

**ANNUAL REPORT OF THE
U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE**

REPORT NO. 21 - 2008 ACTIVITIES

**PORTLAND, MAINE
March 2 – March 5, 2009**



**PREPARED FOR
U.S. SECTION TO NASCO**

Table of Contents

Table of Contents.....	i
Index of Tables and Figures.....	iii
List of Historical Tables.....	vii
1.0 Executive Summary.....	1
1.1 Abstract	1
1.2 Description of Fisheries	1
1.3 Adult Returns	1
1.4 Stock Enhancement Programs.....	2
1.5 Tagging and Marking Programs.....	2
1.6 Farm Production.....	3
1.7 Dam Removals.....	3
2.0 Status of Stocks.....	10
3.0 Geographical Summaries.....	19
3.1 Long Island Sound Area.....	21
3.1.1 Adult Returns.....	21
3.1.2 Hatchery Operations.....	21
3.1.3 Stocking.....	23
3.1.4 Juvenile Population Status.....	24
3.1.5 Fish Passage.....	25
3.1.6 Genetics	26
3.1.7 General Program Information.....	28
3.1.8 Salmon Habitat Enhancement and Conservation.....	28
3.2 Long Island Sound Area	29
3.2.1 Adult Returns.....	29
3.2.2 Hatchery Operations.....	29
3.2.3 Stocking.....	29
3.2.4 Juvenile Population Status.....	30
3.2.5 Fish Passage.....	30
3.2.6 Genetic sampling.....	30
3.2.7 General Program Information.....	30
3.2.8 Salmon Habitat Enhancement and Conservation.....	31
4.1 Central New England.....	32
4.1.1 Adult Returns.....	32
4.1.2 Hatchery Operations.....	32
4.1.3 Stocking.....	33
4.1.4 Juvenile Population Status.....	34
4.1.5 Impacts of River Obstructions.....	35
4.1.6 Genetics.....	37
4.1.7 Atlantic Salmon Domestic Broodstock Sport Fishery	38
4.1.8 Salmon Habitat Enhancement and Conservation.....	40

4.2 Central New England.....	44
4.2.1 Adult Returns.....	44
4.2.2 Hatchery Operations.....	44
4.2.3 Stocking.....	44
4.2.4 Juvenile Population Status.....	45
4.2.5 Fish Passage.....	45
4.2.6 Genetics.....	45
4.2.7 General Program Information.....	45
4.2.8 Salmon Habitat Enhancement and Conservation.....	45
5.1 Gulf of Maine.....	46
5.1.1 Adult Returns.....	46
5.1.2 Hatchery Operations.....	50
5.1.3 Stocking.....	51
5.1.4 Juvenile Population Status.....	52
5.1.5 Fish Passage.....	63
5.1.6 Genetic sampling.....	65
5.1.7 General Program Information.....	65
5.1.8 Salmon Habitat Enhancement and Conservation.....	69
6.1 Outer Bay of Fundy.....	71
6.1.1 Adult Returns.....	71
6.1.2 Hatchery Operations.....	71
6.1.3 Stocking.....	71
6.1.4 Juvenile Population Status.....	72
6.1.5 Fish Passage.....	73
6.1.6 Genetic sampling.....	73
6.1.7 General Program Information.....	73
6.1.8 Salmon Habitat Enhancement and Conservation.....	73
7.0 Terms of Reference and Emerging Issues in New England Salmon.....	74
7.1 Regional Assessment Product Progress Update.....	74
7.2 Fish Health Issues – Biosecurity Enhancements and Documentation of Nucleospora salmonis.....	76
7.3 Update on the NASCO River Database 2009.....	77
7.4 Marine Survival: Acoustic Telemetry Studies.....	77
7.5 Parr Subsidy of Hatchery Return Rates, Penobscot River, Maine.....	79
7.6 Sampling Design for the Gulf of Maine DPS.....	81
7.7 USASAC Draft Terms of Reference 2010.....	84
8.0 Appendices.....	85
8.1 List of Attendees.....	85
8.2 List of Program Summary and Technical Working Papers including PowerPoint Presentation Reports.....	86
8.3 Glossary of Abbreviations.....	88
8.4 Glossary of Definitions.....	90
8.5 Abstracts from Regional Atlantic Salmon Assessment Committee Meeting.....	95
8.5.1 Connecticut River Atlantic Salmon Commission Migratory Fish Restoration Research Forum (2009 Meeting 11 February 2009).....	95
8.6 Historical Tables.....	103

List of Tables and Figures

Table 1.3.1 Documented Atlantic salmon returns to USA rivers, 2008. "Natural" includes fish originating from natural spawning and hatchery fry.....	3
Table 1.3.2 Documented Atlantic salmon returns to the USA, 1967-2007. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.....	4
Table 1.3.3 Two sea winter (2SW) returns for 2007 in relation to spawner requirements for USA rivers.....	5
Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2007.....	5
Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2007 by river.....	6
Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2007.....	7
Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2008...	8
Figure 1.3.1 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2008.....	8
Figure 1.3.2 Return rate of 2SW adults by cohort of hatchery-reared Atlantic salmon smolts released into the Penobscot River (solid line) and wild smolt emigration estimated on the Narraguagus River (dashed line), Maine, USA.....	9
Figure 2.1 Estimated total returns to New England since 1967 from USASAC databases.....	13
Figure 2.2 Return rates of 2SW Atlantic salmon from the Connecticut, Narraguagus, and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and Connecticut populations and from estimated smolt emigration from the Narraguagus River population.....	14
Figure 2.3 Return rates of Atlantic salmon from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.....	15
Figure 2.4 Median large parr densities in selected rivers from 1980 until 2008 from USASAC databases for 3 regions: Long Island Sound and Central New England Regions and in the Gulf of Maine DPS.....	16
Figure 2.5 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basin in total, see text for details of estimation methods.....	18
Figure 3.0.1 General map of New England Atlantic Salmon historic population structure.....	20

Table 4.1.1 Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2005	42
Table 4.1.2 Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 – 2007.....	42
Table 4.1.3 Estimated statistics for yearling parr per habitat unit at Index Sites (IS) and sample sites in the Merrimack River watershed, 1994 – 2008.....	43
Table 5.1.1.2 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2008.....	49
Table 5.1.1.3 Return rates for marked smolts (by auxiliary and individual VIE mark) released below Great Works Dam, Penobscot River, Maine in 2006 and 2007...	49
Table 5.1.1.4 Average return rates (per 10,000) for VIE marked smolts stocked below Great Works Dam, Penobscot River, Maine in 2006 and 2007.....	48
Table 5.1.2.1 Fry development index (DI) and environmental conditions for stocking events from CBNFH in 2008.....	54
Table 5.1.4.1 Minimum (min), median, and maximum (max) large parr Atlantic salmon population densities (fish/100m ²) based on multiple pass electrofishing estimates in selected Maine Rivers, 2008.....	55
Table 5.1.4.2 Minimum (min), median, and maximum (max) relative abundance of large parr Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2008.....	55
Table 5.1.4.3 Time series of basin large parr estimates for the Narraguagus River (1991-2006), the Dennys River (2001-2005), and the Sheepscot River (2003 - 2006), with number of sites (n), total catch of parr estimate variance, and 95 % CI.....	56
Table 5.1.4.4 Freshwater age of naturally reared smolts collected in Rotary Screw Traps on selected Maine rivers.....	58
Table 5.1.4.5 Mean fork length (mm) by origin of smolts captured in Rotary Screw Traps in Maine.....	58
Table 5.1.4.6 Mean smolt weight (g) by origin of smolts captured in Rotary Screw Traps in Maine.....	59
Figure 5.1.4.1 Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2000-2008.....	59

Figure 5.1.4.2 Mean wet weight (g) \pm 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2000-2008.....	60
Figure 5.1.4.3 Population Estimates (\pm Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to 2008.....	61
Figure 5.1.4.4 Cumulative percentage smolt catch in Rotary Screw Traps by date (run timing) on the Narraguagus, Piscataquis, and Sheepscot Rivers, Maine, for years 2005 to 2008.....	62
Table 5.1.4.7 Ordinal day (days from January) of median smolt catch in rotary screw traps on the Narraguagus and Sheepscot Rivers, 1997-2008.....	63
Table 5.1.8.1 Projects restoring stream connectivity in Gulf of Maine Atlantic salmon watersheds, indicating stream, type of work, structure, and km of juvenile salmon habitat upstream.....	70
Table 6.1.4.1 Minimum (min), median, and maximum (max) large parr and young of the year (YOY) Atlantic salmon population densities (fish/100m ²) based on multiple pass electrofishing estimates in the Aroostook River, 2008.....	72
Table 6.1.4.2 Minimum (min), median, and maximum (max) relative abundance of large parr and YOY Atlantic salmon (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in the Aroostook River, 2008.....	72
Table 6.1.8.1 List of projects restoring stream connectivity in St. Croix River watershed watersheds, indicating stream, type of work, structure, and km of juvenile salmon habitat upstream.....	73
Table 7.1.1 Overview of Atlantic salmon life history stages with proposed assessment elements, time series for revisiting elements, and suggested opportunities for expansion of statistical analysis. This table is a living document updated at both the intercessional teleconference and annual meetings.....	75
Figure 7.4.1 Map showing the location of the Penobscot Telemetry Array and the Halifax Array.....	78
Table 7.5.1 Percent marked and unmarked Atlantic salmon smolt and parr stocked on the Penobscot River, Maine.....	80
Figure 7.5.1 Penobscot River, Maine, adult return rates per 10,000 hatchery smolts and parr stocked.....	80
Figure 7.6.1 Electrofishing population estimate samples needed to detect a rate of change in parr density.....	82

Figure 7.6.2 Multi-year panel probability sampling design for juvenile Atlantic salmon assessment in the GOM DPS.....	83
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List of Historical Tables

Table 1.3.1 Documented Atlantic salmon returns to USA rivers, 2008. "Natural" includes fish originating from natural spawning and hatchery fry.

Table 1.3.2 Documented Atlantic salmon returns to the USA, 1967-2008. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Table 1.3.3 Two sea winter (2SW) returns for 2008 in relation to spawner requirements for USA rivers.

Table 4.1.1 Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2005

Table 4.1.2 Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 – 2007

Table 4.1.3 Estimated statistics for yearling parr per habitat unit at Index Sites (IS) and sample sites in the Merrimack River watershed, 1994 – 2008

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2008.

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2008.

Table 7 Juvenile Atlantic salmon stocking summary for New England in 2007.

Table 8 Number of adult Atlantic salmon stocked in New England rivers in 2007.

Table 9.1 Atlantic salmon marking database for New England; marked fish released in 2007.

Table 9.2 Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2007.

Table 10 Documented Atlantic salmon returns to New England rivers in 2007.

Table 11 Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2007.

Table 12 Summary of Atlantic salmon egg production in New England facilities.

Table 13 Summary of all historical Atlantic salmon egg production in hatcheries for New England rivers.

Table 14 Atlantic salmon stocking summary for New England, by river.

Table 15 Overall summary of Atlantic salmon stocking for New England, by river.

Table 16 Documented Atlantic salmon returns to New England rivers.

Table 17 Summary of documented Atlantic salmon returns to New England rivers.

Table 18.1 Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River.

Table 18.2 Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River.

Table 18.3 Return rates for Atlantic salmon that were stocked as fry in the Farmington River.

Table 18.4 Return rates for Atlantic salmon that were stocked as fry in the Merrimack River.

Table 18.5 Return rates for Atlantic salmon that were stocked as fry in the Pawcatuck River.

Table 18.6 Return rates for Atlantic salmon that were stocked as fry in the Salmon River.

Table 18.7 Return rates for Atlantic salmon that were stocked as fry in the Westfield River.

Table 19 Summary return rates in southern New England for Atlantic salmon that were stocked as fry.

Table 20 Summary of age distributions of adult Atlantic salmon that were stocked in southern New England as fry.

1.0 Executive Summary

1.1 Abstract

Total return to USA rivers was 2,613; this is the sum of documented returns to traps and returns estimated on selected Maine rivers. Adult salmon returns to USA rivers with traps or weirs totaled 2,506 in 2008, a 106% more than observed in 2007 and 76% more than returned in 2006. One hundred and thirty eight (90% CI = 106 - 178) adult salmon were estimated to return to the rivers with Endangered populations, the 10th highest for the 1991-2008 time-series. Most returns occurred in Maine, with the Penobscot River accounting for 81% of the total return. Overall, 31% of the adult returns to the USA were 1SW salmon and 69% were MSW salmon. Most (84%) returns were of hatchery smolt origin and the balance (16%) originated from either natural reproduction or hatchery fry. A total of 12,534,300 juvenile salmon (fry, parr, and smolts) and 5,848 adults were stocked, with 468,246 carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 450 sea-run females, 2,882 captive/domestic females, and 146 female kelts. The number of females (3,480) contributing was less than 2007 (3,940); and total egg take (19,579,000) was also less than in 2006 (22,074,000). Production of farmed salmon in Maine was reported to be 9,014 metric tonnes in 2008, just over three times the 2,715 metric tonnes of production reported in 2007.

1.2 Description of Fisheries

Except for a one-month spring recreational fishery on the Penobscot River, Maine commercial and recreational fisheries for sea-run Atlantic salmon are closed in USA waters (including coastal waters). Estimated catch and unreported catch are zero (metric tonne). A total of 177 licenses were sold, with about one third of the anglers complying with reporting requirements. The fishery had an estimated 790 angler trips of effort. The 61 Atlantic salmon captured and released exceeded the quota of 50 salmon set for the fishery. Anglers had the opportunity to fish over at least 600 Atlantic salmon based on the catch of salmon at the Veazie trap. A fishery in the main stem of the Merrimack River and small reach of the Pemigewasset River was supported by the release of 2,372 broodstock in 2008.

1.3 Adult Returns

Total return to USA rivers was 2,613 (Table 1.3.1), a 108% increase from 2007 returns (Table 1.3.2). Changes from 2007 by river were: Connecticut (0%), Merrimack (+59%), Penobscot (+129%), Saco (+158%), and Narraguagus (+109%). In addition to catches at traps and weirs (2,506), returns were estimated for the eight core populations that comprise the federally endangered Gulf of Maine Distinct Population Segment (GOM DPS). Data on adult returns and redd counts collected from the Narraguagus, Pleasant, and Dennys rivers have been used to estimate returns to core populations within the GOM DPS using a linear regression [$\ln(\text{returns}) = 0.5699 \ln(\text{redd count}) + 1.3945$]. One hundred and thirty eight (90% CI = 106 - 178) fish were estimated to return to the rivers with Endangered populations. The ratio of sea ages from trap and weir catches within the GOM DPS was used to estimate the number of 2SW spawners for the estimated returns.

Most returns occurred in Maine, with the Penobscot River accounting for 81% of the total return. Overall, 31% of the adult returns to the USA were 1SW salmon and 69% were MSW salmon. Most (84%) returns were of hatchery smolt origin and the balance (16%) originated from either natural reproduction or hatchery fry (Figure 1.3.1). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2006 was 0.28%, with the 2SW fish return rate 0.24% (Figure 1.3.2). Smolt survival on the Penobscot River correlates well with other large restoration programs in the Connecticut and Merrimack rivers. The estimated return rate for 2SW adults from the 2006 cohort of wild smolts on the Narraguagus was 0.71%, mirroring trends on the Penobscot (Figure 2).

In the USA, returns are well below conservation spawner requirements. Returns of 2SW fish from traps, weirs, and estimated returns were only 6.4 % of the 2SW conservation spawner requirements for USA, with individual river returns ranging from 0.0 to 20.1 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2008 about 12,534,000 juvenile salmon (92% fry) were released into 15 River systems (Table 1.4.1). The number of juveniles released was more than that in 2007 (12,372,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six rivers within the geographic range of the GOM DPS in Maine. The 275,000 parr released in 2008 were primarily the by-products of smolt production programs and included ages 0 and 1 fish. Smolts were stocked in the Penobscot (513,000), Merrimack (89,000), Connecticut (50,000), Narraguagus (54,000), and Pawcatuck (6,000) rivers. In addition to juveniles, 5,848 adult salmon were released into USA rivers (Table 1.4.2). Most were spent broodstock or broodstock excess to hatchery capacity. However, mature pre-spawn salmon released in the Sheepscot, East Machias, and Machias rivers and Hobart Stream produced redds. In the Merrimack River excess broodstock were released to support a recreational fishery and to enhance spawning in the watershed.

Mature adults stocked into Sheepscot, East Machias, and Machias rivers and Hobart Stream in the fall were added to USA 2SW returns to calculate spawners. Thus, spawners exceeded returns in 2008 with USA spawners totaling 3,045. Escapement to natural spawning areas was 1,252 (returns released to rivers + stocked pre-spawn adults).

1.5 Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 468,246 salmon released into USA waters in 2008 was marked or tagged. Tags and marks for parr, smolts and adults included: Floy, Carlin, PIT, radio, acoustical, fin clips, and visual implant elastomer. About 11% of the marked fish were released into the Connecticut River watershed and 60% into the Penobscot River (Table 1.5.1).

1.6 Farm Production

Production of farmed salmon in Maine was reported to be 9,014 metric tonnes in 2008, about three times the 2,715 metric tonnes produced in 2007. Production in three of the last five years has been less than half of the 13,202 t produced in 2001 (Table 1.6.1).

1.7 Dam Removals

Where feasible, non-governmental organizations, State and Federal fisheries agencies are pursuing removing dams that block passage of returning Atlantic salmon. During 2008, the Fort Halifax Dam on the Sebasticook River, a tributary to the Kennebec River, Maine was breached and removed. Merrimack Village Dam on the Souhegan River in New Hampshire was also successfully removed. Both removals provided Atlantic salmon adults returning to the watershed access to historical Atlantic salmon habitat. In June, the Penobscot River Restoration Trust notified the owner of the Veazie, Great Works, and Howland dams on the Penobscot River of its intent to purchase the dams for \$25 million. The Trust's plan is to remove Great Works and Veazie dams and to install a nature like fishway at the Howland Dam within the next 10 years.

Table 1.3.1 Documented Atlantic salmon returns to USA rivers, 2008. "Natural" includes fish originating from natural spawning and hatchery fry.

NUMBER OF RETURNS BY SEA AGE AND ORIGIN									
RIVER	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
Androscoggin	8	2	5	1	0	0	0	0	16
Connecticut	7	3	10	118	0	1	0	2	141
Kennebec	6	0	15	0	0	0	0	0	21
Merrimack	6	5	77	29	0	1	0	0	118
Dennys DPS	0	1	1	3	0	0	0	3	8
Narraguagus DPS	0	4	0	17	0	1	0	1	23
Other GOM DPS 1		17		73		3		14	107
Pawcatuck	0	0	0	0	0	0	0	0	0
Penobscot	713	23	1297	80	0	0	4	0	2117
Saco	11	8	26	12	2	3	0	0	62

Table 1.3.2 Documented Atlantic salmon returns to the USA, 1967-2008. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1SW	2SW	3SW	Repeat	Total	Hatchery	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1764	11	24	2613	2188	425

Table 1.3.3 Two sea winter (2SW) returns for 2008 in relation to spawner requirements for USA rivers.

River	Spawner Requirement	2SW spawners-2008	Percentage of Requirement
Penobscot	6,838	1377	20.14
Connecticut	9,727	128	1.32
Pawcatuck	367	0	0.00
Merrimack	2599	106	4.08
GOM-DPS	1,564	94	6.01
Other Maine rivers	8,104	59	0.73
Total	29199	1764	6.04

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2008. Numbers are rounded to 1,000.

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,041,000	0	0	2,000	0	50,000	6,093,000
Aroostook	365,000	0	0	0	0	0	365,000
Androscoggin	1,000	0	0	0	0	0	1,000
Dennys	292,000	0	0	0	0	0	292,000
East Machias	261,000	0	0	0	0	0	261,000
Kennebec	3,000	0	0	0	0	0	3,000
Machias	585,000	0	0	0	0	0	586,000
Narraguagus	485,000	21,000	0	0	54,000	0	560,000
Pleasant	171,000	0	0	0	0	0	171,000
Penobscot	1,248,000	217,000	0	0	513,000	0	1,394,000
Saco	358,000	9,000	0	0	0	0	367,000
Sheepscot	218,000	13,000	0	0	0	0	231,000
Union	23,000	0	0	0	0	0	23,000
Merrimack	1,766,000	3,000	10,000	0	89,000	0	1,868,000
Pawcatuck	313,000	0	0	0	6,000	0	319,000
Total for USA	12,127,000	263,000	10,000	2,000	662,000	50,000	12,534,000

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2008 by river.

River	Purpose	Captive Reared Domestic		Sea Run	Total
		Pre-spawn	Post-spawn	Post-spawn	
Connecticut	Restoration			1	1
Dennys	Restoration		147		147
East Machias	Restoration	72	73		145
Hobart Stream	Restoration	116			116
Kennebec	Restoration	106			106
Machias	Restoration	68	148		216
Merrimack	Restoration/Recreation	800	1,572		2,372
Narraguagus	Restoration		188		188
Penobscot	Restoration		1,738	640	2,378
Pleasant	Restoration		43		43
Sheepscot	Restoration	71	65		136

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2008.

		Stock Origin									Grand Total
Mark	Life Stage	Connecticut	Dennys	East Machias	Machias	Merrimack	Narraguagus	Pawcatuck	Penobscot	Sheepscot	
FLOY	Adult					2,372					2,372
PIT	Adult	1	202	146	216		199		640	93	1,497
RAD	Adult	10									10
AD	Parr	2,426					20,990			13046	36,462
LV	Parr								130,561		130,561
AD	Smolt	49,657				38,900		5,994			94,551
VIE	Smolt						54,116		147,789		201,905
PING	Smolt								200		200
PIT	Smolt		218								218
RAD	Smolt	470									470
Grand Total		52,564	420	146	216	41,272	75,305	5,994	279,190	13,139	468,246

AD = Adipose Clip, fish often have other marks

VIE = visual implant elastomer; all fish tagged with VIE also had adipose fin clipped

LV = left ventral

RV = right ventral

RAD = radio tag

PIT = passive integrated transponder

PING = ultrasonic acoustic tag

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2008.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014

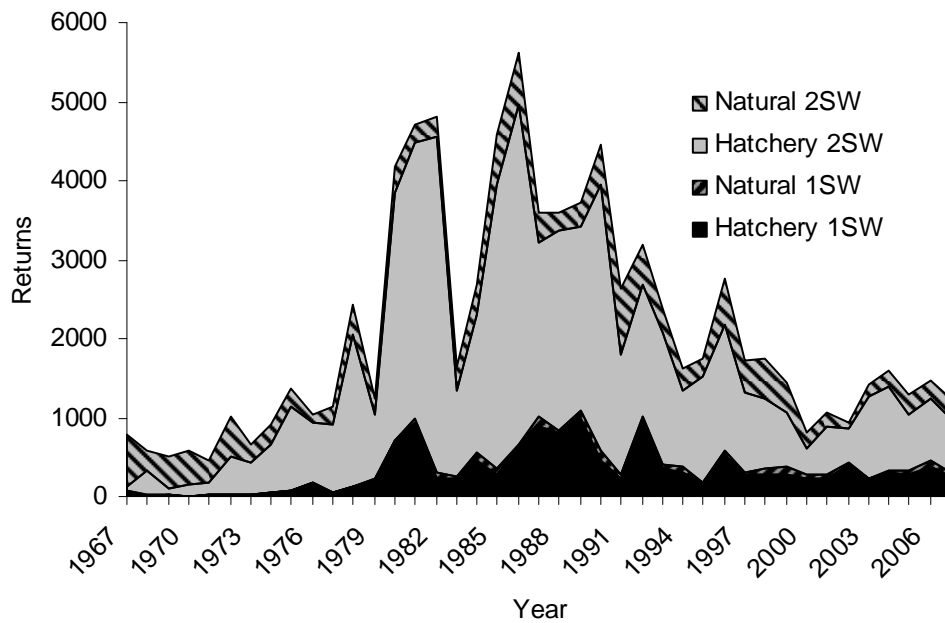


Figure 1.3.1 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2008.

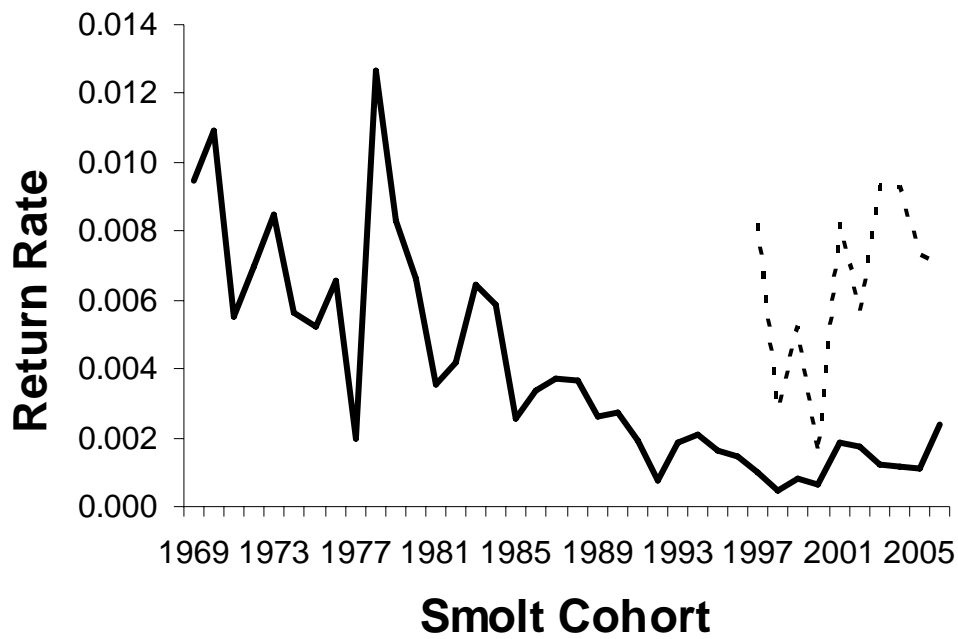
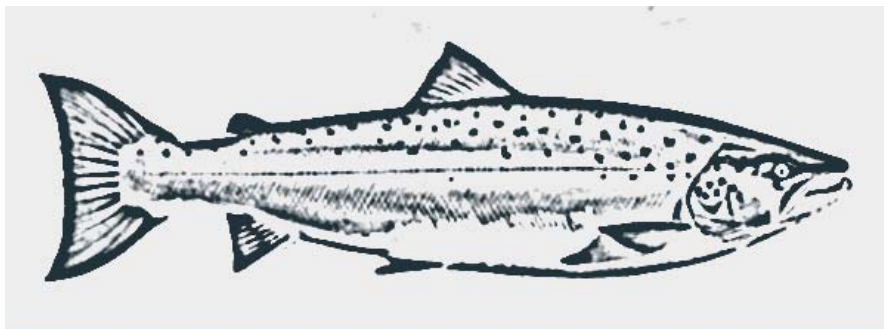


Figure 1.3.2 Return rate of 2SW adults by cohort of hatchery-reared Atlantic salmon smolts released into the Penobscot River (solid line) and wild smolt emigration estimated on the Narraguagus River (dashed line), Maine, USA.



2.0 Status of Stocks

US Atlantic salmon populations are assessed by the US Atlantic Salmon Assessment Committee (USASAC), a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Currently population status of salmon is determined by counting returning adults either directly, at traps and weirs, or indirectly using redd surveys. Total returns also include retained fish from angling in other regions and historical US time series also include these data. Some mortality can and does occur between trap counts and actual spawning – the actual number of spawners is termed spawning escapement and is not estimated for US populations, though redd counts provide a reasonable proxy for some rivers. Fisheries impact escapement as well but since the mid-1990's, most open fisheries were limited to catch and release and because this mortality is lower than retention fisheries impacts on returns or escapement would be lower. The USASAC is starting to develop metrics to examine juvenile production in addition to adult metrics and this report is an initial step in this process with summary data, largely graphical, for large parr and smolts.

