I&E at potentially regulated facilities, using a benefit transfer approach. As discussed in Chapter A5, the Agency used a meta-analysis regression equation to estimate the marginal recreational value per additional fish caught by anglers, for different species in different regions. Since I&E at potentially regulated facilities affects a variety of species, EPA assigned each species with I&E losses to one of the general species groups used in the meta-analysis. The Agency then calculated the economic value of reducing or eliminating baseline I&E losses, for each species group, by multiplying the value per fish for that species group by the number of fish in the group that are lost in the baseline or saved under the policy options.[2] In general, the fit between the species with I&E losses and the species groups in the meta-analysis was good. However, EPA's estimates of baseline I&E losses and reductions in I&E under the policy options included losses

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[1] See the Introduction to this report for a description of the regulatory options.

[2] The estimates of I&E presented in this chapter include only the fraction of impinged and entrained recreational fish that would be caught by anglers. The total amount of I&E of recreational species is actually much higher.

of "unidentified" species. The "unidentified" group includes fish lost indirectly through trophic transfer, as well as species for which no species information was available.[3] Rather than using the meta-analysis regression to try to predict the value per fish for an "unidentified" species, EPA assumed that per-fish values for these species can be approximated by the weighted average value per fish for all species affected by I&E in the Inland region.[4]

G4-1.1 Baseline Losses and Reductions in Recreational Fishery Losses Under the Regulatory Options

Table G4-1 presents EPA's estimates of baseline (i.e., current) annual recreational I&E losses at potentially regulated facilities, and annual reductions in these losses under each of the regulatory options, in the Inland region. The table shows that total baseline losses to recreational fisheries are 0.66 million fish per year. In comparison, the "50 MGD for All Waterbodies" option prevents losses of 0.17 million fish per year, and the "200 MGD for All Waterbodies" option prevents losses of 0.12 million fish per year. No reduction in losses is expected under the "100 MGD for Certain Waterbodies" option. Of all the affected species, sunfish, bluegill, and channel catfish, along with unidentified species, have the highest losses in the baseline and the highest prevented losses under the regulatory options.

Table G4-1: Baseline Recreational Fishing Losses from I&E at Potentially Regulated Phase III Facilities and Reductions in Recreational Losses Under the Regulatory Options in the Inland Region

Species[a,b]	Baseline Annual Recreational Fishing Losses (# of fish)	Annual Reductions in Recreational Fishing Losses (# of fish)		
		50 MGD All	200 MGD All	100 MGD CWB[e]
American shad	416.2	160.7	95.9	0.0
Paddlefish[c]	419.9	126.4	81.8	0.0
Striped bass	2,654.5	1,025.0	611.6	0.0
Sturgeon[c]	195.5	35.9	28.5	0.0
Total (small game)	**3,686.1**	**1,348.0**	**817.7**	**0.0**
Northern pike	3.7	1.4	0.8	0.0
Sauger	19,980.6	3,253.4	2,738.3	0.0
Walleye	20,153.8	2,988.9	2,639.8	0.0
Total (walleye/pike)	**40,138.1**	**6,243.7**	**5,378.9**	**0.0**
Smallmouth bass	14,487.6	2,499.2	2,044.1	0.0
Spotted bass	11.1	4.3	2.6	0.0
White bass	22,483.4	7,493.0	4,683.0	0.0
Total (bass)	**36,982.0**	**9,996.4**	**6,729.7**	**0.0**
Black bullhead	185.5	71.6	42.7	0.0
Black crappie	510.2	196.5	117.3	0.0
Bluegill	57,402.6	21,362.0	12,889.0	0.0
Brown bullhead	3,924.8	957.6	671.0	0.0

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[3] In addition to recreational fish that are lost because they are impinged or entrained, some recreational fish are lost because the forage fish that they feed on are impinged or entrained, and thus removed from the food chain. These trophic transfer losses of recreational species are included in EPA's estimates of total I&E losses. Since it is difficult to predict which recreational species would be affected by losses of forage fish, these losses are classified as "unidentified" recreational species. Also included in the "unidentified" group are losses of fish that were reported by facilities without information about their exact species.

[4] EPA used the estimated level of baseline recreational losses for each species group as a weighting factor.

Table G4-1: Baseline Recreational Fishing Losses from I&E at Potentially Regulated Phase III Facilities and Reductions in Recreational Losses Under the Regulatory Options in the Inland Region

Species[a,b]	Baseline Annual Recreational Fishing Losses (# of fish)	Annual Reductions in Recreational Fishing Losses (# of fish)		
		50 MGD All	200 MGD All	100 MGD CWB[e]
Bullhead	3,478.7	881.8	608.6	0.0
Channel catfish	48,922.1	15,964.5	10,047.9	0.0
Crappie	37,849.4	6,514.1	5,334.0	0.0
Menhaden	41.7	16.1	9.6	0.0
Sunfish	103,406.3	22,703.7	16,623.7	0.0
White perch	239.6	76.4	48.5	0.0
Yellow perch	21,591.0	7,935.0	4,806.2	0.0
Total (panfish)	**277,552.2**	**76,679.5**	**51,198.7**	**0.0**
Whitefish[d]	8.0	3.1	1.8	0.0
Total (trout)	**8.0**	**3.1**	**1.8**	**0.0**
Total (unidentified)	**299,651.3**	**80,260.7**	**54,220.2**	**0.0**
Total (all species)	*658,017.6*	*174,531.4*	*118,347.0*	*0.0*

[a] EPA assigned each species with I&E losses to one of the species groups used in the meta-analysis. The "unidentified" group includes fish lost indirectly through trophic transfer, fish reported lost without information about their species, and freshwater drum. Freshwater drum were included in this group because there were no valuation studies available and this species does not correspond well with any of the other species groups.
[b] This table includes several species of anadromous fish (such as American shad and striped bass) that are classified in saltwater species groups, but that are commonly caught in freshwater during part of their life cycle.
[c] No valuation studies were available for freshwater sturgeon or paddlefish. EPA included these two species in the "small game" group because the typical size of these species is consistent with (or larger than) the size of other species in the "small game" group. Adult lake sturgeon generally weigh 10 to 80 pounds and measure three to five feet in length, and may grow as large as 300 pounds and seven feet long (NYSDEC, 2003). White sturgeon, which are anadromous, can grow to 400 pounds or 10 feet in length (Monterey Bay Aquarium, 1999). Paddlefish are also very large, averaging between 3.3 and 4.8 feet in length (Jenkins and Burkhead, 1993).
[d] EPA included whitefish in the "trout" category because its physical characteristics are similar to trout, and lake whitefish are prized for their meat. Therefore, valuing them in the panfish category would be inappropriate.
[e] No facilities in the Inland region would be regulated under the "100 MGD for Certain Waterbodies" option, so no benefits are expected in this region under this option.
Source: U.S. EPA analysis for this report.

G4-1.2 Recreational Fishing Benefits from Eliminating Baseline I&E Losses

Table G4-2 shows the results of EPA's analysis of the welfare gain to recreational anglers from eliminating baseline recreational fishery losses at potentially regulated facilities in the Inland region. The table presents baseline annual recreational I&E losses, the estimated value per fish, and the monetized annual welfare gain from eliminating recreational losses, for each species group. Total baseline recreational fishing losses for the Inland region are 658.0 thousand fish per year. The undiscounted annual welfare gain to Inland anglers from eliminating these losses is $1.25 million (2004$), with lower and upper bounds of $0.69 million and $2.26 million. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain of eliminating these losses is $1.21 million and $1.16 million, respectively. The majority of monetized recreational losses from I&E under baseline conditions are attributable to losses of freshwater drum (categorized in the "unidentified" group) and other "unidentified" species.

Table G4-2: Recreational Fishing Benefits from Eliminating Baseline I&E at Potentially Regulated Phase III Facilities in the Inland Region (2004$)

Species Group	Baseline Annual Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Benefits from Eliminating Recreational Fishing Losses (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Small game[e]	3.7	$1.19	$4.51	$16.82	$4.4	$16.6	$62.0
Trout	0.0 [f]	$1.22	$2.38	$4.62	$0.0[g]	$0.0[g]	$0.0[g]
Walleye/pike	40.1	$1.85	$3.45	$6.51	$74.2	$138.7	$261.1
Bass	37.0	$4.45	$7.59	$12.96	$164.7	$280.6	$479.2
Panfish	277.6	$0.48	$0.89	$1.63	$133.0	$247.0	$452.1
Unidentified	299.7	$1.05	$1.88	$3.36	$314.1	$562.9	$1,007.5
Total (undiscounted)	**658.0**				**$690.3**	**$1,245.8**	**$2,262.0**
Total (evaluated at 3% discount rate)	**658.0**				**$669.6**	**$1,208.4**	**$2,194.1**
Total (evaluated at 7% discount rate)	**658.0**				**$644.8**	**$1,163.7**	**$2,112.8**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.

[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 for more details on this approach.

[c] Monetized benefits are calculated by multiplying baseline losses by the estimated value per fish.

[d] Annualized values represent the total welfare gain over the time frame of the analysis from eliminating recreational losses, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

[e] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $63.15 (2004$) to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[f] Denotes a positive value less than 50 fish.

[g] Denotes a positive value less than $50.

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

G4-1.3 Recreational Fishing Benefits of the "50 MGD for All Waterbodies" Option

Table G4-3 shows the results of EPA's analysis of the recreational benefits of the "50 MGD for All Waterbodies" option for the Inland region. The table presents the annual reduction in recreational I&E losses expected under this option, the estimated value per fish, and annual monetized recreational welfare gain from this option, by species group. The table shows that this option reduces recreational losses by 174.5 thousand fish per year, resulting in an undiscounted welfare gain to recreational anglers of $0.32 million (2004$), with lower and upper bounds of $0.18 million and $0.59 million. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain from this reduction in recreational losses is $0.27 million and $0.22 million, respectively. The majority of benefits result from reduced losses of freshwater drum (categorized in the "unidentified" group) and other "unidentified" species.

Table G4-3: Recreational Fishing Benefits of the "50 MGD for All Waterbodies" Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Recreational Fishing Benefits (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Small game[e]	1.3	$1.19	$4.51	$16.82	$1.6	$6.1	$22.7
Trout	0.0 [f]	$1.22	$2.38	$4.62	$0.0[g]	$0.0[g]	$0.0[g]
Walleye/pike	6.2	$1.85	$3.45	$6.51	$11.5	$21.6	$40.6
Bass	10.0	$4.45	$7.59	$12.96	$44.5	$75.9	$129.5
Panfish	76.7	$0.48	$0.89	$1.63	$36.7	$68.2	$124.9
Unidentified	80.3	$1.05	$1.88	$3.36	$84.1	$150.8	$269.9
Total (undiscounted)	**174.5**				**$178.5**	**$322.5**	**$587.6**
Total (evaluated at 3% discount rate)	**174.5**				**$152.2**	**$274.9**	**$500.9**
Total (evaluated at 7% discount rate)	**174.5**				**$124.3**	**$224.5**	**$409.0**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.

[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 for more details on this approach.

[c] Monetized benefits are calculated by multiplying the annual reduction in recreational losses by the estimated value per fish.

[d] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

[e] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $63.15 (2004$) to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[f] Denotes a positive value less than 50 fish.

[g] Denotes a positive value less than $50.

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

G4-1.4 Recreational Fishing Benefits of the "200 MGD for All Waterbodies" Option

Table G4-4 shows the results of EPA's analysis of the recreational benefits of the "200 MGD for All Waterbodies" option for the Inland region. The table presents the annual reduction in recreational I&E losses expected under this option, the estimated value per fish, and annual monetized recreational welfare gain from this option, by species group. The table shows that this option reduces recreational losses by 118.3 thousand fish per year, resulting in an undiscounted welfare gain to recreational anglers of $0.22 million (2004$), with lower and upper bounds of $0.12 million and $0.40 million. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain from this reduction in recreational losses is $0.19 million and $0.15 million, respectively. The majority of benefits result from reduced losses of freshwater drum (categorized in the "unidentified" group) and other "unidentified" species.

Table G4-4: Recreational Fishing Benefits of the "200 MGD for All Waterbodies" Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Recreational Fishing Benefits (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Small game[e]	0.8	$1.19	$4.51	$16.82	$1.0	$3.7	$13.8
Trout	0.0 [f]	$1.22	$2.38	$4.62	$0.0[g]	$0.0[g]	$0.0[g]
Walleye/pike	5.4	$1.85	$3.45	$6.51	$9.9	$18.6	$35.0
Bass	6.7	$4.45	$7.59	$12.96	$30.0	$51.1	$87.2
Panfish	51.2	$0.48	$0.89	$1.63	$24.5	$45.6	$83.4
Unidentified	54.2	$1.05	$1.88	$3.36	$56.8	$101.9	$182.3
Total (undiscounted)	**118.3**				**$122.2**	**$220.8**	**$401.7**
Total (evaluated at 3% discount rate)	**118.3**				**$104.3**	**$188.4**	**$342.8**
Total (evaluated at 7% discount rate)	**118.3**				**$85.3**	**$154.1**	**$280.3**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.

[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 for more details on this approach.

[c] Monetized benefits are calculated by multiplying the annual reduction in recreational losses by the estimated value per fish.

[d] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.

[e] The small game species group includes losses of sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $63.15 (2004$) to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[f] Denotes a positive value less than 50 fish.

[g] Denotes a positive value less than $50.

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

G4-1.5 Recreational Fishing Benefits of the "100 MGD for Certain Waterbodies" Option

No facilities in the Inland region are regulated under the "100 MGD for Certain Waterbodies" option. Thus, no recreational benefits are expected under this option in this region.

G4-2 Limitations and Uncertainty

The results of the benefit transfer based on a meta-analysis represent EPA's best estimate of the recreational benefits of the regulatory options. Nonetheless, there are a number of limitations and uncertainties inherent in these estimates. General limitations pertaining to the development of the meta-analysis model, the use of the model to estimate per-fish values, and the validity of the benefit transfer are discussed in section A5-3.3e and section A5-5.3 of the recreational fishing benefits methodology chapter. In addition to these general concerns about the analysis, there are some limitations and uncertainties that are specific to the Inland region.

One limitation of applying the meta-analysis to the Inland region is that the Inland region is extremely diverse (by definition, it includes the entire continental U.S.). The studies used for the meta-analysis were conducted in only a few geographic regions. In particular, most of the studies that evaluated WTP for walleye, pike, and panfish were conducted in the Great Lakes (in Michigan or Wisconsin). Thus, the average values per fish predicted by the regression equation may not represent the actual value per fish in all areas of the U.S.

Another limitation of the analysis is that EPA was unable to locate any studies that evaluated WTP for channel catfish or for freshwater drum, two species with high I&E losses in the Inland region. However, the Agency believes that the per-fish values for channel catfish and freshwater drum can be approximated by the per-fish values for "panfish" and "unidentified" species, respectively.

Appendix G4: Recreational Use Benefits Under Supplemental Policy Options

Introduction

Chapter G4 presents EPA's estimates of the recreational benefits of the three regulatory options for the section 316(b) rule for Phase III facilities in the Inland region. To facilitate comparisons among the options, this appendix presents estimates of the recreational fishing benefits of various supplemental options that EPA evaluated in preparation for this rule:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option;
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option;
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option;
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option; and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

For additional information on the options, please see the TDD. Recreational fishing benefits presented in this chapter were estimated using the benefit transfer approach discussed in Chapter G4 and in Chapter A5, "Recreational Fishing Benefits Methodology."

G4-1   Recreational Fishing Benefits of the Supplemental Options

G4-1.1 Estimated Reductions in Recreational Fishing Losses Under the Supplemental Options

Table G4-1 presents EPA's estimates of the annual reduction in baseline (i.e., current) recreational fishing losses from impingement and entrainment (I&E) in the Inland region under the supplemental options.

Table G4-1: Reductions in Recreational Fishing Losses from I&E Under the Supplemental Options in the Inland Region

Species[a,b]	Annual Reduction in Recreational Losses (# of fish)							
	Electric Generators 2-50 MGD			Manufacturers 2-50 MGD			Manufacturers 50+ MGD	
	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E Everywhere
American shad	4.7	4.7	4.7	32.8	32.8	32.8	160.1	160.1
Paddlefish[c]	3.0	3.3	5.2	21.2	23.5	31.5	103.8	158.9
Striped bass	29.8	29.8	29.8	208.9	208.9	208.9	1,021.0	1,021.0
Sturgeon[c]	0.3	0.6	2.7	2.3	4.8	13.6	11.4	72.3
Total (small game)	**37.8**	**38.3**	**42.4**	**265.2**	**270.0**	**286.8**	**1,296.2**	**1,412.3**
Northern pike	0.0	0.0	0.0	0.3	0.3	0.3	1.4	1.4
Sauger	14.2	43.8	282.2	99.6	381.1	1,374.7	486.6	7,359.9
Walleye	0.5	32.4	288.4	3.8	306.3	1,373.7	18.7	7,402.3
Total (walleye/pike)	**14.8**	**76.2**	**570.6**	**103.7**	**687.7**	**2,748.7**	**506.7**	**14,763.6**
Smallmouth bass	16.9	37.4	202.8	118.5	313.8	1,003.0	579.0	5,346.7
Spotted bass	0.1	0.1	0.1	0.9	0.9	0.9	4.3	4.3
White bass	196.4	204.3	267.8	1,377.1	1,452.1	1,716.9	6,729.8	8,561.0
Total (bass)	**213.4**	**241.9**	**470.7**	**1,496.5**	**1,766.8**	**2,720.7**	**7,313.1**	**13,912.0**
Black bullhead	2.1	2.1	2.1	14.6	14.6	14.6	71.3	71.3
Black crappie	5.7	5.7	5.7	40.0	40.0	40.1	195.3	196.2
Bluegill	606.6	611.9	654.8	4,252.7	4,303.4	4,482.3	20,782.2	22,019.8
Brown bullhead	17.8	21.5	51.3	124.7	159.9	284.2	609.5	1,468.9
Bullhead	17.3	20.4	45.0	121.5	150.6	253.3	593.5	1,304.4
Channel catfish	411.4	430.8	587.1	2,884.4	3,069.1	3,720.7	14,095.6	18,603.3
Crappie	43.4	97.2	529.9	304.6	815.7	2,619.7	1,488.4	13,967.4
Menhaden	0.5	0.5	0.5	3.3	3.3	3.3	16.1	16.1
Sunfish	349.7	464.1	1,384.2	2,452.0	3,538.9	7,374.8	11,982.5	38,517.2
White perch	1.9	2.0	2.9	13.5	14.5	18.1	66.1	91.0
Yellow perch	223.4	226.1	247.6	1,566.6	1,592.0	1,681.5	7,655.6	8,275.1

Table G4-1: Reductions in Recreational Fishing Losses from I&E Under the Supplemental Options in the Inland Region

	Annual Reduction in Recreational Losses (# of fish)							
	Electric Generators 2-50 MGD			Manufacturers 2-50 MGD			Manufacturers 50+ MGD	
Species[a,b]	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E like Phase II	I&E Everywhere	I-only Everywhere	I&E Everywhere
Total (panfish)	1,679.9	1,882.3	3,511.2	11,777.9	13,702.0	20,492.8	57,556.3	104,530.7
Whitefish[d]	0.1	0.1	0.1	0.6	0.6	0.6	3.0	3.1
Total (trout)	0.1	0.1	0.1	0.6	0.6	0.6	3.0	3.1
Total (unidentified)	1,694.8	1,930.1	3,823.5	11,882.4	14,118.9	22,012.5	58,066.8	112,669.6
Total (all species)	**3,640.9**	**4,168.9**	**8,418.5**	**25,526.3**	**30,546.0**	**48,262.2**	**124,742.1**	**247,291.1**

[a] EPA assigned each species with I&E losses to one of the species groups used in the meta-analysis. The "unidentified" group includes fish lost indirectly through trophic transfer, fish reported lost without information about their species, and freshwater drum. Freshwater drum were included in this group because there were no valuation studies available and this species does not correspond well with any of the other species groups

[b] This table includes several species of anadromous fish (such as American shad and striped bass) that are classified in saltwater species groups, but that are commonly caught in freshwater during part of their life cycle.