A unique element of Atlantic salmon populations in New England is the dependence on hatcheries. Since most US salmon are products of stocking, it is important to understand the magnitude of these inputs to understand salmon assessment results. US Atlantic salmon hatcheries are operated by the US Fish and Wildlife Service and state agencies. Hatchery programs in the US take two general forms; 1) conservation hatcheries that produce fish from remnant local stocks within a stock complex and stock them into natal rivers or 2) restoration hatcheries that produce salmon from broodstock established from donor populations outside their native stock complex. Hatchery programs for the Gulf of Maine DPS are conservation hatcheries. All other New England hatcheries are restoration hatcheries. These restoration hatcheries developed broodstock primarily from donor stocks of Penobscot River origin. Most fish stocked in Long Island Sound programs are progeny of domestic broodstock from fish that returned there allowing system-specific selection; the majority of fish reared are progeny of fish that completed their life cycle in this region for 3 or more generations. A portion of the Central New England stock complex was supplemented by Penobscot River origin smolts as recently as 2007 but current management plans are region-specific and all stocked fish will be from local returns to facilitate selection for local river and marine migration conditions.

A total of 12.5 million juvenile salmon were stocked in 2008 across 15 river systems, a number typical of the decade. Fry stocking dominates numerically (92%) with 12.1 million stocked; fry were used in all systems stocked. Six river systems were stocked with parr and five with smolts. Managers stocked around 662,000 age-1 smolts in US waters with 513,000 of them stocked in the Penobscot River. This total and the percentage stocked in the Penobscot River are typical for the last decade. Penobscot River smolts consistently produce over 70% of the adult salmon returns to the US. Cost and logistical issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits at the juvenile stage and naturally-reared smolts typically have a higher marine survival rate than hatchery smolts. From a hatchery perspective, rebuilding Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems that successfully reach the

ocean and using hatchery production to optimally maintain population diversity, distribution, and abundance. However, survival at sea is a dominant factor constraining stock rebuilding.

The modern time series of salmon returns to US Rivers starts in 1967 (Figure 2.1). Average annual Atlantic salmon returns to US rivers from 1967 to present was 2,173 and the median is 1,670. The time series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figure 2.1). Because many of the populations in southern New England were extirpated and the Penobscot River was at very low levels, the salmon returns graph illustrates the sequential rebuilding of the populations through restoration efforts in the 1970s – with increased abundance first in the Penobscot River then the Merrimack and Connecticut Rivers. The remnant populations of the smaller rivers in the Gulf of Maine DPS and the Penobscot River were the donor material for all rebuilding programs during this time. Unfortunately, the trajectory of this recovery did not continue in the late 1980s and early 1990s. Starting in the early 1990s there was a phase shift in marine survival and an overall reduction in marine survival occurred in all US and most Canadian populations. Average annual Atlantic salmon returns to US rivers from 1991 to present is 1,878 only 86% of the time series average. There has been a downward trend in production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish) that have affected US populations. In addition, recovery from historical impacts was never sufficient so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2008 were 2,614 fish – this ranks 14 out of the 42 year time series and is nearly 1,000 fish above the median and the first year above median since 1998. Relative to the average during the current marine phase (1991-present), returns were 4th highest out of the 18 years. Given consistency in stocking levels and natural smolt production measurements, increased marine survival is thought to be the primary factor in this increase. To gain a better sense of the relative status of the stocks, it is informative to examine target spawning escapements. Because juvenile rearing habitat can be measured or estimated efficiently, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed Conservation Spawning Escapement (CSE). These values have been calculated for US populations and total 29,199 spawners. The average percent of the CSE Target for the time series averaged 7.4% and 2008 was 9.0% of CSE. In the last decade, total returns have accounted for less than 2 percent of this target Long Island Sound and Central New England stock complexes. However, salmon returns to the Gulf of Maine DPS have been as high as 20% of CSE during this period, largely due to hatchery smolt returns to the Penobscot River. In smaller rivers of the Gulf of Maine stock complex CSE ranged from 3-15%. CSE levels are minimal recovery targets since they are based on spawning escapement that could fully seed juvenile habitat. In self-sustaining populations, the number of returns would frequently exceed this amount by 50 to 100 percent allowing for sustainable harvests and buffers against losses between return and spawning. As such, the status of US Atlantic salmon populations is critically low for all stocks, with the remnant populations of the Gulf of Maine stock complex listed as endangered.

Over the past 5 years, the contributions of each stock complex to total US returns averaged: Outer Bay of Fundy (<0.5%), Gulf of Maine (83%), Central New England (7%), and Long Island Sound (9.5%). Returns in 2008 were typical in that the Penobscot River population accounted for the largest percentage 81% of the total return. Overall, 31% of the adult returns to the USA were 1SW salmon and 69% were multi sea winter (MSW) salmon – mostly 2SW fish. From 1967–1985, the ratio of 3SW salmon to 2SW fish averaged 2% and was as high as 7%. However, from 1986 to 2008 this average declined to 0.6% and the highest ratio was only 1.2%. No 3SW fish and only 4 repeat spawners were documented in 2008 returns. Most (84%) returns in 2008 were hatchery smolt origin and the balance (16%) originated from fry or parr stocking and natural reproduction.

Return rates also provide an indicator of marine survival. Previous studies have shown that most of the US stock complexes track each other over longer time series for return rates (our best index of marine survival). For a comprehensive look at return rates throughout New England, a cursory examination of returns from smolt stock cohorts provides the most informative comprehensive assessment of all regions (Figure 2.2). While some subtleties such as age structure of hatchery smolts and subsidies from other larger juvenile stocking such as parr need further analysis this is an informative metric. Median return rates per 10,000 hatchery smolts stocked for the 4 areas are highest in the Gulf of Maine (22.4) and decrease southward for Central New England (7.1) and Long Island Sound (4.2) areas. Return rates for Outer Bay of Fundy stocks (10.8) are intermediate and more variable given lower and more inconsistent stocking numbers and locations.

Maine return rate assessments provide both a return rate for naturally-produced fish (fry stocked or wild spawned) in the Narraguagus River and for Penobscot River hatchery smolts - the longest and least variable in release methods and location (Figure 2.3). Penobscot median return rates per 10,000 smolts from 1969 to 2006 smolt cohorts were 5.0 for 1SW salmon and 26.7 for 2SW fish. More recently, from 1997-2006 smolt cohorts the 2SW rate was 11.1 for the Penobscot. The median return rates for the Narraguagus River smolts during the same period were 72.9 or 6.5 times higher. In 2008 adult return rate for 2SW hatchery smolts released in the Penobscot River was 23.6 ranking 22nd in the 38 year record. While the 2008 return rate for 1SW hatchery grilse was 12.7 ranking 6th in the 39 year record. The overall Penobscot return rate (excluding 3SW fish still at sea) was 28. The return rate in the Narraguagus in 2008 was 71.8 or 3.5 times that observed in the Penobscot. This analysis points out a challenge to salmon recovery – naturally-reared smolts have a better marine survival rate than do hatchery fish but the capacity of rivers to produce adequate numbers of smolts is generally well below replacement rates under current marine survival rates.

Progress was made this year in utilizing the USASAC databases beyond the traditional role of generating summary tables for the annual report; these databases are rich in information that could be used to develop large-scale stock assessment products that cross life-history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary were used to summarize return rates across New England for hatchery smolts (e.g., Figure 2.2). Examination of these data in further detail for such a long time-series could

provide insights into program-specific challenges and more general global trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, will allow development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation given the broad geographic area (186,500 km²) with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people with salmon habitat in cities and remote wilderness. However, taken over a long-time series this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

With the addition of Maine juvenile production data going back 50 years, investigations of the production trends over time and more detailed assessments will be possible. A first step towards investigating juvenile data is graphical comparison of large parr densities throughout the region (Figure 2.5). This time series shows higher densities and variability in Gulf of Maine DPS (5.0) estimates relative to Central New England (2.2) and Long Island Sound (1.8) areas overall, but particularly prior to 1990. Since 1991, these density medians seem to reach a general equilibrium around averages median values of 3.3 (Gulf of Maine DPS), 2.1 (Central New England) and 1.8 for Long Island Sound. Examination of these data relative to other clustering factors such as elevation, temperature, and stocking practices may provide additional insights into management and environmental factors. Another juvenile metric that provides a composite view of freshwater rearing is indices of smolt production. These estimates are relatively limited in New England but two longer time series of data are available and provide a good contrast – the Connecticut River Basinwide estimate and the Narraguagus River smolt assessment (Figure 2.6). The Narraguagus metric is a two site mark-recapture estimate using rotary screw traps that monitors production of fry-stocked fish and naturally-spawned fish. The Connecticut estimate is a composite estimate of late summer electrofishing density data weighted geographically with a standard assumed overwinter survival. Further analysis of smolt population dynamics is done periodically to examine other abundance indices, age distribution, and run timing.

Future research directions include New England wide estimates of average juvenile survival rates from fry stocking. Consolidation of such vital rate information would be of use to both scientists and managers. USASC has streamlined data by more efficient electronic databases and the dedicated work of state and federal biologists to enter and share these data. With this resource and the opportunity of having the region's salmon scientists together to graph and visualize data as well as to analyze and discuss implications provides additional opportunities to use the integrated dataset annually to improve assessment products and management advice. To this last point, the USASAC recognizes they need to provide large-scale and long time-series stock assessment information (provide a yardstick of progress) but understands the need to better communicate information to managers as these analyses identify opportunities and threats (provide rebuilding tools).

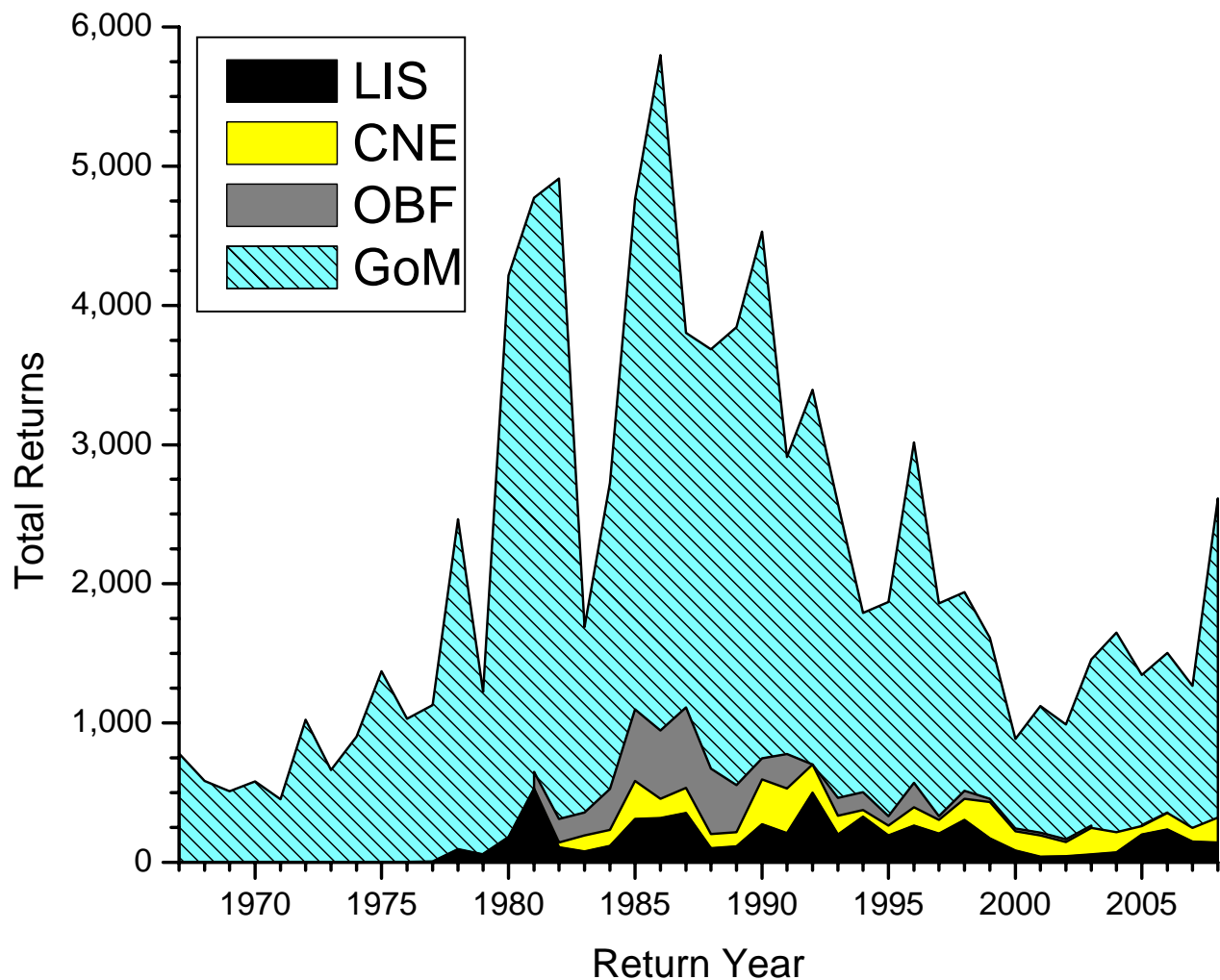


Figure 2.1 Estimated total returns to New England since 1967 from USASAC databases for Outer Bay of Fundy (OBF), Central New England (CNE), and Long Island Sound (LIS) Regions and the Gulf of Maine (GoM) Distinct Population Segment.

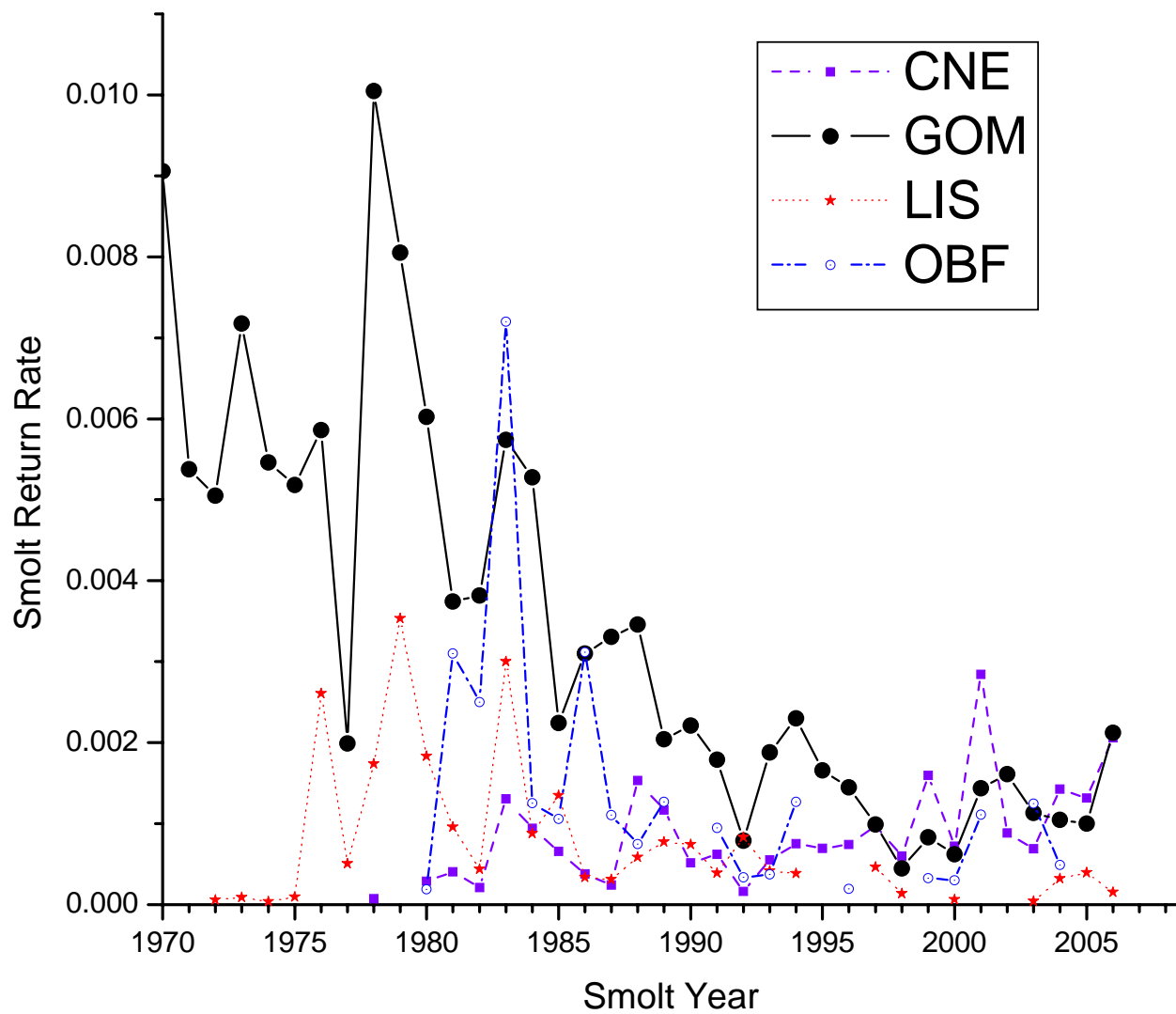


Figure 2.2 Return rates of Atlantic salmon estimated from numbers of stocked smolts and documented hatchery returns in USASAC databases.

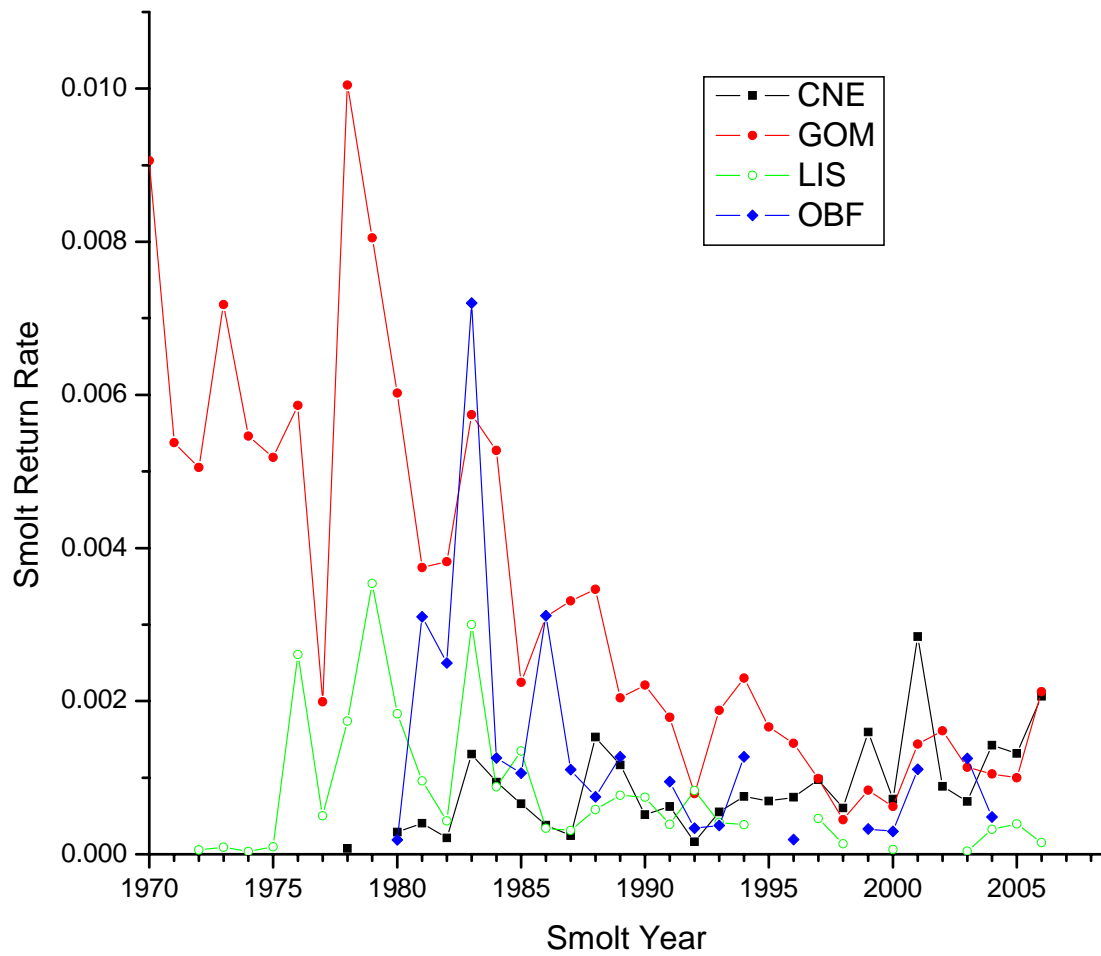


Figure 2.3 Return rates of Atlantic salmon estimated from smolt numbers stocked and documented hatchery returns from USASAC New England databases.

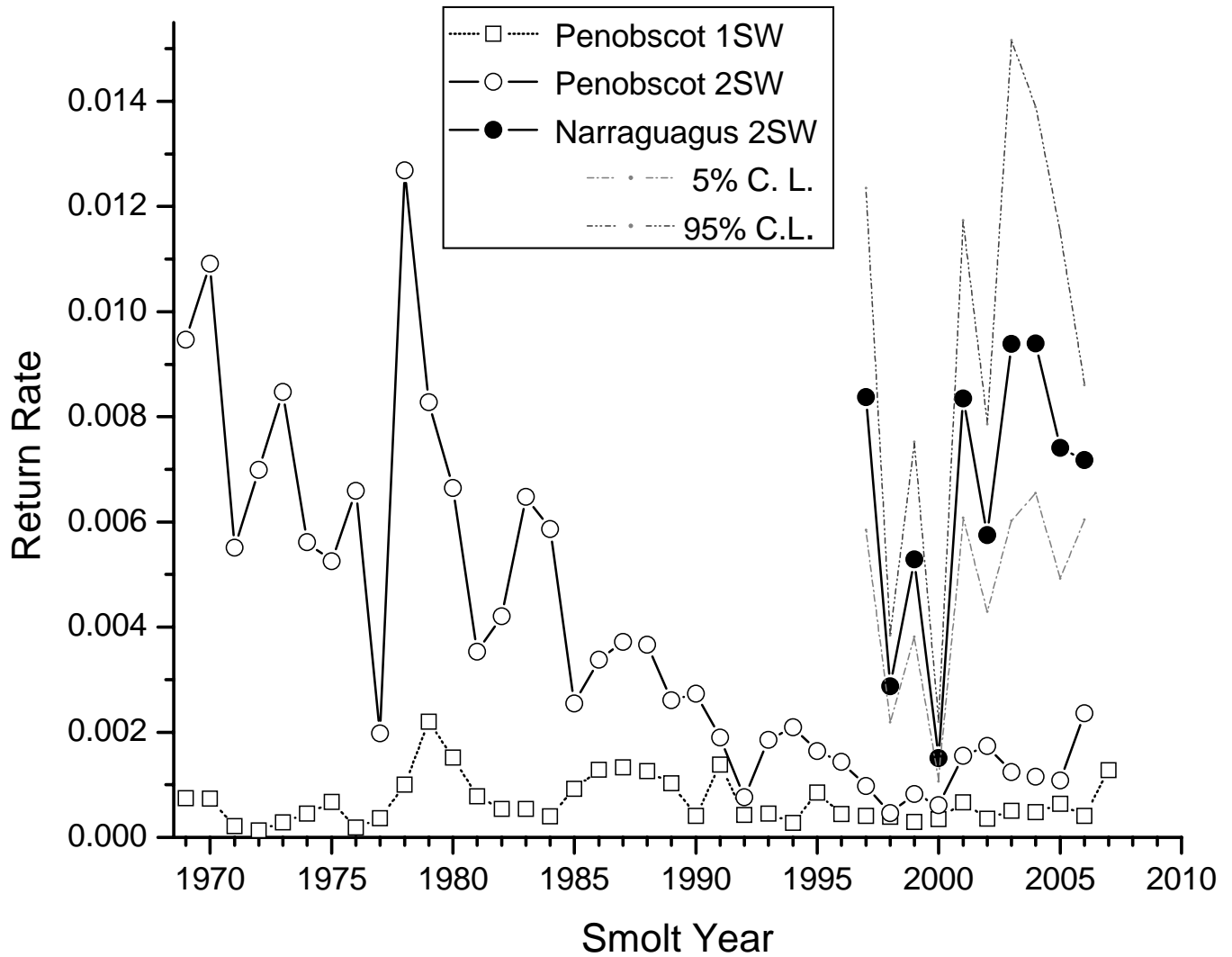


Figure 2.4 Return rates of Atlantic salmon from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

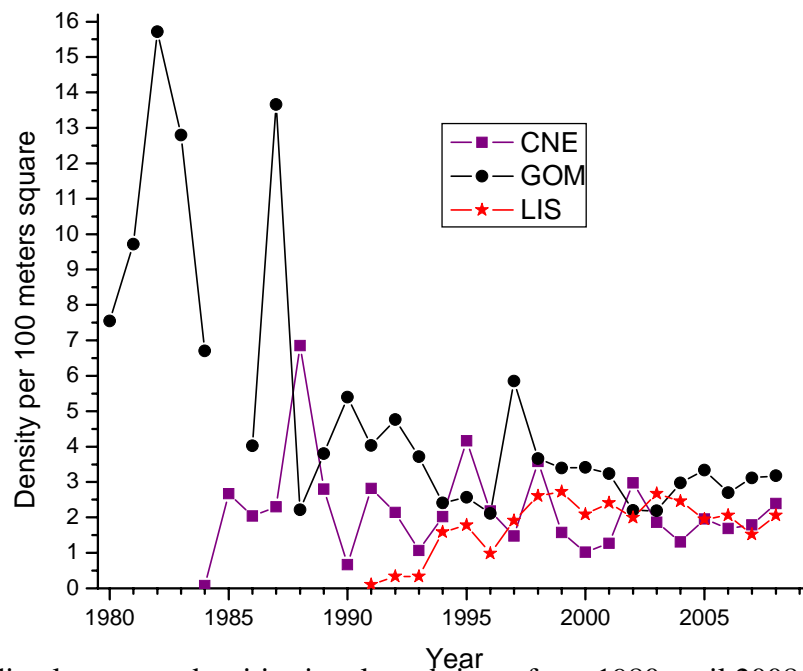


Figure 2.5 Median large parr densities is selected rivers from 1980 until 2008 from USASAC databases for 3 regions: Long Island Sound and Central New England Regions and in the Gulf of Maine DPS.

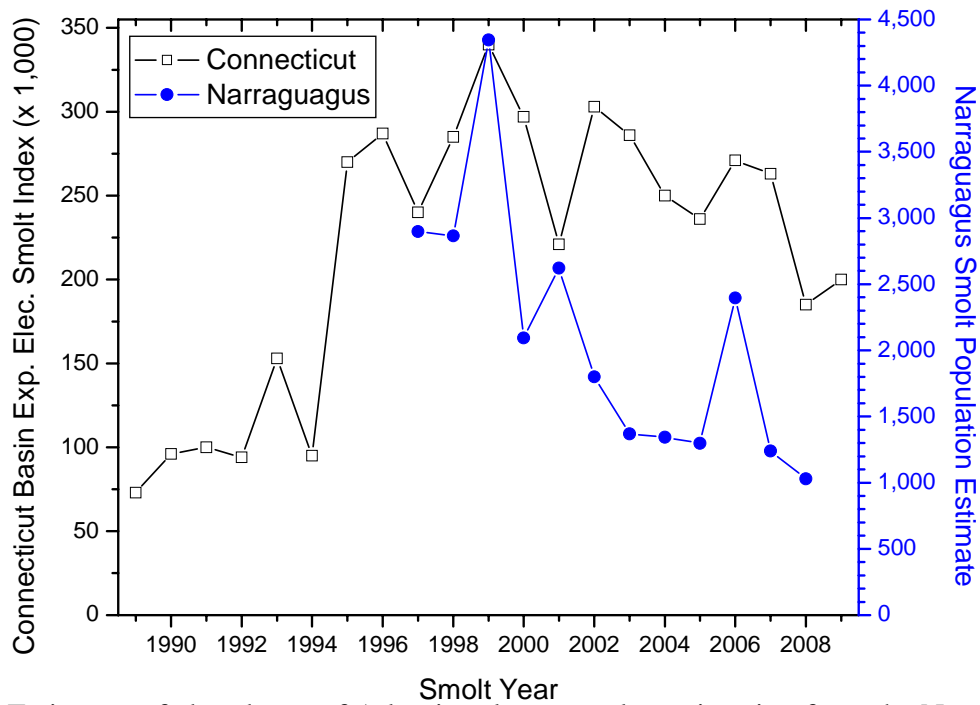


Figure 2.6 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basis in total, see text for details of estimation methods.

3.0 GEOGRAPHICAL SUMMARIES

The historic range of Atlantic salmon in the US has been described in many sources but one of the most recent examinations of historic distribution is Fay et al. 2006. With this more recent understanding of historic population structure as well as current trends in management, a geographical-based organization of the stock-status seems the most appropriate organizational structure. Management throughout New England has out-paced the traditional program summary format since some programs are much more integrated than in the past. This report is now organized geographically from south to north into general management areas: Long Island Sound Area (LIS); Central New England Area (CNE); Gulf of Maine (GoM); and Outer Bay of Fundy (OBoF). These areas are generally outlined in Figure 3.0.1 with the OBoF being delineated for purposes of this report to US boundary waters such as the St. Croix River and US tributaries to the St. John River.

Fay, C., Bartron, M., Craig, S., Hecht, A., Pruden, J., Saunders, R., Sheehan, T., and Trial, J. 2006. Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States. Report to the National Marine Fisheries Service and Wildlife Service.

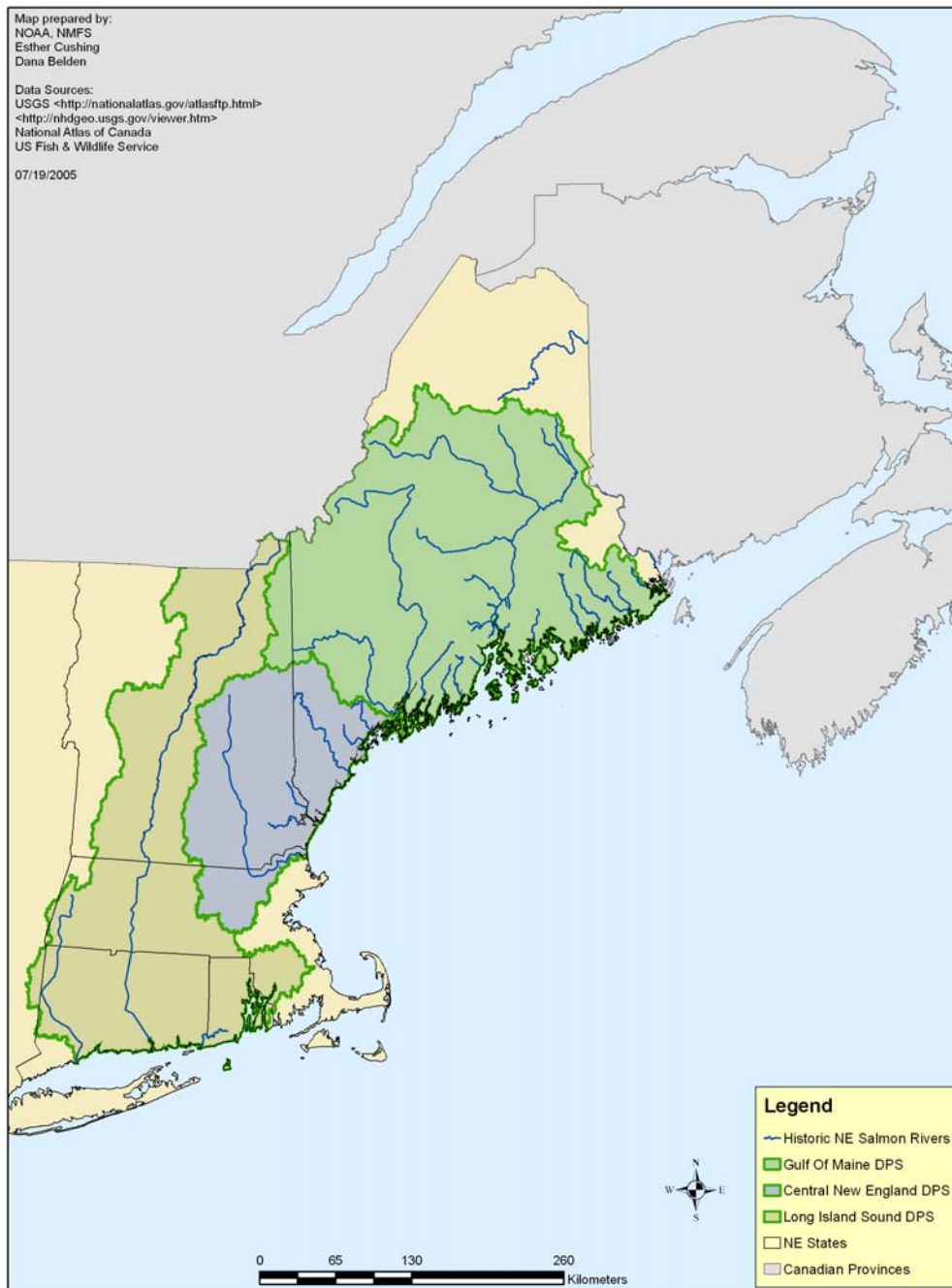


Figure 3.0.1 General map of New England Atlantic Salmon historic population structure.

3.1 Long Island Sound: Connecticut River

Connecticut River Atlantic Salmon Commission (CRASC) partner agencies continued their varied work on diadromous fish restoration in 2008. Below is a summary of work on Atlantic salmon.

3.1.1 Adult Returns

A total of 141 sea-run Atlantic salmon adults were observed returning to the Connecticut River watershed: 82 on the Connecticut River mainstem, 24 in the Farmington River, and 34 in the Westfield River. One salmon was illegally killed by an angler. The spring run lasted from May 6 to July 7. One of the salmon was captured in October. A total of 129 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS). One of the control broodstock, which was not injected with restricted medications, was released after spawning.

Ten salmon were radio-tagged and released above Holyoke and an additional salmon was known to have escaped Holyoke. Of the ten radio-tagged fish, nine passed the Turners Falls fishways and one of these entered the Millers River and one apparently died below Vernon. Seven salmon passed the Vernon and Bellows Falls fishways. One of these entered the Williams River and three entered the White River. Three tagged salmon passed Wilder fishway and all three reached Dodge Falls, which is the first dam without upstream fish passage. One of them eventually entered the Ammonoosuc River passing over a dam lacking fish passage during high water. The untagged Holyoke escape passed all fishways up to and including Wilder.

Seventeen of the returns observed were of hatchery (smolt-stocked) origin. Ten of these were 2SW and seven were grilse. The remaining 124 salmon were of wild (fry-stocked) origin. Sea-age distribution of the wild salmon was three grilse, 118 2SW, one 3SW and two repeat spawners. Freshwater age distribution of wild salmon was 1+ (7%), 2⁺ (88%) and 3⁺ (5%).

3.1.2 Hatchery Operations

The program achieved 72% of egg production goals, 60% of fry stocking goals, and 50% of smolt stocking goals in 2008.

In response to detection of infectious pancreatic necrosis (IPNV) at RCNSS in 2007 and subsequent destruction of all fish and eggs from the station, the USFWS undertook major (\$700K) biosecurity renovations in 2008 to reduce the risk of losing an entire year class again. Four pools were treated as separate units and were equipped with individual equipment and splash barriers to minimize the risk of disease transmission between pools. Egg rearing capacity at RCNSS was established by installation of a chiller, backup power generator, and incubators. A bank of 90 egg jars was installed at RCNSS for incubating families for future broodstock production at White River National Fish Hatchery (WRNFH). Sixteen individually isolated

USASAC Annual Report 2008/21

vertical flow stacks were installed at RCNSS for incubation of eggs for fry stocking and for future broodstock production at Kensington State Salmon Hatchery (KSSH) and Roger Reed State Fish Hatchery (RRSFH). All males, including mature parr, were lethally sampled after spawning and all females had ovarian samples taken for disease testing. The intent was that only eggs from which a parent tested positive in the egg jars would have to be destroyed and only those stacks containing contributions from a suspect parent would have to be destroyed. Many other biosecurity measures were also implemented. Spawning required a crew of about 25 staff supplied by CRASC cooperators to meet biosecurity needs.

All 2008 sea-run returns tested negative for IPNV and eggs for future broodstock were transferred from RCNSS to KSSH and WRNFH after testing. Production sea-run eggs for fry stocking had been intended to remain at RCNSS until stocking, but problems with the newly installed chiller forced their transfer to WRNFH to allow incubation on suitable water temperatures.

A fin condition survey was conducted in February at Pittsford National Fish Hatchery (PNFH) to evaluate smolts prior to stocking in 2008. Based on this evaluation and length measurements, PNFH produced 736 parr (1% of total), 30,725 smolts with fatal fin condition (38%), and 48,308 viable smolts (61%). Parr are those salmon less than 150 mm in total length. Fatal fin condition is defined as severely eroded pectoral or caudal fins. Smolts with fatal fin condition were not included in the stocking database.

A total of 83,000 1+ presmolts is in production at PNFH for stocking in 2009. In October, they were marked with an adipose fin clip and vaccinated with a multivalent vaccine for *Vibrio* and *Aeromonas salmonicida* (furunculosis). The presmolts will be evaluated for size and fin condition prior to stocking.

The USFWS has initiated salmon production at the Berkshire National Fish Hatchery (BNFH). The facility is operated by volunteers supervised by USFWS staff. The first year class of two-year old smolts was stocked in spring 2008. A fin condition survey was conducted prior to stocking. Based on this evaluation and length measurements, BNFH produced 1,690 parr (50% of total), 284 smolts with fatal fin condition (9%), and 1,349 viable smolts (41%). BNFH has 4,300 1+ presmolts in production for stocking in 2009. They were adipose fin clipped and vaccinated in December and their fins will be evaluated before release.

Ongoing budget difficulties prevented planned chiller installation at the Warren State Fish Hatchery (WSFH) operated by NHFG. No Connecticut River fry were produced at WSFH this year and no Connecticut River eggs are currently incubating there.

The nuisance diatom *Didymosphenia geminata* (Didymo) was discovered in the extreme upper Connecticut River mainstem and the White River in 2007. Extensive public education efforts were undertaken in the hope of limiting its spread. The presence of Didymo in the White River at and upstream of the river water intake for WRNFH led to concern that use of river water for egg incubation could lead to the spread of Didymo during fry stocking. Additional chiller

capacity was successfully installed to temper well water to suitable temperatures for fry development in the absence of cold river water for incubation. This will continue for the 2008-2009 incubation season. No additional locations of *Didymo* infestation were discovered in the Connecticut River watershed in 2008.

The discovery in 2008 of an intracellular parasite, *Nucleospora salmonis*, and infestation in hatcheries that had shipped lake trout eggs in previous years to WRNFH led to concern that lake trout and/or salmon broodstock at WRNFH may have become infected. While the parasite apparently is ubiquitous elsewhere in the United States, its status in the Northeast was not known. The Lamar Fish Health Center subsequently utilized PCR (polymerase chain reaction) to screen 350 samples provided by CRASC cooperators from six hatcheries, including WRNFH, and eight stream locations. All were negative for *Nucleospora*. No lake trout eggs were transferred to WRNFH in 2008 from *Nucleospora* positive facilities.

A jaw deformity was noticed in some domestic broodstock at KSSH, RRSFH, and WRNFH. Concern was raised that these so called “shark jaw” or “screamer” fish may have a maladaptive genetic defect. It appears from breeding practices and other data that it is not likely that this deformity is genetic. The Northeast Fishery Center (NEFC) is conducting breeding experiments to fully evaluate its heritability and to examine the effect of dietary phosphorus on the condition.

Egg Collection

A total of 10.8 million green eggs were produced at five state and federal hatcheries within the program. Sea-run broodstock produced 602,000 eggs from 85 females held at the RCNSS. Domestic broodstock produced 9.0 million eggs from 1,633 females held at WRNFH, KSSH, and RRSFH. Kelt broodstock produced 1.2 million eggs from 101 females held at North Attleboro National Fish Hatchery (NANFH).

Egg production continues to remain below production in past years and the program goal of 15 million. Domestic egg production could be increased at WRNFH, but required funding and staff are not available at this time.

3.1.3 Stocking

Juvenile Atlantic Salmon Releases

A total of 6.1 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2008. Totals of 438,000 fed fry and 5.6 million unfed fry were stocked into 41 tributary systems with the assistance of hundreds of volunteers. Totals of 50,000 smolts and 2,400 parr were released into the lower Connecticut River mainstem, the Westfield River, and the Farmington River. Numbers of fry stocked decreased from last year and remain far short of totals stocked in prior years and program goals.

NEFC developed a simulation model using program data to examine the effect of not meeting program egg production goals on adult returns. The model compared predicted adult returns at the program goal (15 million eggs) to the 1994-2007 average production of 12 million eggs. The mean difference between the two production levels is 40 adult salmon returns, but this would be difficult to detect given the high variability in fry return rates.

Surplus Adult Salmon Releases

Domestic broodstock surplus to program needs were made available to the states to create sport fishing opportunities outside the Connecticut River.

3.1.4 Juvenile Population Status

Smolt Monitoring

FirstLight Power Resource Services (FLPRS) and the USFWS contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2008. This was the sixteenth consecutive year that a study has been conducted on the Connecticut River mainstem by marking smolts at the Cabot Station bypass facility at Turners Falls and recapturing them at the bypass facility in the Holyoke Canal. The population estimate was 57,000 (+/- 38,000 95% confidence limits). Low recapture rates resulted in wide confidence limits.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 185,000 smolts were produced in tributaries basin wide. Of these, 145,000 (78%) were produced above Holyoke in 2008. Actual overwinter mortality is unknown and the estimate does not include smolt mortality during migration. Most smolts have to travel long distances and pass multiple dams to reach Holyoke. Recent research in Connecticut River tributaries and Maine suggests that overwinter survival is lower than assumed in the electrofishing smolt estimate.

Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at 225 index stations throughout the watershed. Sampling was conducted by CTDEP, MAFW, NHFG, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production. Densities and growth of parr varied widely throughout the watershed. The basin wide mean stocking density was 44.7 /100m² unit and the mean 0+ parr density was 9.9/unit with a mean first summer survival of 23%. The mean density of 1+ parr was 2.8/unit with a mean survival from stocked fry of 7%. Mean total lengths at capture of 0+ and 1+ parr were 84 and 144 mm, respectively.

Most smolts produced are again expected to be two year olds, with some yearlings and three year olds. The basin wide smolt production estimate for 2009 calculated from expanding electrofishing data from index stations and assumed overwinter survival is 200,000. The estimate is slightly higher than low level of 2008, but lower than the previous 13 years. This is likely due, at least in part, to decreased fry stocking levels.

3.1.5 Fish Passage

Program cooperators continued to work to improve upstream and downstream passage at dams as well as to remove dams to benefit all diadromous fish. Projects that affect salmon are summarized below.

Holyoke Dam- Studies and engineering evaluations continue to make progress towards development of a new downstream passage screen and bypass system for the main Holyoke generating station. The evaluations also will address upstream passage interference caused by the current downstream passage system.

Turners Falls Dam and Northfield Mountain Pumped Storage Plant- These projects were sold by FLPRS to GDF Suez Energy Generation North America. Both projects are scheduled for relicensing in 2018.

Vernon Dam- Installation of replacement turbines that increased hydraulic capacity at this TransCanada dam was completed in 2008. Smolt turbine mortality studies were done on the new units and found 9% 48h mortality, with an additional 5% injury. A radio tagging study is planned for 2009 to determine route selection by smolts with the new flow regime. This project, along with TransCanada projects at Bellows Falls and Wilder, will be relicensed in 2018.

Vermont Yankee Nuclear Power Plant- Entergy continues to seek a 20 year extension to their operating license scheduled to expire in 2012.

Fifteen Mile Falls Project –TransCanada operated the smolt sampler at Moore Dam to continue to collect data on seasonal and diurnal timing and smolt abundance as a precursor to passage facility development at Moore and Comerford. A total of 691 wild smolts was captured and trucked below McIndoes Dam for release, fewer than in the three previous years. TransCanada did a hydraulic modeling study to examine ways to improve passage because modifications are needed to reduce delay and improve efficiency. Flow inducers and guidance net are being considered for implementation in 2009.

Gilman Dam- Designs for downstream fish passage facilities at this upper mainstem Connecticut River dam are being developed and construction is planned for 2009.

Woronoco Dam- A smolt passage telemetry study was done at this Westfield River dam in 2008. Partial depth angled screens were not effective at guiding smolts. A full depth trash rack overlay performed better but additional data is needed.

Deerfield River- A final downstream passage plan was completed for TransCanada dams on the Deerfield involving spill and facility modifications. The upstream passage construction trigger

of radio-tagged adult salmon reaching the first dam was met in 2006. The Agencies and TransCanada are discussing how to proceed.

Fiske Mill Dam- This project was sold which has further delayed fish passage construction. The new owner is examining construction of a denil ladder, rather than a fish lift which the previous owner began constructing.

Homestead Dam (West Swanzey Dam) - Removal of this Ashuelot River dam was delayed again due to further design discussions and coordination with work to protect an upstream historic bridge. Removal is scheduled for 2009.

Townshend Dam (West River) - Improvements are planned to improve attraction flow at this USACE salmon trap and transport facility.

Brockways Mills- Improved temporary downstream passage was in place in 2008, but construction of a permanent facility was again delayed at this Williams River dam.

Slack Dam- A permanent downstream passage facility was operational at this Black River dam for the spring 2008 smolt run.

Small Hydro - Several projects to develop hydroelectric facilities at existing dams are in various stages of consideration on several tributaries including the Farmington, Westfield, West, Black, and Ammonoosuc rivers. These projects will have flow and passage issues for salmon.

Fish Passage Monitoring- Salmonsoft® computer software was again used with lighting and video cameras to monitor passage at Turners Falls, Vernon, Bellows Falls, Wilder, and Rainbow fishways. The software captures and stores video frames only when there is movement in the observation window, which greatly decreases review time while allowing 24h/d passage and monitoring.

3.1.6 Genetics

The USGS Biological Resources Division, through the Conte Anadromous Fish Research Center (CAFRC), again sampled tissue from all sea-run broodstock for genetic monitoring. In cooperation with USGS, microsatellite analysis for broodstock management was completed by the NEFC which will assume this task in the future. The sea-run broodstock were PIT tagged to ensure individual identification at spawning. This information is necessary to develop the mating scheme that is a deliberate effort to mate salmon that are not closely related. It is also used to create known families so the fry can be genetically “marked” for post stocking evaluation and marked families of domestic brood stock can be created. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

Mature male parr, collected from the Sawmill River, supplemented sea-run males. Mating of sea-run females utilized a 3 male: 1 female breeding matrix in which one cross was used for future broodstock production at WRNFH and two crosses were incubated to produce genetically marked fry for stocking and future broodstock for KSSH and RRSFH.

Kelt and kelt/domestic cross origin fry from last year's egg take were stocked in the Williams (246,000) and Sawmill Rivers (55,000) in spring of 2008 for mature parr production due to the lack of sea-run fry due to IPN.

A 1:1 spawning ratio was observed for domestic brood stock spawned at the WRNFH, KSSH, and RRSFH. Prior to 2002, all genetically marked fry were of sea-run origin. Beginning in 1998, genetically identifiable domestic broodstock have been maintained at the WRNFH. In 2001, these fish were spawned and families of domestic eggs were produced with known genetic marks that are stocked in specific tributaries or groups of tributaries for later identification. The resultant fry were stocked in 2002 to expand the marking and program evaluation efforts. This effort is has continued since then. Partial fin clips were taken from 1,500 smolts sampled in downstream bypasses at Rainbow, Cabot Station (Turners Falls Dam) and Holyoke Dam in 2008 for genetic analysis.

Data analysis of the 2004 smolt and 2006 adult tissue samples has been completed for six of the ten regions of fry stocked in 2002. The four regions not yet analyzed were created by a different brood year of sea-runs, which has not been genotyped yet. The results validated hatchery operations and the genetic marking technique. Past attempts to assign the fish to their grandparents (and thus their region of origin) using nine and twenty loci were not successful because of non-unique assignments and genotyping error. The current effort used seven highly variable loci which yielded the best balance between genotyping error and accurate assignments. All regions upstream of Turners Falls Dam contributed to the 2004 smolt run sampled at the dam and all but one contributed to the 2006 adults sampled. Major differences were noted between the smolt contribution of a region and the subsequent adult contribution from the same region. More upstream regions had later smolt run timing but size of smolts was similar among regions. Additional funding is needed to complete the remaining four regions from the 2004 smolts and 2006 adults as well as analyze the 2005-2008 smolt samples and 2007-2008 adult samples already collected and future samples. Ten marked year classes have been created so far and will continue to provide opportunities for sampling through the 2013 smolt and 2015 adult runs.

A CRASC Broodstock Management Plan is being developed to assist genetic management and document practices. A first draft has been completed and is under review.

3.1.7 General Program Information

Ongoing budget difficulties faced by program cooperators have hampered restoration efforts. Additional specific funding to the USFWS for the Connecticut River Program has not been

received since a one time congressional add in 2004. Production goals at USFWS facilities have been maintained at 2004 levels without additional funding increases. A sustained funding increase is required to increase production at USFWS hatcheries. Additional funding is also needed to conduct needed evaluation and research, and to provide fish passage program wide.

The use of salmon egg incubators in school as a tool to teach about salmon, watersheds and conservation continued to expand throughout the basin. The Connecticut River Salmon Association (CRSA), in cooperation with CTDEP conducted their Fish Friends program at schools in Connecticut. Trout Unlimited in cooperation with MADFW carried a similar message to schools in Massachusetts. Several cooperators including CRSA, NHFG, USFS, USFWS, VTFW and the Southern Vermont Natural History Museum cooperatively conducted the program in Vermont and New Hampshire. For the 2008-2009 school years 165 schools participated in this type of salmon education in the four states.

3.1.8 Salmon Habitat Enhancement and Conservation

Program cooperators continued their habitat protection efforts in 2008. The USFS completed three habitat restoration projects on approximately one mile of stream in the Green Mountain National Forest. NHFG, in cooperation with several partners, plans to conduct additional habitat restoration work on Warren Brook, a Cold River tributary, in 2009.



3.2 Long Island Sound: Pawcatuck River

3.2.1 Adult Returns

No Atlantic salmon were captured at the Potter Hill Fishway in 2008.

3.2.2 Hatchery Operations

Egg Collection

Sea-Run Broodstock

The two sea run kelts were spawned in November yielding approximately 12,000 eggs. Milt was provided by the NANFH.

Captive/Domestic Broodstock

We currently have 5, six year old fish and 3, four year old fish of wild origin at the Perryville Hatchery. These were not spawned in 2008.

3.2.3 Stocking

Juvenile Atlantic Salmon Releases

Approximately 312,000 Atlantic salmon fry from the NANFH were stocked into the Pawcatuck River and its tributaries in early May, 2008. The *Salmon in the Classroom* program was responsible for stocking 5,000 fry into the Pawcatuck River and its tributaries.

One year old smolts of domestic origin, totaling approximately 5,900, were raised and fin-clipped at the Arcadia Hatchery. The majority of the smolts were released in late March; these totaled 4,591. Mean length and weight for these smolts were 195.4 mm and 59.0 g, respectively. An additional 1403 smolts were released in late April. When released they averaged 184.5 mm in length and 49.9 g. The majority of the smolts were released at the Westerly Boat Ramp however 1,565 smolts were released at the Westerly Yacht Club which is about 1.6 km downstream from the boat ramp. This location does get a saltwater intrusion from Little Narragansett Bay during high tide. The smolts were stocked at low tide and the salinity during stocking was less than 2 ppt at the surface and bottom of the water column.

Adult Salmon Releases

No adults were released into the Pawcatuck River. Domestic broodstock surplus to Merrimack River program needs were made available to support sport fishing opportunities outside the Pawcatuck River.

3.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were conducted in the fall of 2008 and depletion electrofishing was used to estimate salmon densities. Maximum likelihood estimates of population size were made using the procedures of Van Deventer and Platts (1989). Twelve stations were sampled in September and October.

Parr, 0 years old, ranged in length from 36 mm to 97 mm, with an average of 65.9 mm. Parr, 1 year old, ranged in length from 103 mm to 230 mm, averaging 139.1 mm. Mean lengths in 2008 were higher than those found in 2007 for 0 year old parr and lower for 1 year old parr. Mean densities of 0 year old parr and age 1 year old parr were 2.1 and 0.64 per 100 m², respectively (Tables 2 and 3), a decrease from last year. This decrease, even with an increase (by almost 400%) in fry stocking is most likely due to high water levels and numerous rain events during September and October of 2008, whereas in 2007 water levels in the fall were extremely low and in a drought condition until December.

Smolt Monitoring

No work was conducted on this topic during 2008.

Tagging

All smolts were released with adipose fin clips.

3.2.5 Fish Passage

Problems with upstream fish passage exist at Potter Hill Dam. Although the existing fish ladder seems to work well at normal and low flows, extremely high water levels in early spring can completely flood the ladder, and making access difficult. In addition, broken gates on the opposite side of the dam are creating attraction flow, which draws fish away from the fish ladder. The dam is under private ownership and in 2006 the owner applied for a FERC license to develop hydropower at this location. RIDEM has indicated our desire to be an intervener in the FERC process to ensure that we are allowed a say in any further developments to the dam during this process. Due to the importance of this location to fisheries management in Rhode Island extensive comments were submitted to FERC. The dam owner continues to pursue the hydropower license but has yet to develop and submit a finalized plan to FERC.

3.2.6 Genetics

No genetics samples were collected in 2008.

3.2.7 General Program Information

Fishway reconstruction has been completed at the Bradford Dam, which is the next dam upstream from Potter Hill where the fish trap is located. Initial improvements in the area creating a canoe portage were conducted in 2007. The next phase of the project, which entailed

a redesign of the leaky fishway to make it fully functioning, was completed in the fall of 2008. Plans for fishways at dams located upstream including Horseshoe Falls and Shannock are under development.

3.2.8 Salmon Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2008.



4.1 Central New England: Merrimack River

4.1.1 Adult Returns

One hundred and eighteen sea-run Atlantic salmon returned to the Essex Dam, Lawrence, MA and were captured in the fish lift. Captured salmon were transported to the Nashua National Fish Hatchery, NH (NNFH). Sex determination was made for 118 of the salmon, with 50 (42.4%) being male and 68 (57.6%) female. One hundred and fifteen salmon were spawned, including 49 (42.6%) males and 66 (57.4%) females. Following the results of tests to ensure the absence of pathogens, 66 female salmon were transported to the North Attleboro National Fish Hatchery, MA (NANFH) in February 2009 for reconditioning.