[c] No valuation studies were available for freshwater sturgeon or paddlefish. EPA included these two species in the "small game" group because the typical size of these species is consistent with (or larger than) the size of other species in the "small game" group. Adult lake sturgeon generally weigh 10 to 80 pounds and measure three to five feet in length, and may grow as large as 300 pounds and seven feet long (NYSDEC, 2003). White sturgeon, which are anadromous, can grow to 400 pounds or 10 feet in length (Monterey Bay Aquarium, 1999). Paddlefish are also very large, averaging between 3.3 and 4.8 feet in length (Jenkins and Burkhead, 1993).

[d] EPA included whitefish in the "trout" category because its physical characteristics are similar to trout, and lake whitefish are prized for their meat. Therefore, valuing them in the panfish category would be inappropriate.

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

G4-1.2 Recreational Fishing Benefits of the Supplemental Options

Tables G4-2 through G4-9 present EPA's estimates of the annualized recreational benefits of the supplemental options in the Inland region.

Table G4-2: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I-only Everywhere" Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.0[e]	$1.19	$4.51	$16.82	0.0[f]	$0.2	$0.6
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.0[e]	$1.85	$3.45	$6.51	0.0[f]	$0.1	$0.1
Bass	0.2	$4.45	$7.59	$12.96	$1.0	$1.6	$2.8
Panfish	1.7	$0.48	$0.89	$1.63	$0.8	$1.5	$2.7
Unidentified	1.7	$1.05	$1.88	$3.36	$1.8	$3.2	$5.7
Total (undiscounted)	**3.6**				**$3.6**	**$6.5**	**$11.9**
Total (evaluated at 3% discount rate)	**3.6**				**$3.1**	**$5.6**	**$10.2**
Total (evaluated at 7% discount rate)	**3.6**				**$2.5**	**$4.6**	**$8.4**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $63.15 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.
[e] Denotes a nonzero value less than 50 fish.
[f] Denotes a nonzero value less than $50.

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

**Table G4-3: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I&E like Phase II"
Option in the Inland Region (2004$)**

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.0[e]	$1.19	$4.51	$16.82	0.0[f]	$0.2	$0.6
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.1	$1.85	$3.45	$6.51	$0.1	$0.3	$0.5
Bass	0.2	$4.45	$7.59	$12.96	$1.1	$1.8	$3.1
Panfish	1.9	$0.48	$0.89	$1.63	$0.9	$1.7	$3.1
Unidentified	1.9	$1.05	$1.88	$3.36	$2.0	$3.6	$6.5
Total (undiscounted)	**4.2**				**$4.2**	**$7.6**	**$13.8**
Total (evaluated at 3% discount rate)	**4.2**				**$3.6**	**$6.5**	**$11.9**
Total (evaluated at 7% discount rate)	**4.2**				**$3.0**	**$5.4**	**$9.8**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.
[e] Denotes a nonzero value less than 50 fish.
[f] Denotes a nonzero value less than $50.

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

Table G4-4: Recreational Fishing Benefits of the "Electric Generators 2-50 MGD I&E Everywhere"
Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.0[e]	$1.19	$4.51	$16.82	$0.1	$0.2	$0.7
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.6	$1.85	$3.45	$6.51	$1.1	$2.0	$3.7
Bass	0.5	$4.45	$7.59	$12.96	$2.1	$3.6	$6.1
Panfish	3.5	$0.48	$0.89	$1.63	$1.7	$3.1	$5.7
Unidentified	3.8	$1.05	$1.88	$3.36	$4.0	$7.2	$12.9
Total (undiscounted)	**8.4**				**$8.9**	**$16.0**	**$29.1**
Total (evaluated at 3% discount rate)	**8.4**				**$7.6**	**$13.8**	**$24.9**
Total (evaluated at 7% discount rate)	**8.4**				**$6.3**	**$11.3**	**$20.5**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.
[e] Denotes a nonzero value less than 50 fish.
[f] Denotes a nonzero value less than $50.

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

**Table G4-5: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I-only Everywhere"
Option in the Inland Region (2004$)**

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.3	$1.19	$4.51	$16.82	$0.3	$1.2	$4.5
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.1	$1.85	$3.45	$6.51	$0.2	$0.4	$0.7
Bass	1.5	$4.45	$7.59	$12.96	$6.7	$11.4	$19.4
Panfish	11.8	$0.48	$0.89	$1.63	$5.6	$10.5	$19.2
Unidentified	11.9	$1.05	$1.88	$3.36	$12.5	$22.3	$40.0
Total (undiscounted)	**25.5**				**$25.3**	**$45.7**	**$83.7**
Total (evaluated at 3% discount rate)	**25.5**				**$21.0**	**$38.0**	**$69.5**
Total (evaluated at 7% discount rate)	**25.5**				**$16.6**	**$30.0**	**$55.0**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.
[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.
[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.
[e] Denotes a nonzero value less than 50 fish.
[f] Denotes a nonzero value less than $50.

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

Table G4-6: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I&E like Phase II" Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.3	$1.19	$4.51	$16.82	$0.3	$1.2	$4.5
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.7	$1.85	$3.45	$6.51	$1.3	$2.4	$4.5
Bass	1.8	$4.45	$7.59	$12.96	$7.9	$13.4	$22.9
Panfish	13.7	$0.48	$0.89	$1.63	$6.6	$12.2	$22.3
Unidentified	14.1	$1.05	$1.88	$3.36	$14.8	$26.5	$47.5
Total (undiscounted)	**30.5**				**$30.8**	**$55.7**	**$101.7**
Total (evaluated at 3% discount rate)	**30.5**				**$25.7**	**$46.4**	**$84.7**
Total (evaluated at 7% discount rate)	**30.5**				**$20.4**	**$36.8**	**$67.2**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.

[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[e] Denotes a nonzero value less than 50 fish.

[f] Denotes a nonzero value less than $50.

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

Table G4-7: Recreational Fishing Benefits of the "Manufacturers 2-50 MGD I&E Everywhere" Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	0.3	$1.19	$4.51	$16.82	$0.3	$1.3	$4.8
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	2.7	$1.85	$3.45	$6.51	$5.1	$9.5	$17.9
Bass	2.7	$4.45	$7.59	$12.96	$12.1	$20.6	$35.3
Panfish	20.5	$0.48	$0.89	$1.63	$9.8	$18.2	$33.4
Unidentified	22.0	$1.05	$1.88	$3.36	$23.1	$41.4	$74.0
Total (undiscounted)	**48.3**				**$50.4**	**$91.0**	**$165.4**
Total (evaluated at 3% discount rate)	**48.3**				**$42.0**	**$75.9**	**$137.8**
Total (evaluated at 7% discount rate)	**48.3**				**$33.4**	**$60.2**	**$109.4**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.

[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[e] Denotes a nonzero value less than 50 fish.

[f] Denotes a nonzero value less than $50.

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

Table G4-8: Recreational Fishing Benefits of the "Manufacturers 50+ MGD I-only Everywhere"
Option in the Inland Region (2004$)

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	1.3	$1.19	$4.51	$16.82	$1.5	$5.8	$21.8
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	0.5	$1.85	$3.45	$6.51	$0.9	$1.8	$3.3
Bass	7.3	$4.45	$7.59	$12.96	$32.6	$55.5	$94.8
Panfish	57.6	$0.48	$0.89	$1.63	$27.6	$51.2	$93.8
Unidentified	58.1	$1.05	$1.88	$3.36	$60.9	$109.1	$195.2
Total (undiscounted)	**124.7**				**$123.5**	**$223.4**	**$408.9**
Total (evaluated at 3% discount rate)	**124.7**				**$105.2**	**$190.4**	**$348.4**
Total (evaluated at 7% discount rate)	**124.7**				**$85.9**	**$155.4**	**$284.3**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.

[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[e] Denotes a nonzero value less than 50 fish.

[f] Denotes a nonzero value less than $50.

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

**Table G4-9: Recreational Fishing Benefits of the "Manufacturers 50+ MGD I&E Everywhere"
Option in the Inland Region (2004$)**

Species Group	Annual Reduction in Recreational Fishing Losses (thousands of fish)	Value per Fish[a]			Annualized Recreational Fishing Benefits (thousands)[b,c]		
		Low	Mean	High	Low	Mean	High
Small Game[d]	1.4	$1.19	$4.51	$16.82	$1.7	$6.4	$23.7
Trout	0.0[e]	$1.22	$2.38	$4.62	0.0[f]	0.0[f]	0.0[f]
Walleye/Pike	14.8	$1.85	$3.45	$6.51	$27.3	$51.0	$96.0
Bass	13.9	$4.45	$7.59	$12.96	$61.9	$105.6	$180.3
Panfish	104.5	$0.48	$0.89	$1.63	$50.1	$93.0	$170.3
Unidentified	112.7	$1.05	$1.88	$3.36	$118.1	$211.7	$378.8
Total (undiscounted)	**247.3**				**$259.1**	**$467.6**	**$849.2**
Total (evaluated at 3% discount rate)	**247.3**				**$221.1**	**$399.1**	**$724.7**
Total (evaluated at 7% discount rate)	**247.3**				**$180.8**	**$326.4**	**$592.7**

[a] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.

[b] Monetized benefits are calculated by multiplying the reduction in losses by the estimated value per fish.

[c] Annualized benefits represent the value of all recreational benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting methodology, refer to Chapter A8.

[d] The small game species group includes sturgeon. However, applying the use value for small game to sturgeon may understate the value of this species. A marine fishing valuation study indicates that California anglers are willing to pay $61.43 to catch a sturgeon in saltwater (U.S. EPA, 2004a). However, sturgeon in freshwater are often landlocked and may not be as large as sturgeon found in saltwater, and therefore not as valuable.

[e] Denotes a nonzero value less than 50 fish.

[f] Denotes a nonzero value less than $50.

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

G4-2   Comparison of Recreational Fishing Benefits by Option

Table G4-10 compares the recreational fishing benefits of some supplemental options.

Policy Option	Annual Reduction in Recreational Fishing Losses from I&E (thousands of fish)	Undiscounted Recreational Fishing Benefits (thousands; 2004$)[a]		
		Low	Mean	High
Electric Generators 2-50 MGD				
I-only Everywhere	3.6	$3.6	$6.5	$11.9
I&E like Phase II	4.2	$4.2	$7.6	$13.8
I&E Everywhere	8.4	$8.9	$16.0	$29.1
Manufacturers 2-50 MGD				
I-only Everywhere	25.5	$25.3	$45.7	$83.7
I&E like Phase II	30.5	$30.8	$55.7	$101.7
I&E Everywhere	48.3	$50.4	$91.0	$165.4
Manufacturers 50+ MGD				
I-only Everywhere	124.7	$123.5	$223.4	$408.9
I&E Everywhere	247.3	$259.1	$467.6	$849.2

Table G4-10: Annual Recreational Benefits of the Supplemental Options in the Inland Region

[a] These benefit estimates were calculated using the meta-analysis approach discussed in Chapter A5 and Chapter B4.

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

Chapter G5: Federally Listed T&E Species in the Inland Region

This chapter lists current federally listed threatened and endangered (T&E) fish and shellfish species in the Inland Region. This list does not address proposed or candidate species; In addition, fish and shellfish listed as cave species, marine mammals, reptiles, amphibians, and snails are not included in this chapter.

Table G5-1: Alabama Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Dromus dromas*	Dromedary pearlymussel: entire range except where listed as experimental populations
T	*Elliptoideus sloatianus*	Purple bankclimber mussel
E	*Epioblasma florentina walkeri (= E. walkeri)*	Tan riffleshell mussel
E	*Epioblasma othcaloogensis*	Southern acornshell mussel
E	*Epioblasma torulosa torulosa*	Tubercled blossom pearlymussel: entire range except where listed as experimental populations
E	*Leptodea leptodon*	Scaleshell mussel
E	*Medionidus parvulus*	Moccasinshell mussel
E	*Medionidus penicillatus*	Gulf moccasinshell mussel
E	*Pegias fabula*	Littlewing pearlymussel
E	*Percina antesella*	Amber darter
E	*Pleurobema clava*	Clubshell mussel: entire range except where listed as experimental populations
E	*Pleurobema curtum*	Black clubshell mussel
E	*Pleurobema pyriforme*	Oval pigtoe mussel
E	*Pristis pectinata*	Smalltooth sawfish
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Villosa trabalis*	Cumberland bean pearlymussel: entire range except where listed as experimental populations

Source: USFWS, 2006a.

Table G5-2: Arizona Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Gila elegans*	Bonytail chub
T	*Cyprinella formosa*	Beautiful shiner
E	*Poeciliopsis occidentalis*	Gila topminnow (including Yaqui) (U.S. only)
T	*Oncorhynchus apache*	Apache trout
E	*Cyprinodon macularius*	Desert pupfish
E	*Gila cypha*	Humpback chub
T	*Gila ditaenia*	Sonora chub
E	*Gila intermedia*	Gila chub
E	*Gila purpurea*	Yaqui chub
E	*Gila seminuda (= robusta)*	Virgin River chub
T	*Ictalurus pricei*	Yaqui catfish
T	*Lepidomeda vittata*	Little Colorado spinedace
T	*Meda fulgida*	Spikedace
E	*Oncorhynchus gilae*	Gila trout
T	*Tiaroga cobitis*	Loach minnow
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-3: Arkansas Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Arkansia wheeleri*	Ouachita rock pocketbook mussel
E	*Epioblasma florentina curtisii*	Curtis pearlymussel
E	*Lampsilis abrupta*	Pink mucket pearlymussel
T	*Lampsilis powelli*	Arkansas fatmucket mussel
E	*Lampsilis streckeri*	Speckled pocketbook mussel
E	*Leptodea leptodon*	Scaleshell mussel
T	*Notropis girardi*	Arkansas River shiner (Arkansas River basin)
T	*Percina pantherina*	Leopard darter
E	*Potamilus capax*	Fat pocketbook mussel
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-4: California Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Branchinecta conservatio*	Conservancy fairy shrimp
E	*Branchinecta longiantenna*	Longhorn fairy shrimp
T	*Branchinecta lynchi*	Vernal pool fairy shrimp
E	*Branchinecta sandiegonensis*	San Diego fairy shrimp
E	*Catostomus microps*	Modoc sucker
T	*Catostomus santaanae*	Santa Ana sucker (3 California river basins)
E	*Chasmistes brevirostris*	Shortnose sucker
E	*Cyprinodon macularius*	Desert pupfish
E	*Cyprinodon radiosus*	Owens pupfish
E	*Deltistes luxatus*	Lost River sucker
E	*Eucyclogobius newberryi*	Tidewater goby
E	*Gasterosteus aculeatus williamsoni*	Unarmored threespine stickleback
E	*Gila bicolor mohavensis*	Mohave tui chub
E	*Gila bicolor snyderi*	Owens tui chub
E	*Gila elegans*	Bonytail chub
T	*Haliotis sorenseni*	White abalone
T	*Hypomesus transpacificus*	Delta smelt
E	*Lepidurus packardi*	Vernal pool tadpole shrimp
T	*Oncorhynchus (= Salmo) kisutch*	Coho salmon (Oregon and California populations)
E	*Oncorhynchus (= Salmo) kisutch*	Coho salmon (central California coast)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (Central Valley, California)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (central California coast)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (northern California)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (south central California coast)
E	*Oncorhynchus (= Salmo) mykiss*	Steelhead (southern California coast)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (California Central Valley) (spring run)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (California coastal)
E	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Sacramento River) (winter run)
T	*Oncorhynchus aguabonita whitei*	Little Kern golden trout
T	*Oncorhynchus clarki henshawi*	Lahontan cutthroat trout
T	*Oncorhynchus clarki seleniris*	Paiute cutthroat trout
E	*Pacifastacus fortis*	Shasta crayfish
E	*Ptychocheilus lucius*	Pikeminnow (= squawfish), Colorado except Salt and Verde River drainages, AZ
T	*Salvelinus confluentus*	Bull trout (U.S., conterminous, lower 48 states)
E	*Streptocephalus woottoni*	Riverside fairy shrimp
E	*Syncaris pacifica*	California freshwater shrimp
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-5: Colorado Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Gila cypha*	Humpback chub
E	*Gila elegans*	Bonytail chub
E	*Ptychocheilus lucius*	Pikeminnow (= squawfish), Colorado except Salt and Verde R. drainages, AZ
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-6: Connecticut Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-7: Delaware Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-8: District of Columbia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-9: Florida Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Amblema neislerii*	Fat three-ridge mussel
T	*Elliptio chipolaensis*	Chipola slabshell mussel
T	*Elliptoideus sloatianus*	Purple bankclimber mussel
E	*Etheostoma okaloosae*	Okaloosa darter
E	*Lampsilis subangulata*	Shinyrayed pocketbook mussel
E	*Medionidus penicillatus*	Gulf moccasinshell
E	*Medionidus simpsonianus*	Ochlockonee moccasinshell
E	*Pleurobema pyriforme*	Oval pigtoe mussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table G5-10: Georgia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Elliptoideus sloatianus*	Purple bankclimber mussel
T	*Medionidus acutissimus*	Alabama moccasinshell
E	*Pleurobema decisum*	Southern clubshell mussel
E	*Acipenser brevirostrum*	Shortnose sturgeon
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Amblema neislerii*	Fat three-ridge mussel
T	*Cyprinella caerulea*	Blue shiner
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma metastriata*	Upland combshell mussel
E	*Epioblasma othcaloogensis*	Southern acornshell mussel
T	*Erimonax monachus*	Spotfin chub: entire range except where listed as experimental populations
E	*Etheostoma etowahae*	Etowah darter
T	*Etheostoma scotti*	Cherokee darter
T	*Lampsilis altilis*	Finelined pocketbook mussel
E	*Lampsilis subangulata*	Shinyrayed pocketbook mussel
E	*Medionidus parvulus*	Coosa moccasinshell
E	*Medionidus penicillatus*	Gulf moccasinshell
E	*Medionidus simpsonianus*	Ochlockonee moccasinshell
E	*Percina antesella*	Amber darter
T	*Percina aurolineata*	Goldline darter
E	*Percina jenkinsi*	Conasauga logperch
T	*Percina tanasi*	Snail darter
E	*Pleurobema georgianum*	Southern pigtoe mussel
E	*Pleurobema perovatum*	Ovate clubshell mussel
E	*Pleurobema pyriforme*	Oval pigtoe mussel
E	*Ptychobranchus greenii*	Triangular kidneyshell mussel

Source: USFWS, 2006a.

Table G5-11: Idaho Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Oncorhynchus (= Salmo) nerka*	Sockeye salmon (U.S, Snake River, Idaho stock wherever found)
E	*Acipenser transmontanus*	White sturgeon (U.S.: Idaho, Montana. Canada: B.C., Kootenai River system)
T	*Oncorhynchus(= Salmo) mykiss*	Steelhead (Snake River basin)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (fall run)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (spring/summer run)
T	*Salvelinus (= Salmo) confluentus*	Bull trout (U.S., conterminous, lower 48 states)

Source: USFWS, 2006a.