Scales from 118 sea-run Atlantic salmon were analyzed to determine age and origin. Of the 118 sea-run salmon, 83 (70.3%) were of hatchery smolt origin and 35 (29.7%) were of fry origin. Of the 83 hatchery smolt origin salmon, 6 (7.2%) were grilse (1SW) and 77 (92.8%) were two sea-winter fish (2SW). Of the 35 fry origin salmon, five (14.3%) were grilse, 12 (82.9%) were two sea-winter fish, and one (2.9%) was a three sea-winter fish.

In 2008, adult salmon that returned represented three cohorts: 2003 - 2005. The rate of return, per 10,000 fry stocked, increased in the past three years (2001-2004). In these years the return rates were: 0.027, 0.050, 0.142 and 0.207, respectively (Table 4.1.1). Return rates have improved to levels last seen in the mid to late 1990s. However, current return rates are far below the rates observed in the late 1970's to the mid 1980's when returns exceeded one fish per 10,000 fry stocked. Beginning in 1999, fry stocking densities were decreased to approximately half of what had previously been stocked. Concerns had been raised that density dependent factors were contributing to low parr survival and a reduction in sea-run returns.

Also in 2008, adult salmon of hatchery smolt origin represented two cohorts: 2006 - 2007. The rate of return per 1,000 smolts stocked in years 2003-2006 was: 0.87, 1.48, 1.24 and 1.70, respectively (Table 4.1.2). Return rates do not differ markedly from rates of return in previous years.

4.1.2 Hatchery Operations

NANFH shipped a total of 1,210,960 domestic eyed eggs to Warren State Fish Hatchery, NH (WSFH) in two shipments on February 11 and 21. Resulting fry were released in the upper Merrimack River watershed. The hatchery provided 610,763 unfed fry for release in the lower watershed during the period 14 April - 1 May. Genetically marked fry released in the lower watershed consisted of 47% sea-run and 53% kelt progeny.

On 25 January and 8 February eyed eggs (38,161) were shipped to the Green Lake National Fish Hatchery, ME (GLNFH) for smolt production and will be released downstream of Essex Dam as one year old smolts. Eggs were selected at random from

most kelt (5%) and domestic (95%) females to obtain the greatest genetic diversity.

Egg Collection

Sea-Run Broodstock

One hundred and eighteen sea-run Atlantic salmon were trapped at the Essex Dam in 2008 and 66 females and 49 males were held at NNFH. Fish were spawned during the period 17 October - 18 November, and produced 533,369 eggs. All sea-run eggs were kept and incubated at NNFH this year resultant from a decision made to prevent exposing other hatcheries to eggs that could potentially have infectious pathogens from their wild parentage. NNFH achieved 80% eye-up in its first year of significant egg incubation. The 66 females produced an average of 8,081 eggs each. Approximately 49,400 (9.3% of total) eyed eggs were shipped to GLNFH for incubation/smolt production, and approximately 470,800 (88.3% of total) sea-run eggs were retained at NNFH for incubation/fry and subsequent release in the lower watershed. Also, NNFH retained 13,200 (2.5% of the total) sea-run eggs for captive/F1 broodstock production.

Domestic Broodstock

A total of 275 female domestic broodstock spawned at NNFH provided an estimated 1,017,637 eggs in 2008. Of the 275 females, 66 were four-year-old and 209 were three-year-old broodstock, respectively. The domestic broodstock spawning season began on 7 November, ended 29 January, and included 13 spawning events. Approximately 838,536 (82.4 %) eggs from broodstock were shipped to NANFH during the period 7 November to 16 December. Captive/F1 broodstock eggs were also retained at NNFH, and represented 179,101 (17.6%) of the total. Approximately 41,278 (4.1%) eyed eggs were eventually shipped to GLNFH for incubation/smolt production and 137,823 (13.5%) were retained at NNFH for incubation/fry and subsequent release in the upper watershed and for use in educational outreach programs.

NANFH spawned 47 female kelts between 6 November and 24 November. In total, 511,110 eggs were collected from two year classes, including years 2005 and 2006. Eggs were fertilized with milt collected from reconditioned kelts and NNFH domestic broodstock. Domestic males did not produce viable milt until 13 November and it was necessary to use milt from reconditioned kelts multiple times during the season. The kelt spawning season was compressed, and occurred in about 2.5 weeks where 92% (472,592) of eggs were collected in the first week of spawning. Sixty new female kelts (2007 sea-run returns) were received from NNFH on 7 January for reconditioning and none were spawned in 2008.

4.1.3 Stocking

Approximately 1.7 million juvenile Atlantic salmon were released in the Merrimack River watershed during the period April - June. The release included approximately 1,654,000 unfed fry (NANFH), 90,000 yearling smolt (GLNFH - 50,000; NNFH - 40,000); 3,386 under yearling parr and 9,556 yearling parr (NNFH). This year marks the first that all smolts stocked were fish that returned to the Merrimack (sea-run returns or kelts) or

captive broodstock progeny of sea-run returns initiating a region-specific stock origin program within Central New England that is similar to the Connecticut River. Smolts produced at GLNFH were not marked or tagged, whereas smolts reared at NNFH received an adipose clip prior to release to allow identification of this smolt production method. It is possible to determine the origin of adult returns by analyzing the pattern or signature on the scales of fish. Scale analyses are used to differentiate between fish stocked as fry, parr, or smolts.

All major tributaries upstream from the Nashua River, NH, excluding the Winnepesaukee and Contoocook rivers, were stocked with fry. Numerous small tributaries to the Merrimack River and its principal tributary, the Pemigewasset River, also were stocked with fry. In addition, the 3,386 underyearling parr were released in the Souhegan River, and the 9,556 yearling parr were disbursed equally between the main stem Merrimack River (Concord, NH) and the Piscataquog River watershed.

4.1.4 Juvenile Population Status

All smolts were released into the main stem of the Merrimack River a short distance downstream from the Essex Dam in early April. Smolt stocking has been timed to reduce the potential impacts of predation by striped bass. Bass typically arrive in the estuary and near shore coastal environment proximal to the Merrimack River in mid to late April.

Yearling Fry / Parr Assessment

Since 2003, the number of fall parr sample sites has been reduced from a high of 28 to seven traditional (historic) index sites. The sampling protocol uses the depletion method to estimate the abundance of only yearling parr at sites. Sampling occurs during the late summer and early fall. Sampling at sites is a cooperative effort involving staff from the NHFG, USFS, USFWS, USACOE, members of Trout Unlimited (TU), school groups, the Student Conservation Association (SCA), and numerous volunteers.

The seven index sites, established as early as 1982, provide an extensive time series of yearling parr catch-per-unit effort, relative abundance, and density. The sites include a total of 165.4 units (one unit = 100 m²) of habitat. Sites are located on the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers.

During the period 1994 - 2003 stocking density of fry had been altered at index sites to evaluate population level responses to stocking rates. Stocking densities had generally ranged from 36 to 96 fry/unit among sites, but in recent years, 1999 - 2008, the densities have ranged from 18 to 48 fry/unit among sites. The results of evaluations of yearling parr at sites suggest that past high fry stocking densities had resulted in density dependent factors that may have adversely affected the growth of parr. Given the shift in 1999 to lower stocking densities, parr abundance presented for index sites in Table 4.1.2 are not representative of a standardized stocking effort in years 1994 - 2008.

4.1.5 Impacts of River Obstructions

Approximately 60% of the juvenile production habitat in the Merrimack River watershed is located in the Pemigewasset River watershed, a major headwater tributary. Smolts migrating from this region encounter seven hydroelectric facilities and one earthen flood control dam. Fish passage studies have been conducted at all seven mainstem hydroelectric generating facilities with the most recent studies completed in 2006. Tributaries throughout the watershed also have numerous obstructions impeding the migration of fish with more than 100 dams located in these smaller watersheds.

The number of smolts that successfully exit the Merrimack River and enter the ocean is based in large part on the survival of fish as they pass successive dams. Fishery resource agencies have focused intensively on mitigating impacts associated with fish passing mainstem dams, and as such, have coordinated with the two principle hydroelectric owner/operators of dams that include Northeast Utilities - Public Service Company of New Hampshire (PSNH) [five (5) NH mainstem dams] and Enel North America, Inc. (Enel) [two (2) MA mainstem dams]. Comprehensive fish passage plans identifying necessary measures, implementation schedules, and study criteria have been developed and implemented throughout the last two decades. An annotated list of references identifying fish passage studies to date was compiled and presented at the 2004 stock assessment meeting.

Studies and evaluations of fish passage efficiency and effectiveness at most mainstem and numerous tributary dams have occurred. Studies have demonstrated that smolt mortality occurs at dams due to a variety of reasons (turbine entrainment, passage route, and predation) and that seaward migration is impeded or delayed at dams. Natural water flow regimes, altered during the period of seaward migration due to the presence of dams, can negatively impact migrating smolts. While extensive studies to evaluate smolt passage and survival have been conducted at hydroelectric sites, work continues at both mainstem and tributary dams to improve the effectiveness and efficiency of upstream and downstream passage for salmon and a variety of other fish species.

All returning adult salmon are currently captured at Essex Dam, the first upstream dam from tidewater. The construction of additional upstream fish passage facilities at both mainstem and tributary dams to provide fish access to spawning habitat is not likely in the near term. The number of adult returns has been low and while target fish levels have been identified that require construction of additional fish passage facilities throughout the watershed, they have not been reached so as to trigger the need for construction of upstream fish passage facilities. Fishery resource agencies will continue to consult and coordinate with hydroelectric facility owner/operators and water resource users to construct and improve upstream and downstream fish passage facilities and to improve and ensure the survival of migrating salmon and other fish species.

Upstream and Downstream Fish Passage – Mainstem Dams

At Essex Dam, a new lift assembly including hopper, guide rails, and lifting apparatus was installed in fall of 2004. The completion of this critical modification has minimized delays in upstream migration of numerous fish species including Atlantic salmon. Older facilities had become less reliable and prone to failure and malfunction during the fish passage season. The new facilities were operated and tested in fall 2004 and were fully operational in spring 2005. High flows in 2005 and record floods in 2006 and 2007 decreased fish passage efficiency at the dam. Floods in years 2006 and 2007 halted fish lift operations in spring with near record flows approaching 100,000 cfs at the dam. Continued high water in May and June again precluded efforts to clear the fish lift of debris and limited operation of the lift until the mid and later part of the upstream migration period in 2007. As a result of floods and problems with the fish lift, Enel, owner and operator of facilities at Essex Dam, chose to make improvements to the dam.

The company has replaced wooden flashboards on the crest of the dam with a multiple-operating-zone inflatable system anchored into the present dam crest. Replacement of the existing flashboard system with an inflatable crest gate system provides a number of operational and environmental benefits including: elimination of impoundment drawdown for flashboard replacement; improved control of upstream water levels in both high and low-flow situations; more effective fish passage as flashboard damage and leakage periods, which provide “false fish attraction” to the dam, would be minimized in extent and duration; and enhanced aesthetics associated with advanced water-control technology and decreased trash loading at the dam.

The company has also developed design drawings and specifications for a gate structure that when deployed will protect the entrance gallery of the fish lift from debris loading and damage during periods of high water. Initial design drawings and specifications have been reviewed by fishery resource agencies and it is likely the installation will occur in year 2009.

The operating license for the Merrimack River Project (Amoskeag, Hooksett and Garvins Falls dams - FERC No. 1893) was renewed in May 2007. PSNH completed consultation and reached a settlement with fishery resource agencies regarding future prescriptions for fishway construction at the project. The new license includes fishway prescriptions and other provisions that will benefit a number of fish species. The installation of upstream fish passage facilities at Hooksett and Garvins Falls dams will be required in future years when the target spawning stocks of shad and/or river herring reach designated thresholds. Further assessment of the effectiveness of the Amoskeag Dam fishway in passing shad will also be undertaken.

A similar inflatable crest gate system as that installed at Essex Dam is currently being

installed at the Amoskeag Dam. PSNH determined that this modification would also provide operational and environmental benefits including: elimination of impoundment drawdown for flashboard replacement; improved control of upstream water levels in both high and low-flow situations; minimize the extent and duration of “false fish attraction” to the dam due to leakage; and enhanced aesthetics associated with advanced water-control technology and decreased trash loading at the dam.

PSNH continues to work cooperatively with the USFWS, NHFGD, and USGS by operating the Ayers Island Dam (Pemigewasset River) fish sampler. The company will continue meeting regularly with the state and federal fishery resource agencies to develop fish passage strategies and monitor the progress of fish passage agreements.

4.1.6. Genetics

Funding was secured in 2002 for genetic analyses of sea-run salmon, domestic broodstock, and kelts used in Merrimack River hatchery production programs. Fin samples from all sea-run fish and kelts and a sub-sample of domestic broodstock were obtained and archived for analysis by the USFWS, Northeast Fishery Technology Center. As in previous years, paired matings in the fall of 2008 were tracked by tissue samples with eggs/fry segregated in hatcheries to enable the identification of parent origin and point of initial stocking in defined geographic regions. These regions are primarily partitioned into lower (sea-run parentage fry), middle (kelt parentage fry), and upper watershed (F1/domestic parentage fry).

All fish stocked downstream from Ayers Island Dam (Bristol, NH) located on the Pemigewasset River, a major headwater tributary, are composed of fry from sea-run and kelt parentage and have a genetic signature, whereas those stocked upstream of Ayers Island Dam are not marked. Fin clips are obtained from salmon captured at Essex Dam and the genetic information is used to determine paired matings and also to determine fry stocking location (tributary, river reach/location). Fry origin adult numbers have been low and have not met program expectations. The first genetically marked year class returned in Spring 2007, and at this time results from the genetic marking program are being reviewed by the Merrimack River Technical Committee.

Sea-run fry develop at an earlier date due to the time of spawning which subsequently leads to targeting lower watershed tributaries for this group in early spring. A primary point of interest is whether fry-origin adult returns are occurring from areas in proportion to stocking densities, or if other mechanisms (improved fitness of sea-run fry) or impacts (dams in the upper watershed) are affecting stream reared smolt production and subsequently the proportion of adult returns from these areas. The results of genetic analyses should provide opportunities to better understand genetic relatedness among fish and to subsequently develop improved and refined mating protocols. Genetic analyses of tissue samples for characterization are complete and it is anticipated that results will guide culture and management measures to be implemented in future years.

In 2008 the Merrimack River program began releasing smolts from Merrimack River sea-

run return parentage at the traditional site upriver from tidewater. Based on work conducted by the Northeast Fishery Technology Center and Conte Anadromous Fish Lab and as reported by the Center and Lab, genetic relationships among populations of Merrimack, Connecticut, Penobscot, and Maine Distinct Population Segment (DPS) salmon populations were determined using microsatellite loci to quantify estimates of genetic diversity within and between populations. Results indicate a lower amount of genetic differentiation among the Penobscot, Connecticut, and Merrimack river populations compared to the differences observed among the DPS populations. Slight, but significant genetic differences were observed between the Connecticut and Penobscot River populations, however significant differences were generally not observed between the Merrimack and Penobscot populations. Accordingly, following the establishment of a river-specific broodstock and discontinuation of stocking Penobscot River juveniles, the Connecticut River population has become slightly genetically divergent from the Penobscot stock, although there is a clear indication of recent shared lineage.

Continued directed gene flow, through stocking, of juveniles from the Penobscot River stock into the Merrimack River would likely maintain genetic similarities between these populations. Maintenance of such a similarity may not be desirable if a genetically divergent more robust Merrimack River population is required to achieve the restoration goal, identified as a self sustaining Merrimack River population. Management and restoration goals for the Merrimack River program include river specific stock development, an adaptive fry production/stocking program, and the production of 200,000 smolts. Accordingly, eyed eggs from the Merrimack River program were again shipped to GLNFH for smolt production and subsequent release in the Merrimack River in Spring 2008. Eggs were selected at random from nearly all sea-run, kelt, and domestic females to obtain the greatest genetic diversity. All smolt released into the watershed are now of Merrimack River stock. Parr are a “bonus” by-product of smolt production, and parr (~40,000) excess to the smolt production target of 50,000 at GLNFH are now transferred in fall to the NNFH for winter grow-out. It is anticipated that an estimated 40,000 smolt will again be released into the watershed from NNFH in Spring 2009.

4.1.7 Atlantic Salmon Domestic Broodstock Sport Fishery

The NHFG via a permit system manages an Atlantic salmon broodstock fishery in the mainstem Merrimack River (NH) and a lower portion of the Pemigewasset River. Whereas angled Atlantic salmon required an angler tag for harvest in previous years, rule changes have now eliminated the angler tagging requirement. Creel limits are one fish per day, five fish per season with a minimum length of 15 inches. The season is open all year for taking salmon with a catch and release season from 1 October to 31 March. In Spring 2008, 822 (age 3 and 4) domestic broodstock were released for the fishery. In Fall 2008, an additional 800 (age 2) broodstock were released for a combined total release of 2,372 fish to support the fishery.

For many years anglers had submitted catch and harvest reporting diaries on a voluntary basis. However, in 2006 and 2007, participation in the volunteer reporting program fell below 10% of the total number of anglers that purchased an Atlantic salmon broodstock

permit. A minimum participation level of 10% was determined to be necessary for a meaningful statistical assessment of the fishery, and therefore diaries are no longer be used to monitor the fishery.

The decline in volunteer angler reporting does not appear to indicate a decline in the popularity of the broodstock program. Permit sales have remained steady in recent years, with a slight decrease from 1,446 sold in 2006 to 1,359 in 2007. Data from the 2008 season is not yet available. Permit sales suggest that anglers continue to value this unique opportunity to fish for Atlantic salmon in northern New England. Feedback from anglers has been mostly positive in 2008, with anglers reporting some of the best fishing in years at Sewalls Falls in Concord, NH. Alternative methods of monitoring the broodstock fishery, such as an online angler reporting system, will be investigated in the future.

Broodstock are known to be captured and killed in the fishery for consumption. However, the time series of creel data for this fishery suggests that the majority of anglers practice catch and release. Studies to determine body burden levels of contaminants (primarily PCBs and Dioxins) in broodstock salmon reared at the NNFH were conducted in Spring 2004, and while levels were determined to be elevated, they did not exceed consumption advisory criteria identified by the State of New Hampshire, Department of Environmental Services.

Adopt-A-Salmon Family

The 2008 school year marked the sixteenth year in which the Adopt-A-Salmon Family Program has been providing outreach and education to school groups in ME, NH, and MA in support of Atlantic salmon recovery and restoration efforts. The program is administered by the CNEFRO with support from the NNFH, the Amoskeag Fishways, and a corps of very dedicated volunteers and SCA interns. Most participating schools implement the program throughout the school year with highlights including a visit to NNFH for a ninety minute educational program in November, and incubating salmon eggs in the classroom beginning in January/February for release as fry into the watershed in the late Spring. In February 2008, 36 schools received 13,470 eggs to be reared in classroom incubators. Throughout the winter and spring, eggs were monitored by students until they hatched. In late Spring, fry were released into the Merrimack River watershed. In November 2008, 1,007 students and 67 teachers and parents from 13 schools throughout central New England participated in the educational program at NNFH. During the visit, participants learned about the effects of human impacts on migratory fish and other aquatic species and observed Atlantic salmon spawning demonstrations.

The Amoskeag Fishways Partnership

The Merrimack River Anadromous Fish Restoration Program continued to be represented in The Amoskeag Fishways Partnership [Partnership (www.amoskeagfishways.org)]. Partners that include PSNH, Audubon Society of New Hampshire, NHFG, and the USFWS continue to create and implement award winning environmental education

programs based at the Amoskeag Fishways Learning and Visitors Center (Fishways) in Manchester, NH. With the Merrimack River watershed as a general focus, the partnership is offering educational outreach programming to school groups, teachers, the general public, and other targeted audiences.

Fishways is open throughout the year, offers environmental education programs from pre-school to adult, museum quality exhibits, seasonal underwater viewing windows, family centered special events, live animal programs, and a vacation series for children. Fishways visitation in 2008 was 23,326, including 13,573 students and 9,753 adults. Since its inception Fishways has documented greater than one half-million visitors, and about 7,000 school programs have been delivered to date. School programs taught in 2008 totaled 224 with 99 programs taught offsite. Fishways continues to be an exciting, educational place to attend programs, to see wildlife and fish up-close, and to carry out environmental education and conservation programs. All agencies continue to participate as active members of the Management and Program committees that provide oversight for the Partnership.

The Partnership was formed to create, manage, and oversee educational activities at the Fishways. The four-way collaboration among partners was formed in 1995 to increase visitation to the Fishways by creating new and improved educational programs, expanded year-round hours of operation, and an innovative, hands-on exhibit hall; by strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire; and by broadening the educational focus of the visitor center to encompass more than just the fish passage facility. Grants and contracts awarded to the Fishways were funded by NH Department of Education – Math and Science Partnerships; Twin City Public Television – Dragonfly TV; USEPA, and Lincoln Financial totaling \$28,000.

4.1.8. Salmon Habitat Enhancement and Conservation

Habitat Restoration

In 2008, the multi-agency New Hampshire River Restoration Task Force (NHRRTF) continued to work on identifying dams and fish passage impediments for removal in state waters, as well as pursuing strategic alterations and/or modifications of dams. Merrimack Village Dam, Souhegan River, Merrimack, NH was successfully removed. Work has begun on the Black Brook Dam, Black Brook, and Manchester, NH.

Merrimack Village Dam, Souhegan River, NH

Design, engineering and permitting for the Merrimack Village Dam removal were completed. The project was put out for bid and the dam successfully removed in the late summer. Removal of the dam provides fish access to 14.4 miles of main stem river habitat and five miles of tributary habitat. Funding for the project was provided by Pennichuck Water Works, federal and state agencies, and non-government organizations. The

National Oceanic and Atmospheric Administration, NOAA (Restoration Center), the lead federal agency for the project, continues to fund an ongoing physical parameter study of the dam site that is being conducted by Boston College.

Maxwell Pond Dam, Black Brook, NH

As of the close of 2008, project partners had completed work on the design, engineering and permitting for the Maxwell Pond Dam removal. The project is currently fully funded and all permits have been retained. The pond behind the dam was drawn down in the summer and physical removal of the dam began in February 2009.

Pemigewasset River and Headwater Streams, NH

In the headwaters of the watershed (Pemigewasset River), review continues regarding the removal of a small dam in North Woodstock, NH that would affect juvenile salmon rearing habit. In addition, habitat restoration and protection projects are being coordinated with the staff of the WMNF. One ongoing project involves the use of new temporary bridge technology to protect streams during logging operations. It involves the use of folding bridges that can be quickly installed by a small crew and just as easily removed. One forty-foot bridge has been purchased and is in use. Its effectiveness is being evaluated. Bridges such as this can be used on many timber sales over several years. Plans are in place to purchase two more bridges as funds become available. The second project involves replacing six permanent stream crossings that are currently preventing upstream access to valuable salmon and brook trout habitat. Replacing these crossings will protect downstream habitat and provide access to upstream habitat for salmonids and other aquatic species. Funding has been obtained to replace two of the crossings and funding is being sought to replace the remaining crossings.



Table 4.1.1 Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2005.

Stocking Year	Adult Sea Run Returns: Fry Stocking Origin						Number of Fry Stocked	Return Rate (per 10,000)
	2.1	2.2	2.3	3.1	3.2	Total Returns		
1994	8	45	0	0	1	54	2,816,000	0.192
1995	19	63	0	5	0	87	2,827,000	0.308
1996	4	23	0	0	0	27	1,795,000	0.150
1997	1	3	0	0	0	4	2,000,000	0.020
1998	2	6	0	0	0	8	2,589,000	0.031
1999	1	4	0	0	3	8	1,756,000	0.046
2000	0	11	0	0	0	11	2,217,000	0.050
2001	2	1	0	0	2	5	1,708,000	0.029
2002	0	6	1	0	0	7	1,414,000	0.050
2003	6	12	1	0	0	19	1,335,000	0.142
2004	1	29	-	2	-	32	1,541,500	0.207 est
2005	3	-	-	-	-	-	962,500	-
2006	-	-	-	-	-	-	1,009,325	-
2007	-	-	-	-	-	-	1,140,000	-

Table 4.1.2 Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 - 2007.

Stocking Year	Adult Sea Run Returns				Number of Smolt Stocked	Return Rate (per 1000)
	H1.1	H1.2	H1.3	Total Returns		
1996	9	45	0	54	50,000	1.08
1997	11	65	0	76	52,500	1.45
1998	46	32	0	78	51,900	1.50
1999	26	73	0	99	56,400	1.76
2000	5	17	0	22	52,500	0.42
2001	31	129	2	158	49,500	3.19
2002	12	89	0	101	50,000	2.02
2003	17	25	1	43	49,600	0.87
2004	8	66	0	74	50,000	1.48
2005	10	52	-	62	50,000	1.24
2006	8	77	-	85	50,000	1.70
2007	6	-	-	-	50,000	-
2008	-	-	-	-	50,000	-

Table 4.1.3 Estimated statistics for yearling parr per habitat unit at Index Sites (IS) and sample sites in the Merrimack River watershed, 1994 – 2008.

Sample Site	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Mean	SD	CV
Hubbard		14.1	0.8	3.6	12.8	11.8	2.8	4.9	12.3							7.9	5.4	68
Needleshop			6.1	13.6	5.2	6.4	1.2	1.5	7.6							5.9	4.2	70
Blood								4.8	4.8							4.8	0.0	0
Mid Mad	3.3	2.5					6.7	1.9	7.1							4.3	2.4	57
Smith*	3.3	6.5	7.1	0.9	9.2	4.7	0.9	0.7	2.8	1.0	1.8	2.1	0.9	0.3	5.5	3.2	2.8	88
SB Piscat.*	3.5	2.8	8.7	3.7	5.5	3.4	1.6	2.1	4.1	0.1	1.2	1.2	1.2	2.1	1.2	2.8	2.2	77
USB Baker*	5.5	3.7	2.5	1.2	4.0	3.7	0.5	1.5	4.9							3.1	1.7	56
Stirrup								1.1	4.4							2.8	2.8	85
Stoney*	1.0	3.3	6.7	1.2	8.0	1.2	0.2	0.3	3.0							2.8	2.4	102
Souhegan*	3.1	1.8	4.5	0.1	11.7	0.3	0.5	0.1	1.8	0.9	1.5	0.3	1.7	0.6	2.4	2.1	2.9	141
Pemi Wood.		4.3	1.4	1.6	2.1	2.6	3.0	0.5	5.3							2.6	1.6	61
Pemi Hist*	0.6	8.8	0.5	1.7	1.2	1.4	4.1	1.1	3.5	2.8	4.7	5.5	2.3	2.6	3.6	3.0	2.2	74
Eastman		2.0	1.3	0.8	4.4	1.8	4.6	2.8	2.8							2.5	1.4	54
Lower Mad*	0.6	4.3	1.4	1.8	2.9	3.2	2.5	1.3	3.2							2.4	1.2	50
Beebe*	1.3	1.8	1.8	2.7	3.9	3.0	2.7	1.7	2.1							2.3	0.8	35
U Baker*	1.9	5.5	2.1	0.8	2.4	1.1	1.4	2.5	2.3							2.2	1.4	62
Baker*	1.0	3.2	2.0	1.4	4.3	1.4	0.7	0.8	4.2	1.5	1.3	4.2	2.8	1.7	3.7	2.3	1.3	58
Mid Pemi		5.2	0.7	1.8	1.8	2.6	1.6	1.0	2.3							2.1	1.4	66
Upper Pemi*	2.7	3.3	0.9	0.5	1.6	7.2	0.2	0.2	2.0							2.1	2.2	106
LSB Baker*	3.4	3.4	2.0	1.1	1.7	1.5	0.5	2.0	2.6							2.0	1.0	48
Mad*	1.8	2.9	0.8	1.2	2.4	0.7	3.0	0.9	2.0	2.2	2.1	1.9	1.7	1.7	1.8	1.8	0.7	38
Lower Pemi		3.5	0.3	0.6	1.0	2.7	1.3	0.6	1.9							1.5	1.2	78
U Souhegan	1.3	0.9	6.5	0.3		0.1	0.3	0.1	0.6							1.3	2.2	170
Mid Piscat.	3.4	1.3	0.0	0.0	4.2	0.3	0.0	0.3								1.2	1.7	143
Black	0.5	1.6	1.4	0.5	3.8	1.6	0.0		0.0							1.2	1.2	105
Mill		2.1	0.5	0.3	1.8	1.4	2.2	0.7	0.5							1.2	0.8	66
L. S.B. Piscat.	2.2	0.8			0.4											1.2	0.9	82
Blake	1.6	1.2	0.5													1.1	0.6	50
Beards	0.9	0.5	1.8		3.5	0.4	0.1	0.2	0.9							1.0	1.1	108
Punch								0.3	1.3							0.8	0.7	85
EB Pemi*	1.6	3.4	0.1	0.0	0.1	0.5	0.5	0.0	1.0	1.4	0.3	0.7	0.1	0.4	0.8	0.7	0.9	122
Academy		0.3	0.0													0.1	0.2	141
Select Mean*	2.2	3.9	2.9	1.3	4.2	2.4	1.4	1.1	2.8	1.4	1.8	2.3	1.5	1.3	2.7	2.3	1.9	
SD*	1.4	1.9	2.7	1.0	3.3	1.9	1.2	0.8	1.1	0.9	1.4	1.9	0.9	0.9	1.6	0.8	0.9	
CV*	63	48	92	75	79	82	90	72	38	63	76	84	60	68	61	37	48	

4.2 Central New England: Saco River

4.2.1 Adult Returns

Florida Power and Light currently operate three fish passage-monitoring facilities on the Saco River. The Cataract fish lift, located on the East Channel in Saco and the Denil fishway-sorting facility located on the West Channel in Saco and Biddeford were operational from early May to late October. Sixty-two salmon were observed moving upriver through these facilities. Only visual observations are recorded at Cataract. Thus, the salmon captured at a third passage facility upriver at Skelton Dam in Dayton and Buxton include those observed passing through the Cataract sites as well as those that may have passed without being observed. Fish length is measured, marks noted, and scales taken for fish handled at the Skelton facility. Forty salmon were captured at the Skelton Dam and transported by FPL to the Ossipee River and released. The total returns for the Saco are considered to be 62 salmon; however, due to the possibility of adults ascending Cataract without passing through one of the counting facilities the count could exceed 62. The proportion of wild and hatchery origin salmon, determined from scale samples taken at the Skelton facility, were used to prorate the age and origin for the total run. Of the 62 salmon counted at Cataract, 23 were naturally reared (12-2SW, 8-1SW and 3-3SW) and 39 were hatchery origin (26-2SW, 11-1SW and 2-3SW). Of the naturally reared adults, one was recaptured from a previous season.

4.2.2 Hatchery Operations

Egg Collection

In 2008, 604,000 eggs from domestic broodstock of Penobscot River origin were transferred from Green Lake National Fish Hatchery to the Saco River Salmon Hatchery. A portion of these were distributed to school programs (Fish Friends) and the remaining were reared for stocking as fry.

4.2.3 Stocking

Juvenile Atlantic Salmon Releases

A total of 357,700 fry were stocked throughout the Saco River system, primarily in moderate sized tributaries by volunteers from the Saco River Salmon Hatchery. In addition, 9,100 0+ parr from North Attleboro National Fish Hatchery were stocked into the Saco River.

Adult Salmon Releases

No adult Atlantic salmon were stocked into the Saco River.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

One CPUE survey was conducted on a new stocking stream. No 0+ juveniles were captured.

Smolt Monitoring

Tagging

4.2.5 Fish Passage

On August 26, 2008 a new license was issued from the Federal Energy Regulatory Commission to Florida Power and Light Energy (FPLE) for the Bar Mill hydro project located on the Saco River. The issuance of the license initiated an agreement reached between Saco River stakeholders and FPLE. The Saco River Fisheries Assessment Agreement outlines numerous restoration activities along with upstream and downstream passage timing and funding for anadromous fish restoration. One fund is currently being set up to enhance Atlantic salmon adult returns to the Saco River. Both the Maine Department of Marine Resources and the U.S. Fish & Wildlife are developing a memorandum of understanding to use a portion of the funds for rearing smolts. The first smolt release is expected in 2009.

4.2.6 Genetics

Forty genetic samples were collected in 2008. The samples were taken from sea-run adult returns captured at the Skelton Dam passage facility. All tissue samples were preserved in 95% ethanol.

4.2.7 General Program Information

4.2.8 Salmon Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2008.

5.1 Gulf of Maine

5.1.1 Adult Returns

Adult Atlantic salmon returns reported for the Gulf of Maine DPS as proposed in 73 FR 51415-51436 are the sum of counts at fishways and weirs and estimates from redd surveys. No fish returned “to the rod”, because with the exception of a one-month catch and release season on a portion of the Penobscot River, angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Narraguagus, Penobscot, Kennebec, and Union rivers, and at a semi-permanent weir on the Dennys River. Fall conditions were suitable for adult dispersal throughout the rivers, and conditions allowed redd counting.

Because there was no rod catch, the number of spawners was assumed to equal returns plus released pre-spawn captive broodstock. In 2008, pre-spawn captive broodstock were stocked in the Kennebec, Sheepscot, East Machias and Machias Rivers, and in Hobart Stream. These 433 fish will be included in spawner numbers forwarded to ICES because the number of ripe fish was known and their reproductive capacity may be comparable to returning 2SW females.

Small Coastal Rivers

Dennys River. The Dennys River weir trap was operated from 14 May, 2008 to 6 November, 2008. We captured one two sea-winter female from smolt stocking (identified by scale reading), one female and five male two sea-winter fish, and one grilse. One captured two sea-winter male died in the trap on 26 July, 2008. No suspected aquaculture escapees were captured in 2008.

Three redds were observed on the Dennys River during surveys covering approximately 27 % of spawning identified in the habitat database (spawning area surveyed/total spawning area) and 60.7% of length of river containing spawning habitat (surveyed river length/total river length with spawning habitat).

East Machias River. Fourteen redds attributed to wild returns were counted during redd surveys in 2008 in Northern Stream and the East Machias River that included approximately 70 % of known spawning habitat area (33% length). An additional 20 redds were located in Chase Mill Stream where 72 pre-spawn captive reared adults from CBNFH were stocked.

Machias River. We counted a total of 74 redds, covering approximately 85 % of the spawning habitat area (25% length) in the Machias drainage. Eighteen of these redds were likely created by the 68 pre-spawn adult captive broodstock stocked in Mopang Stream, at the outlet of Second Mopang Lake. The remaining 58 redds were in different tributaries and likely from wild returns.

Pleasant River. No redds were found in the Pleasant River in 2008 during surveys of about 42% of spawning habitat area (30% length).

Narraguagus River. Bureau of Sea Run Fisheries and Habitat (BSRFH) staff operated the Narraguagus fishway trap from 28 April, 2008 to 28 October, 2008. We captured 14 two sea-winter fish, four grilse, one three sea-winter salmon, one repeat spawner, and three captive broodstock released in autumn 2007. Three salmon were observed ascending the spillway on video resulting in 23 returns and an escapement of 25. One of the two sea-winter salmon died in the trap on 8 July, 2008; it was observed on underwater camera video entering the fish trap roughly an hour after the daily tend and was discovered dead the next day by BSRFH staff. Temperature exceeded 25 degrees Celsius for over 16 hours while the fish was in the trap. To prevent future mortalities at the trap, our protocols have been changed to a minimum of two tends per day (morning and afternoon) for the month of July.

In 2008, a total of 37 redds were counted during surveys by canoe and foot covering approximately 98% of spawning habitat area (63% length).

Ducktrap River. Thirteen redds were observed during surveys in late November that encompassed 35% of the spawning habitat area in the Ducktrap River watershed (37% length).

Sheepscot River. The river was surveyed on five dates, focusing on spawning habitat in the upper portion of the mainstem and West Branch. Eighteen redds were attributed to sea-run returns and five redds were attributed to the 61 adults stocked pre-spawn adults from CBNFH. Surveys encompassed 19% of spawning habitat by area and 39% by linear distance.

Cove Brook. No spawning activity was found in Cove Brook during redd surveys in mid and late November 2008 that included 100% of identified Atlantic salmon spawning habitat in the system. This year was the eighth consecutive year where no Atlantic salmon spawning activity was detected, despite repeated and extensive searches annually.

Total Returns to small coastal rivers.

Scientists estimate the total number of returning salmon to small coastal rivers using capture data on rivers with trapping facilities (Dennys, Pleasant, and Narraguagus Rivers) combined with redd count data from five additional rivers. Estimated returns are extrapolated from redd count data using a return-redd regression [$\ln(\text{returns}) = 0.5699 \ln(\text{redd count}) + 1.3945$] based on redd and adult counts from 1991-2005 on the Narraguagus River, Dennys River and Pleasant River (USASAC 2006). Total estimated return for the DPS was 138 (90% CI = 106 - 178) (Table 5.1.1.2).

Table 5.1.1.2 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2008.

Year	LCI	Mean	UCI
1991	235	294	366
1992	200	247	307
1993	222	261	315
1994	154	192	239
1995	131	162	200
1996	229	284	348
1997	131	164	207
1998	154	200	259
1999	138	175	222
2000	79	100	127
2001	90	107	120
2002	28	37	48
2003	62	76	96
2004	60	83	113
2005	44	71	111
2006	49	79	122
2007	39	59	72
2008	106	138	178

Large Rivers

Penobscot River. The total return to the Penobscot River was 2,117 salmon, which includes 2,115 sea-run salmon captured at the Veazie fishway trap and two dead salmon observed (one on Kenduskeag Stream and one on the Penobscot River below Veazie) during 2008. Of the 1,465 released salmon back to the river (402 females, 377 males, and 686 grilse (one sea winter, 1SW)), 173 were recaptured once after dropping downstream over the dam and ascending the fishway for a second time, 12 ascended the fishway a third time and one ascended the fishway a fourth time. This year's total catch represents an increase of 1,199 fish from the 2007 (916 sea-run salmon) and is the highest trap catch since 1992. Seven hundred and thirty two (35%) were 1SW fish. The percentage of 1SW fish fluctuates yearly, and while this years rate is above the 15 year mean (~25%), it is within the normal range observed (11% - 48%). The median capture date was June 26, three days later than in 2007, still a week earlier than what was observed in the late 1980's and early 1990's.

Brookfield Power operated the Weldon fishway, Penobscot River in Mattawamkeag from 10 June 2008 through the end of October. The trap captured 216 salmon migrating into the East Branch of the Penobscot River. This year the number handled at the Weldon Trap and released upriver (106 multi-sea winter fish and 110 grilse) was 156 more than in 2007 and 175 more than in 2006.

In 2006 and 2007, marked smolts were stocked below Great Works Dam, Penobscot River, Maine. Each year three groups received an identifying visible implant elastomer (VIE) and an adipose fin clip (AC). The primary purpose of these marked groups was to have an index of marine survival, with three pseudo-replicates to estimate the variance associated with the return rate. In 2007, 65 1SW adults with detectable VIEs returned to the adult collection trap, Penobscot River, Veazie, Maine. In 2008, 387 1SW and 2SW adults with detectable VIEs returned to the adult trap. The return rate per 10,000 smolts stocked was similar among groups within cohorts (Table 5.1.1.3). Returns per cohort averaged 18.33 ± 1.57 for the 2006 cohort (1SW and 2SW) and returns for the 2007 cohort (1SW) averaged 9.62 ± 2.08 (Mean \pm 1 standard deviations; Table 5.1.1.4). The percent coefficient of variation (CV) for the 2006 cohort was 8.59% and for 2007 cohort was 21.58%. The increased variation for the 2007 cohort is, in part, because only 1SW fish have returned. It seems reasonable to expect that variation associated with total return rate for a cohort will be less than 10%.

Table 5.1.1.3 Return rates for marked smolts (by auxiliary and individual VIE mark) released below Great Works Dam, Penobscot River, Maine in 2006 and 2007.

Smolt Cohort		1SW	2SW	Total	Number	Return	Return Rate
Year	Mark Observed	Returns	Returns	Returns	Stocked	Rate	per 10,000
2006	Adipose Clip	73	335	408	169066	0.0024	24.13
2005	EyeLeft VIE Green	19	82	101	56156	0.0018	17.99
2006	EyeRight VIE Green	25	89	114	56870	0.0020	20.05
2006	EyeRight VIE Red	21	74	95	56040	0.0017	16.95
2007	Adipose Clip	203	--	203	147619	0.0014	13.75
2007	EyeLeft VIE Green	56	--	56	49219	0.0011	11.38
2007	EyeRight VIE Green	36	--	36	49122	0.0007	7.33
2007	EyeRight VIE Red	50	--	50	49278	0.0010	10.15

Table 5.1.1.4 Average return rates (per 10,000) for VIE marked smolts stocked below Great Works Dam, Penobscot River, Maine in 2006 and 2007.

Year	Mark Observed	Average Return Rate per 10,000	Standard Deviation	Coefficient of Variation (%)
2006	VIE	19.78	3.17	16.04
2007	VIE	9.62	2.08	21.58

In 2008, 42 salmon stocked as marked autumn parr (0+ from GLNFH) in the Pleasant River returned to Veazie. Of the 42 returns, five were 1SW with adipose and left ventral clips, one was a 1SW with an LV clip (2006 stocking cohort), and 36 were 2SW with left ventral clips (2004 or 2005 stocking cohort). Returns were from three stockings years (2004-2006) because fall parr can spend 8, 20, or possible 32 months in freshwater before migrating to sea.

Androscoggin River. BSRFH operated the fishway trap on the Androscoggin River in Brunswick from early May until 26 September 2008. A total of 16 sea-run Atlantic salmon were trapped and passed upstream. Of the 16 adults, three were naturally reared (2-2SW, 1-1SW) and 13 were of hatchery origin (4-2SW, 8-1SW).

Kennebec River. Florida Power and Light (FPL) started operated the fish lift at the Lockwood Project in Waterville from early May 2008 until the end of October. In cooperation with FPL, BSRFH transported all captured salmon upstream of the four upriver dams and released them into the Sandy River, a tributary to the Kennebec River. In this third season of operation, 21 salmon were captured and successfully moved to the Sandy River. One in-season recaptured salmon was also transported to the Sandy River. Scale samples indicate 13 of the returns were of hatchery origin (7-2SW, 6-1SW) and 8 were naturally reared (8-2SW).

Union River. No Atlantic salmon were captured at the fishway trap operated by Pennsylvania Power and Light on the Union River in Ellsworth below Graham Lake. This year the fishway was operated from approximately May 14th through June 22nd and again from June 26th to August 14th. The trap and lift was not operated during the fall because of penstock maintenance.

5.1.2 Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 6.7 million eggs (as compared to 7.4 million in 2007) for the Maine program in November 2008. 2.5 million eggs from Penobscot sea-run broodstock; 2.8 million eggs from six captive broodstock populations; and 1.4 million eggs from Penobscot domestic broodstock were obtained.). At CBNFH 595 sea-run fish were successfully spawned. These included 297 females, and 298 males. Grilse comprised 50 of these males (17%). Spawning protocols for river specific DPS broodstock continued to give priority to first time spawners and utilized 1:1 paired matings. Spawning protocols for Penobscot sea run broodstock also continue to utilize 1:1 paired matings. The Pleasant River pedigree line is composed of genetically selected broodstock reared entirely at hatchery. This pedigree line was spawned for the fourth time at CBNFH in 2008.

Mean daily water temperatures at CBNFH during spawning ranged from 11.0 to 2.8 C and averaged 8.0 C from Nov. 3 to Nov. 24 2008. This is not significantly warmer than last years daily mean water temperature of 7.0 C (range 11.0 to 3.8) over the same time period (t-test P=0.10). The variance between the two years was also not significantly different, 4.7 vs. 3.8 in 2008 vs. 2007, respectively (F-test P=0.31). Mean water temperature and variance during the 2008-09 incubation period (Nov 24 – Feb 24) was significantly cooler, coupled with different ranges of variance from the previous year. 2.4 C, var. 0.4 (2008-09) and 2.7 C, var. 1.4 (2007-08) (t-test p=0.04, F-test <0.01).

Egg Transfers

All three egg sources (sea-run, captive, and domestic) from the 2007 spawning cohort were used for the Salmon-in-Schools (FWS) and Atlantic Salmon Federation Fish Friends programs. Domestic Penobscot eggs from GLNFH 2007 spawners were transferred to: Saco River Hatchery (604,000); and 302,000 to CBNFH for fry supplementation in the Penobscot sub-basin. The Wild Salmon Resource Center, located in Columbia Falls, received approximately 49,000 Pleasant River eyed eggs from CBNFH in 2008.

CBNFH Broodstock Collection

Collection of juvenile Atlantic salmon from six DPS rivers for the captive broodstock program at CBNFH continued in 2008. Juvenile Atlantic salmon are collected annually from their native rivers and brought to CBNFH for rearing. In 2008, 1,104 parr were collected from the following rivers: 155 from the Dennys; 170 East Machias; 257 Machias; 104 Pleasant; 255 Narraguagus; and 163 Sheepscot. No domestic parr were retained at CBNFH from the Dennys and Pleasant River pedigree-domestic lineages (collection occurs every other year). GLNFH retained approximately 1,000 fish from the 2007 year class of sea run Penobscot-strain Atlantic salmon. These fish will be used for F2 domestic egg production at GLNFH for 2-3 years.

During the 2008 trapping season 650 salmon were transported to Craig Brook National Fish Hatchery (CBNFH), three of which were in-season recaptures. All Penobscot River adults captured for broodstock were marked with PIT tags and genetically characterized. In addition, all Penobscot broodstock were sampled for the presence of Infectious Salmon Anemia virus (ISAv) prior to spawning. No ISAv was detected.

5.1.3 Stocking

Progeny produced from sea-run, captive, and domestic broodstock were released into their rivers of origin as eggs, fry, parr, and smolts. In addition, surplus adult broodstock were returned to their river-of-origin.

Overview of Fry Stocking Conditions

Twenty nine fry stocking trips departed CBNFH from May 1 to May 27, 2008 (Table 5.1.3.1). All fry were released by May 19, as compared to May 15 in 2007. River discharge during fry stocking was not significantly different from last year. Overall, the daily discharge to mean daily discharge ratio was 88% (variance 0.16%) in 2008, compared to 90% (variance 0.12%) in 2007 (t-test $P=0.79$, F-test $P=0.23$). Water temperature was not significantly warmer at CBNFH (12.8 C, 2.1 var.) compared to the actual river temperature (12.4 C, 3.5 var.) as measured at the start of the daily stocking trip (paired t-test $P=0.08$). Water temperatures at CBNFH ranged from 8.0 to 15.5 C while river temperatures were 8.0 to 15.5 C over the duration of fry stocking. Fry development as calculated by the Developmental Index (DI) (Kane 1987) ranged from 95-147 during 2008 CBNFH stocking efforts (81-135 in 2007). Because Penobscot

progeny spawn earlier and are stocked later, these fry have consistently higher DI's (111-147) over the captive reared DPS fish (95-120). Overall, mean DI's in 2008 (116) were significantly higher than year 2007 fry releases (105) (t-test $P < 0.01$).

Eggs, Fry, Parr, and Smolt Stocking

During 2008, approximately 4.78 million Atlantic salmon were stocked into rivers of Maine as fertilized eggs, fry, parr and smolts (Table 5). Of this total, fry accounted for 4.01 million (84%) of the life stages stocked. The six rivers in the 2001 geographic range of the GOM DPS and the Penobscot River received 2.0 and 1.3 million fry, respectively. Fry numbers for the other GOM Rivers were as follows: Kennebec (2,800), Androscoggin (1,200), and Union (22,700). Age-1 smolts were stocked into the Penobscot River (512,500), and Narraguagus (54,100). Age-2 smolts were stocked into the Dennys River in 2008 (200). Age 0-parr were stocked in the Penobscot (100,500), Narraguagus rivers (21,000), and Sheepscot (13,000). Age 0⁺ (100) and 1 parr (400) from the CBNFH visitor display pool were stocked into the Machias River. Both eyed (59,400) and green (2,000) eggs were placed into the Kennebec River by BSRFH biologists from eggs taken in year 2007.

Adults

Following spawning, 640 Penobscot sea-run broodstock were released back into the Penobscot River in 2008. No sea-run adults were specifically sacrificed for health screening purposes because requirements were met through incidental mortalities and subsequent routine necropsies as well as sampling of ovarian fluid and milt during spawning. GLNFH released 1,690 excess adults, comprised of four and three year old domestic broodstock, into the Penobscot River. The remaining 5 and 6 year old DPS broodstock at CBNFH were released into their natal rivers: Dennys (147); East Machias (73); Machias (148), Narraguagus (188); and Sheepscot (65).

River-specific broodstock reared at CBNFH are routinely released into their natal rivers based on water constraints at the hatchery, individual contribution of each broodfish to stocked progeny, and the need to maintain adequate numbers of broodstock to meet production and other genetic goals. In 2008, excess broodstock were released pre-spawn to the Sheepscot (11), East Machias (72), and Machias (68). For the second year BSRFH conducted experimental pre-spawn release of gravid adults into Hobart Stream, near Dennysville, ME. The origins of pre-spawn releases into Hobart were Dennys (55), Narraguagus (11), and Pleasant (50). In addition, 106 pre-spawn Penobscot River stock that were transferred from USDA to Cook Aquaculture were released in the Kennebec River.

5.1.4 Juvenile Population Status

BSRFH conducts electrofishing surveys to monitor abundance of Atlantic salmon juveniles using three sampling approaches. The first is to continue estimating density at index sites on each river to maintain a spatial and temporal record of juvenile abundance.

The second method provides a basin-wide population estimate of juvenile salmon (BGEST). The third is a catch per unit effort (CPUE) method based on standardized wand sweeping protocols for a specified time period, typically 300 seconds of wand time.



Example of electrofishing technique being employed on Sedgeunkedunk Stream, a tributary to the Penobscot River.

Table 5.1.2.1 Fry development index (DI) and environmental conditions for stocking events from CBNFH in 2008.

River - Trip	Date (2008)	D.I. For Group		Temperature (C)		Discharge			
		Min	Max	CBNFH	River	Day (CFS)	Mean (CFS)	% Mean Flow	USGS Gage Number
Dennys-1	5-May	99	113	10.6	10.5	170	320	53%	1021200
Dennys-2	6-May	95	100	11.3	11.6	164	304	54%	1021200
East Machias-1	7-May	100	113	12.4	14.4				
East Machias-2	8-May	101	101	13.2	12.5				
Machias-1	9-May	107	112	13	12.7	1,410	1,880	75%	1021500
Machias-2	12-May	107	112	12.9	12	1,140	1,750	65%	1021500
Machias-3	13-May	108	108	12.9	12.5	1,050	1,750	60%	1021500
Machias-4	14-May	110	110	13.2	11.5	957	1,740	55%	1021500
Machias-5	16-May	113	113	14.8	15	819	1,620	51%	1021500
Machias-6	19-May	117	120	15.7	15.3	866	1,560	56%	1021500
Narraguagus-1	5-May	104	113	10.6		898	787	114%	1022500
Narraguagus-2	6-May	105	105	11.3	10.5	784	734	107%	1022500
Narraguagus-3	7-May	101	101	12.4	14	689	710	97%	1022500
Narraguagus-4	8-May	103	108	13.2	11.2	614	712	86%	1022500
Narraguagus-5	9-May	100	104	13	13	600	696	86%	1022500
Pleasant-1	1-May	97	105	10.6	9.8	355	250	142%	1022260
Pleasant-2	2-May	99	99	10.6	8	442	240	184%	1022260
Sheepscot-1	8-May	106	110	13.2	15.5	743	397	187%	1038000
Sheepscot-2	12-May	107	112	12.9	14	433	369	117%	1038000
Sheepscot-3	16-May	111	114	14.8		281	330	85%	1038000
East Branch Penob- 1	14-May	128	128	13.2	13	771	545	141%	1029200
East Branch Penob- 2	21-May	138	141	10.8	10	480	463	104%	1029500
East Branch Penob- 3	22-May	131	139	12.7		460	443	104%	1029500
East Branch Penob- 4	27-May	138	147	13.8	11	320	375	85%	1029500
Mattawamkeag-1	15-May	111	118	14.6	13	3,320	5,360	62%	1030500
Piscataquis Penob-1	12-May	131	131	12.9	11	558	1,280	44%	1031500
Piscataquis Penob-2	13-May	126	133	12.9	13	481	1,310	37%	1031500
Piscataquis Penob-3	19-May	138	138	15.7	14	67	263	25%	1031450
Penobscot-1	20-May	140	140	13.7		13,400	20,700	65%	1034500

Fish abundance is presented as fish per unit, where one unit equals 100 m² and relative abundance (CPUE) is presented in fish/minute. Data for 2007 were added to the USASAC Juvenile Salmon database.

BSRFH estimated parr and/or YOY density 65 sites (Table 5.1.4.1). BSRFH also determined relative abundance at 50 sites (6 not reported because efficiencies were low) using the CPUE method (Table 5.1.4.2). An additional 27 sites were visited to determine presence and absence of juvenile salmon. Special projects included: CPUE assessment of stocking in the Pleasant River in the Penobscot drainage. Juvenile densities and CPUE varied considerably among sites in Maine rivers in 2008 (Table 5.1.4.1 and 5.1.4.2). Further, University of Maine and EPA projects provided relative abundance data at approximately 75 sites. These data will be included in the database during the winter of 2009.

Table 5.1.4.1 Minimum (min), median, and maximum (max) large parr Atlantic salmon population densities (fish/100m²) based on multiple pass electrofishing estimates in selected Maine Rivers, 2008.

Drainage	Min	Median	Max	N
Dennys	0.42	2.68	7.26	7
East Machias	1.51	4.19	11.29	6
Machias	0.32	3.88	10.79	11
Narraguagus	1.58	3.74	9.84	11
Pleasant	0.57	3.46	20.05	4
Kennebec	2.33	3.13	3.92	2
Sheepscot	0.00	1.08	21.65	13
Ducktrap	0.00	0.53	0.54	3
Penobscot	0.74	9.51	17.75	8

Table 5.1.4.2 Minimum (min), median, and maximum (max) relative abundance of large parr Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2008.

Drainage	Min	Median	Max	N
Machias	0.00	0.00	0.00	6
Narraguagus	0.75	0.87	1.00	2
Lower Kennebec	0.00	0.39	0.60	7
Ducktrap	0.00	0.00	0.00	1
Penobscot	0.00	0.00	0.00	12
Penobscot/Piscataquis	0.00	0.00	0.59	16

Basinwide Estimates of Large Parr Abundance

Assessment scientists have data to estimate the basinwide production of large Atlantic salmon parr (>1+ fish) using a habitat-based stratification method for the Narraguagus River (1991-2006), the Dennys River (2001-2005), and the Sheepscot River (2003 - 2006). This method uses ecological and geographical data to develop spatially discrete habitat-based strata that minimize differences within strata and maximize differences

between strata (J.F. Kocik, NOAA Fisheries Personal Communication). Following discussions at last years USASAC meeting, parr abundance data were used to calculate revised estimates from the BGEST model and produce a time series of basin-wide large parr (ages 1+ and 2+) population estimates (Table 5.1.4.3).