Table G5-12: Illinois Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Epioblasma torulosa torulosa*	Tubercled-blossom pearlymussel: entire range, except where listed as experimental populations
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel (= catspaw): entire range, except where listed as experimental populations
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range, except where listed as experimental populations
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations
E	*Potamilus capax*	Fat pocketbook mussel
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-13: Indiana Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations
E	*Pleurobema plenum*	Rough pigtoe mussel
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel (= catspaw): entire range, except where listed as experimental populations
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range, except where listed as experimental populations
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Obovaria retusa*	Ring pink mussel
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Potamilus capax*	Fat pocketbook mussel

Source: USFWS, 2006a.

Table G5-14: Iowa Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Potamilus capax*	Fat pocketbook mussel
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range, except where listed as experimental populations
E	*Notropis topeka*	Topeka shiner
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-15: Kansas Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Notropis girardi*	Arkansas River shiner (Arkansas River basin)
E	*Notropis topeka (= tristis)*	Topeka shiner
T	*Noturus placidus*	Neosho madtom
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-16: Kentucky Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta atropurpurea*	Cumberland elktoe mussel
E	*Cyprogenia stegaria*	Fanshell mussel
E	*Dromus dromas*	Dromedary pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma brevidens*	Cumberlandian combshell mussel: entire range except where listed as experimental populations
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma florentina walkeri (= E. walkeri)*	Tan riffleshell mussel
E	*Epioblasma obliquata obliquata*	Catspaw (= purple cat's paw pearlymussel): entire range except where listed as experimental populations
E	*Epioblasma torulosa rangiana*	Riffleshell, northern
E	*Etheostoma chienense*	Darter, relict
E	*Hemistena lata*	Pearlymussel, cracking: entire range except where listed as experimental populations
E	*Lampsilis abrupta*	Pink mucket pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Notropis albizonatus*	Palezone shiner
E	*Obovaria retusa*	Ring pink mussel
E	*Pegias fabula*	Littlewing pearlymussel

Table G5-16: Kentucky Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Phoxinus cumberlandensis*	Blackside dace
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Plethobasus cooperianus*	Orangefoot pimpleback pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range except where listed as experimental populations
E	*Pleurobema plenum*	Rough pigtoe mussel
E	*Potamilus capax*	Fat pocketbook mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Scaphirhynchus albus*	Pallid sturgeon
E	*Villosa trabalis*	Cumberland bean pearlymussel: entire range except where listed as experimental populations

Source: USFWS, 2006a.

Table G5-17: Louisiana Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Lampsilis abrupta*	Pink mucket pearlymussel
T	*Margaritifera hembeli*	Louisiana pearlshell mussel
T	*Potamilus inflatus*	Alabama heelsplitter (= inflated) mussel
E	*Pristis pectinata*	Smalltooth sawfish
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-18: Maine Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Salmo salar*	Atlantic salmon (Gulf of Maine Atlantic salmon DPS)

Source: USFWS, 2006a.

Table G5-19: Maryland Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel
E	*Etheostoma sellare*	Maryland darter

Source: USFWS, 2006a.

Table G5-20: Massachusetts Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-21: Michigan Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range, except where listed as experimental populations

Source: USFWS, 2006a.

Table G5-22: Minnesota Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Leptodea leptodon*	Scaleshell mussel
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Notropis topeka*	Topeka shiner
E	*Quadrula fragosa*	Winged mapleleaf mussel

Source: USFWS, 2006a.

Table G5-23: Mississippi Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Lampsilis perovalis*	Orangenacre mucket mussel
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Epioblasma brevidens*	Cumberlandian combshell mussel: entire range except where listed as experimental populations
E	*Epioblasma penita*	Southern combshell mussel
T	*Etheostoma rubrum*	Bayou darter
T	*Medionidus acutissimus*	Alabama moccasinshell
E	*Pleurobema curtum*	Black clubshell mussel
E	*Pleurobema decisum*	Southern clubshell mussel
E	*Pleurobema marshalli*	Flat pigtoe mussel
E	*Pleurobema perovatum*	Ovate clubshell mussel
E	*Pleurobema taitianum*	Heavy pigtoe mussel
E	*Potamilus capax*	Fat pocketbook mussel
T	*Potamilus inflatus*	Alabama heelsplitter (= inflated) mussel
E	*Pristis pectinata*	Smalltooth sawfish
E	*Quadrula stapes*	Stirrupshell mussel

Table G5-23: Mississippi Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Scaphirhynchus albus*	Pallid sturgeon
E	*Scaphirhynchus suttkusi*	Alabama sturgeon

Source: USFWS, 2006a.

Table G5-24: Missouri Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Epioblasma florentina curtisi*	Curtis' pearlymussel
T	*Ethiostoma nianguae*	Niangua darter
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Notropis topeka*	Topeka shiner
T	*Noturus placidus*	Neosho madtom
E	*Potamilus capax*	Fat pocketbook mussel
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-25: Montana Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser transmontanus*	White sturgeon: U.S.A. (ID, MT), Canada (B.C.), Kootenai River system
T	*Salvelinus confluentus*	Bull trout: U.S.A. (conterminous, lower 48 states)
E	*Scaphirhynchus albus*	Sturgeon, pallid

Source: USFWS, 2006a.

Table G5-26: Nebraska Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Notropis topeka (= tristis)*	Topeka shiner
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-27: Nevada Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Chasmistes cujus*	Cui-ui
E	*Crenichthys baileyi baileyi*	White River springfish
E	*Crenichthys baileyi grandis*	Hiko White River springfish
T	*Crenichthys nevadae*	Railroad Valley springfish
E	*Cyprinodon diabolis*	Devil's Hole pupfish
E	*Cyprinodon nevadensis mionectes*	Ash Meadows Amargosa pupfish
E	*Cyprinodon nevadensis pectoralis*	Warm Springs pupfish
E	*Empetrichthys latos*	Pahrump poolfish
T	*Eremichthys acros*	Deset dace
E	*Gila elegans*	Bonytail chub
E	*Gila robusta jordani*	Pahranagat roundtail chub
E	*Gila seminuda (= robusta)*	Virgin River chub
E	*Lepidomeda albivallis*	White River spinedace
T	*Lepidomeda mollispinis pratensis*	Big Spring spinedace
E	*Moapa coriacea*	Moapa dace
T	*Oncorhynchus clarki henshawi*	Lahontan cutthroat trout
E	*Ptychocheilus lucius*	Pikeminnow (= squawfish), Colorado except Salt and Verde River drainages, AZ
E	*Rhinichthys osculus lethoporus*	Independence Valley speckled dace
E	*Rhinichthys osculus nevadensis*	Ash Meadows speckled dace
E	*Rhinichthys osculus oligoporus*	Clover Valley speckled dace
T	*Salvelinus confluentus*	Bull trout (U.S., conterminous, lower 48 states)
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-28: New Hampshire Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-29: New Jersey Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-30: New Mexico Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Gila intermedia*	Gila chub
T	*Cyprinella formosa*	Beautiful shiner
E	*Gambusia nobilis*	Pecos gambusia
T	*Gila nigrescens*	Chihuahua chub
E	*Hybognathus amarus*	Rio Grande silvery minnow
T	*Meda fulgida*	Spikedace
T	*Notropis girardi*	Arkansas River shiner (Arkansas River basin)
T	*Notropis simus pecosensis*	Pecos bluntnose shiner
E	*Oncorhynchus gilae*	Gila trout
E	*Poeciliopsis occidentalis*	Gila topminnow (including Yaqui) (U.S. only)
E	*Ptychocheilus lucius*	Colorado pikeminnow (= squawfish), except Salt and Verde River drainages
T	*Tiaroga cobitis*	Loach minnow
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-31: New York Federally Listed T&E Fish and Shellfish

E	*Alasmidonta heterodon*	Dwarf wedgemussel
E	*Acipenser brevirostrum*	Shortnose sturgeon

Source: USFWS, 2006a.

Table G5-32: North Carolina Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta raveneliana*	Appalachian elktoe mussel
E	*Elliptio steinstansana*	Tar River spinymussel
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma florentina walkeri (= E. walkeri)*	Tan rifleshell mussel
T	*Erimonax monachus*	Spotfin chub: entire range except where listed as experimental populations
E	*Lasmigona decorata*	Carolina heelsplitter mussel
T	*Menidia extensa*	Waccamaw silverside
E	*Notropis mekistocholas*	Cape Fear shiner
E	*Pegias fabula*	Littlewing pearlymussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table G5-33: North Dakota Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-34: Ohio Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprogenia stegaria (= C. irrorata)*	Fanshell mussel
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel
E	*Epioblasma obliquata perobliqua*	White catspaw pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Lampsilis orbiculata (= L. abrupta)*	Pink mucket pearlymussel
E	*Noturus trautmani*	Scioto madtom
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Leptodea leptodon*	Scaleshell mussel: entire range except where listed as experimental populations
E	*Hemistena lata*	Cracking pearlymussel: entire range, except where listed as experimental populations
E	*Plethobasus cooperianus (= P. striatus)*	Orange-footed pimpleback pearlymussel
E	*Potamilus capax*	Fat pocketbook mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Pleurobema clava*	Clubshell mussel

Source: USFWS, 2006a.

Table G5-35: Oregon Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Salvelinus confluentus*	Bull trout (U.S., conterminous, lower 48 states)
T	*Branchinecta lynchi*	Vernal pool fairy shrimp
T	*Catostomus warnerensis*	Warner sucker
E	*Chasmistes brevirostris*	Shortnose sucker
E	*Deltistes luxatus*	Lost River sucker
T	*Gila bicolor* spp.	Hutton tui Hutton chub
E	*Gila boraxobius*	Borax Lake chub
T	*Oncorhynchus (= Salmo) keta*	Chum salmon (Columbia River)
T	*Oncorhynchus (= Salmo) kisutch*	Coho salmon (Oregon, California pop.)
T	*Oncorhynchus (= Salmo) kisutch*	Coho salmon (lower Columbia River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (Snake River basin)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (middle Columbia River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (upper Willamette River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (lower Columbia River)

Table G5-35: Oregon Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Oncorhynchus (= Salmo) nerka*	Sockeye salmon (U.S., Snake River, ID stock wherever found)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (fall run)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (lower Columbia River)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (spring/summer run)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (upper Willamette River)
T	*Oncorhynchus clarki henshawi*	Lahontan cutthroat trout
E	*Oregonichthys crameri*	Oregon chub
T	*Rhinichthys osculus* spp.	Foskett dace (= speckled Foskett)

Source: USFWS, 2006a.

Table G5-36: Pennsylvania Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Pleurobema clava*	Clubshell mussel: entire range except where listed as experimental populations
E	*Cyprogenia stegaria*	Fanshell mussel
E	*Lampsilis abrupta*	Pink mucket pearlymussel
E	*Pleurobema plenum*	Rough pigtoe pearlymussel
E	*Plethobasus cooperianus*	Orange-foot pimpleback pearlymussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-37: South Carolina Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Lasmigona decorata*	Carolina heelsplitter mussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table G5-38: South Dakota Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Leptodea leptodon*	Scaleshell mussel
E	*Notropis topeka*	Topeka shiner
E	*Scaphirhynchus albus*	Pallid sturgeon

Source: USFWS, 2006a.

Table G5-39: Tennessee Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Cyprinella (= Hybopsis) cahni*	Spotfin chub
T	*Cyprinella (= Notropis) caerulea (= caeruleus)*	Blue shiner
E	*Etheostoma. (= Catonotus) percnurum*	Duskytail darter
E	*Etheostoma (= Doration) spp.*	Bluemask (= jewel) darter
E	*Etheostoma (= Nothonotus) wapiti*	Boulder darter
T	*Erimystax (= Hybopsis) cahni*	Slender chub
T	*Etheostoma boschungi*	Slackwater darter
E	*Hemistena (= Lastena) lata*	Cracking pearlymussel: entire range except where listed as experimental populations
E	*Lampsilis virescens*	Alabama lampmussel: entire range except where listed as experimental populations
E	*Lampsilis abrupta (= orbiculata)*	Pink mucket pearlymussel
E	*Epioblasma othcaloogensis*	Southern acornshell mussel
E	*Epioblasma torulosa gubernaculum*	Green blossom pearlymussel
E	*Epioblasma turgidula*	Turgid blossom pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma florentina florentina*	Yellow blossom pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma obliquata obliquata*	Purple catspaw pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma brevidens*	Cumberlandian combshell mussel: entire range except where listed as experimental populations
E	*Epioblasma metastriata*	Upland combshell mussel
E	*Percina aurolineata*	Goldline darter
E	*Alasmidonta raveneliana*	Appalachian elktoe mussel
E	*Alasmidonta atropurpurea*	Cumberland elktoe mussel
E	*Cyprogenia stegaria*	Fanshell mussel
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Leptodea leptodon*	Scaleshell mussel
E	*Conradilla caelata*	Birdwing pearlymussel: entire range except where listed as experimental populations
E	*Dromus dromas*	Dromedary pearlymussel: entire range except where listed as experimental populations
E	*Pleurobema gibberum*	Cumberland pigtoe mussel
E	*Epioblasma florentina walker (= E. walkeri)*	Tan riffleshell mussel
E	*Fusconaia cor*	Shiny pigtoe mussel: entire range except where listed as experimental populations
E	*Medionidus parvulus*	Coosa moccasinshell
E	*Notropis albizonatus (cf. N. procne)*	Palezone shiner
E	*Noturus baileyi*	Smoky madtom
T	*Noturus flavipinnis*	Yellowfin madtom
E	*Noturus stanauli*	Pygmy madtom

Table G5-39: Tennessee Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Obovaria retusa*	Ring pink mussel
E	*Orconectes shoupi*	Nashville crayfish
E	*Plethobasus cooperianus*	Orange-foot pimpleback pearlymussel
E	*Pleurobema decisum*	Southern clubshell mussel
E	*Pleurobema georgianum*	Southern pigtoe mussel
E	*Pleurobema gibberum*	Cumberland pigtoe mussel
E	*Percina jenkinsi*	Conasauga (= Reticulate) logperch
E	*Pleurobema perovatum*	Ovate clubshell
E	*Pleurobema plenum*	Rough pigtoe pearlymussel
T	*Percina tanasi*	Snail darter
E	*Pegias fabula*	Littlewing pearlymussel
E	*Percina antesella*	Amber darter
T	*Phoxinus cumberlandensis*	Blackside dace
E	*Plethobasus cicatricosus*	White wartyback pearlymussel
E	*Pleurobema clava*	Clubshell mussel: entire range except where listed as experimental populations
E	*Ptychobranchus greeni*	Triangular kidneyshell mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel: entire range except where listed as experimental populations
E	*Quadrula sparsa*	Appalachian monkeyface pearlymussel
E	*Quadrula cylindrica strigillata*	Rough rabbitsfoot mussel
E	*Quadrula intermedia*	Cumberland monkeyface pearlymussel: entire range except where listed as experimental populations
E	*Scaphirhynchus albus*	Pallid sturgeon
E	*Toxolasma (= Carunculina) cylindrella*	Pale lilliput pearlymussel
E	*Villosa (= Micromya) trabalis*	Cumberland bean pearlymussel: entire range except where listed as experimental populations
E	*Villosa perpurpurea*	Purple bean mussel

Sources: Tennessee Wildlife Resources Agency, 2006; USFWS, 2006a.

Table G5-40: Texas Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprinodon bovinus*	Leon Springs pupfish
E	*Cyprinodon elegans*	Comanche Springs pupfish
T	*Dionda diaboli*	Devils River minnow
E	*Etheostoma fonticola*	Fountain darter
E	*Gambusia gaigei*	Big Bend gambusia
E	*Gambusia georgei*	San Marcos gambusia
E	*Gambusia heterochir*	Clear Creek gambusia
E	*Gambusia nobilis*	Pecos gambusia
E	*Hybognathus amarus*	Rio Grande silvery minnow
T	*Notropis girardi*	Arkansas River shiner (Arkansas River basin)
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table G5-41: Utah Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Chasmistes liorus*	June sucker
E	*Gila cypha*	Humpback chub
E	*Gila elegans*	Bonytail chub
E	*Gila seminuda (= robusta)*	Virgin River chub
T	*Oncorhynchus clarki henshawi*	Lahontan cutthroat trout
E	*Plagopterus argentissimus*	Woundfin
E	*Ptychocheilus lucius*	Colorado pikeminnow (= squawfish), except Salt and Verde River drainages
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Table G5-42: Vermont Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Alasmidonta heterodon*	Dwarf wedgemussel

Source: USFWS, 2006a.

Table G5-43: Virginia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta heterodon*	Dwarf wedgemussel
E	*Conradilla caelata*	Birdwing pearlymussel: entire range except where listed as experimental populations
T	*Cyprinella monacha*	Spotfin chub
E	*Cyprogenia stegaria*	Fanshell mussel
E	*Dromus dromas*	Dromedary pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma brevidens*	Cumberlandian combshell mussel: entire range except where listed as experimental populations
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma florentina walker (= E. walkeri)*	Tan riffleshell mussel
T	*Erimystax cahni*	Slender chub
E	*Etheostoma percnurum*	Duskytail darter
E	*Fusconaia cor*	Shiny pigtoe mussel: entire range except where listed as experimental populations
E	*Fusconaia cuneolus*	Fine-rayed pigtoe mussel: entire range except where listed as experimental populations
E	*Hemistena lata*	Cracking pearlymussel: entire range except where listed as experimental populations
T	*Noturus flavipinnis*	Yellowfin madtom
E	*Pegias fabula*	Little-wing pearlymussel
E	*Percina rex*	Roanoke logperch
E	*Pleurobema collina*	James spinymussel
E	*Pleurobema plenum*	Rough pigtoe mussel
E	*Quadrula cylindrica strigillata*	Rough rabbitsfoot mussel
E	*Quadrula intermedia*	Cumberland monkeyface pearlymussel: entire range except where listed as experimental populations
E	*Quadrula sparsa*	Appalachian monkeyface pearlymussel
E	*Villosa trabalis*	Cumberland bean pearlymussel: entire range except where listed as experimental populations
E	*Epioblasma torulosa gubernaculum*	Green blossom pearlymussel: entire range except where listed as experimental populations
E	*Villosa perpurpurea*	Purple bean mussel

Source: USFWS, 2006a.

Table G5-44: Washington Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Oncorhynchus (= Salmo) keta*	Chum salmon (Hood Canal) (summer run)
T	*Oncorhynchus (= Salmo) keta*	Chum salmon (Columbia River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (lower Columbia River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (middle Columbia River)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (Snake River basin)
T	*Oncorhynchus (= Salmo) mykiss*	Steelhead (upper Columbia River basin)
T	*Oncorhynchus (= Salmo) nerka*	Sockeye salmon (Ozette Lake)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (lower Columbia River)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Puget Sound)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (fall run)
T	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (Snake River) (spring/summer run)
T	*Oncorhynchus (= Salmo) kisutch*	Coho salmon (lower Columbia River)
E	*Oncorhynchus (= Salmo) tshawytscha*	Chinook salmon (upper Columbia River) (spring run)

Source: USFWS, 2006a.

Table G5-45: West Virginia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Cyprogenia stegaria (= irrorata)*	Fanshell mussel
E	*Lampsilis abrupta (= orbiculata)*	Pink mucket pearlymussel
E	*Pleurobema (= Canthyria) collina*	James spiny mussel
E	*Epioblasma torulosa rangiana*	Northern riffleshell mussel
E	*Obovaria retusa*	Ring pink mussel
E	*Pleurobema clava*	Clubshell mussel

Source: USFWS, 2006a.

Table G5-46: Wisconsin Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Lampsilis higginsii*	Higgins eye pearlymussel
E	*Leptodea leptodon*	Scaleshell mussel
E	*Quadrula fragosa*	Winged mapleleaf mussel

Sources: USFWS, 2006a,b.

Table G5-47: Wyoming federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Gila cypha*	Humpback chub
E	*Gila elegans*	Bonytail chub
E	*Ptychocheilus lucius*	Colorado pikeminnow (= squawfish)
E	*Rhinichthys osculus thermalis*	Kendall Warm Springs dace
E	*Xyrauchen texanus*	Razorback sucker

Source: USFWS, 2006a.

Part H: South Atlantic

Chapter H1: Background

Introduction

This chapter presents an overview of the potential Phase III existing facilities in the South Atlantic study region and summarizes their key cooling water and compliance characteristics. For further

discussion of the technical and compliance characteristics of potential Phase III existing facilities, refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* and the *Technical Development Document for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a,c).

H1-1 Facility Characteristics

The South Atlantic Regional Study includes one sample facility that is potentially subject to the national standards for Phase III existing facilities. Figure H1-1 presents a map of this manufacturing facility. Industry-wide, this one sample facility represents four manufacturing facilities.[1]

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[1] EPA applied sample weights to the survey respondents to account for non-sampled facilities and facilities that did not respond to the survey. For more information on EPA's 2000 Section 316(b) Industry Survey, please refer to the Information Collection Request (U.S. EPA, 2000b).

Figure H1-1: Potential Existing Phase III Facilities in the South Atlantic Regional Study[a]
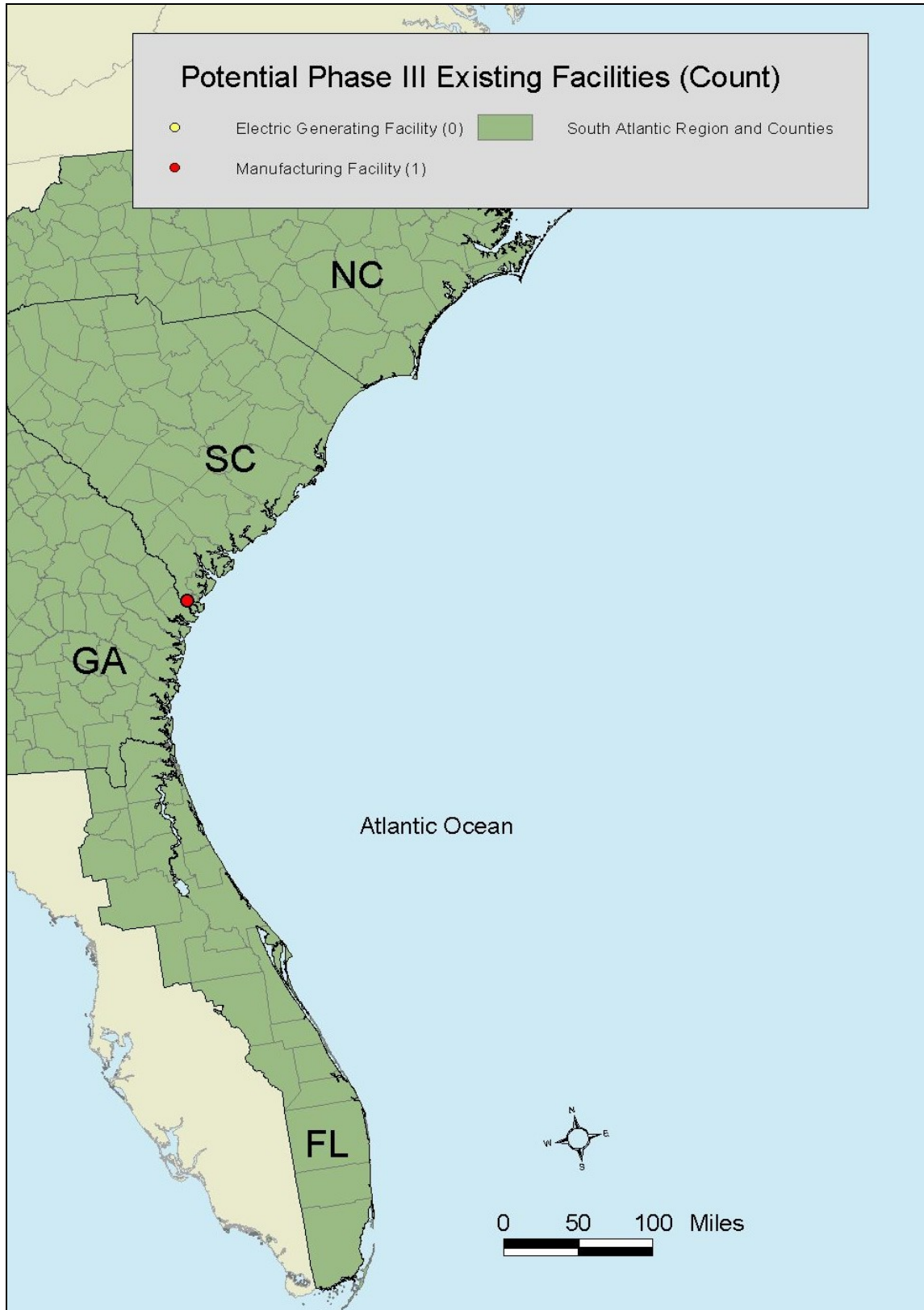
[a] The map includes locations of sample facilities only.

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

Table H1-1 summarizes key technical and compliance characteristics for all potentially regulated Phase III existing facilities in the South Atlantic study region for the regulatory options considered by EPA for this rule (the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option). Facilities with a design intake flow below the three applicability thresholds would be subject to permitting based on best professional judgment and are excluded from EPA's analyses.[2] Therefore, a different number of facilities is affected under each option.

Table H1-1 shows that four Phase III existing facilities in the South Atlantic study region would potentially be subject to the national requirements. Under the "50 MGD for All Waterbodies" option, the most inclusive of the regulatory options, no facilities would be subject to the national requirements for Phase III existing facilities. Under the less inclusive "200 MGD for All Waterbodies" and "100 MGD for Certain Waterbodies" options, no facilities would be subject to the nation requirements. This facility in the South Atlantic study region does not have a recirculating system in the baseline. Data on design intake flow for the South Atlantic study facilities have been withheld due to data confidentiality reasons.

Table H1-1: Technical and Compliance Characteristics of Existing Phase III Facilities (sample-weighted)

	All Potentially Regulated Facilities	Regulatory Options		
		50 MGD All	200 MGD All	100 MGD CWB
Total Number of Facilities (sample-weighted)	**4**	-	-	-
Number of Facilities with Recirculating System in Baseline	**-**	-	-	-
Design Intake Flow (MGD)	**w[a]**	-	-	-
Number of Facilities by Compliance Response				
New larger intake structure with fine mesh and fish H&R	-	-	-	-
Fine mesh traveling screens with fish H&R	-	-	-	-
Passive fine mesh screens	-	-	-	-
None	4	-	-	-
Compliance Cost, Discounted at 3%[b]	$0.68	$0.00	$0.00	$0.00
Compliance Cost, Discounted at 7%[b]	$0.63	$0.00	$0.00	$0.00

[a] Data withheld because of confidentiality reasons.
[b] Annualized pre-tax compliance cost (2004$, millions).

Sources: U.S. EPA, 2000b; U.S. EPA analysis for this report.

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[2] Also excluded are facilities that are estimated to be baseline closures. For additional information on EPA's baseline closure analyses, please refer to the *Economic Analysis for the Final Section 316(b) Rule for Phase III Facilities* (U.S. EPA, 2006a).

Appendix H1: Life History Parameter Values Used to Evaluate I&E in the South Atlantic Region

The tables in this appendix present the life history parameter values used by EPA to calculate age-1 equivalents and fishery yields from impingement and entrainment (I&E) data for the South Atlantic region. Because of differences in the number of life stages represented in the loss data, there are cases where more than one life stage sequence was needed for a given species or species group. Alternative parameter sets were developed for this purpose and are indicated with a number following the species or species group name (i.e., Winter flounder 1, Winter flounder 2).

Table H1-1: Atlantic Menhaden Life History Parameters				
Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0.000	0	0.000000716
Larvae	5.71	0.000	0	0.00000204
Juveniles	2.85	0.000	0	0.000746
Age 1+	0.450	0.000	0	0.0937
Age 2+	0.450	0.800	0.5	0.356
Age 3+	0.450	0.800	1	0.679
Age 4+	0.450	0.800	1	0.974
Age 5+	0.450	0.800	1	1.21
Age 6+	0.450	0.800	1	1.38
Sources: PG&E National Energy Group, 2001; and Froese and Pauly, 2003.				

Table H1-2: Bay Anchovy Life History Parameters[a]				
Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0.000	0	0.0000000186
Larvae	7.69	0.000	0	0.00000158
Juveniles	1.29	0.000	0	0.000481
Age 1+	1.62	0.000	0	0.00381
Age 2+	1.62	0.000	0	0.00496
Age 3+	1.62	0.000	0	0.00505

[a] Includes bay anchovy and striped anchovy.

Sources: PG&E National Energy Group, 2001; and Froese and Pauly, 2003.

Table H1-3: Blue Crab Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Larvae	15.1	0.000	0	0.00000156
Juveniles	1.73	0.48	0.5	0.00000293
Age 1+	1.00	1.00	1	0.00719
Age 2+	1.00	1.00	1	0.113
Age 3+	1.00	1.00	1	0.326

[a] Includes lesser blue crab.

Sources: Hartman, 1993; PSE&G, 1999; and Murphy et al., 2000.

Table H1-4: Drums/Croakers Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.500	0.000	0	0.000000721
Larvae	4.61	0.000	0	0.00000464
Juveniles	3.38	0.000	0	0.000212
Age 1+	0.420	0.000	0	0.120
Age 2+	0.420	0.000	0	0.156
Age 3+	0.210	0.210	0.5	0.195
Age 4+	0.210	0.210	1	0.239
Age 5+	0.210	0.210	1	0.287
Age 6+	0.210	0.210	1	0.340
Age 7+	0.210	0.210	1	0.398
Age 8+	0.210	0.210	1	0.458
Age 9+	0.210	0.210	1	0.519
Age 10+	0.210	0.210	1	0.584
Age 11+	0.210	0.210	1	0.648
Age 12+	0.210	0.210	1	0.723

[a] Includes croakers.

Sources: Isaacson, 1964; Tenera Environmental Services, 1988, 2000b, 2001; and Cailliet, 2000.

Table H1-5: Flounders Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.223	0.000	0	0.000000303
Larvae	6.28	0.000	0	0.00121
Juveniles	1.14	0.000	0	0.00882
Age 1+	0.363	0.242	0.5	0.0671
Age 2+	0.649	0.432	1	0.226
Age 3+	0.752	0.501	1	0.553
Age 4+	0.752	0.501	1	1.13

Sources: Cailliet, 2000; ENSR and Marine Research, 2000; Tenera Environmental Services, 2000a, 2001; Leet et al., 2001; and personal communication with Y. DeReynier (NMFS, November 19, 2002).

Table H1-6: Forage Shrimp Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.693	0.000	0	0.000000249
Larvae	3.00	0.000	0	0.000000736
Juveniles	2.30	0.000	0	0.0000865
Age 1+	2.30	0.000	0	0.000131
Age 2+	2.30	0.000	0	0.00236

[a] Includes brown shrimp, hardback shrimp, Penaeid species, and white shrimp.

Sources: Siegfried, 1989; Virginia Tech, 1998; and Tenera Environmental Services, 2001.

Table H1-7: Gobies Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.000	0.000	0	0.0000115
Larvae	5.77	0.000	0	0.0000190
Juveniles	0.871	0.000	0	0.000169
Age 1+	1.10	0.000	0	0.00194
Age 2+	1.10	0.000	0	0.00414
Age 3+	1.10	0.000	0	0.00762
Age 4+	1.10	0.000	0	0.0310
Age 5+	1.10	0.000	0	0.0810

[a] Includes Gobionellus and Gobiosoma species.

Sources: Wang, 1986; Froese and Pauly, 2000, 2002; Tenera Environmental Services, 2000a; and NMFS, 2003a.

Table H1-8: Other Commercial Crabs Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.000	0.000	0	0.000000153
Larvae	7.99	0.000	0	0.0000279
Age 1+	2.43	0.000	0	0.289
Age 2+	2.43	0.000	0	0.654
Age 3+	2.43	0.000	0	1.26
Age 4+	1.82	0.610	0.5	1.97
Age 5+	1.82	0.610	1	2.55
Age 6+	1.82	0.610	1	3.00

[a] Includes Portunidae and swimming crabs.

Sources: Carroll, 1982; Tenera Environmental Services, 2000a; University of Washington, 2000; and Leet et al., 2001.

Table H1-9: Other Commercial Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0.000	0	0.000000716
Larvae	5.71	0.000	0	0.00000204
Juveniles	2.85	0.000	0	0.000746
Age 1+	0.450	0.000	0	0.0937
Age 2+	0.450	0.800	0.50	0.356
Age 3+	0.450	0.800	1.0	0.679
Age 4+	0.450	0.800	1.0	0.974
Age 5+	0.450	0.800	1.0	1.21
Age 6+	0.450	0.800	1.0	1.38

[a] Includes mojarra.

Sources: USFWS, 1978; Durbin et al., 1983; Ruppert et al., 1985; Able and Fahay, 1998; PSE&G, 1999; Entergy Nuclear Generation Company, 2000; and ASMFC, 2001b.

Table H1-10: Other Forage Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0.000	0	0.0000000186
Larvae	7.70	0.000	0	0.00000158
Juveniles	1.29	0.000	0	0.000481
Age 1+	1.62	0.000	0	0.00381
Age 2+	1.62	0.000	0	0.00496
Age 3+	1.62	0.000	0	0.00505

[a] Includes blackcheek tonguefish, cutlassfish, grunt, and Atlantic silversides, as well as other organisms not identified to species.

Sources: Derickson and Price, 1973; and PSE&G, 1999.

Table H1-11: Other Recreational and Commercial Species Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0.000	0	0.000000716
Larvae	5.71	0.000	0	0.00000204
Juveniles	2.85	0.000	0	0.0240
Age 1+	0.450	0.000	0	0.0937
Age 2+	0.450	0.800	0.50	0.356
Age 3+	0.450	0.800	1.0	0.679
Age 4+	0.450	0.800	1.0	0.974
Age 5+	0.450	0.800	1.0	1.21
Age 6+	0.450	0.800	1.0	1.38

[a] Includes jack.

Sources: USFWS, 1978; Durbin et al., 1983; Ruppert et al., 1985; Able and Fahay, 1998; PSE&G, 1999; Entergy Nuclear Generation Company, 2000; and ASMFC, 2001b.

Table H1-12: Pinfish Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0.000	0	0.00000107
Larvae	7.39	0.000	0	0.0000238
Juveniles	1.91	0.000	0	0.00668
Age 1+	0.340	0.340	0.5	0.0791
Age 2	0.340	0.340	1	0.218

Sources: Muncy, 1984; Nelson, 1998; and Froese and Pauly, 2001.

Table H1-13: Pink Shrimp Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	3.22	0.000	0	0.0000000253
Larvae	3.40	0.000	0	0.00000274
Juveniles	0.140	0.140	1	0.0473
Age 1+	0.140	0.140	1	0.0770

Source: Bielsa et al., 1983.

Table H1-14: Scaled Sardine Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.12	0.000	0	0.00000533
Larvae	7.09	0.000	0	0.00000586
Juveniles	0.916	0.000	0	0.000483
Age 1+	1.02	0.000	0	0.275

[a] Includes threadfin shad.

Sources: Houde et al., 1974; Stone & Webster Engineering Corporation, 1980; Pierce et al., 2001; Froese and Pauly, 2003; and NMFS, 2003a.

Table H1-15: Silver Perch Life History Parameters[a]

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.75	0.000	0	0.000000527
Larvae	5.37	0.000	0	0.00000771
Juveniles	1.71	0.000	0	0.0444
Age 1+	3.84	0.000	0	0.273
Age 2+	3.84	0.100	0.5	0.415
Age 3+	3.84	0.100	1	0.607

[a] Includes star drum.

Sources: Able and Fahay, 1998; PSE&G, 1999; Florida Fish and Wildlife Conservation Commission, 2001; Froese and Pauly, 2001, 2003; and personal communication with Michael D. Murphy (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002).

Table H1-16: Spot Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.825	0.000	0	0.000000131
Larvae	7.42	0.000	0	0.000000854
Juveniles	2.57	0.000	0	0.000121
Age 1+	0.463	0.400	1	0.0791
Age 2+	0.400	0.400	1	0.299
Age 3+	0.400	0.400	1	0.507
Age 4+	0.400	0.400	1	0.648
Age 5+	0.400	0.400	1	0.732
Age 6+	0.400	0.400	1	0.779
Age 7+	0.400	0.400	1	0.779
Age 8+	0.400	0.400	1	0.779
Age 9+	0.400	0.400	1	0.779
Age 10+	0.400	0.400	1	0.779
Age 11+	0.400	0.400	1	0.779
Age 12+	0.400	0.400	1	0.779
Age 13+	0.400	0.400	1	0.779
Age 14+	0.400	0.400	1	0.779
Age 15+	0.400	0.400	1	0.779

Sources: Warlen et al., 1980; and PSE&G, 1984, 1999.

Table H1-17: Spotted Seatrout Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0.000	0	0.000000842
Larvae	8.42	0.000	0	0.000000926
Juveniles	0.272	0.272	0.5	0.571
Age 1+	0.272	0.272	1	0.913
Age 2+	0.272	0.272	1	1.55
Age 3+	0.272	0.272	1	2.50
Age 4+	0.272	0.272	1	3.15
Age 5+	0.272	0.272	1	3.54
Age 6+	0.272	0.272	1	4.41
Age 7+	0.272	0.272	1	4.97
Age 8+	0.272	0.272	1	4.99

Sources: Stone & Webster Engineering Corporation, 1980; Johnson and Seaman, 1986; Sutter et al., 1986; and Murphy and Taylor, 1994.

Table H1-18: Stone Crab Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Larvae	11.8	0.000	0	0.00000160
Juveniles	1.97	0.000	0	0.0000182
Age 1+	0.939	0.751	0.5	1.02
Age 2+	0.939	0.751	1	3.63
Age 3+	0.939	0.751	1	7.12
Age 4+	0.939	0.751	1	10.0

Sources: Bert et al., 1978; Sullivan, 1979; Lindberg and Marshall, 1984; Van den Avyle and Fowler, 1984; and Ehrhardt et al., 1990.

Table H1-19: Striped Mullet Life History Parameters

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.90	0.000	0	0.000000537
Larvae	4.61	0.000	0	0.0000110
Juveniles	0.916	0.000	0	0.131
Age 1+	0.230	0.300	0.5	0.187
Age 2+	0.230	0.300	1	0.379
Age 3+	0.230	0.300	1	0.774
Age 4+	0.230	0.300	1	1.58
Age 5+	0.230	0.300	1	3.21
Age 6+	0.230	0.300	1	6.53

Sources: Collins, 1985; Wang, 1986; PSE&G, 1999; and Froese and Pauly, 2003.