Table 5.1.4.3 Time series of basin large parr estimates for the Narraguagus River (1991-2006), the Dennys River (2001-2005), and the Sheepscot River (2003 - 2006), with number of sites (n), total catch of parr estimate variance, and 95 % CI.

Year	n	Total Catch	95% LCI	Estimate	95% UCI	Variance
Narraguagus						
1990	8	144	8,605	14,092	19,579	7,527,955
1991	46	757	7,670	14,978	22,286	13,351,151
1992	63	946	10,094	14,154	18,214	4,121,621
1993	41	1,027	16,454	23,159	29,864	11,240,625
1994	76	680	6,999	8,832	10,665	839,713
1995	31	394	7,584	12,508	17,432	6,061,704
1996	30	660	10,910	13,836	16,762	2,140,727
1997	42	1,212	17,579	24,067	30,555	10,521,918
1998	44	1,052	15,801	20,898	25,995	6,495,171
1999	44	906	10,816	16,329	21,842	7,597,945
2000	39	755	9,102	13,873	18,644	5,690,539
2001	44	631	8,818	12,932	17,046	4,230,333
2002	43	631	7,821	12,088	16,355	4,550,791
2003	43	695	5,676	9,549	13,422	3,750,787
2004	38	754	6,088	10,332	14,576	4,501,976
2005	37	659	11,655	15,963	20,271	4,639,368
2006	39	536	7,980	10,980	13,980	2,249,676
Dennys						
2001	25	276	3,361	4,620	5,879	396,319
2002	25	237	2,233	4,309	6,385	1,077,235
2003	25	325	3,821	5,200	6,579	475,210
2004	25	307	3,572	5,214	6,856	674,239
2005	25	308	3,104	4,953	6,802	854,291
Sheepscot						
2003	26	181	2,809	5,548	8,287	1,876,163
2004	27	114	1,338	2,762	4,186	507,092
2005	27	348	7,342	10,981	14,620	3,310,170
2006	27	276	4,295	8,052	11,809	3,528,203

Smolt Abundance

NOAA-National Marine Fisheries Service (NOAA) and the Maine Bureau of Sea Run Fisheries and Habitat (BSRFH), conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in many of Maine's coastal rivers. Summaries for each river follow.

Narraguagus River. A total of 4,712 smolts was handled, measured and sampled by NOAA staff. Of the 79 scale samples collected from naturally reared smolts, 76 (96.2%) were readable. The smolts had the following age distribution: 4.2% were age 1+, 90.1% were age 2+, and 5.6% were age 3+ (Table 5.1.4.4). Age 2+ smolts averaged 165.0 ± 12.6 mm fork length and 43.8 ± 12.7 g wet weight (Tables 5.1.4.5 and 5.1.4.6 and Figures 5.1.4.1 and 5.1.4.2). The naturally reared smolts were slightly smaller than smolts of previous years. Most of Narraguagus River smolts were of hatchery origin, because approximately 54,000 age 1+ salmon were stocked in the spring of 2008. Genetic samples ($n = 194$) were also collected from a sub-sample of the fish trapped during field operations. The population estimate for naturally reared smolts generated using a Darroch MLE at the NOAA sites was $1,029 \pm 232$ (Figure 5.1.4.3). The 2008 population estimate of emigrating smolts of all origins was $49,253 \pm 9,874$. This estimate includes age 0+ fish that were stocked in the fall of 2006 and 2007, and age 1+ fish that were stocked in the spring of 2008 and naturally reared smolts.

Of the 218 smolts captured upstream of Beddington Lake, 168 were marked and released 5.39 km upriver. Fifty smolts were recaptured and using a ML Darroch MLE, we estimated upstream production to be 750 ± 88 smolts.

Sheepscot River. Three RSTs captured 101 smolts, 32 of which were marked with an adipose clip, indicating that they were released in 2006 as age 0+ fall parr. Mean fork length and weight by smolt origin (Tables 5.1.4.5 and 5.1.4.6, Figures 5.1.4.1 and 5.1.4.2) were comparable to averages of previous years. This year, the Sheepscot River smolt run was composed of 11.4% age 1+, 85.7% age 2+, and 2.8% age 3+ naturally reared smolts ($n=35$) (Table 5.1.4.4). Genetic samples ($n=70$) were also collected from fish trapped during field operations.

Penobscot River. Total captures in the Pleasant River RSTs in 2008 were 456 smolts, 376 (82.6%) of which were marked with a ventral clip, indicating that the fish were stocked as age 0+ parr. Of the 376 marked hatchery fish captured, 17% were stocked as fall parr in 2006 and 83% were stocked as fall parr in 2007. The age distribution of naturally reared smolts was as follows: 89.8% were age 2+ and 10.1% were age 3+, based on scale reading ($n=59$) (Table 5.1.4.4). Age 2+ naturally reared smolts averaged 162.3 ± 11.8 mm fork length ($n = 53$) and 40.9 ± 7.9 g wet weight ($n = 53$) (Tables 5.1.4.5 and 5.1.4.6, Figures 5.1.4.1 and 5.1.4.2). Genetic samples ($n = 40$) were also collected from fish trapped during field operations.

On the Pleasant River 153 smolts were marked at the RSTs and moved upstream: of these 14 were recaptured. Using the average recapture proportion for marks applied during two time periods, it was estimated that 10,067 smolts (95% confidence interval of 4,069—20,311) emigrated from the Pleasant River to the Piscataquis River.

The age distribution of the 648 naturally reared smolts captured in the Piscataquis River RSTs (based on 513 scales) was: 48.3% were age 2+, 50.9% were age 3+, and 0.8% were age 4+ (Table 5.1.4.4). Two smolts were hatchery origin, stocked as fall parr in 2006. Age 2+ naturally reared smolts averaged 138.9 ± 12.2 mm fork length (n = 248) and 25.2 ± 7.2 g wet weight (n = 248) (Tables 5.1.4.5 and 5.1.4.6, Figures 5.1.4.1 and 5.1.4.2).

Smolt Run Timing. In 2008, trapping operations were suspended for a week due to a high flows following heavy rain during the last week of April. Median run dates on the Sheepscot River and the Narraguagus River were within two days of each other in both 2007 and 2008, and also varied little among years and within rivers (Table 5.1.4.7). Rotary screw trap catch was similar between the Narraguagus, Sheepscot, and Pleasant Rivers in 2008.

Table 5.1.4.4 Freshwater age of naturally reared smolts collected in Rotary Screw Traps on selected Maine rivers.

River	2008			5 year average (2003-2007)		
	1+	2+	3+	1+	2+	3+
Narraguagus	4.2%	90.1%	5.6%	1.0%	88.4%	10.6%
Piscataquis- Pleasant River*	0%	89.8%	10.1%	1.0%	91.2%	8.1%
Piscataquis	0%	48.3%	50.9%	N/A	N/A	N/A
Sheepscot*	11.4%	85.7%	2.9%	4.4%	91.3%	4.3%

* Years 2004-2007

Table 5.1.4.5 Mean fork length (mm) by origin of smolts captured in Rotary Screw Traps in Maine.

River	Age 1+ hatchery-origin		Age 2+ naturally reared	
	2008	4 year average (2004-2007)	2008	5 year average (2003-2007)
Narraguagus	167.1 ± 22.3 n=42	N/A	165.0 ± 12.6 n=62	169.0 ± 14.4 n= 2349
Piscataquis- Pleasant River	133.9 ± 11.8 n=80	137.7 ± 13.4 n=247	162.3 ± 11.8 n=53	162.0 ± 10.6 n=199
Piscataquis	N/A	N/A	138.9 ± 12.2 n=248	N/A
Sheepscot*	N/A	151.1 ± 21.8 n=195	181.1 ± 16.6 n=30	178.8 ± 21.8 n=386

* Years 2004-2007

Table 5.1.4.6 Mean smolt weight (g) by origin of smolts captured in Rotary Screw Traps in Maine.

River	Age 1+ hatchery-origin		Age 2+	
	2008	4 year average (2004-2007)	2008	5 year average (2003-2007)
Narraguagus	48.1±20.0 n=43	N/A	43.8± 12.7 n=62	48.6± 13.4 n=1749
Piscataquis- Pleasant River*	20.7±5.6 n=80	23.6±7.2 n=247	40.9±7.9 n=53	41.1±8.3 n=199
Piscataquis	N/A	N/A	25.2±7.2 n=248	N/A
Sheepscot*	N/A	38.3±19.4 n=194	64.3±19.4 n=29	59.8±20.7 n=386

* Years 2004-2007

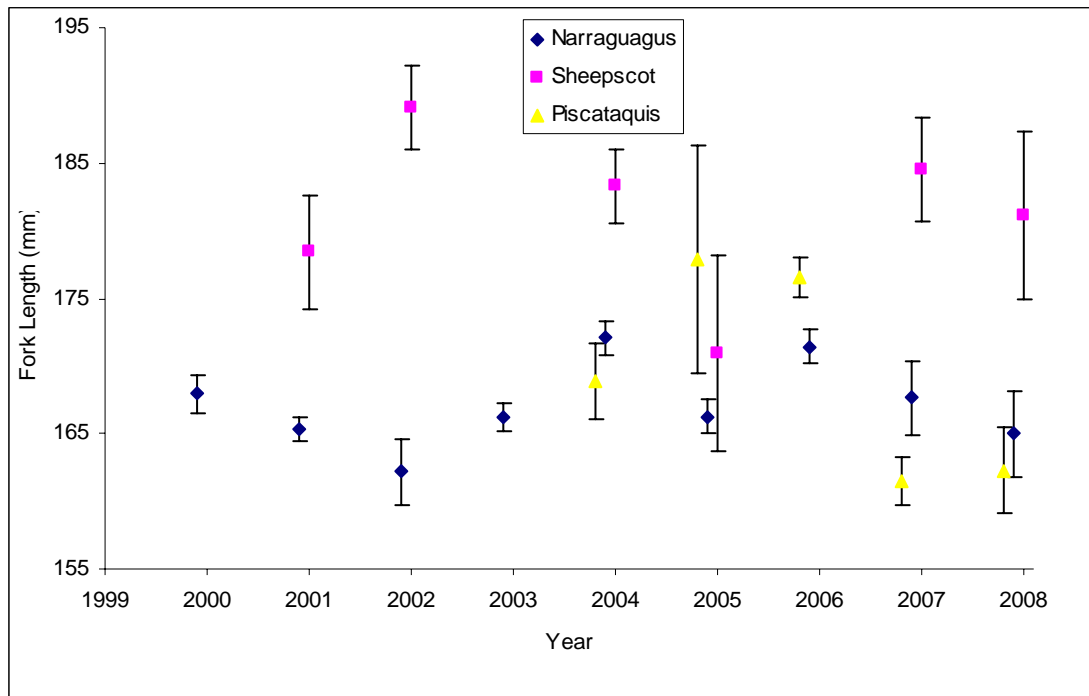


Figure 5.1.4.1 Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2000-2008.

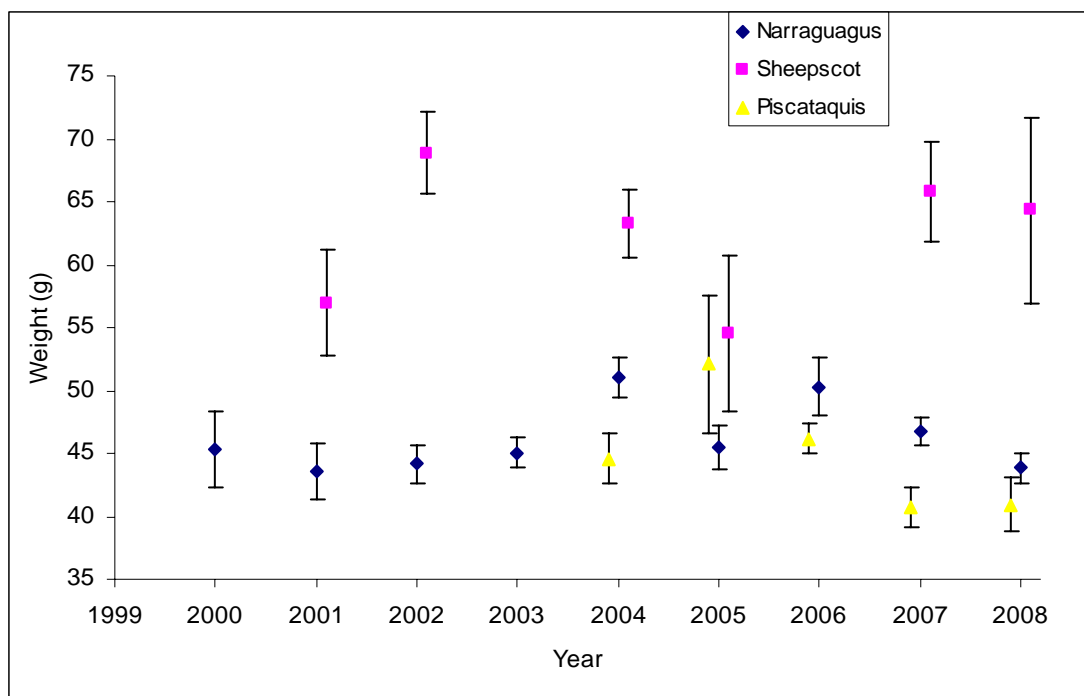


Figure 5.1.4.2 Mean wet weight (g) \pm 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2000-2008.

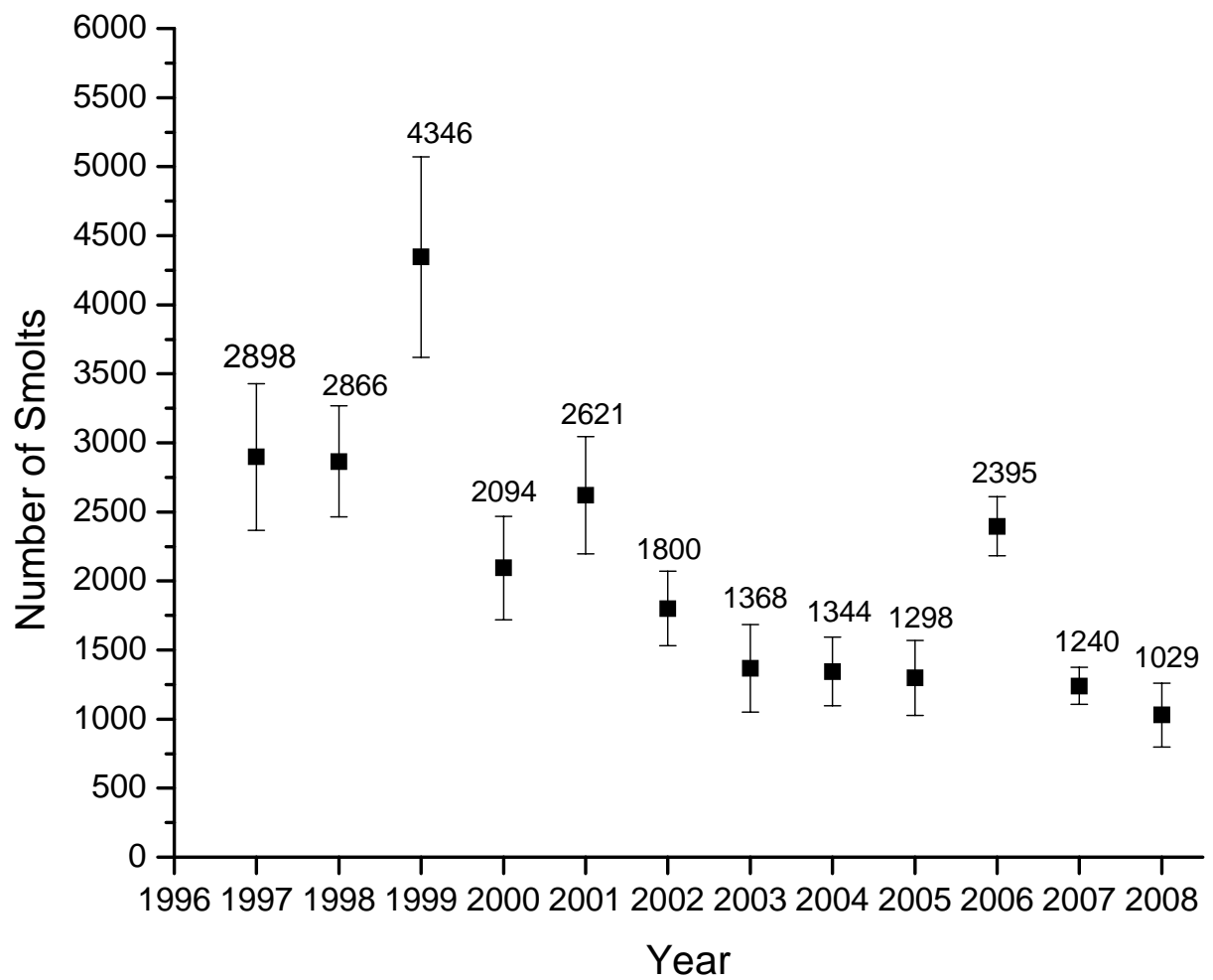


Figure 5.1.4.3 Population Estimates (\pm Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to 2008.

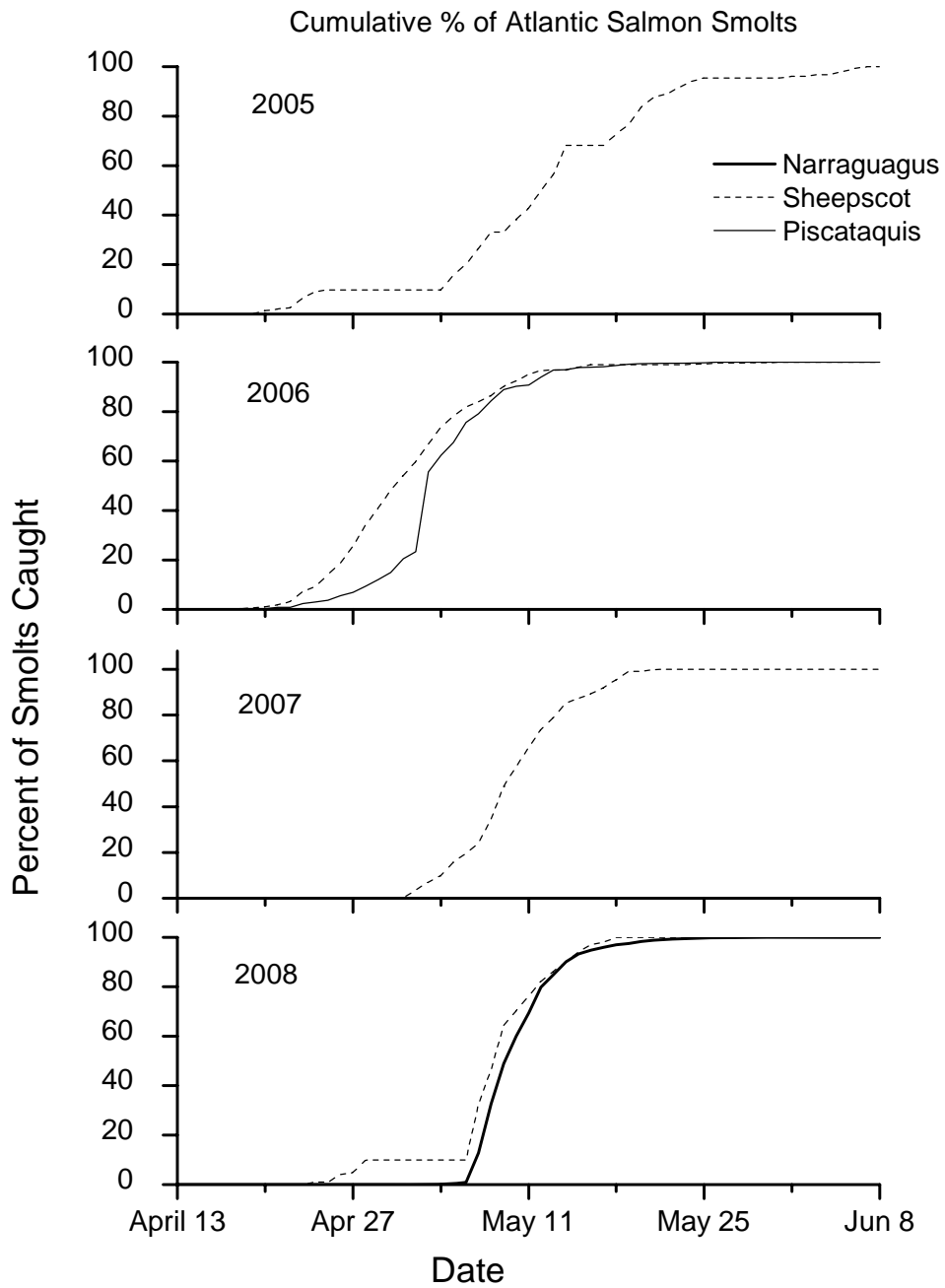


Figure 5.1.4.4 Cumulative percentage smolt catch in Rotary Screw Traps by date (run timing) on the Narraguagus, Piscataquis, and Sheepscot Rivers, Maine, for years 2005 to 2008.

Table 5.1.4.7 Ordinal day (days from January) of median smolt catch in rotary screw traps on the Narraguagus and Sheepscot Rivers, 1997-2008.

Year	River	
	Narraguagus	Sheepscot
1997	143	
1998	126	
1999	126	
2000	129	
2001	138	130
2002	130	120
2003	138	
2004	131	127
2005	134	128
2006	124	121
2007	132	130
2008	130	129

5.1.5 Fish Passage

Sheepscot River. Over the past five years there have been several engineering studies that identified the Coopers Mill dam on the Sheepscot River as a passage problem for anadromous fish. The problem stems from many structural issues which cause major water leaks. The town of Whitefield, which owns the dam, turned down resource agency and non-governmental organizations assistance to alter the dam or remove it to improve passage. In the most recent vote the town dedicated some funds to dam repairs in an effort to halt leaks that would allow more water to go to the existing fishway. Both U.S. Fish & Wildlife Service and the Maine Department of Marine Resource have sent letters to the town urging them to make the necessary repairs as soon as possible.

Recently there have been plans to remove or partially breach the Headtide Dam in Alna on the Sheepscot River. An engineering firm has produced a report outlining the improvements to passage for all anadromous fish if changes to the dam are made. The Headtide Dam was decommissioned in 1952 when the valves were removed, opening up two slots for alewives and salmon to pass. A series of meetings are planed to explore options and local concerns.

The lack of connectivity within the Sheepscot River watershed can hinder the movement of anadromous and catadromous fish to spawning and rearing habitat. In 2008 road/stream crossing surveys (236 completed) along with natural barrier surveys (20 completed) within the Sheepscot River drainage, which flows through five counties in Maine, were completed with a collaborative effort between the Sheepscot Valley Conservation Association, Sheepscot River Watershed Council, U.S. Fish & Wildlife, Gulf of Maine Coastal Maine Program, and the Department of Marine Resources, with funding from Maine Yankee. Field crews recorded multiple characteristics of each site surveyed, such as structure type, channel width, crossing length, and also took multiple photos of each site. After compilation of the data, 76 sites were determined to be in severe need of repair and/ or replacement at an estimated cost of \$614,000.

On Thursday, June 19, 2008, pursuant to the Lower Penobscot River Agreement dated June 22, 2004, the Penobscot River Restoration Trust notified PPL Corporation of its intent to purchase the Veazie, Great Works, and Howland dams for \$25 million. This was an important milestone on the road to restoring the largest river within Maine, the Penobscot. In early November 2008 the Penobscot River Restoration Trust and PPL Maine filed permit applications with FERC, Maine Department of Environmental Protection, and Army Corps of Engineers to transfer the operating licenses of the Veazie, Great Works, and Howland Dams from PPL to the Trust, and to surrender those licenses and decommission the dams. FERC is currently reviewing of these permits.

Kennebec River. On 18 July 2008 the Fort Halifax Dam was breached, with removal occurring over the next few weeks. The impetus for dam removal was the 1998 Lower Kennebec River Comprehensive Hydropower Accord. The accord's purpose is to facilitate the federal licensing of eight hydroelectric projects and to restore diadromous fish in the watershed. Fort Halifax dam's owner decision to remove the dam was based the fact that it didn't make business sense to build an expensive fish lift on the small dam. So in 2001, the company announced it would surrender the dam's license and take it down. The intervening years have been spent waiting for a series of court rulings on the project. In addition to the Fort Halifax dam removal, the accord resulted in the removal of the Edwards Dam in 1998, upstream and downstream fish passage at three hydroelectric projects, and funding for restoring diadromous fishes.

In 2008 Brookfield Power, conducted a downstream passage study on Atlantic salmon smolts at their Hydro Kennebec accord resulted in the removal of the Edwards Dam in 1998, upstream and downstream fish passage at three hydroelectric projects, funding for the restoration of the fish runs, and momentum to install fish passage at non-regulated dams through the Service's Gulf of Maine Coastal Program. The study was based on a design approved by FERC and used total of 200 pit tagged hatchery smolts.

5.1.6 Genetic sampling

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick and at the Lockwood fish lift on the Kennebec River. In total 38 (22 on the Kennebec and 16 on the Androscoggin) genetic samples were collected in 2008. All tissue samples were preserved in 95% ethanol.

Since 1999, all broodstock at CBNFH have been PIT tagged and sampled for genetic characterization via fin clips. This activity allows for the establishment of genetically identifiable fry and smolt families, which can be tracked through non-lethal fin samples at various life stages. Genetic characterization of broodstock prior to spawning also allows biologists an opportunity to identify and manage undesirable genes, such as those associated with aquaculture escapees. When individual genetic results are used in conjunction with gene optimization software (see section 2.2.2 Hatchery Research Section), matings can be assigned during spawning to achieve specific program goals, such as increasing genetic diversity by eliminating sibling or other closely related family matings.

To reduce handling stress, tag loss, and tagging-related mortality, juvenile broodstock are currently tagged one year post-capture at CBNFH. This allows the fish to reach an appropriate size to allow for intramuscular insertion of PIT tags. In October 2008, DPS broodstock (collected in 2007) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.1.7 General Program Information

Penobscot Fishery

A spring fishery occurred on the Penobscot River, Maine from 1 May to 15 October 2007. The BSRFH staff had the authority to close the fishery during the open season as necessary to protect the resource. The primary criterion for temporary closures was river temperature and the fishery was closed for one day early in the season, when river temperatures exceeded 68 F (20 C). Anglers had 24 hours to report a hooked and released salmon, and the Season was to be closed when 50 salmon were reported caught and released. The 2008 spring season had regulations similar to the 2006 and 2007 fall experimental seasons:

- Anglers were required to an Atlantic Salmon license prior to fishing for Atlantic Salmon.
- Directed angling for Atlantic Salmon was permitted only in a specified open area on the Penobscot River. (between two painted red markers on opposing banks that are 150 feet below the Veazie Dam fishway, down river to the former site of the Bangor Dam)
- Only catch and release angling was allowed. Any salmon hooked had to be released immediately, without injury.
- No salmon shall be removed from the water for any reason.

- Fly fishing only; fly must be tied on single pointed barbless hook. Only one fly or hook can be fished at any one time
- Daily catch and release limit was one fish. Any angler who hooked and released one salmon was required to stop fishing for the day
- Fishing was only permitted only when green flags were displayed at the Veazie Dam, Veazie Salmon Club, Eddington Salmon Club, and Penobscot Salmon Club
- All Atlantic salmon license holders were required to report all fishing activity at the end of the season in a logbook.