Stage Name	Instantaneous Natural Mortality (M)	Instantaneous Fishing Mortality (F)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0	0	0.0000000787
Larvae	7.70	0	0	0.000000235
Juveniles	3.92	0	0	0.0251
Age 1+	0.349	0.250	0.1	0.260
Age 2+	0.250	0.250	0.5	0.680
Age 3+	0.250	0.250	1	1.12
Age 4+	0.250	0.250	1	1.79
Age 5+	0.250	0.250	1	2.91
Age 6+	0.250	0.250	1	6.21
Age 7+	0.250	0.250	1	7.14
Age 8+	0.250	0.250	1	9.16
Age 9+	0.250	0.250	1	10.8
Age 10+	0.250	0.250	1	12.5
Age 11+	0.250	0.250	1	12.5
Age 12+	0.250	0.250	1	12.5
Age 13+	0.250	0.250	1	12.5
Age 14+	0.250	0.250	1	12.5
Age 15+	0.250	0.250	1	12.5

Table H1-20: Weakfish Life History Parameters

Sources: PSE&G, 1999; PG&E National Energy Group, 2001; and Froese and Pauly, 2003.

Chapter H2: Evaluation of Impingement and Entrainment in the South Atlantic Region

Background: South Atlantic Marine Fisheries

Among the species that are vulnerable to impingement and entrainment (I&E) by intakes in the South Atlantic region are menhaden, several members of the drum and croaker family, and shrimps, crabs, and other invertebrates (NMFS, 1999a).

Menhaden are an important food source for many species of fish and birds. There is also an active bait fishery for menhanden, and purse seiners harvest menhaden for fish meal, fish oil, and fish solubles. Menhaden fisheries are managed by individual states but because menhaden migrate long distances along the coast, there is also interstate coordination by the Atlantic States Marine Fisheries Commission and the Gulf States Marine Fisheries Commission.

Atlantic croaker, black drum, weakfish, spotted seatrout and other species of the family Sciaenidae are important for both commercial and recreational fisheries in the South Atlantic region. However, regulations in some states favor recreational uses (NMFS, 1999a). Bycatch of these species in the shrimp fishery is currently an important management concern.

The penaeid shrimp fishery is extensive and valuable (NMFS, 1999a). In fact, all commercial shrimps in NOAA's Southeast Region are harvested at maximum levels (NMFS, 1999a).

Recent average fishery yields in the region are considered underestimated because they generally include only commercial landings (NMFS, 1999a). Although recreational landings can be considerable, they are generally not available for invertebrate species such as blue crab that dominate the nearshore fisheries of the region.

Chapter Contents

H2-1 I&E Species/Species Groups Evaluated

Table H2-1 provides a list of species/species groups evaluated by EPA that are subject to I&E in the South Atlantic region. Appendix H1 provides the life history parameters that were used to express these losses as age-1 equivalents and foregone fishery yield.

Table H2-1: Species/Species Groups Evaluated by EPA that are Subject to I&E in the South Atlantic Region

Species/Species Group	Recreational	Commercial	Forage
Atlantic menhaden		X	
Bay anchovy			X
Blue crab		X	
Crabs (commercial)		X	
Drums and croakers	X	X	
Flounders	X		
Gobies			X
Herrings			X
Other (commercial)		X	
Other (forage)			X
Other (recreational and commercial)	X	X	
Pinfish	X		
Pink shrimp	X	X	
Scaled sardine			X
Shrimp (forage)			X
Silver perch	X		
Spot	X	X	
Spotted seatrout	X		
Stone crab		X	
Striped mullet	X	X	
Weakfish	X	X	

H2-2 I&E Data Evaluated

Table H2-2 lists the facility I&E data evaluated by EPA to estimate current I&E rates at Phase III facilities in the South Atlantic Region. See Chapter A1 of Part A for a discussion of the methods used to evaluate the I&E data.

Table H2-2: Facility I&E Data Evaluated for the South Atlantic Analysis

Facility	Phase	Years of Data
Brunswick Nuclear	II	1974-2000
St. Lucie Nuclear	II	1977

H2-3 EPA's Estimate of Current I&E at Phase III Facilities in the South Atlantic Region Expressed as Age-1 Equivalents and Foregone Yield

Table H2-3 provides EPA's estimates of the annual age-1 equivalents and foregone fishery yield resulting from the impingement of aquatic species at Phase III facilities located in the South Atlantic region. Table H2-4 displays this information for entrainment. Note that in these tables, "total yield" includes direct losses of harvested species and the yield of harvested species that is lost due to losses of forage species (trophic transfer).

The lost yield estimates presented in Tables H2-3 and H2-4 are expressed as total pounds and include losses to both commercial and recreational catch. To estimate the economic value of these losses, total yield was partitioned between commercial and recreational fisheries based on the landings in each fishery. Table H2-5 presents the percentage impacts assumed for each species/species group.

Table H2-3: Estimated Current Annual Impingement at Phase III Facilities in the South Atlantic Region Expressed as Age-1 Equivalents and Foregone Fishery Yield

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Atlantic menhaden	99,000	19,600
Bay anchovy	1,180,000	<1
Blue crab	4,390	54
Crabs (commercial)	332	<1
Drums and croakers	271,000	15,800
Flounders	77	7
Gobies	1,940,000	<1
Herrings	213	<1
Other (commercial)	181	36
Other (forage)	31,000	<1
Other (recreational and commercial)	129	25
Pinfish	40,800	1,730
Pink shrimp	294	3
Scaled sardine	83	<1
Shrimp (forage)	468,000	<1
Silver perch	11,000	1
Spot	508,000	57,000
Spotted seatrout	6,450	5,770
Stone crab	16	12
Striped mullet	9	4
Trophic transfer[a]	<1	493
Weakfish	4,020	3,160

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

**Table H2-4: Estimated Current Annual Entrainment at Phase III Facilities
in the South Atlantic Region Expressed as Age-1 Equivalents and
Foregone Fishery Yield**

Species/Species Group	Age-1 Equivalents (#s)	Total Yield (lbs)
Atlantic menhaden	244,000	48,200
Bay anchovy	4,700,000	<1
Blue crab	<1	<1
Crabs (commercial)	188,000	38
Drums croakers	3,660,000	214,000
Flounders	<1	<1
Gobies	14,200,000	<1
Herrings	<1	<1
Other (commercial)	<1	<1
Other (forage)	117,000	<1
Other (recreational and commercial)	<1	<1
Pinfish	49	2
Pink shrimp	<1	<1
Scaled sardine	<1	<1
Shrimp (forage)	14,300,000	<1
Silver perch	60	<1
Spot	187,000	20,900
Spotted seatrout	11	10
Stone crab	<1	<1
Striped mullet	<1	<1
Trophic transfer[a]	<1	4,150
Weakfish	2	2

[a] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

H2-4   Reductions in I&E at Phase III Facilities in the South Atlantic Region

There were no reductions in I&E under any of the options.

H2-5   Assumptions Used in Calculating Recreational and Commercial Losses

The lost yield estimates presented in Tables H2-3 and H2-4 are expressed as total pounds and include losses to both commercial and recreational catch. Total yield was partitioned between commercial and recreational fisheries based on the landings in each fishery. Table H2-5 presents the percentage impacts assumed for each species/species group.

**Table H2-5: Percentage of Total Impacts Occurring to Commercial and Recreational Fisheries
in the South Atlantic Region as a Result of I&E at Phase III Facilities**

Species/Species Group	Percent Impact to Recreational Fishery[a,b]	Percent Impact to Commercial Fishery[a,b]
Alewife	0.0%	100.0%
American plaice	0.0%	100.0%
American shad	0.0%	100.0%
Atlantic cod	50.0%	50.0%
Atlantic croaker	77.3%	22.7%
Atlantic herring	19.0%	81.0%
Atlantic mackerel	22.2%	77.8%
Atlantic menhaden	0.0%	100.0%
Bigmouth buffalo	100.0%	0.0%
Black bullhead	100.0%	0.0%
Black crappie	100.0%	0.0%
Black drum	93.0%	7.0%
Blue crab	0.0%	100.0%
Bluefish	89.1%	10.9%
Bluegill	100.0%	0.0%
Brown bullhead	100.0%	0.0%
Bullhead species	100.0%	0.0%
Butterfish	0.0%	100.0%
Channel catfish	100.0%	0.0%
Crabs (commercial)	0.0%	100.0%
Crappie	100.0%	0.0%
Cunner	100.0%	0.0%
Darter species	100.0%	0.0%
Drums and croakers	69.1%	30.9%
Flounders	100.0%	0.0%
Freshwater drum	100.0%	0.0%
Golden redhorse	100.0%	0.0%
Leatherjacket	0.0%	100.0%
Logperch	100.0%	0.0%
Mackerels	73.5%	26.5%
Menhaden species	50.0%	50.0%
Muskellunge	100.0%	0.0%
Other (commercial)	0.0%	100.0%
Other (recreational and commercial)	50.0%	50.0%
Other (recreational)	100.0%	0.0%
Paddlefish	100.0%	0.0%
Pinfish	100.0%	0.0%
Pink shrimp	50.0%	50.0%
Pollock	50.0%	50.0%

Table H2-5: Percentage of Total Impacts Occurring to Commercial and Recreational Fisheries in the South Atlantic Region as a Result of I&E at Phase III Facilities

Species/Species Group	Percent Impact to Recreational Fishery[a,b]	Percent Impact to Commercial Fishery[a,b]
Red drum	100.0%	0.0%
Red hake	0.0%	100.0%
River carpsucker	100.0%	0.0%
Salmon	100.0%	0.0%
Sauger	100.0%	0.0%
Sculpins	79.0%	21.0%
Scup	50.0%	50.0%
Searobin	92.0%	8.0%
Sheepshead	67.0%	33.0%
Silver hake	0.0%	100.0%
Silver perch	100.0%	0.0%
Skate species	0.0%	100.0%
Smallmouth bass	100.0%	0.0%
Smelts	100.0%	0.0%
Spot	38.1%	61.9%
Spotted seatrout	100.0%	0.0%
Spotted sucker	100.0%	0.0%
Stone crab	0.0%	100.0%
Striped bass	95.5%	4.5%
Striped mullet	10.1%	89.9%
Sturgeon species	100.0%	0.0%
Sucker species	100.0%	0.0%
Summer flounder	88.0%	12.0%
Sunfish	100.0%	0.0%
Tautog	92.2%	7.8%
Trophic transfer[c]	63.5%	36.5%
Walleye	100.0%	0.0%
Weakfish	77.2%	22.8%
White bass	100.0%	0.0%
White perch	66.0%	34.0%
Whitefish	100.0%	0.0%
Windowpane	0.0%	100.0%
Winter flounder	63.0%	37.0%
Yellow perch	100.0%	0.0%

[a] Based on landings from 1993 to 2001.
[b] Calculated using recreational landings data from NMFS (2003b, http://www.st.nmfs.gov/recreational/queries/catch/snapshot.html) and commercial landings data from NMFS (2003a, http://www.st.nmfs.gov/commercial/landings/annual_landings.html).
[c] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

Appendix H2: Reductions in I&E Under Supplemental Policy Options

Table H2-1: Estimated Reductions in I&E in the South Atlantic Region Under Supplemental Options		
Option	Age-1 Equivalents (#s)	Foregone Fishery Yield (lbs)
Electric Generators 2-50 MGD		
I-only Everywhere	0	0
I&E like Phase II	0	0
I&E Everywhere	0	0
Manufacturers 2-50 MGD		
I-only Everywhere	0	0
I&E like Phase II	0	0
I&E Everywhere	0	0
Manufacturers 50+ MGD		
I-only Everywhere	0	0
I&E Everywhere	0	0

Chapter H3: Commercial Fishing Benefits

Introduction

This chapter presents the results of the commercial fishing benefits analysis for the South Atlantic region. The chapter presents EPA's estimates of baseline (i.e., current) annual commercial fishery losses from impingement and entrainment (I&E) at potentially regulated facilities in the South Atlantic

region and annual reductions in these losses under the regulatory options for Phase III existing facilities[1]:

- ▸ the "50 MGD for All Waterbodies" option,
- ▸ the "200 MGD for All Waterbodies" option, and
- ▸ the "100 MGD for Certain Waterbodies" option.

The chapter then presents the estimated benefits to commercial fisheries under the regulatory options from eliminating baseline losses from I&E.

Chapter A4, "Methods for Estimating Commercial Fishing Benefits," details the methods used by EPA to estimate the commercial fishing benefits of reducing and eliminating I&E losses.

EPA considered a wide range of policy options in developing this regulation. In addition to the regulatory options, EPA evaluated supplemental options. For additional information on the options, please see the TDD. Appendix H3 presents results of the commercial fishing benefits analysis for the supplemental options.

H3-1 Baseline Commercial Losses

Table H3-1 provides EPA's estimate of the value of gross revenues lost in commercial fisheries resulting from the impingement of aquatic species at facilities in the South Atlantic region. Table H3-2 displays this information for entrainment. Total annualized revenue losses are approximately $99,210 (undiscounted).

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[1] See the Introduction to this report for a description of the regulatory options.

Table H3-1: Annualized Commercial Fishing Gross Revenues Lost due to Impingement at Facilities in the South Atlantic Region

Species[a]	Estimated Pounds of Harvest Lost	Commercial Value per Pound (2004$)	Estimated Value of Harvest Lost (2004$) Undiscounted
Atlantic menhaden	19,565	$0.07	$1,357
Blue crab	54	$0.74	$40
Drums and croakers	4,888	$1.06	$5,180
Other (species are only commercially fished not recreationally)	36	$0.56	$20
Other (species are fished both commercially and recreationally)	13	$0.56	$7
Pink shrimp	1	$1.24	$2
Spot	35,228	$0.37	$13,016
Stone crab	12	$1.54	$18
Striped Mullet	4	$0.71	$3
Weakfish	720	$0.69	$497
Trophic transfer[b]	180	$0.54	$97

[a] Species included are only those that have baseline losses greater than $1.
[b] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

Table H3-2: Annualized Commercial Fishing Gross Revenues Lost due to Entrainment at Facilities in the South Atlantic Region

Species[a]	Estimated Pounds of Harvest Lost	Commercial Value per Pound (2004$)	Estimated Value of Harvest Lost (2004$) Undiscounted
Atlantic menhaden	48,231	$0.07	$3,344
Commercial crabs	38	$0.57	$21
Drums and croakers	66,058	$1.06	$70,009
Spot	12,947	$0.37	$4,784
Trophic. transfer[b]	1,516	$0.54	$815

[a] Species included are only those that have baseline losses greater than $1.
[b] Contribution of forage fish to yield based on trophic transfer (see Chapter A1).

H3-2 Expected Benefits Under Regulatory Analysis Options

There are no facilities in the South Atlantic region that have technology requirements under any of the three regulatory options. Thus, no commercial fishing benefits are expected from the three regulatory options, the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, and the "100 MGD for Certain Waterbodies" option, in the South Atlantic Region.

Appendix H3: Commercial Fishing Benefits Under Supplemental Policy Options

Introduction

Chapter H3 presents EPA's estimates of the commercial benefits of the three regulatory options for the section 316(b) rule for Phase III facilities in the South Atlantic region. To facilitate comparisons among the options, this appendix presents estimates of the commercial fishing benefits of various supplemental options that EPA evaluated in preparation for this rule:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option;
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option;
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option;
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option; and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

For additional information on the options, please see the TDD. Commercial fishing benefits presented in this chapter were estimated using the benefit transfer approach discussed in Chapter H3 and in Chapter A4, "Methods for Estimating Commercial Fishing Benefits."

H3-1   Commercial Fishing Benefits of the Supplemental Options

No facilities located in the South Atlantic region have technology requirements under the supplemental options. Thus, no reductions in commercial fishing losses are expected under the supplemental options in the South Atlantic region.

Chapter H4: Recreational Use Benefits

Introduction

This chapter presents the results of the recreational fishing benefits analysis for the South Atlantic region. The chapter presents EPA's estimates of baseline (i.e., current) annual recreational fishery losses from impingement and entrainment (I&E) at potentially regulated facilities in the South Atlantic region and annual reductions in these losses under the regulatory options for Phase III existing facilities[1]:

- ▸ the "50 MGD for All Waterbodies" option,
- ▸ the "200 MGD for All Waterbodies" option, and
- ▸ the "100 MGD for Certain Waterbodies" option.

The chapter then presents the estimated welfare gain to South Atlantic anglers from eliminating baseline recreational fishing losses from I&E and the expected benefits under the regulatory options.

EPA estimated the recreational benefits of reducing and eliminating I&E losses using a benefit transfer methodology based on a meta-analysis of the marginal value of catching different species of fish. This meta-analysis is discussed in detail in Chapter A5, "Recreational Fishing Benefits Methodology."

EPA considered a wide range of policy options in developing this regulation. In addition to the regulatory options, EPA evaluated supplemental options. For additional information on the options, please see the TDD. Appendix H4 presents results of the recreational fishing benefits analysis for the supplemental options.

H4-1 Benefit Transfer Approach Based on Meta-Analysis

EPA estimated the recreational welfare gain from the reduction in annual I&E losses expected under the policy options, and the welfare gain from eliminating I&E at potentially regulated facilities, using a benefit transfer approach. As discussed in Chapter A5, the Agency used a meta-analysis regression equation to estimate the marginal recreational value per additional fish caught by anglers, for different species in different regions. Since I&E at potentially regulated facilities affects a variety of species, EPA assigned each species with I&E losses to one of the general species groups used in the meta-analysis. The Agency then calculated the economic value of reducing or eliminating baseline I&E losses, for each species group, by multiplying the value per fish for that species group by the number of fish in the group that are lost in the baseline or saved under the policy options.[2]

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[1] See the Introduction to this report for a description of the regulatory options.

[2] The estimates of I&E presented in this chapter include only the fraction of impinged and entrained recreational fish that would be caught by anglers. The total amount of I&E of recreational species is actually much higher.

In general, the fit between the species with I&E losses and the species groups in the meta-analysis was good. However, EPA's estimates of baseline I&E losses and reductions in I&E under the policy options included losses of "unidentified" species. The "unidentified" group includes fish lost indirectly through trophic transfer, as well as species for which no species information was available.[3] Rather than using the meta-analysis regression to try to predict the value per fish for an "unidentified" species, EPA assumed that per-fish values for these species can be approximated by the weighted average value per fish for all species affected by I&E in the South Atlantic region.[4]

H4-1.1 Baseline Losses and Reductions in Recreational Fishery Losses Under the Regulatory Options

Table H4-1 presents EPA's estimates of baseline (i.e., current) annual recreational I&E losses at potentially regulated facilities, and annual reductions in these losses under each of the regulatory options, in the South Atlantic region. The table shows that total baseline losses to recreational fisheries are 549.2 thousand fish per year. In comparison, the "50 MGD for All Waterbodies" option prevents losses of 0 fish per year, the "200 MGD for All Waterbodies" option prevents losses of 0 fish per year, and the "100 MGD for Certain Waterbodies" option prevents losses of 0 fish per year. Of all the affected species, croakers and spot have the highest losses in the baseline.

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[3] In addition to recreational fish that are lost because they are impinged or entrained, some recreational fish are lost because the forage fish that they feed on are impinged or entrained, and thus removed from the food chain. These trophic transfer losses of recreational species are included in EPA's estimates of total I&E losses. Since it is difficult to predict which recreational species would be affected by losses of forage fish, these losses are classified as "unidentified" recreational species. Also included in the "unidentified" group are losses of fish that were reported by facilities without information about their exact species.

[4] EPA used the estimated level of baseline recreational losses for each species group as a weighting factor.