A total of 177 licenses were sold, 145 to Maine residents. The fishery ended at noon on Saturday, 31 May 2008 with a total of 61 salmon caught and released; 20 on the last day and a half. Only 35% of the logbooks were returned and data have not been analyzed. Preliminary estimates of effort based on angler counts ranged from 540 to 760 angler trips. Using this range and a catchability range estimated from the fishery (4 to 8 times higher than used in the risk model), mortality was estimated at 8 salmon (95 %CI 1 to 20).

Expanding the geographic range of the Endangered GOM DPS

On September 3, 2008, the U.S. Fish and Wildlife Service (USFWS) and NMFS (collectively, the Services) under the authority of the Endangered Species Act (ESA) of 1973, as amended, jointly proposed that the expanded Gulf of Maine (GOM) distinct population segment (DPS) of Atlantic salmon be listed under the ESA as an endangered species (73 FR 51415-51436). The GOM DPS, as proposed, includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, the extent of their marine range, and all associated conservation hatchery populations used to supplement natural populations; currently, such populations are maintained at Green Lake and Craig Brook National Fish Hatcheries. The Services considered the best available scientific and commercial information on the biological status of the species, threats facing the species, and efforts being made to protect the species and concluded that the GOM DPS of Atlantic salmon is in danger of extinction throughout all of its range.

The basis for this proposed rule dates back to November 17, 2000, with the Services issuance of a final rule listing the GOM DPS of Atlantic salmon as endangered. At that time, the GOM DPS was defined as all naturally reproducing wild populations and those river-specific hatchery populations of Atlantic salmon having historical, river-specific characteristics found north of and including tributaries of the lower Kennebec River to, but not including, the mouth of the St. Croix River at the U.S.-Canada border.

In the 2000 final rule listing the GOM DPS, the Services deferred the determination of inclusion of fish that inhabit the mainstem and tributaries of the Penobscot River above the site of the former Bangor Dam and fish that inhabit the mainstem and tributaries of the Kennebec River above the site of the former Edwards Dam. The deferred decision reflected the need for further analysis of scientific information, including a detailed

genetic characterization of the Penobscot population. Furthermore, the Services committed to reviewing data regarding the appropriateness of including the upper Kennebec and other rivers as part of the DPS. When the necessary information was available, the Services assembled a new Biological Review Team (BRT) to review and analyze all relevant scientific information necessary to evaluate the current DPS delineations and determine the conservation status of the populations that were deferred in 2000 and their relationship to the currently listed GOM DPS. In September 2006, a new report entitled “Status Review for Atlantic Salmon in the United States” was made available to the public.

The 2006 Status Review Report concluded that the salmon currently inhabiting the larger rivers (e.g., Penobscot) are genetically similar to those found in the coastal rivers of Maine (e.g., Narraguagus) and have similar life history characteristics. Further, the populations inhabiting the large and small rivers within the geographic range of the GOM DPS differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada. Thus, the BRT concluded that the GOM DPS, comprised of populations inhabiting the large and small coastal rivers, meets both the discreteness and significance criteria of the DPS policy and therefore, recommended that the GOM DPS be comprised of all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, including all associated conservation hatchery populations used to supplement natural populations; currently, such populations are maintained at Green Lake and Craig Brook National Fish Hatcheries. A final rule is expected out by the end of April, 2009.

U. S. Fish & Wildlife Service Schools Programs

2008 marked the fourteenth year of U. S. Fish & Wildlife Service outreach and education programs, which focusing on endangered Atlantic salmon populations and their habitats in Maine rivers. The program reaches approximately 1400 students, teachers, and parents annually. Participants are provided the opportunity to raise river-specific Atlantic salmon eggs and fry in their classroom in a temperature-controlled aquarium, and then release the resulting fry into their natal river in early May. Classroom instruction involves the life cycle of Atlantic salmon and other diadromous fish, habitat and migration requirements of the species and the human impacts which affect their survival.

Salmon-in-Schools program sites include nineteen schools within the Dennys, Machias, East Machias, Pleasant, Narraguagus and Sheepscot river watersheds, as well as seven schools where students release fry into the Union River and nine schools releasing into the Penobscot River. The Muddy Rudder Restaurant hosts a rearing site in Brewer and release on Kenduskeag Stream. Total program visibility beyond the public and private school venues is estimated to be nearly 20,000 people per year.

Fish Friends Partnership with the Maine Council, Atlantic Salmon Federation Craig Brook and Green Lake National Fish Hatcheries also provide Atlantic salmon eggs for

the Maine Council, Atlantic Salmon Federation Fish Friends program. Like the Fish & Wildlife Service's Salmon-in-Schools, Fish Friends offers comparable educational opportunities in 77 additional Maine schools, reaching some 2,200 students, cooperating teachers and parents annually. The two programs, working in partnership, reach over 3,600 people each school year.

Egg Survival at CBNFH

For the Penobscot River, the broodstock target of 650 was met, however, egg production from 40+ females was lost due to water intrusion and subsequent egg water hardening within the fish. This loss was the result of two factors; a strategic change to spawning timing, and the precipitous decline of water temperature during the middle stages of the eggtake.

Over the past several years, previous CBNFH management had progressively moved the first spawning date of the PN's earlier into October. In 2007, CBNFH experienced a moderately large and significant reduction in eye-up survival (~30%) in the early spawn lots, which experienced prolonged 10 C water with significant intervals over 12 C. Further, GLNFH experienced large (>30%) delayed losses on the first spawn lot during start-up rearing, developmentally well past the stage where fry from CBNFH would be stocked. Warm water temperatures during early incubation rapidly advance egg development, which result in fry being developmentally ready to be stocked up to 6 weeks earlier than river conditions allow. CBNFH is not designed to carry fry through the initial feeding period (the room is actually well designed for fry staging between incubation and stocking). To compound the problem, the water temperature is very cold in the spring, well below the 10 C Atlantic salmon need to effectively begin feeding, and the large production numbers for the Penobscot result in rearing densities 2 to 3 times the maximum density ceiling used at GLNFH. These factors all conspire to create poor rearing conditions, for much too long a time, at unfavorable water temperatures and excessive densities. The result is a less than high quality fry product being stocked into the Penobscot drainage.

The CBNFH team made a conscious and strategic decision to push the front end of the Penobscot eggtake back to the 1st week of November s to try to avoid early incubation season warm temperatures and the deleterious effects they cause. The loss of this egg production was the expression of the inherent risk involved when normally operational practice is altered. CBNFH staff believe that holding off on the 1st PN spawn until the historical Halloween eggtake initiation and conservative grading to identify spawn readiness during that 1st week of eggtake, is a viable way to manage around the warm temperature of late October. Egg production loss occurred during the 2nd week of the spawn because the conservative grading approach was maintained. A more aggressive approach would have identified more fish for spawning. To further compound this issue, we believe an abnormal rapid decline in water temperature collapsed the normal female ripeness progression window. We were not aware of the lost egg production until the last day of Penobscot eggtake when we observed poor egg quality for females which we

had graded as ripe and ready to spawn. Staff then spawned the 30+ females that had been graded as green (which were as hard as fresh, green females at the beginning of eggtake). These eggs showed that water intrusion had already occurred longer ago than just the last few days, and were a total loss (they were not mixed with male spawning product, just stripped and discarded). Several of the initially ripe graded fish were also determined to be a total loss (this condition a result of more recent water intrusion).

In addition to the lost production from late spawned females, the Penobscot eggs had lower than normal eye-up (80% first take, 63% second take, not including total family losses) and many more total family losses than normal (14% first take, 24% second take). With similar or worse occurrence of total family losses in takes 3-5. Although the total family losses in take #5 can be attributed to delaying spawning operations and female water intrusion (as noted during incubation loading), CBNFH staff have been unable to pinpoint a cause for losses in takes 1 to 4 or for low eye-up. The eggs from early takes (1-4) looked good during fertilization, and when loaded into the incubators. A range of possible causes: environmental, spawning / handling technique, similarities among families (holding pools, capture dates) are being investigated. Milt quality is a possible issue. However, neither sperm motility nor fertilization rate is evaluated at CBNFH. In addition to our internal investigation, egg samples have been sent to USGS for Thymine analysis (Early Mortality Syndrome) and to several pathologists to evaluate for Cold Water Disease.

5.1.8 Salmon Habitat Enhancement and Conservation

Habitat Connectivity

Road networks essential to Downeast's working forests and blueberry barrens are extensive. Beginning with the Studmill Road in 1970, approximately 150 miles of commercial forest gravel roads were developed per year for approximately 15 years. Both St. Regis and Champion International were aware of the significance of salmon habitat in the rivers and principle tributaries. Roads crossing these waters were kept to a minimum and bridges, with minimal or no impact to anadromous fish passage, were constructed. As a result the road network was designed to run parallel to the mainstem and major tributaries virtually crossing all 1st and 2nd order streams a relatively short distance upstream from their confluence. Undersized culverts on 1st and 2nd order streams represent the principle anthropogenic barrier to fish passage in SHARE's focus area. Other factors affecting salmon in this region are related to water chemistry and log-drive legacies (e.g. remnant structures causing hydraulic checks). In 2008, SHARE focused on-the ground restoration efforts primarily within tributary systems draining the Machias River, an important and well-protected salmon migration corridor. Projects completed included: installing 7 open-bottom arched culverts, assisting the Cove Brook Watershed Council with installation of 1 open-bottom arched culvert in Winterport, decommissioning 9 road/stream crossings, native vegetation plantings at over a dozen restoration sites, and partial removal of six remnant log drive dams (Table 5.1.8.1).

Habitat Complexity

BSRFH treated two paired control/treatment sites on Baker Brook, a tributary of the Narraguagus River, on July, 2008. Both wood addition sites we treated similar to previous work by felling streamside trees at a rate of approximately one tree every 12 meters of stream length. Each site was approximately 100 to 150 meters long, thus, 13 trees were felled in the downstream site and 15 trees in the upstream sites for a total of 28 trees. Treatment was conducted by a certified wood cutter under cooperation with American Forest Management, Inc. and Maine Department of Marine Resources biologist(s) planned the projects and were on site for treatments. One paired control/treatment site on Holmes Brook, Machias drainage was treated in November, 2008. Pre-treatment assessment of each site included fish surveys and geomorphologic surveys in cooperation with a geology research team from Boston College.

Table 5.1.8.1 Projects restoring stream connectivity in Gulf of Maine Atlantic salmon watersheds, indicating stream, type of work, structure, and km of juvenile salmon habitat upstream.

Watershed	Stream	2008 Activity (width m)	Previous Structure (#) @ Diameter (m)	Est.km Opened
East Machias River	Harmon Brook	Removed Culvert	1@0.8	0.0
Machias River	Thompson Brook	Removed Culvert	1@1.2	0.0
Machias River	LB Trib Machias	Removed Culvert	1@1.1	0.0
Machias River	Trib to Big Springy	Removed Culvert	1@1.2	0.0
Machias River	Trib to Honeymoon	Removed Culvert	1@0.6	0.0
Machias River	Honeymoon trib	Removed Culvert	1@0.6	0.0
Machias River	Honeymoon trib	Removed Culvert	1@1.2	0.0
Machias River	Campbell outlet	Removed Culvert	1@1.2	0.0
Machias River	WB Machias Trib.	Removed Crossing	Abandoned	0.0
East Machias River	Barrows	Open Arch (6.6)	1@3.7	0.0
Machias River	Magazine	Open Arch (3.0)	1@1.1	0.0
Machias River	Thompson	Open Arch (3.7)	1@1.7	0.0
Machias River	Sam Hill Brook	Open Arch (4.6)	1@1.8	0.0
Machias River	Campbell outlet	Open Arch (4.3)	1@1.2	0.0
Penobscot River (6)	Meadow Brook	Open Arch (4.9)	0.9 & 1.2	0.0
Pleasant River	Pleasant River*	Open Arch (9.3)	1@7.3	62.7
Pleasant River	Bog Stream	Open Arch (4.9)	2@1.8	0.0
East Machias River	Harmon Brook	Remnant Dam		5.2
East Machias River	Harmon Brook	Remnant Dam		5.4
Machias River	Mopang Stream	Remnant Dam		0.0
Narraguagus River	Sinclair Brook	Remnant Dam		0.0
Narraguagus River	Pork Brook	Remnant Dam		0.0

6.1 Outer Bay of Fundy

The rivers in this group are boundary waters with Canada. Further the majority of the watershed area for both watersheds is in Canada. As such, The Department of Fisheries and Oceans conducts assessments and reports status of stock information to ICES and NASCO.

6.1.1 Adult Returns

Aroostook River. The salmon returns to the Aroostook River are a subset of the returns to the St. John River. The Tinker fish lift and trap opened on 7 July following the releases of salmon trapped downriver at the Mactaquac Dam. The 2008 trap catch of 44 Atlantic salmon was the highest since 1996 (65 fish) and nearly 6 times greater than the 5-yr mean (7.8 salmon). Nineteen of the salmon were marked captive-reared adults that were stocked in the St John River (red Floy-tag).

The 2008 assigned sea-age distribution, based on fork length, was 32 –1SW, 11-2SW, and 1-unknown age. The fish length to age relationship for this population is derived from DFO analyses of scale and length data collected from fish trapped at Mactaquac Dam. To minimize handling stress at the Tinker trap, scale samples are not collected.

St. Croix River. The research trap at Milltown on the St. Croix operated from 6 May to 3 July 2008. No salmon were documented during that time period. After 3 July, the trap was opened for free passage. On 29 September 2008 one dead salmon was removed from the Milltown Dam racks. It was a hatchery origin 3SW female.

6.1.2 Hatchery Operations

Aroostook River. Atlantic Salmon for Northern Maine, Inc. (ASNM) owns and operates the Dug Brook Hatchery in Sheridan, Maine to produce Atlantic salmon fry for the Aroostook River. The hatchery relies on eyed salmon eggs from “St. John River strain” salmon spawned at the Mactaquac Biodiversity Facility. The eggs are tested in compliance with U.S. Title 50 fish health criteria and then imported to Dug Brook Hatchery for hatching. Transfers in 2008 totaled 442,130 eyed eggs. Of these 51,068 were from sea run salmon captured by the DFO at the Mactaquac Dam fishway trap in Fredericton, NB and 391,062 were from captive reared broodstock held at the Mactaquac Biodiversity Facility.

St. Croix River. There are no hatcheries rearing salmon for stocking into the St. Croix River.

6.1.3 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River. ASNM stocked a total of 365,200 non-feeding fry soon after hatching into the Aroostook River in accordance with BSRFH recommendations. Tributary Streams (e.g. Mooseleuk, Big Machias, Little Madawaska) were targeted for stocking in 2008 based on analysis of previous fry stocking and habitat data.

St. Croix River. The 300 fry stocked in the St Croix were eggs hatched in school programs (Fish Friends, Salmon in Schools).

Adult Salmon Releases

Aroostook River. Although there were no adult releases into the Aroostook River, Department of Fisheries and Oceans has an adult release program for the St. John River that results in spawners entering the Aroostook River. In 2008, the captive-reared adults that passed the Tinker fishway were; collected as smolts in the gatewells at Beechwood Dam in 2006 and reared two years to maturity at Mactaquac. They were from the 259 salmon (179 females 80 males) released at Perth-Andover (Beechwood Headpond) to 'free-swim' to their tributary of origin (i.e. Aroostook R., Salmon R., Tobique R.) on 1 October (adipose clip + red Floy tag).

St. Croix River. There were no adult releases into the St. Croix River.

6.1.4 Juvenile Population Status

Electrofishing Surveys

Median juvenile salmon densities were 2.6 parr and 10.6 YOY per unit at two sites in the Aroostook River watershed (Table 6.1.4.1). Median relative abundances (fish /minute) at nine sites in the system ranged from 0 to 0.44 for parr and 0 to 4.99 for YOY (Table 6.1.4.2).

Table 6.1.4.1 Minimum (min), median, and maximum (max) large parr and young of the year (YOY) Atlantic salmon population densities (fish/100m²) based on multiple pass electrofishing estimates in the Aroostook River, 2008.

Life Stage	Min	Median	Max	n
PARR	1.27	2.63	3.99	2
YOY	4.45	10.62	16.79	2

Table 6.1.4.2 Minimum (min), median, and maximum (max) relative abundance of large parr and YOY Atlantic salmon (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in the Aroostook River, 2008.

Life Stage	Min	Median	Max	n
PARR	0.00	0.22	0.44	9
YOY	0.00	2.24	4.99	9

Smolt Monitoring

No smolt monitoring was conducted for either the St. Croix or Aroostook River program.

Tagging

No tagging occurred in either the St. Croix or Aroostook River program.

6.1.5 Fish Passage

Aroostook River. The Tinker trap was closed for routine maintenance for 16 days (July 17-27, Aug. 27-Sept.4) and was inoperable due to high water for five days (Oct. 28-Nov.1). Representatives from the Tinker Dam operator (WPS Canada, Inc.), DFO, and DMR met in 2008 to discuss potential strategies to provide fish passage during maintenance periods.

St. Croix River. In March of 2008, the Maine Legislature's Marine Resources Committee heard testimony on LD 1957, an act to overturn the 1995 state law closing fishways at the Woodland and Grand Falls Dam to anadromous alewives. While the original bill would have provided access to 52% of the spawning habitat available in the 1980s, an amended bill was passed, opening fish passage at the Woodland Dam only and restoring alewives to just over 2% of that habitat. The Maine Department of Marine Resources, the Department of Inland Fisheries and Wildlife, and the Passamaquoddy Tribal Government will be working collaboratively over the next year to resolve the issues that resulted in the changed legislation.

6.1.6 Genetics

No genetics samples were collected in 2008.

6.1.7 General Program Information

IPNV was detected in Atlantic salmon at the Mactaquac Biodiversity Facility seven years ago (2000). Since then the ME DIFW pathology laboratory has not detected IPNV in ovarian fluids (100% sample) of either sea-run or captive reared females supplying eggs for import. The Maine testing was in addition to ovarian fluid and lethal samples processed by the Canadian pathology laboratory each year.

6.1.8 Salmon Habitat Enhancement and Conservation

Connectivity

Project SHARE replaced two culverts within the St Croix watershed (Table 3.8.1). The primary goals of these enhancement projects were to restore aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment) through the crossing.

Table 6.1.8.1 List of projects restoring stream connectivity in St. Croix River watershed watersheds, indicating stream, type of work, structure, and km of juvenile salmon habitat upstream.

Watershed	Stream	2008 Activity (width m)	Previous Structure (#) @ Diameter (m)	Est.km Opened
St Croix	Rolfe Brook	Open Arch (3.7)	2@0.9	0.0
St Croix	Scott Brook	Open Arch (3.8)	3@0.9	0.0

7.0 Terms of Reference and Emerging Issues in New England Salmon

This section was formerly named “Developments in the Management of Atlantic Salmon.” Given changes in USASAC responsibilities and in guidance requests from ICES and to some extent NASCO, this section has been renamed and it now focuses primarily on emerging issues and terms of reference beyond the scope of routine stock assessments included in earlier sections. The purpose of this section is to provide some additional overview of information presented or developed at the meeting that identifies emerging issues or new science or management activities important to Atlantic salmon in New England. These sections review highlighted working papers and the discussions surrounding them to provide information on emerging issues.

The focus topics for this meeting were 1) continuing efforts toward regional assessment products; 2) Fish Health Issues; 3) NASCO Rivers Databases; 4) marine survival – acoustic telemetry studies; 5) parr subsidies of hatchery smolt return rates; and 6) sampling design for Gulf of Maine DPS juvenile production.

7.1 Regional Assessment Product Progress Update

Last year, the USASAC endorsed the concept of the report as a more integrated regional assessment product in addition to a consolidated assessment report. This next step has been made possible by a high quality consolidated Access database through the the expertise and stewardship of this database by Dr. John Sweka. His approach of including the group in development and focusing design around relevant questions has made a useful data resource. In addition, having a database leader has made all groups more responsive to populating this database in a timely manner. While the database has been used by USASAC primarily to generate tables for this report, it is rich in information that could be used to develop stock assessment products beyond adult return counts and percentage of conservation spawning escapement. In particular, the incorporation of more juvenile data across the regions, especially incorporation of additional data from the Maine juvenile database may allow opportunities for regional assessment of juvenile indices and development of new metrics.

In discussions at the meeting, it became apparent that some progress could be made by creating tables or graphs that combine data from different programs/regions. The first step envisioned at the 2008 meeting was to develop more graphical summaries of juvenile data across New England. We successfully, completed some of these summary graphics and they are presented in section 2.0 Status of Stocks. That section includes parr density summaries and smolt return rate summaries for the first time in a long-time series and inter-program manner. The USASC believes that the time saved by pre-meeting assembly and the opportunity of having the region’s salmon scientists together to graph and visualize data as well as to analyze and discuss provides additional

opportunities to use the integrated dataset annually. The USASC felt that this is a large undertaking and should be accomplished over the course of several meetings. We believe we made some significant progress this year. Some considerations that the USASAC believed were essential were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New England and NASCO managers for US data, and 3) making sure that as more data is developed and analyzed it was utilized as a tool to rebuild Atlantic salmon stocks. To this last point, the USASAC recognizes they need to provide core stock assessment information (provide a yardstick of progress) but understands the need to better communicate information to managers as opportunities and threats are recognized (provide rebuilding tools).

Table 7.1.1 Overview of Atlantic salmon life history stages with proposed assessment elements, time series for revisiting elements, and suggested opportunities for expansion of statistical analysis. This table is a living document updated at both the intercessional teleconference and annual meetings.

<i>Stage</i>	<i>Parameter</i>	<i>Type</i>	<i>Programs</i>			<i>Regional</i>	<i>Asmt Cycle</i>	<i>Opportunities</i>
			<i>CT</i>	<i>MR</i>	<i>ME</i>			
Adult	Trap Catch	Count	Y	Y	Y	graphical	annual	regional trends, 5 year rep rate, 5 year geomean of rep rate, metric of CSE
Adult	Redd Count Escapement	Index	y	n	Y	n	annual/5 year recalc	5 year rep rate, 5 year geomean of rep rate, actual escapement to wild- sex specific
Adult	Return Rates	Vital rate	Y	Y	y	graphical	annual	currently done only for smolts, ME could do for fry too to match CT and MR programs, PN - needs cohort analysis,
Large Parr	E-fish Densities	Estimate	Y	Y	Y	density map	5 year	cohort and regional anlysis
Large Parr	Basinwide Estimate	Model	Y	n	Y	n	annual	variance, sampling efficiency, trends between CT and Narraguagus, etc.
YoY	E-fish Densities	Estimate	Y	n	n	density map	2 year	inconsistent, could target, cohort and regional anlysis
Smolts	Population Estimate	Estimate	y	n	Y	n	annual/5 year recalc	trends of median timing, size
Large Parr	survival from stocking	Estimate	Y	y	n	tabluar	annual	a table comparing rates would be useful as would a time series graph
YoY	survival from stocking	Estimate	Y	n	n	tabluar	annual	a table comparing rates would be useful as would a time series graph

Y - yes relatively complete, y - partial, n - no or little data

7.2 Fish Health Issues – Biosecurity Enhancements and Documentation of *Nucleospora salmonis*

The discovery in 2008 of an intracellular parasite, *Nucleospora salmonis* infestation in hatcheries that had shipped lake trout eggs in previous years to WRNFH led to concern that lake trout and/or salmon broodstock at WRNFH may have become infected. *Nucleospora* is not a listed pathogen and appears to be a low level stressor with very low virulence. While the parasite apparently is ubiquitous elsewhere in the United States, its status in the Northeast was not known. The Lamar Fish Health Center subsequently utilized PCR (polymerase chain reaction) to screen 350 samples provided by CRASC cooperators from six hatcheries, including WRNFH, and eight stream locations. All were negative for *Nucleospora*. No lake trout eggs were transferred to WRNFH in 2008 from *Nucleospora* positive facilities.

Richard Cronin National Salmon Station (RCNSS) is the broodstock holding facility for Connecticut River sea-run Atlantic salmon returns. In response to detection of infectious pancreatic necrosis (IPNV) at RCNSS in 2007 and subsequent destruction of all fish and eggs from the station, the USFWS undertook major (\$700K) biosecurity renovations in 2008 to reduce the risk of losing an entire year class again. Four pools were treated as separate units and were equipped with individual equipment and splash barriers to minimize the risk of disease transmission between pools. Egg rearing capacity at RCNSS was established by installation of a chiller, backup power generator, and incubators. A bank of 90 egg jars was installed at RCNSS for incubating families for future broodstock production at White River National Fish Hatchery (WRNFH). Sixteen individually isolated vertical flow stacks were installed at RCNSS for incubation of eggs for fry stocking and for future broodstock production at Kensington State Salmon Hatchery (KSSH) and Roger Reed State Fish Hatchery (RRSFH). All males, including mature parr, were lethally sampled after spawning and all females had ovarian samples taken for disease testing. The intent was that only eggs from which a parent tested positive in the egg jars would have to be destroyed and only those stacks containing contributions from a suspect parent would have to be destroyed. Many other biosecurity measures were also implemented. Spawning required a crew of about 25 staff supplied by Connecticut River Atlantic Salmon Commission cooperators to meet biosecurity needs.

All 2008 sea-run returns tested negative for IPNV and eggs for future broodstock were transferred from RCNSS to KSSH and WRNFH after testing. Production sea-run eggs for fry stocking had been intended to remain at RCNSS until stocking, but problems with the newly installed chiller forced their transfer to WRNFH to allow incubation on suitable water temperatures.

7.3 Update on the NASCO River Database 2009

Members of the USASAC have been cooperating in past years to populate a database that documented all salmon rivers in the US. The effort has been duplicated in other nations that are party to NASCO. The intent was to have the data accessible on the NASCO website. The effort has been hampered by several factors including a cumbersome database structure, excessive time commitments required to provide the requested data, lack of effort on the part of some nations, and troublesome interaction between the database and the website. At the 25th Annual Meeting (2008) in Gijon, Spain, the Secretariat agreed to work with its website consultant to determine ways to improve the product. Emails were exchanged between the Secretariat and Database Coordinators for each Party since the Annual Meeting. Recently, the Secretariat provided a simplified version of the database for work by the Parties and is requesting each Party to provide the appropriate data.

The new approach includes: (1) use of Excel instead of Access (at least for the Database Coordinators), (2) the elimination of the many fields of required information, (3) simplification of the data that is requested, and (4) elimination of all tributary streams, i.e. only streams that flow into the sea will be listed. This much simplified database has been sent to the US to be populated and returned to the Secretariat by March 27. It is hoped that the new database will be on the website by the Annual Meeting in June. Much of the information is already entered but several key members of the USASAC will be contacted before, during, or shortly after the USASAC to provide needed information or review the information that has been entered for rivers for which they are familiar. In either case, the time requirements will be modest. Once compiled, the US data will be submitted to the NASCO Secretariat as one comprehensive spreadsheet.