Table H4-1: Baseline Recreational Fishing Losses from I&E at Potentially Regulated Phase III Facilities and Reductions in Recreational Losses Under the Regulatory Options in the South Atlantic Region

Species[a]	Baseline Annual Recreational Fishing Losses (# of fish)	Annual Reductions in Recreational Fishing Losses (# of fish)		
		50 MGD All[b]	200 MGD All[b]	100 MGD CWB[b]
Spotted seatrout	2,353.5	0	0	0
Weakfish	446.5	0	0	0
Total (small game)	**2,799.9**	**0**	**0**	**0**
Flounders	17.2	0	0	0
Total (flatfish)	**17.2**	**0**	**0**	**0**
Croakers	462,234.3	0	0	0
Pinfish	9,572.1	0	0	0
Silver perch	3.0	0	0	0
Spot	71,641.7	0	0	0
Total (other saltwater)	**543,451.3**	**0**	**0**	**0**
Total (unidentified)	**2,966.3**	**0**	**0**	**0**
Total (all species)	**549,252.6**	**0**	**0**	**0**

[a] EPA assigned each species with I&E losses to one of the species groups used in the meta-analysis. The "other saltwater" group includes bottomfish and other miscellaneous species. The "unidentified" group includes fish lost indirectly through trophic transfer and fish reported lost without information about their species.
b No facilities in the South Atlantic region have technology requirements under the "50 MGD for All Waterbodies" option, the "200 MGD for All Waterbodies" option, or the "100 MGD for Certain Waterbodies" option.

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

H4-1.2 Recreational Fishing Benefits from Eliminating Baseline I&E Losses

Table H4-2 shows the results of EPA's analysis of the welfare gain to recreational anglers from eliminating baseline recreational fishery losses at potentially regulated facilities in the South Atlantic region. The table presents baseline annual recreational I&E losses, the estimated value per fish, and the monetized annual welfare gain from eliminating recreational losses, for each species group. Total baseline recreational fishing losses for the South Atlantic region are 549.2 thousand fish per year. The undiscounted annual welfare gain to South Atlantic anglers from eliminating these losses is $1.3 million (2004$), with lower and upper bounds of $0.8 million and $2.2 million. Evaluated at 3% and 7% discount rates, the mean annualized welfare gain of eliminating these losses is $1.2 million and $1.2 million, respectively. The majority of monetized recreational losses from I&E under baseline conditions are attributable to losses of species in the "other saltwater" group, such as croakers and spot.

Table H4-2: Recreational Fishing Benefits from Eliminating Baseline I&E at Potentially Regulated Phase III Facilities in the South Atlantic Region (2004$)

Species Group	Baseline Annual Recreational Fishing Losses (thousands of fish)[a]	Value per Fish[b]			Annualized Benefits from Eliminating Recreational Fishing Losses (thousands)[c,d]		
		Low	Mean	High	Low	Mean	High
Small game	2.8	$1.96	$4.82	$11.60	$5.5	$13.5	$32.5
Flatfish	0.0[e]	$2.91	$4.73	$7.68	$0.0[f]	$0.1	$0.1
Other saltwater	543.5	$1.48	$2.40	$3.91	$806.2	$1,302.8	$2,124.3
Unidentified	3.0	$1.49	$2.41	$3.95	$4.4	$7.1	$11.7
Total (undiscounted)	**549.2**				**$816.1**	**$1,323.5**	**$2,168.6**
Total (evaluated at 3% discount rate)	**549.2**				**$768.6**	**$1,246.3**	**$2,042.2**
Total (evaluated at 7% discount rate)	**549.2**				**$712.4**	**$1,155.3**	**$1,893.1**

[a] Recreational fishing losses include only the portion of impinged and entrained fish that would have been caught by recreational anglers.
[b] Lower and upper bounds on per-fish values are based on the 5% and 95% confidence bounds predicted by the Krinsky and Robb approach. See section A5-5.1 of Chapter A5 for more details on this approach.
[c] Monetized benefits are calculated by multiplying baseline losses by the estimated value per fish.
[d] Annualized values represent the total welfare gain over the time frame of the analysis from eliminating recreational losses, discounted to 2007, and then annualized over a thirty year period. For a detailed discussion of the discounting and annualization methodology, refer to Chapter A8.
[e] Denotes a positive value less than 50 fish.
[f] Denotes a positive value less than $50.

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

H4-1.3 Recreational Fishing Benefits of the "50 MGD for All Waterbodies" Option

No facilities located in the South Atlantic region have technology requirements under the "50 MGD for All Waterbodies" option. Thus, no recreational benefits are expected under this option in the South Atlantic region.

H4-1.4 Recreational Fishing Benefits of the "200 MGD for All Waterbodies" Option

No facilities located in the South Atlantic region have technology requirements under the "200 MGD for All Waterbodies" option. Thus, no recreational benefits are expected under this option in the South Atlantic region.

H4-1.5 Recreational Fishing Benefits of the "100 MGD for Certain Waterbodies" Option

No facilities located in the South Atlantic region have technology requirements under the "100 MGD for Certain Waterbodies" option. Thus, no recreational benefits are expected under this option in the South Atlantic region.

H4-2 Limitations and Uncertainty

The results of the benefit transfer based on a meta-analysis represent EPA's best estimate of the recreational benefits of the regulatory options. Nonetheless, there are a number of limitations and uncertainties inherent in these estimates. General limitations pertaining to the development of the meta-analysis model, the use of the model to estimate per-fish values, and the validity of the benefit transfer are discussed in section A5-3.3e and section A5-5.3 of Chapter A5.

Appendix H4: Recreational Use Benefits Under Supplemental Policy Options

Introduction

Chapter H4 presents EPA's estimates of the recreational benefits of the three regulatory options for the section 316(b) rule for Phase III facilities in the South Atlantic region. To facilitate comparisons among the options, this appendix presents estimates of the recreational fishing benefits of supplemental options that EPA evaluated in preparation for this rule:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option;
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option;
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option;
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option;
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option;
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option; and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

For additional information on the options, please see the TDD. Recreational fishing benefits presented in this chapter were estimated using the benefit transfer approach discussed in Chapter H4 and in Chapter A5, "Recreational Fishing Benefits Methodology."

H4-1　Recreational Fishing Benefits of the Supplemental Options

No facilities located in the South Atlantic region have technology requirements under the supplemental options. Thus, no reductions in recreational fishing losses are expected under the supplemental options in the South Atlantic region.

Chapter H5: Federally Listed T&E Species in the South Atlantic Region

This chapter lists current federally listed threatened and endangered (T&E) fish and shellfish species in the South Atlantic Region. This list does not address proposed or candidate species; In addition, fish and shellfish listed as cave species, marine mammals, reptiles, amphibians, and snails are not included in this chapter.

Table H5-1: Florida Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Amblema neislerii*	Fat three-ridge mussel
T	*Elliptio chipolaensis*	Chipola slabshell mussel
T	*Elliptoideus sloatianus*	Purple bankclimber mussel
E	*Etheostoma okaloosae*	Okaloosa darter
E	*Lampsilis subangulata*	Shinyrayed pocketbook mussel
E	*Medionidus penicillatus*	Gulf moccasinshell
E	*Medionidus simpsonianus*	Ochlockonee moccasinshell
E	*Pleurobema pyriforme*	Oval pigtoe mussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table H5-2: Georgia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
T	*Elliptoideus sloatianus*	Purple bankclimber mussel
T	*Medionidus acutissimus*	Alabama moccasinshell
E	*Pleurobema decisum*	Southern clubshell mussel
E	*Acipenser brevirostrum*	Shortnose sturgeon
T	*Acipenser oxyrinchus desotoi*	Gulf sturgeon
E	*Amblema neislerii*	Fat three-ridge mussel
T	*Cyprinella caerulea*	Blue shiner
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma metastriata*	Upland combshell mussel
E	*Epioblasma othcaloogensis*	Southern acornshell mussel
T	*Erimonax monachus*	Spotfin chub: entire range except where listed as experimental populations
E	*Etheostoma etowahae*	Etowah darter
T	*Etheostoma scotti*	Cherokee darter
T	*Lampsilis altilis*	Finelined pocketbook mussel
E	*Lampsilis subangulata*	Shinyrayed pocketbook mussel

Table H5-2: Georgia Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Medionidus parvulus*	Coosa moccasinshell
E	*Medionidus penicillatus*	Gulf moccasinshell
E	*Medionidus simpsonianus*	Ochlockonee moccasinshell
E	*Percina antesella*	Amber darter
T	*Percina aurolineata*	Goldline darter
E	*Percina jenkinsi*	Conasauga logperch
T	*Percina tanasi*	Snail darter
E	*Pleurobema georgianum*	Southern pigtoe mussel
E	*Pleurobema perovatum*	Ovate clubshell mussel
E	*Pleurobema pyriforme*	Oval pigtoe mussel
E	*Ptychobranchus greenii*	Triangular kidneyshell mussel

Source: USFWS, 2006a.

Table H5-3: North Carolina Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Alasmidonta raveneliana*	Appalachian elktoe mussel
E	*Elliptio steinstansana*	Tar River spinymussel
E	*Epioblasma capsaeformis*	Oyster mussel: entire range except where listed as experimental populations
E	*Epioblasma florentina walkeri (= E. walkeri)*	Tan riffleshell mussel
T	*Erimonax monachus*	Spotfin chub: entire range except where listed as experimental populations
E	*Lasmigona decorata*	Carolina heelsplitter mussel
T	*Menidia extensa*	Waccamaw silverside
E	*Notropis mekistocholas*	Cape Fear shiner
E	*Pegias fabula*	Littlewing pearlymussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Table H5-4: South Carolina Federally Listed T&E Fish and Shellfish

Status	Scientific Name	Common Name
E	*Acipenser brevirostrum*	Shortnose sturgeon
E	*Lasmigona decorata*	Carolina heelsplitter mussel
E	*Pristis pectinata*	Smalltooth sawfish

Source: USFWS, 2006a.

Part I: National Benefits

Chapter I1: National Benefits

Introduction

This chapter summarizes the results of the seven regional analyses and presents EPA's estimates of the national commercial and recreational benefits of the regulatory analysis options for Phase III existing facilities:

- ▸ the "50 MGD for All Waterbodies" option,
- ▸ the "200 MGD for All Waterbodies" option, and
- ▸ the "100 MGD for Certain Waterbodies" option.

EPA considered a wide range of policy options in developing this regulation. Results of the national benefits analysis for supplemental options evaluated by EPA are presented in Appendix I1.

Greater detail on the methods and data used in the regional analyses is provided in the previous chapters of this report. See Chapters A1 and A2 for a discussion of the methods used to estimate impingement and entrainment (I&E), and Chapters A3 through A9 for a discussion of the methods used to estimate the value of I&E losses and the benefits of the policy options considered for the final rule. The results of the regional analyses are presented in Parts B through H.

EPA was unable to assess benefits of reducing I&E at existing offshore oil and gas extraction facilities in the same manner as other existing facilities, which would require predicting where these facilities would build and/or operate, and due to lack of I&E data for these facilities. Therefore, the benefits estimates presented in this section do not reflect benefits associated with reducing I&E at existing offshore oil and gas extraction facilities and overall national benefits may be accordingly higher.

I1-1   Calculating National Losses and Benefits

EPA's analysis of national baseline losses and benefits under the regulatory analysis options includes 629 sample-weighted facilities, excluding facilities that are expected to close in the baseline. The Agency calculated baseline losses by summing losses from all 629 facilities in the seven case study regions. EPA's estimates of benefits are based on only those facilities that would be expected to install compliance technologies under each regulatory analysis option because the baseline is best professional judgment.

EPA notes that quantifying and monetizing reductions in I&E under the regulatory analysis options considered for the final section 316(b) rule for Phase III facilities is extremely challenging. As described in Chapters A3 and A6, EPA has estimated non-use values qualitatively and, as a result, the estimated monetized benefits of the regulatory analysis options reflect use values only. The preceding sections of this report discuss specific limitations and uncertainties associated with estimating commercial and recreational benefits. National benefit estimates, which are based on the regional estimates, are subject to the same uncertainties inherent in the valuation approaches used for assessing each of the two benefits categories. The combined effect of these uncertainties is of unknown magnitude and direction (i.e., the estimates may over- or understate the anticipated national level of use benefits). Nevertheless, EPA has no data to indicate that the results for any of the benefit categories are atypical or unreasonable.

I1-2   Summary of Baseline Losses and Expected Reductions in I&E

Based on the results of the regional analyses, EPA calculated total I&E losses under baseline (i.e., pre-Phase III regulatory) conditions and the total amount by which losses would be reduced under each of the regulatory analysis options. Losses are presented using two measures of I&E:

1. Age-1 equivalent losses (the number of individual fish of different ages impinged and entrained by facility intakes, expressed as age-1 equivalents); and
2. Foregone fishery yield (pounds of commercial harvest and numbers of recreational fish and shellfish that are not harvested due to I&E, including indirect losses of harvested species due to losses of forage species).

Table I1-1 presents baseline I&E losses using each of these measures. The table shows that total national losses of age-1 equivalents for all 629 facilities are 265 million fish. Nationwide, EPA estimates that 9.6 million pounds of fishery yield is foregone under current rates of I&E. The table shows that about 33% of all age-1 equivalent losses, or 86.4 million fish, occur in the Mid-Atlantic region. The Gulf of Mexico region has the highest foregone fishery yield, with 7.5 million pounds, followed by the Mid-Atlantic region with 0.7 million pounds. More detailed discussions of the I&E losses in each region are provided in Parts B through H of this report.

Table I1-1: Total Annual Baseline I&E Losses for Potential Phase III Existing Facilities by Region		
Region	Age-1 Equivalents (thousands)	Foregone Fishery Yield (thousands; lbs)
California	1,710	121
North Atlantic	2,310	11
Mid-Atlantic	86,400	682
South Atlantic	42,100	391
Gulf of Mexico	35,800	7,450
Great Lakes	31,500	374
Inland	65,100	609
National Total	265,000	9,640
Source: U.S. EPA analysis for this report.		

EPA also calculated the total national I&E losses prevented by each of the regulatory analysis options. These prevented losses are based on the expected reductions in I&E at each facility due to technology installation required under each option. Table I1-2 presents expected percent reductions in I&E, by region and option. The table also presents estimates of regional and national expected reductions in I&E losses, expressed as age-1 equivalents lost and foregone fishery yield. The table shows that at the 629 national facilities potentially subject to regulation, the "50 MGD for All Waterbodies" option reduces age-1 equivalent losses by 98.2 million fish and prevents losses of 4.8 million pounds of fishery yield. In comparison, the "200 MGD for All Waterbodies" option and the "100 MGD for Certain Waterbodies" option reduce age-1 equivalent losses by 74.5 million fish and 71.1 million fish and prevent 3.3 million pounds and 4.5 million pounds of fishery yield from being lost, respectively.

Table I1-2 also shows that expected reductions vary across the regions. Under the "50 MGD for All Waterbodies" and "100 MGD for Certain Waterbodies" options, facilities in the Gulf of Mexico region are expected to make the largest average percentage reductions in impingement (51%) and entrainment (58%). Facilities in the Gulf of Mexico region also have the largest average percentage reductions in I&E for the "200 MGD for All Waterbodies" option, with 30% and 42%, respectively. Under the 50 MGD All, 200 MGD All, and 100 MGD

CWB options, the largest percentage of age-1 equivalent losses that are prevented are attributed to facilities in the Mid-Atlantic region with 45%, 53% and 55%, respectively. Under all three options, the largest prevented losses of fishery yield occur in the Gulf of Mexico (88% under the 50 MGD All option, 88% under the 200 MGD All option, and 93% under the 100 MGD CWB option). More detailed discussions of regional benefits are provided in Parts B through H of this report.

Table I1-2: Expected Reduction in I&E for Existing Phase III Facilities by Option					
Region	Number of Facilities Installing Technology	Reduction in Impingement	Reduction in Entrainment	Prevented Age-1 Equivalent Losses (thousands)	Prevented Foregone Fishery Yield (thousands; lbs)
50 MGD All					
California	1	37%	28%	474	33
North Atlantic	4	0%	40%	910	4
Mid-Atlantic	3	23%	53%	44,500	212
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	7	51%	58%	19,400	4,200
Great Lakes	18	42%	45%	13,300	160
Inland	78	39%	15%	19,700	155
National Total	111			98,200	4,770
200 MGD All					
California[b]	0	0%	0%	0	0
North Atlantic	1	0%	8%	193	1
Mid-Atlantic	2	16%	47%	39,400	163
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	3	30%	42%	12,500	2,900
Great Lakes	7	30%	36%	9,650	119
Inland	13	23%	13%	12,700	107
National Total	27			74,500	3,290
100 MGD CWB					
California[b]	0	0%	0%	0	0
North Atlantic	3	0%	32%	736	4
Mid-Atlantic	2	16%	47%	39,400	163
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	7	51%	58%	19,400	4,200
Great Lakes	10	36%	40%	11,600	141
Inland[c]	0	0%	0%	0	0
National Total	22			71,100	4,510

[a] No I&E reductions are expected at the potentially regulated facilities in the South Atlantic region. Since these facilities withdraw less than 50 MGD, none of the facilities in this region would be required to install technology to comply with the regulatory analysis options.
[b] Since the California facilities withdraw less than 100 MGD, none of the facilities in this region would be required to install technology to comply with the 200 MGD All and 100 MGD CWB options. Thus, no I&E reductions are expected at the potentially regulated facilities in the California region under the 200 MGD All and 100 MGD CWB options.
[c] None of the facilities in the Inland region would be required to install technology to comply with the 100 MGD CWB option. Thus, no I&E reductions are expected at the potentially regulated facilities in the Inland region.

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

I1-3   Time Profile of Benefits

EPA's estimates of total national baseline losses and total national benefits under each option are based on EPA's regional estimates of monetized baseline losses and regulatory analysis option benefits. To recognize the difference in timing of benefits and costs, EPA developed a time profile of total benefits from all potentially regulated Phase III facilities that reflects when benefits from compliance-related changes at each facility would be realized. The methodology that EPA used to develop this time profile is detailed in Chapter A8. For each study region, EPA first calculated the undiscounted use benefits (i.e., commercial and recreational fishing benefits) from the expected annual I&E reductions under the regulatory analysis options, based on the assumptions that all facilities in each region would achieve compliance and that benefits are realized immediately following compliance. Then, since there would be regulatory and biological time lags between promulgation of the regulatory analysis options and the realization of benefits, EPA created a time profile of benefits that takes into account the fact that benefits do not begin immediately. Using this time profile of benefits, EPA discounted the total benefits generated in each year of the analysis to 2007 using discount rates of 3% and 7%.[1],[2]

After calculating the present value of these benefits streams, EPA calculated their constant annual equivalent value (annualized value), again using the discount rates of 3% and 7%. Although the analysis period extends from 2007 through 2048, a period of 42 years, EPA annualized benefits over 30 years, since 30 years is the assumed period of compliance.[3]

The development of the time profile of benefits is discussed in detail in Chapter A8, "Discounting Benefits." Table I1-3 below presents a profile of the benefits of eliminating baseline I&E at all potentially regulated facilities. Time profiles of benefits for the "50 MGD for All Waterbodies," "200 MGD for All Waterbodies," and "100 MGD for Certain Waterbodies" options are presented in Tables I1-4, I1-5, and I1-6, respectively.

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[1] The 3% rate represents a reasonable estimate of the social rate of time preference. The 7% rate represents an alternative discount rate, recommended by the Office of Management and Budget (OMB), that reflects the estimated opportunity cost of capital.

[2] The 2007 start date was chosen because this is the assumed effective date of the rule.

[3] This same annualization concept and period of annualization were also followed in the analysis of costs, although for costs the time horizon of analysis for calculating the present value is shorter than for benefits. Using a 30-year annualization period for both benefits and costs allows comparison of constant annual equivalent values of benefits and costs that have been calculated on a mathematically consistent basis.

**Table I1-3: Time Profile of Mean Total Use Benefits of Eliminating Baseline I&E
at Potentially Regulated Phase III Facilities
(thousands; 2004$)[a,b]**

Year	California	North Atlantic	Mid-Atlantic	South Atlantic	Gulf of Mexico	Great Lakes	Inland	National Total
2007	$0	$0	$0	$0	$345	$128	$125	$598
2008	$14	$5	$39	$142	$690	$256	$249	$1,396
2009	$29	$11	$77	$285	$2,759	$1,025	$997	$5,182
2010	$115	$43	$308	$1,138	$3,104	$1,153	$1,121	$6,982
2011	$129	$49	$347	$1,280	$3,277	$1,217	$1,184	$7,482
2012	$136	$51	$366	$1,352	$3,449	$1,281	$1,246	$7,881
2013	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2014	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2015	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2016	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2017	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2018	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2019	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2020	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2021	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2022	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2023	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2024	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2025	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2026	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2027	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2028	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2029	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2030	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2031	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2032	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2033	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2034	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2035	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2036	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
2037	$143	$54	$385	$1,423	$3,104	$1,153	$1,121	$7,384
2038	$129	$49	$347	$1,280	$2,759	$1,025	$997	$6,585
2039	$115	$43	$308	$1,138	$690	$256	$249	$2,799
2040	$29	$11	$77	$285	$345	$128	$125	$999
2041	$14	$5	$39	$142	$172	$64	$62	$499
2042	$7	$3	$19	$71	$0	$0	$0	$100
2043	$0	$0	$0	$0	$0	$0	$0	$0

**Table I1-3: Time Profile of Mean Total Use Benefits of Eliminating Baseline I&E
at Potentially Regulated Phase III Facilities
(thousands; 2004$)[a,b]**

Year	California	North Atlantic	Mid-Atlantic	South Atlantic	Gulf of Mexico	Great Lakes	Inland	National Total
2044	$0	$0	$0	$0	$0	$0	$0	$0
2045	$0	$0	$0	$0	$0	$0	$0	$0
2046	$0	$0	$0	$0	$0	$0	$0	$0
2047	$0	$0	$0	$0	$0	$0	$0	$0
2048	$0	$0	$0	$0	$0	$0	$0	$0
Evaluated at 0% (i.e., undiscounted)								
Present value[c]	$4,300	$1,624	$11,554	$42,681	$103,476	$38,424	$37,375	$239,434
Annualized value[d]	$143	$54	$385	$1,423	$3,449	$1,281	$1,246	$7,981
Evaluated at 3% Discount Rate								
Present value[c]	$2,646	$999	$7,109	$26,260	$65,575	$24,350	$23,685	$150,625
Annualized value[d]	$135	$51	$363	$1,340	$3,346	$1,242	$1,208	$7,685
Evaluated at 7% Discount Rate								
Present value[c]	$1,553	$586	$4,172	$15,411	$39,979	$14,845	$14,440	$90,986
Annualized value[d]	$125	$47	$336	$1,242	$3,222	$1,196	$1,164	$7,332

[a] This table presents the benefits of eliminating baseline I&E at potentially regulated Phase III facilities from 2007 to 2036.
[b] Because EPA estimated non-use benefits qualitatively, the monetary value of benefits includes only use values.
[c] Values for a given year in the table are not discounted. Total present values of benefits are discounted with the corresponding rate.
[d] Annualized benefits represent the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

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

Table I1-4: Time Profile of Mean Total Use Benefits of the "50 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Year	California	North Atlantic	Mid-Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland	National Total
2007	$0	$0	$0	$0	$0	$0	$0	$0
2008	$0	$0	$0	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0	$0	$0	$0
2010	$0	$0	$0	$0	$0	$3	$6	$9
2011	$3	$0	$2	$0	$0	$30	$29	$64
2012	$7	$1	$3	$0	$165	$75	$84	$335
2013	$27	$3	$22	$0	$330	$249	$195	$825
2014	$30	$11	$36	$0	$1,320	$315	$235	$1,946
2015	$32	$13	$96	$0	$1,484	$460	$291	$2,377
2016	$33	$19	$125	$0	$1,567	$495	$313	$2,552
2017	$33	$20	$133	$0	$1,649	$507	$318	$2,662
2018	$33	$21	$139	$0	$1,649	$518	$322	$2,683
2019	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2020	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2021	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2022	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2023	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2024	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2025	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2026	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2027	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2028	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2029	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2030	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2031	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2032	$33	$21	$141	South	$1,649	$518	$323	$2,685
2033	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2034	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2035	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2036	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2037	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2038	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2039	$33	$21	$141	$0	$1,649	$518	$323	$2,685
2040	$33	$21	$141	$0	$1,649	$515	$316	$2,676
2041	$30	$21	$139	$0	$1,649	$488	$294	$2,622
2042	$27	$20	$138	$0	$1,484	$444	$238	$2,351
2043	$7	$18	$119	$0	$1,320	$269	$127	$1,860
2044	$3	$10	$105	$0	$330	$203	$87	$739

Table I1-4: Time Profile of Mean Total Use Benefits of the "50 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Year	California	North Atlantic	Mid-Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland	National Total
2045	$2	$8	$45	$0	$165	$58	$31	$309
2046	$0	$2	$16	$0	$82	$23	$10	$133
2047	$0	$1	$8	$0	$0	$11	$4	$24
2048	$0	$0[e]	$2	$0	$0	$0	$0[e]	$2
Evaluated at 0% (i.e., undiscounted)								
Present Value[c]	$1,004	$629	$4,228	$0	$49,483	$15,543	$9,676	$80,563
Annualized Value[d]	$33	$21	$141	$0	$1,649	$518	$323	$2,685
Evaluated at 3% Discount Rate								
Present Value[c]	$565	$336	$2,244	$0	$27,050	$8,543	$5,389	$44,128
Annualized Value[d]	$29	$17	$115	$0	$1,380	$436	$275	$2,251
Evaluated at 7% Discount Rate								
Present Value[c]	$296	$165	$1,090	$0	$13,631	$4,341	$2,786	$22,308
Annualized Value[d]	$24	$13	$88	$0	$1,098	$350	$224	$1,798

[a] Because EPA estimated non-use benefits qualitatively, the monetary value of benefits includes only use values.
[b] Since the potentially regulated facilities in the South Atlantic region withdraw less than 50 MGD, none of the facilities in this region would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.
[c] Values for a given year in the table are not discounted. Total present values of benefits are discounted with the corresponding rate.
[d] Annualized benefits represent the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.
[e] Denotes a positive value less than $500.

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

Table I1-5: Time Profile of Mean Total Use Benefits of the "200 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Year	California[b]	North Atlantic	Mid- Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland	National Total
2007	$0	$0	$0	$0	$0	$0	$0	$0
2008	$0	$0	$0	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0	$0	$0	$0
2010	$0	$0	$0	$0	$0	$0	$3	$3
2011	$0	$0	$0	$0	$0	$19	$20	$39
2012	$0	$0	$0	$0	$106	$38	$52	$197
2013	$0	$0	$9	$0	$213	$172	$142	$536
2014	$0	$0[e]	$20	$0	$851	$210	$163	$1,245
2015	$0	$1	$76	$0	$958	$337	$203	$1,575
2016	$0	$4	$102	$0	$1,011	$366	$215	$1,698
2017	$0	$4	$110	$0	$1,064	$376	$218	$1,772
2018	$0	$4	$116	$0	$1,064	$386	$221	$1,790
2019	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2020	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2021	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2022	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2023	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2024	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2025	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2026	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2027	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2028	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2029	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2030	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2031	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2032	$0	$4	$117	South	$1,064	$386	$221	$1,792
2033	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2034	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2035	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2036	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2037	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2038	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2039	$0	$4	$117	$0	$1,064	$386	$221	$1,792
2040	$0	$4	$117	$0	$1,064	$386	$218	$1,789
2041	$0	$4	$117	$0	$1,064	$367	$201	$1,753
2042	$0	$4	$117	$0	$958	$348	$169	$1,595
2043	$0	$4	$108	$0	$851	$214	$78	$1,256
2044	$0	$4	$97	$0	$213	$176	$58	$547

Table I1-5: Time Profile of Mean Total Use Benefits of the "200 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Year	California[b]	North Atlantic	Mid-Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland	National Total
2045	$0	$4	$41	$0	$106	$49	$17	$217
2046	$0	$1	$15	$0	$53	$20	$5	$94
2047	$0	$0[e]	$7	$0	$0	$10	$3	$20
2048	$0	$0[e]	$1	$0	$0	$0	$0	$2
Evaluated at 0% (i.e., undiscounted)								
Present Value[c]	$0	$134	$3,510	$0	$31,923	$11,568	$6,623	$53,757
Annualized Value[d]	$0	$4	$117	$0	$1,064	$386	$221	$1,792
Evaluated at 3% Discount Rate								
Present Value[c]	$0	$69	$1,849	$0	$17,451	$6,324	$3,693	$29,386
Annualized Value[d]	$0	$4	$94	$0	$890	$323	$188	$1,499
Evaluated at 7% Discount Rate								
Present Value[c]	$0	$32	$889	$0	$8,794	$3,191	$1,912	$14,817
Annualized Value[d]	$0	$3	$72	$0	$709	$257	$154	$1,194

[a] Because EPA estimated non-use benefits qualitatively, the monetary value of benefits includes only use values.
[b] Since the potentially regulated facilities in the California and South Atlantic regions withdraw less than 200 MGD, none of the facilities in these regions would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.
[c] Values for a given year in the table are not discounted. Total present values of benefits are discounted with the corresponding rate.
[d] Annualized benefits represent the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.
[e] Denotes a positive value less than $500.

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

Table I1-6: Time Profile of Mean Total Use Benefits for the "100 MGD for Certain Waterbodies" Option (thousands; 2004$)[a]

Year	California[b]	North Atlantic	Mid-Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland[c]	National Total
2007	$0	$0	$0	$0	$0	$0	$0	$0
2008	$0	$0	$0	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0	$0	$0	$0
2010	$0	$0	$0	$0	$0	$3	$0	$3
2011	$0	$0	$0	$0	$0	$28	$0	$28
2012	$0	$1	$0	$0	$165	$66	$0	$232
2013	$0	$3	$9	$0	$330	$223	$0	$564
2014	$0	$10	$20	$0	$1,320	$267	$0	$1,618
2015	$0	$12	$76	$0	$1,484	$403	$0	$1,976
2016	$0	$15	$102	$0	$1,567	$435	$0	$2,120
2017	$0	$17	$110	$0	$1,649	$445	$0	$2,221
2018	$0	$17	$116	$0	$1,649	$456	$0	$2,238
2019	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2020	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2021	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2022	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2023	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2024	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2025	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2026	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2027	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2028	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2029	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2030	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2031	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2032	$0	$17	$117	South	$1,649	$456	$0	$2,239
2033	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2034	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2035	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2036	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2037	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2038	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2039	$0	$17	$117	$0	$1,649	$456	$0	$2,239
2040	$0	$17	$117	$0	$1,649	$453	$0	$2,237
2041	$0	$17	$117	$0	$1,649	$428	$0	$2,212
2042	$0	$16	$117	$0	$1,484	$390	$0	$2,007
2043	$0	$14	$108	$0	$1,320	$233	$0	$1,675
2044	$0	$7	$97	$0	$330	$189	$0	$622

Table I1-6: Time Profile of Mean Total Use Benefits for the "100 MGD for Certain Waterbodies" Option (thousands; 2004$)[a]

Year	California[b]	North Atlantic	Mid-Atlantic	South Atlantic[b]	Gulf of Mexico	Great Lakes	Inland[c]	National Total
2045	$0	$5	$41	$0	$165	$52	$0	$263
2046	$0	$2	$15	$0	$82	$21	$0	$119
2047	$0	$0[f]	$7	$0	$0	$10	$0	$18
2048	$0	$0[f]	$1	$0	$0	$0	$0	$2
Evaluated at 0% (i.e., undiscounted)								
Present Value[d]	$0	$509	$3,510	$0	$49,483	$13,675	$0	$67,177
Annualized Value[e]	$0	$17	$117	$0	$1,649	$456	$0	$2,239
Evaluated at 3% Discount Rate								
Present Value[d]	$0	$274	$1,849	$0	$27,050	$7,513	$0	$36,687
Annualized Value[e]	$0	$14	$94	$0	$1,380	$383	$0	$1,872
Evaluated at 7% Discount Rate								
Present Value[d]	$0	$136	$889	$0	$13,631	$3,816	$0	$18,472
Annualized Value[e]	$0	$11	$72	$0	$1,098	$308	$0	$1,489

[a] Because EPA estimated non-use benefits qualitatively, the monetary value of benefits includes only use values.
[b] Since the potentially regulated facilities in the California and South Atlantic regions withdraw less than 100 MGD, none of the facilities in these regions would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.
[c] None of the facilities in the Inland region would be required to install technology to comply with the 100 MGD CWB option. Thus, no I&E reductions are expected at the potentially regulated facilities in the Inland region.
[d] Values for a given year in the table are not discounted. Total present values of benefits are discounted with the corresponding rate.
[e] Annualized benefits represent the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.
[f] Denotes a positive value less than $500.

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

I1-4   National Benefits from Eliminating and Reducing I&E Losses

EPA used the profiles of benefits, by region, to calculate a total present value of benefits and then to calculate a constant annual equivalent value (annualized value) of the present value. EPA calculated present value and annualized value using two discount rate values: a real rate of 3% and a real rate of 7%. EPA estimated mean values, as well as lower and upper bound values reflecting uncertainty in the recreational benefits estimates. Tables I1-7, I1-8, I1-9, and I1-10 present these results, for each region and for the nation as a whole. Because EPA did not estimate non-use benefits quantitatively, the monetized benefits presented in these tables reflect only use values.[4]

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[4] Use values include commercial and recreational fishing benefits from reduced I&E. See Chapter A6 of this report for a detailed description of the ecological benefits from reduced I&E.

Table I1-7 shows that the total annual national value of fishery resources lost to I&E (i.e., benefits of eliminating baseline I&E losses at Phase III facilities) includes $1.3 million in commercial fishing losses, $6.4 million in recreational fishing losses, and an unknown amount in foregone non-use benefits (2004$, discounted at 3%). The total use value of fishery resources lost is $7.7 million per year, with lower and upper bounds of $5.0 million and $12.6 million, respectively (discounted at 3%). Discounted at 7%, the total annual national value of fishery resources lost to I&E includes $1.3 million in commercial fishing losses, $6.1 million in recreational fishing losses, and an unknown amount in foregone non-use benefits. The total use value of fishery resources lost, discounted at 7%, is $7.3 million per year, with lower and upper bounds of $4.8 million and $12.0 million, respectively. Total monetized losses are greatest in the Gulf of Mexico region. More detailed discussions of the valuation of recreational and commercial fishing losses under the baseline conditions in each region are provided in Parts B through H of this document.

Tables I1-8, I1-9 and I1-10 present EPA's estimates of the national and regional use benefits of reducing I&E under each of the regulatory analysis options (2004$, discounted at 3% and 7%). The national value of these reductions in I&E losses, evaluated at a 3% discount rate, are as follows:

▸ the "50 MGD for All Waterbodies" option results in national use benefits of $2.3 million per year, with lower and upper bounds of $1.4 million and $3.8 million (see Table I1-8);
▸ the "200 MGD for All Waterbodies" option results in national use benefits of $1.5 million per year, with lower and upper bounds of $1.0 million and $2.5 million (see Table I1-9); and
▸ the "100 MGD for Certain Waterbodies" option results in national use benefits of $1.9 million per year, with lower and upper bounds of $1.2 million and $3.1 million (see Table I1-10).

Evaluated at a 7% discount rate, the national use benefits of the regulatory analysis options are somewhat smaller:

▸ the 50 MGD All option results in national use benefits of $1.8 million per year, with lower and upper bounds of $1.1 million and $3.0 million (see Table I1-8);
▸ the 200 MGD All option results in national use benefits of $1.2 million per year, with lower and upper bounds of $0.8 million and $2.0 million (see Table I1-9); and
▸ the 100 MGD CWB option results in national use benefits of $1.5 million per year, with lower and upper bounds of $1.0 million and $2.5 million (see Table I1-10).

The majority of the value of use benefits is attributable to benefits to recreational anglers from improved catch rates. As shown in Tables I1-8, I1-9, and I1-10, use benefits are largest in the Gulf of Mexico for the "50 MGD for All Waterbodies," "200 MGD for All Waterbodies," and the "100 MGD for Certain Waterbodies" options. More detailed discussions of regional benefits under each option are provided in Parts B through H of this report.

Table I1-7: Summary of Use Benefits from Eliminating Baseline I&E at Potentially Regulated Phase III Facilities

| Region | Commercial Fishing | Annualized Use Benefits from Eliminating Baseline I&E (thousands; 2004$)[a] | | | | | |
| | | Recreational Fishing | | | Total Use Value[b] | | |
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% Discount Rate							
California	$0-$54	$42	$81	$155	$97	$135	$209
North Atlantic	$0-$1	$26	$50	$95	$27	$51	$97
Mid-Atlantic	$0-$84	$142	$279	$569	$226	$363	$653
South Atlantic	$0-$93	$769	$1,246	$2,042	$862	$1,340	$2,136
Gulf of Mexico	$0-$990	$1,255	$2,356	$4,544	$2,245	$3,346	$5,533
Great Lakes	$0-$97	$786	$1,145	$1,679	$883	$1,242	$1,776
Inland[c]	n/a	$670	$1,208	$2,194	$670	$1,208	$2,194
National Total	$1,320	$3,689	$6,365	$11,278	$5,009	$7,685	$12,597
Evaluated at a 7% Discount Rate							
California	$0-$50	$39	$75	$143	$89	$125	$194
North Atlantic	$0-$1	$24	$46	$88	$25	$47	$90
Mid-Atlantic	$0-$78	$131	$258	$527	$209	$336	$605
South Atlantic	$0-$87	$712	$1,155	$1,893	$799	$1,242	$1,980
Gulf of Mexico	$0-$953	$1,209	$2,269	$4,376	$2,162	$3,222	$5,328
Great Lakes	$0-$94	$757	$1,103	$1,617	$850	$1,196	$1,710
Inland[c]	n/a	$645	$1,164	$2,113	$645	$1,164	$2,113
National Total	$1,263	$3,517	$6,070	$10,757	$4,780	$7,332	$12,020

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

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

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High

Table I1-8: Summary of Use Benefits of the "50 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Low	Mean	High	Low	Mean	High
Evaluated at a 3% Discount Rate							
California	$0-$8	$11	$21	$40	$19	$29	$48
North Atlantic	$0-$0[e]	$9	$17	$33	$9	$17	$33
Mid-Atlantic	$0-$18	$48	$96	$198	$67	$115	$216
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$283	$589	$1,097	$2,101	$872	$1,380	$2,384
Great Lakes	$0-$11	$292	$425	$624	$302	$436	$634
Inland[d]	n/a	$152	$275	$501	$152	$275	$501
National Total	$0-$321	$1,101	$1,931	$3,496	$1,421	$2,251	$3,816
Evaluated at a 7% Discount Rate							
California	$0-$7	$9	$17	$33	$16	$24	$39
North Atlantic	$0-$0[e]	$7	$13	$25	$7	$13	$25
Mid-Atlantic	$0-$14	$37	$74	$152	$51	$88	$166
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$225	$468	$873	$1,672	$694	$1,098	$1,898
Great Lakes	$0-$9	$234	$341	$500	$243	$350	$509
Inland[d]	n/a	$124	$224	$409	$124	$224	$409
National Total	$0-$255	$880	$1,543	$2,792	$1,135	$1,798	$3,047

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region withdraw less than 50 MGD, none of the facilities in this region would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-9: Summary of Use Benefits of the "200 MGD for All Waterbodies" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% Discount Rate							
California[c]	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0-$0[e]	$2	$3	$7	$2	$4	$7
Mid-Atlantic	$0-$15	$40	$80	$164	$55	$94	$179
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$188	$382	$702	$1,328	$570	$890	$1,516
Great Lakes	$0-$8	$216	$315	$462	$224	$323	$470
Inland[d]	n/a	$104	$188	$343	$104	$188	$343
National Total	$0-$211	$744	$1,288	$2,303	$955	$1,499	$2,514
Evaluated at a 7% Discount Rate							
California[c]	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0-$0[e]	$1	$3	$5	$1	$3	$5
Mid-Atlantic	$0-$11	$30	$60	$125	$42	$72	$136
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$150	$304	$559	$1,057	$454	$709	$1,207
Great Lakes	$0-$6	$172	$251	$368	$178	$257	$374
Inland[d]	n/a	$85	$154	$280	$85	$154	$280
National Total	$0-$167	$593	$1,027	$1,835	$760	$1,194	$2,002

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the California and South Atlantic regions withdraw less than 200 MGD, none of the facilities in this region would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-10: Summary of Use Benefits of the "100 MGD for Certain Waterbodies" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% Discount Rate							
California[c]	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0-$0[f]	$7	$14	$27	$7	$14	$27
Mid-Atlantic	$0-$15	$40	$80	$164	$55	$94	$179
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$283	$589	$1,097	$2,101	$872	$1,380	$2,384
Great Lakes	$0-$9	$257	$374	$548	$266	$383	$558
Inland[d,e]	n/a	$0	$0	$0	$0	$0	$0
National Total	$0-$308	$892	$1,564	$2,840	$1,200	$1,872	$3,148
Evaluated at a 7% Discount Rate							
California[c]	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0-$0[f]	$6	$11	$21	$6	$11	$21
Mid-Atlantic	$0-$11	$30	$60	$125	$42	$72	$136
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$225	$468	$873	$1,672	$694	$1,098	$1,898
Great Lakes	$0-$7	$206	$300	$440	$213	$308	$447
Inland[d,e]	n/a	$0	$0	$0	$0	$0	$0
National Total	$0-$244	$710	$1,244	$2,258	$955	$1,489	$2,502

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the California and South Atlantic regions withdraw less than 100 MGD, none of the facilities in this region would be required to install technology to comply with this option and thus, no I&E reductions are expected for these facilities.

[d] None of the facilities in the Inland region would be required to install technology to comply with the 100 MGD CWB option. Thus, no I&E reductions are expected at the potentially regulated facilities in the Inland region.

[e] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[f] Denotes a positive value less than $500.

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

Appendix I1: National Benefits Under Supplemental Policy Options

Introduction

This appendix supplements Chapter I1 by presenting EPA's estimates of the national commercial and recreational benefits of eight supplemental options that EPA evaluated for the purposes of comparison:

- ▸ "Electric Generators 2-50 MGD I-only Everywhere" option,
- ▸ "Electric Generators 2-50 MGD I&E like Phase II" option,
- ▸ "Electric Generators 2-50 MGD I&E Everywhere" option,
- ▸ "Manufacturers 2-50 MGD I-only Everywhere" option,
- ▸ "Manufacturers 2-50 MGD I&E like Phase II" option,
- ▸ "Manufacturers 2-50 MGD I&E Everywhere" option,
- ▸ "Manufacturers 50+ MGD I-only Everywhere" option, and
- ▸ "Manufacturers 50+ MGD I&E Everywhere" option.

Greater detail on the methods and data used in the regional analyses is provided in the previous chapters of this report. See Chapters A1 and A2 for a discussion of the methods used to estimate I&E, and Chapters A3 through A9 for discussion of the methods used to estimate the value of I&E losses and the benefits of the policy options. The results of the regional analyses are presented in Parts B through H of this report. Chapter I1 presents estimates of national baseline losses and discusses methods used to calculate national benefits under each of the regulatory analysis options.

I1-1   Summary of Expected Reductions in I&E

Table I1-1 presents the number of facilities with technology requirements under the supplemental evaluated options, by region, and EPA's estimates of the percentage by which I&E will be reduced under each option. The table also presents estimates of regional and national fishery losses prevented under each option, expressed as age-1 equivalents and fishery yield.

Table I1-1: Expected Reductions in I&E for Existing Phase III Facilities by Option

Region	Number of Facilities Installing Technology	Reduction in Impingement	Reduction in Entrainment	Prevented Age-1 Equivalent Losses (thousands)	Prevented Foregone Fishery Yield (thousands; lbs)
"Electric Generators 2-50 MGD I-only Everywhere" Option					
California	0	0%	0%	0	0
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	1	1%	0%	27	3
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	0	0%	0%	0	0
Great Lakes	3	1%	0%	303	3
Inland	14	1%	0%	473	3
National total	19			802	9
"Electric Generators 2-50 MGD I&E like Phase II" Option					
California	0	0%	0%	0	0
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	1	1%	0%	27	3
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	0	0%	0%	0	0
Great Lakes	3	1%	1%	327	4
Inland	15	1%	0%	509	4
National total	20			863	10
"Electric Generators 2-50 MGD I&E Everywhere" Option					
California	0	0%	0%	0	0
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	2	1%	2%	1,480	6
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	0	0%	0%	0	0
Great Lakes	3	1%	1%	331	4
Inland	16	1%	1%	802	8
National total	22			2,610	18
"Manufacturers 2-50 MGD I-only Everywhere" Option					
California	3	37%	0%	10	0
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	3	4%	0%	150	18
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	4	3%	0%	543	48
Great Lakes	16	2%	0%	698	7
Inland	126	8%	0%	3,320	21
National total	152			4,720	94

		Table I1-1: Expected Reductions in I&E for Existing Phase III Facilities by Option			
Region	**Number of Facilities Installing Technology**	**Reduction in Impingement**	**Reduction in Entrainment**	**Prevented Age-1 Equivalent Losses (thousands)**	**Prevented Foregone Fishery Yield (thousands; lbs)**
		"Manufacturers 2-50 MGD I&E like Phase II" Option			
California	3	37%	28%	481	34
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	3	4%	3%	2,310	22
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	4	3%	2%	855	162
Great Lakes	16	2%	1%	732	8
Inland	140	8%	2%	3,660	27
National total	166			8,040	252
		"Manufacturers 2-50 MGD I&E Everywhere" Option			
California	3	37%	31%	534	38
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	3	4%	3%	2,310	22
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	4	3%	2%	855	162
Great Lakes	16	2%	2%	764	9
Inland	142	8%	7%	4,880	44
National total	168			9,340	275
		"Manufacturers 50+ MGD I-only Everywhere" Option			
California	1	37%	0%	10	0
North Atlantic	0	0%	0%	0	0
Mid-Atlantic	2	23%	0%	1,000	118
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	5	51%	0%	10,400	917
Great Lakes	15	42%	0%	11,700	109
Inland	74	38%	0%	16,200	105
National total	97			39,400	1,250

Table I1-1: Expected Reductions in I&E for Existing Phase III Facilities by Option

Region	Number of Facilities Installing Technology	Reduction in Impingement	Reduction in Entrainment	Prevented Age-1 Equivalent Losses (thousands)	Prevented Foregone Fishery Yield (thousands; lbs)
"Manufacturers 50+ MGD I&E Everywhere" Option					
California	1	37%	28%	474	33
North Atlantic	4	0%	40%	910	4
Mid-Atlantic	3	23%	53%	44,500	212
South Atlantic[a]	0	0%	0%	0	0
Gulf of Mexico	7	51%	58%	19,400	4,200
Great Lakes	18	42%	46%	13,400	161
Inland	94	38%	37%	24,600	228
National total	127			103,000	4,840

[a] Since the potentially regulated facilities in the South Atlantic region withdraw less than 50 MGD and are projected to close in the baseline, no I&E reductions are expected for these facilities.

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

I1-2   Total Annualized Monetary Value of National Losses and Benefits

Tables I1-3 through I1-10 present EPA's estimates of the value of national and regional reductions in I&E under the supplemental options analyzed for the final rule. The tables show that, for these options, benefits to recreational anglers account for the majority of use benefits. National use benefits are largest in the Gulf of Mexico, Great Lakes, and Inland regions. More detailed discussions of regional benefits under each option are provided in Parts B through H of this report.

Table I1-2: Summary of Use Benefits from Eliminating Baseline I&E at Potentially Regulated Phase III Facilities

Region	Commercial Fishing	Recreational Fishing			Total Use Value[b]		
		Low	Mean	High	Low	Mean	High
				Annualized Use Benefits from Eliminating Baseline I&E (thousands; 2004$)[a]			
Evaluated at a 3% discount rate							
California	$0-$54	$42	$81	$155	$97	$135	$209
North Atlantic	$0-$1	$26	$50	$95	$27	$51	$97
Mid-Atlantic	$0-$84	$142	$279	$569	$226	$363	$653
South Atlantic	$0-$93	$769	$1,246	$2,042	$862	$1,340	$2,136
Gulf of Mexico	$0-$990	$1,255	$2,356	$4,544	$2,245	$3,346	$5,533
Great Lakes	$0-$97	$786	$1,145	$1,679	$883	$1,242	$1,776
Inland[c]	n/a	$670	$1,208	$2,194	$670	$1,208	$2,194
National total	$0-$1,320	$3,689	$6,365	$11,278	$5,009	$7,685	$12,597
Evaluated at a 7% discount rate							
California	$0-$50	$39	$75	$143	$89	$125	$194
North Atlantic	$0-$1	$24	$46	$88	$25	$47	$90
Mid-Atlantic	$0-$78	$131	$258	$527	$209	$336	$605
South Atlantic	$0-$87	$712	$1,155	$1,893	$799	$1,242	$1,980
Gulf of Mexico	$0-$953	$1,209	$2,269	$4,376	$2,162	$3,222	$5,328
Great Lakes	$0-$94	$757	$1,103	$1,617	$850	$1,196	$1,710
Inland[c]	n/a	$645	$1,164	$2,113	$645	$1,164	$2,113
National total	$0-$1,263	$3,517	$6,070	$10,757	$4,780	$7,332	$12,020

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

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

Table I1-3: Summary of Use Benefits of the "Electric Generators 2-50 MGD I-only Everywhere" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$0[e]	$0[e]	$1	$1	$0[e]	$1	$1
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$5	$7	$10	$5	$7	$11
Inland[d]	n/a	$3	$6	$10	$3	$6	$10
National total	$0-$0[e]	$8	$13	$22	$9	$14	$22
Evaluated at a 7% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$0[e]	$0[e]	$0[e]	$1	$0[e]	$1	$1
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$4	$6	$8	$4	$6	$8
Inland[d]	n/a	$3	$5	$8	$3	$5	$8
National total	$0-$0[e]	$7	$11	$17	$7	$11	$18

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region do not include small electric generators, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-4: Summary of Use Benefits of the "Electric Generators 2-50 MGD I&E like Phase II" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$0[e]	$0[e]	$1	$1	$0[e]	$1	$1
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$6	$9	$14	$7	$10	$14
Inland[d]	n/a	$4	$7	$12	$4	$7	$12
National total	$0-$0[e]	$10	$16	$27	$11	$17	$27
Evaluated at a 7% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$0[e]	$0[e]	$0[e]	$1	$0[e]	$1	$1
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$5	$7	$11	$5	$8	$11
Inland[d]	n/a	$3	$5	$10	$3	$5	$10
National total	$0-$0[e]	$8	$13	$21	$9	$13	$22

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region do not include small electric generators, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-5: Summary of Use Benefits of the "Electric Generators 2-50 MGD I&E Everywhere" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$1	$2	$3	$6	$2	$4	$7
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$7	$10	$14	$7	$10	$14
Inland[d]	n/a	$8	$14	$25	$8	$14	$25
National total	$0-$1	$16	$26	$45	$17	$27	$46
Evaluated at a 7% discount rate							
California	$0	$0	$0	$0	$0	$0	$0
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$0[e]	$1	$2	$5	$2	$3	$5
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0	$0	$0	$0	$0	$0	$0
Great Lakes	$0-$0[e]	$5	$8	$11	$5	$8	$11
Inland[d]	n/a	$6	$11	$21	$6	$11	$21
National total	$0-$1	$13	$21	$36	$13	$22	$37

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region do not include small electric generators, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-6: Summary of Use Benefits of the "Manufacturers 2-50 MGD I-only Everywhere" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0-$0[e]	$1	$1	$2	$1	$1	$2
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$1	$2	$4	$8	$3	$5	$9
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$6	$16	$33	$70	$22	$39	$76
Great Lakes	$0-$0[e]	$12	$17	$25	$12	$17	$25
Inland[d]	n/a	$21	$38	$70	$21	$38	$70
National total	$0-$7	$51	$93	$174	$59	$100	$181
Evaluated at a 7% discount rate							
California	$0-$0[e]	$0[e]	$1	$2	$0[e]	$1	$2
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$1	$2	$3	$6	$2	$4	$7
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$5	$13	$26	$56	$18	$31	$60
Great Lakes	$0-$0[e]	$10	$14	$20	$10	$14	$21
Inland[d]	n/a	$17	$30	$55	$17	$30	$55
National total	$0-$6	$41	$74	$139	$47	$80	$144

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region are projected to close in the baseline, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-7: Summary of Use Benefits of the "Manufacturers 2-50 MGD I&E like Phase II" Option (thousands; 2004$)[a]							
Region	**Annualized Commercial Fishing Benefits**	**Annualized Recreational Fishing Benefits**			**Total Annualized Use Benefits**[b]		
		Low	**Mean**	**High**	**Low**	**Mean**	**High**
Evaluated at a 3% discount rate							
California	$0-$8	$10	$19	$37	$18	$27	$44
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$2	$4	$7	$15	$5	$9	$17
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$12	$26	$49	$96	$38	$61	$108
Great Lakes	$0-$0[e]	$14	$20	$29	$14	$21	$30
Inland[d]	N/a	$26	$46	$85	$26	$46	$85
National total	$0-$22	$79	$142	$262	$101	$164	$284
Evaluated at a 7% discount rate							
California	$0-$6	$7	$14	$27	$13	$20	$33
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$1	$3	$6	$12	$4	$7	$13
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$9	$21	$39	$77	$30	$49	$86
Great Lakes	$0-$0[e]	$11	$17	$24	$12	$17	$25
Inland[d]	n/a	$20	$37	$67	$20	$37	$67
National total	$0-$17	$63	$113	$207	$79	$129	$224

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region are projected to close in the baseline, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
Region		**Low**	**Mean**	**High**	**Low**	**Mean**	**High**
Evaluated at a 3% discount rate							
California	$0-$8	$11	$21	$41	$20	$30	$49
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$2	$4	$7	$15	$5	$9	$17
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$12	$26	$49	$96	$38	$61	$108
Great Lakes	$0-$1	$16	$23	$34	$16	$24	$35
Inland[d]	n/a	$42	$76	$138	$42	$76	$138
National total	$0-$22	$99	$177	$324	$121	$199	$346
Evaluated at a 7% discount rate							
California	$0-$6	$8	$16	$30	$14	$22	$36
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$1	$3	$6	$12	$4	$7	$13
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$9	$21	$39	$77	$30	$49	$86
Great Lakes	$0-$0[e]	$13	$19	$28	$14	$20	$28
Inland[d]	n/a	$33	$60	$109	$33	$60	$109
National total	$0-$17	$78	$140	$256	$96	$157	$273

Table I1-8: Summary of Use Benefits of the "Manufacturers 2-50 MGD I&E Everywhere" Option (thousands; 2004$)[a]

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region are projected to close in the baseline, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-9: Summary of Use Benefits of the "Manufacturers 50+ MGD I-only Everywhere" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0-$0[e]	$1	$1	$2	$1	$1	$2
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$6	$13	$25	$49	$19	$31	$55
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$115	$307	$636	$1,339	$422	$751	$1,454
Great Lakes	$0-$7	$190	$276	$403	$197	$283	$410
Inland[d]	n/a	$105	$190	$348	$105	$190	$348
National total	$0-$128	$616	$1,129	$2,142	$744	$1,257	$2,270
Evaluated at a 7% discount rate							
California	$0-$0[e]	$1	$1	$2	$1	$1	$2
North Atlantic	$0	$0	$0	$0	$0	$0	$0
Mid-Atlantic	$0-$5	$10	$19	$38	$15	$24	$43
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$92	$244	$506	$1,066	$336	$598	$1,157
Great Lakes	$0-$5	$151	$219	$319	$156	$224	$324
Inland[d]	n/a	$86	$155	$284	$86	$155	$284
National total	$0-$102	$491	$900	$1,709	$593	$1,002	$1,811

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region withdraw less than 50 MGD and are projected to close in the baseline, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

Table I1-10: Summary of Use Benefits of the "Manufacturers 50+ MGD I&E Everywhere" Option (thousands; 2004$)[a]

Region	Annualized Commercial Fishing Benefits	Annualized Recreational Fishing Benefits			Total Annualized Use Benefits[b]		
		Low	Mean	High	Low	Mean	High
Evaluated at a 3% discount rate							
California	$0-$8	$11	$21	$40	$19	$29	$48
North Atlantic	$0-$0[e]	$9	$17	$33	$9	$17	$33
Mid-Atlantic	$0-$18	$48	$96	$198	$67	$115	$216
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$283	$589	$1,097	$2,101	$872	$1,380	$2,384
Great Lakes	$0-$11	$295	$429	$629	$305	$440	$640
Inland[d]	n/a	$221	$399	$725	$221	$399	$725
National total	$0-$321	$1,172	$2,059	$3,726	$1,493	$2,380	$4,046
Evaluated at a 7% discount rate							
California	$0-$7	$9	$17	$33	$16	$24	$39
North Atlantic	$0-$0[e]	$7	$13	$25	$7	$13	$25
Mid-Atlantic	$0-$14	$37	$74	$152	$51	$88	$166
South Atlantic[c]	$0	$0	$0	$0	$0	$0	$0
Gulf of Mexico	$0-$225	$468	$873	$1,672	$694	$1,098	$1,898
Great Lakes	$0-$8	$236	$345	$505	$245	$353	$514
Inland[d]	n/a	$181	$326	$593	$181	$326	$593
National total	$0-$255	$939	$1,648	$2,980	$1,194	$1,903	$3,235

[a] All benefits presented in this table are annualized, i.e., equal to the value of all benefits generated over the time frame of the analysis, discounted to 2007, and then annualized over a thirty year period.

[b] The total monetizable value of I&E reductions includes use benefits only. EPA evaluated non-use benefits qualitatively. A range of recreational fishing benefits is provided, based on the Krinsky and Robb technique to estimated the 95th and 5th percentile limits on the marginal value per fish predicted by the meta-analysis. Commercial fishing benefits are computed based on a region- and species-specific range of gross revenue, as explained in Chapter A4 of this report. To calculate the total monetizable value columns (low, mean, and high), the high end value for commercial fishing benefits is added to the low, mean, and high values for recreational fishing benefits, respectively.

[c] Since the potentially regulated facilities in the South Atlantic region withdraw less than 50 MGD and are projected to close in the baseline, no I&E reductions are expected for these facilities.

[d] No significant commercial fishing takes place in the Inland region. Thus, this region is excluded from the commercial fishing analysis.

[e] Denotes a positive value less than $500.

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

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