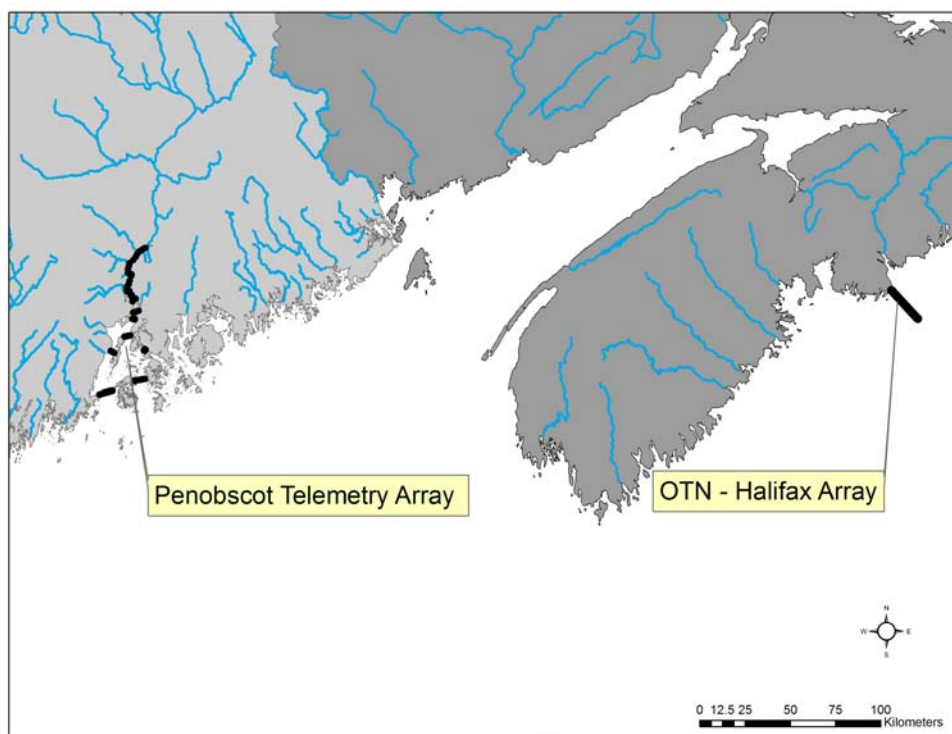
7.4 Marine Survival: Acoustic Telemetry Studies

NOAA's National Marine Fisheries Service Northeast Fishery Science Center (NEFSC) has used ultrasonic telemetry to assess Atlantic salmon smolt migration since 1997. In 2008, NEFSC tagged and released 156 emigrating smolts of 3 rearing histories, naturally reared ($n = 46$), fall parr ($n=31$) and hatchery smolts ($n = 80$), into the lower Penobscot River. Fish movement was passively monitored via the NEC Pen Bay Array a network of ultrasonic receivers deployed throughout the estuarine and near-shore marine environment to observe migration dynamics of the emigrating smolts. The NEFSC Penobscot Bay Array is connected to 11 buoys in the Gulf of Maine Ocean Observing System (GoMOOS - www.gomoos.org) through cooperative efforts of NEFSC and Umaine. One of the GoMOOS buoys was located in Penobscot Bay and the remaining 10 were located throughout the Gulf of Maine. These sites are monitored continuously, throughout the year. Further offshore, NEFSC collaborates with the Ocean Tracking Network (OTN - www.oceantrackingnetwork.org) headquartered out of Dalhousie University (Halifax, NS) to gain a comprehensive understanding of Marine life and conditions with hopes that the worldwide network of telemetry receivers and research equipment will assist in better managing the oceans. In 2008, the Halifax array consisted

of 27 units extending from a nearshore location to about 15 km off the coast. This array is also designed to be a continuous operation.

NEFSC found all three smolt groups partitioned use of Penobscot Bay in the same manner. Similar percentages of naturally reared (76.9 %; 20/26), fall parr (87.5 %; 7/8) and hatchery reared (72.7 %; 32/44) smolts were found to pass through the middle bay using the eastern side of Islesboro (Mullen Head). Similarities in migration path continued though the outer array. Higher percentages of successful smolts exited via Owls Head (outermost western array), 75.0 % (15/20) naturally reared, 71.4 % (5/7) fall parr and 87.2 % (34/39) hatchery reared, versus the Mullen Head and Eggemoggin Reach (outermost eastern array). A total of 67 smolts with transmitters were documented exiting Penobscot Bay and entered the Gulf of Maine. There were no smolts detected by the GoMOOS telemetry array in 2008 but given the sparse nature of this network this was not unexpected. However, the OTN Halifax array (Figure 7.4.1) detected 23 smolts (15% of overall total and 34% of those detected in outer PN Bay) with the first fish detection on June 11th and the last June 23rd. The median days at large (last detection at Penobscot outer array to first detect at Halifax) for smolts was 26.44 (± 4.15) days.

Figure 7.4.1 Map showing the location of the Penobscot Telemetry Array and the Halifax Array.



7.5 Parr Subsidy of Hatchery Return Rates, Penobscot River, Maine

Atlantic salmon parr are stocked each fall as a byproduct of the Green Lake National Fish Hatchery's (GLNFH) yearling smolt program. These fall parr constitute 29 – 42% of advanced juvenile hatchery products (parr and smolts) stocked in the Penobscot River, Maine. This statistic excludes fry and adult stocking. Since 2002, 75% of all smolts and fall parr stocked were unmarked (Table 7.5.1). Seventy nine percent of all parr stocked were unmarked and 73% of all smolts were unmarked. Past calculations of return rates have credited all unmarked hatchery returns to the unmarked smolt stocking (Figure 7.5.1). This was under an assumption of negligible contributions of fall parr. This assumption is violated and recent information indicated that it discounts the contribution of unmarked fall parr to adult returns and overestimates the smolt return rate.

The question of fall parr contributions to adult returns was brought to the forefront because of a bimodal distribution of postsmolts observed in the Penobscot Bay postsmolt trawl in the early 2000's. This was coincidental with parr stocking events in the lower Penobscot River. Because of this finding, a sample of fall parr has been marked to determine adult returns from these fall parr starting in 2003. Originally, marked parr were released in the lower river but other management/assessment needs resulted in marked parr also being released in the Pleasant River, a Penobscot tributary. Most parr assessment is now focused in that area of the watershed. In 2008, 42 adult returns to the Veazie adult trap were from known parr stockings. The returns of marked parr represent only one specific hatchery product and stocking location, and are not representative of all parr stocked. In the past, fall parr stocked fish were primarily a graded product - a selective sorter was used to passively grade fish. Larger fish were retained for additional hatchery rearing and stocking the following spring as 1+ smolts. Smaller fish were stocked in September at age 0+ as fall parr. However, there has been a transition away from grading and toward managing hatchery production by releasing full pools of ungraded fish in the fall. As a result, the size distribution of fall parr currently released into the Penobscot River differs from the historical size distribution of fall stocked parr.

In recent years, marked fall parr are typically a graded product (34-35 per pound), while the balance of autumn stockings are a mix of small and large (pre-smolts) parr (14 – 42 per pound). Marked parr were stocked in the Pleasant drainage while the balances were stocked in the Piscataquis drainage and the main stem.

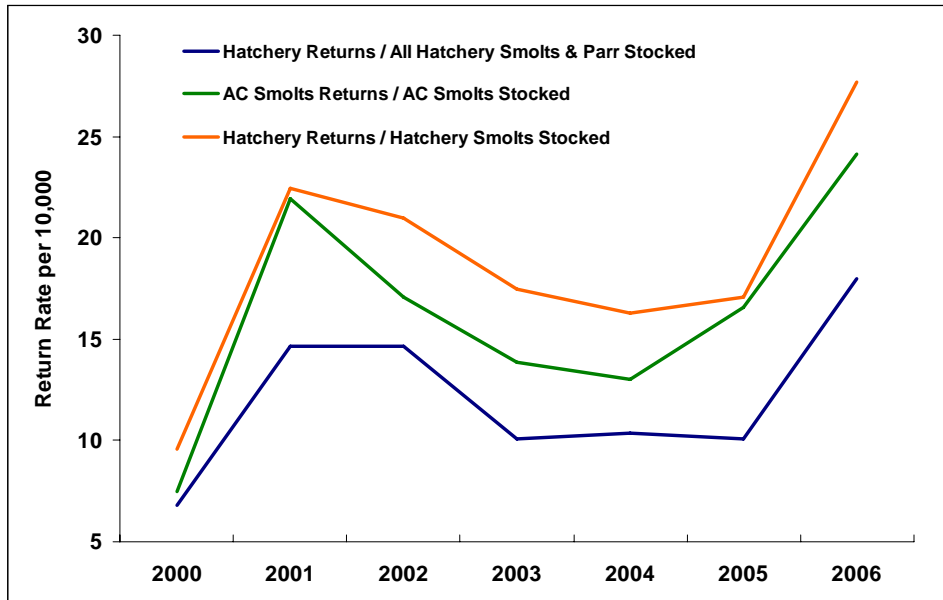
Size and stocking location influences life history characteristics of the parr, subsequent age at migration, and return rates. Known return rates are therefore useful to estimate the contributions of graded marked parr, but cannot be used to pro-rate unmarked parr contributions to overall hatchery returns. In an effort to understand the contribution of parr to adult returns and to assess management, it is necessary to partition return rates by stocking groups. Possible solutions include a change in marking schemes and/or marking groups of parr that are representative of the majority of fall stocking.

Table 7.5.1 Percent marked and unmarked Atlantic salmon smolt and parr stocked on the Penobscot River, Maine.

Stock Year	Combined			Smolts			Parr*		
	Total	Unmarked	Marked	Stocked	Unmarked	Marked	Stocked	Unmarked	Marked
2000	794,300	78%	22%	563,200	69%	31%	231,100	100%	0%
2001	833,500	79%	21%	544,000	68%	32%	289,500	100%	0%
2002	784,900	78%	22%	547,000	68%	32%	237,900	100%	0%
2003	945,838	76%	31%	547,300	77%	36%	398,538	75%	25%
2004	888,807	74%	34%	566,007	77%	36%	322,800	69%	31%
2005	899,798	71%	37%	530,616	81%	33%	369,182	57%	43%
2006	844,553	68%	32%	549,200	69%	31%	295,353	67%	33%
2007	853,419	71%	29%	559,919	74%	26%	293,500	66%	34%
Average	855,639	75%	28%	550,905	73%	32%	304,734	79%	21%

*Parr are Stocked the previous fall (Stock Year -1)

Figure 7.5.1 Penobscot River, Maine, adult return rates per 10,000 hatchery smolts and parr stocked.



7.6 Sampling Design for the Gulf of Maine DPS

This work follows discussion from the 2008 meeting where sampling design and the benefits of random and fixed, non-random sites were discussed. The outcome of this was that fixed sites allow trend detection, while dispersed, random sites capture spatial distribution and abundance. Discussion also addressed stratification, and combining fixed and random site sampling designs. The work presented here addresses these issues with a rigorous approach to creating spatially stratified random samples at a programmatic level. The focus of this work is the Gulf of Maine DPS but this technique could be equally useful in other regions and scales.

Sampling natural systems for management requires unbiased and spatially-distributed sampling. Sampling must balance trend and status data collection goals, and should allow for greater emphasis (sampling) effort within certain areas depending on needs of biologists and managers. Sampling must be flexible to allow un-sampled sites to be accounted for, and to add sites as needed. Collecting data under a unified probability sampling plan with standardized protocols will greatly increase statistical power for the same level of sampling effort, allowing biologists to more powerfully analyze large spatial and temporal trends and status.

Such surveys are constructed using the following: 1) Objectives, the population attributes must be clearly defined, 2) The Sampling Frame defines the domain from which samples are drawn (e.g. the river network or collection of all river networks in the state), 3) Multi-density categories are attributes of the frame that allow the sampling design to specify sampling effort based on the attribute (such as stream order), 4) Stratification allows the frame to be divided into units of interest for sampling, and strata may have differing sampling designs based on needs, 5) Panels allow the sampling design to incorporate multi-year designs so rotating samples may be used, and 6) Oversample allows the sampling design to specify “extra” samples that can be used if needed.

We used the `spsurvey` package for R, developed by the US Environmental Protection Agency Environmental Monitoring and Assessment Program (<http://www.epa.gov/nheerl/arm/analysispages/software.htm>). This package allows the creation of generalized random-tessellation stratified sampling designs (GRTS), where random samples are regularly distributed in space with known inclusion probabilities. Such samples are compatible with standard statistical methods, but statistical methods that take advantage of inclusion probability may also be used. We developed strata within the GOM DPS, used USGS NHD High GIS data as our sampling frame, and developed sampling designs in R. These designs can be readily edited to accommodate alternative sampling needs.

We chose to sample at least 5-10 sites per strata statewide based on the power analysis described below. This amount of sampling effort will provide 80% power in detecting a trend in the index of abundance for annual rates of change between 0.1 and 0.2 (Figure

7.6.1), (J. Sweka, J. Trial, and J. Kocik, draft White Paper on Atlantic Salmon Stock Assessment Status and Needs, April 7, 2008.).

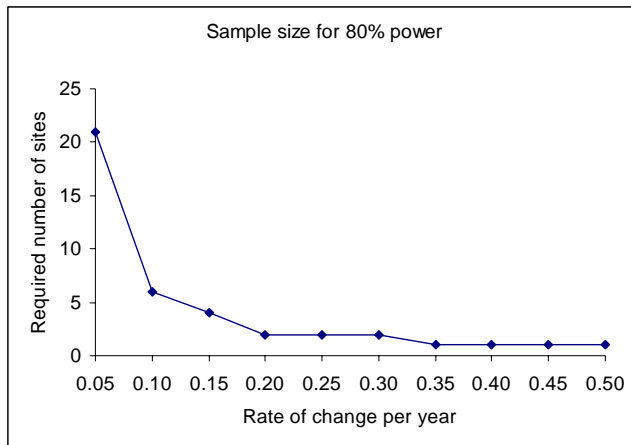


Figure 7.6.1 Electrofishing population estimate samples needed to detect a rate of change in parr density.

Development of Sampling Design

The following represents an example of juvenile Atlantic salmon probability sample for the GOM DPS. The map in Figure 7.6.2 shows a sampling design with five annually visited sites per strata, with an additional set of three rotating panels of five sites per year. This provides ten sites per year per stratum, with a total of 20 sites sampled after three years. The samples are also distributed across three stream width categories: 0-12 m, 12-24 m, and >24 m. An over-sample was generated to account for additional sites if needed.

This same sampling design can be used for other sampling needs, such as randomly identifying reaches, streams or sites to conduct water quality, water temperature, habitat attribute survey, or redd surveys. Sites must simply be chosen in order within a stratum to conform to the random sample design. This offers flexibility and compatibility with complementary sampling efforts.

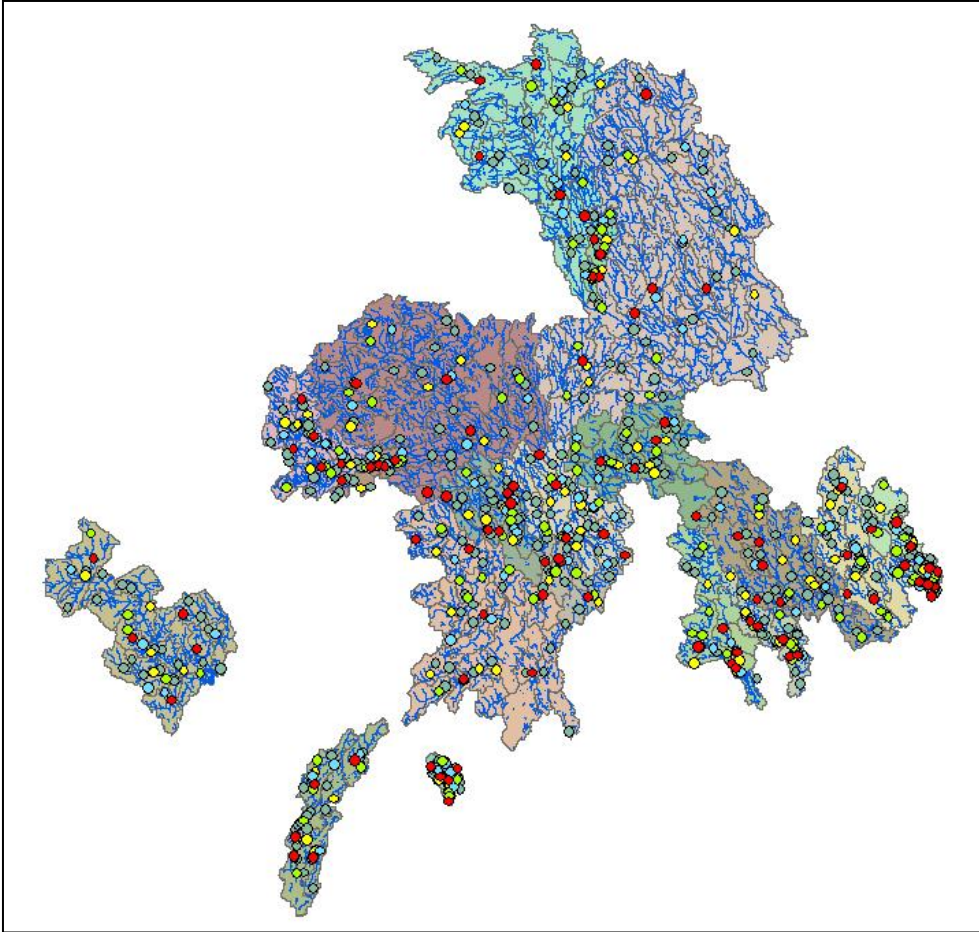


Figure 7.6.2 Multi-year panel probability sampling design for juvenile Atlantic salmon assessment in the GOM DPS.

Further work will be done to create and refine objectives, population definition, sampling frame and design, and implementation of the sampling design. This will be presented as an emerging issue at the 2010 meeting.

7.7 USASAC Draft Terms of Reference 2010

The purpose of this section is to outline potential terms of reference identified at the USASAC annual meeting in March to start an outline for refinement at our summer teleconference.

- 1) Suspected ICES and ICES Requests (TOR document pending)
 - a. NASCO Rivers Database
 - b. Marine Survival
 - c. Marine Survival – biological characteristics
- 2) Fish Health
 - a. Status of Biosecurity Improvements throughout New England (RCNFH standard?)
 - b. Update on emerging disease threats
- 3) Conservation Spawning Escapement Targets
 - a. Time to revisit since there are revised habitat estimates and recovery regions?
 - b. Minimally need to revisit historical documents for specific details
- 4) Smolt Parr-Subsidy Issue
 - a. Intercession Study Group – info on grading over time from FWS, data sets of known origin – marked fish, potential of scale and feasibility of complete marking.
- 5) Random sampling Designs – progress update
- 6) Return Rates for Atlantic salmon stocked as Fry in Maine River
 - a. Continue to refine juvenile database
 - b. Add Maine fry stocking vis-à-vis Tables 18.1-18.6
 - i. Need to develop a redd-based subsidy
- 7) Stock Assessment
 - a. Red Based Estimate Benchmark Year 2010
 - b. New England Smolt Summary Benchmark Year 2011 – develop specific TOR
- 8) Suggested Speakers and/or Topics
 - a. Letcher group production model
 - b. Bean/Pruden – NASCO Aquaculture Production Focus Topic
 - c. Bean/Bartron - update on Genetic Mark program to USASAC

8.0 Appendices

8.1 List of Attendees

<u>First Name</u>	<u>Last Name</u>	<u>Primary Email</u>	<u>Agency</u>	<u>Location</u>
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Joan	Trial	Joan.Trial@maine.gov	ME	Bangor, ME

8.2 List of Program Summary and Technical Working Papers including PowerPoint Presentation Reports.

Number	Authors	E-mail Address	Title
BK09-01	Tim Sheehan	Tim.Sheehan@noaa.gov	ICES Request 2009
BK09-02	Tim Sheehan	Tim.Sheehan@noaa.gov	WGNAS TOR 2009
BK09-03	Jessica Pruden	Jessica.Pruden@noaa.gov	USA NASCO Section 2008 Summary and Focus Area Report on Protection, Restoration and Enhancement of Salmon Habitat
PS09-01	Veronica Masson	veronica.masson@dem.ri.gov	Pawcatuck River Atlantic salmon restoration, 2008 (WP)
PS09-02	Jay McMenemy	Jay.McMenemy@state.vt.us	Connecticut River Atlantic salmon restoration, 2008 (WP, PPT)
PS09-03	Joseph McKeon	Joe_McKeon@fws.gov	Merrimack River Atlantic salmon restoration, 2008 (WP, PPT)
PS09-04	Joan Trial	Joan.Trial@maine.gov	Maine Atlantic salmon restoration, 2008 (WP, PPT)
WP09-01	Christine Lipsky James Hawkes Ruth Haas-Castro Peter Ruksznis Oliver Cox Mitch Simpson Randy Spencer Joan Trial	Christine.Lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smolt Studies: 2008 (WP)
W09-02	James Hawkes Graham Goulette John Kocik Paul Music	James.Hawkes@noaa.gov	Update on NOAA Fisheries Service Coastal Maine River Atlantic Salmon Smolt Telemetry Studies: 2008 (WP)
WP09-03	Steve Gephard	Steve.Gephard@ct.gov	Update on the NASCO River Database 2009 (WP)

Number	Authors	E-mail Address	Title
WP09-04	Dave Bean John Sowles Jon Lewis	David.Bean@noaa.gov	Update on Aquaculture Activities (WP)
WP09-05	John Sweka Bill Fletcher Mike Millard Ken Gillette	John_Sweka@fws.gov	Population Model to evaluate alternative stocking strategies (PPT)
WP09-06	Oliver Cox	Oliver.N.Cox@maine.gov	Penobscot Smolt Returns, 1969-2005 (PPT)
WP09-07	Bill Fletcher John Sweka		Cronin Biosecurity (PPT)
WP09-08	Jessica Pruden	Jessica.Pruden@noaa.gov	NASCO 2009 (PPT)
WP09-09	Tim Sheehan	Tim.Sheehan@noaa.gov	2009 Preview ICES TOR and Workshops (PPT)
WP09-10	Rory Saunders	Rory.Saunders@noaa.gov	US FAR Habitat (WP)
WP09-11	Tim Sheehan	Tim.Sheehan@noaa.gov	2008 Review ICES WGNAS Meeting Summary (PPT)
WP09-12	John Sweka	John_Sweka@fws.gov	USASAC Database Status (PPT)
WP09-13	Greg Mackey Ben Naumann	Greg.Mackey@maine.gov	LWD Survey Work (PPT)
WP09-14	Greg Mackey	Greg.Mackey@maine.gov	Spatially Balanced Sampling (PPT)
WP09-15	Greg Mackey Joan Trial Oliver Cox	Greg.Mackey@maine.gov	Penobscot River plan (PPT, WP)
WP09-16	Christine Lipsky Ed Hastings Russell Brown Richard Dill	Christine.Lipsky@noaa.gov	Correcting VIE tag ID (WP)
WP09-17	Ernie Atkinson	Ernie.Atkinson@maine.gov	Explanation of Determination of Spawner Survey Coverage by Drainage

8.3 Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Bureau of Sea Run Fisheries and Habitat	BSRFH
Central New England Fisheries Resource Office	CNEFRO
Connecticut River Atlantic Salmon Association	CRASA
Connecticut Department of Environmental Protection	CTDEP
Connecticut River Atlantic Salmon Commission	CRASC
Craig Brook National Fish Hatchery	CBNFH
Decorative Specialities International	DSI
Developmental Index	DI
Distinct Population Segment	DPS
Federal Energy Regulatory Commission	FERC
Geographic Information System	GIS
Greenfield Community College	GCC
Green Lake National Fish Hatchery	GLNFH
International Council for the Exploration of the Sea	ICES
Kensington State Salmon Hatchery	KSSH
Maine Atlantic Salmon Commission	MASC
Maine Department of Marine Resources	MDMR
Maine Department of Transportation	MDOT
Massachusetts Division of Fisheries and Wildlife	MAFW
Massachusetts Division of Marine Fisheries	MAMF
Nashua National Fish Hatchery	NNFH
National Academy of Sciences	NAS
National Hydrologic Dataset	NHD
National Oceanic and Atmospheric Administration	NOAA
National Marine Fisheries Service	NMFS
New England Atlantic Salmon Committee	NEASC
New Hampshire Fish and Game Department	NHFG
New Hampshire River Restoration Task Force	NHRRTF
North Atlantic Salmon Conservation Organization	NASCO
North Attleboro National Fish Hatchery	NANFH
Northeast Fisheries Science Center	NEFSC
Northeast Utilities Service Company	NUSCO
Passive Integrated Transponder	PIT
PG&E National Energy Group	PGE
Pittsford National Fish Hatchery	PNFH
Power Point, Microsoft	PPT
Public Service of New Hampshire	PSNH
Rhode Island Division of Fish and Wildlife	RIFW
Richard Cronin National Salmon Station	RCNSS
Roger Reed State Fish Hatchery	RRSFH
Roxbury Fish Culture Station	RFCS
Salmon Swimbladder Sarcoma Virus	SSSV

Silvio O. Conte National Fish and Wildlife Refuge	SOCNFWR
Southern New Hampshire Hydroelectric Development Corp	SNHHDC
Sunderland Office of Fishery Assistance	SOFA
University of Massachusetts / Amherst	UMASS
U.S. Army Corps of Engineers	USACOE
U.S. Atlantic Salmon Assessment Committee	USASAC
U.S. Generating Company	USGen
U.S. Geological Survey	USGS
U.S. Fish and Wildlife Service	USFWS
U.S. Forest Service	USFS
Vermont Fish and Wildlife	VTFW
Warren State Fishery Hatchery	WSFH
White River National Fish Hatchery	WRNFH
Whittemore Salmon Station	WSS

8.4 Glossary of Definitions

GENERAL

Domestic Broodstock	Salmon that are progeny of sea-run adults and have been reared entirely in captivity for the purpose of providing eggs for fish cultural activities.
Freshwater Smolt Losses	Smolt mortality during migration downstream, which may or may not be ascribed to a specific cause.
Spawning Escapement	Salmon that return to the river and successfully reproduce on the spawning grounds.
Egg Deposition	Salmon eggs that are deposited in gravelly reaches of the river.
Fecundity	The number of eggs a female salmon produces, often quantified as eggs per female or eggs per pound of body weight.
Fish Passage	The provision of safe passage for salmon around a barrier in either an upstream or downstream direction, irrespective of means.
Fish Passage Facility	A man-made structure that enables salmon to pass a dam or barrier in either an upstream or downstream direction. The term is synonymous with fish ladder, fish lift, or bypass.
Upstream Fish Passage Efficiency	A number (usually expressed as a percentage) representing the proportion of the population approaching a barrier that will successfully negotiate an upstream or downstream fish passage facility in an effort to reach spawning grounds.
Goal	A general statement of the end result that management hopes to achieve.
Harvest	The amount of fish caught and kept for recreational or commercial purposes.

Nursery Unit / Habitat Unit	A portion of the river habitat, measuring 100 square meters, suitable for the rearing of young salmon to the smolt stage.
Objective	The specific level of achievement that management hopes to attain towards the fulfillment of the goal.
Restoration	The re-establishment of a population that will optimally utilize habitat for the production of young.
Salmon	A general term used here to refer to any life history stage of the Atlantic salmon from the fry stage to the adult stage.
Captive Broodstock	Captive broodstock refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.
Sea-run Broodstock	Atlantic salmon that return to the river, are captured alive, and held in confinement for the purpose of providing eggs for fish culture activities.
Strategy	Any action or integrated actions that will assist in achieving an objective and fulfilling the goal.
Wild Atlantic Salmon	Salmon that are the product of natural reproduction or the stocking of fry. Stocked fry are included because of the difficulty associated with discriminating between salmon produced through natural reproduction and those produced as a result of the stocking of fry.

LIFE HISTORY RELATED

Green Egg	The stage from spawning until faint eyes appear.
Eyed Egg	The stage from the appearance of faint eyes until hatching.
Fry	
Sac Fry	The period from hatching until end of primary dependence on the yolk sac.
Feeding Fry	The period from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Fed Fry	Fry stocked subsequent to being fed an artificial diet. Often used interchangeably with the term “feeding fry” when associated with stocking activities.
Unfed Fry	Fry stocked without having been fed an artificial diet or natural diet. Most often associated with stocking activities.
Parr	Life history stage immediately following the fry stage until the commencement of migration to the sea as smolts.
Age 0 Parr	The period from August 15 to December 31 of the year of hatching.
Age 1 Parr	The period from January 1 to December 31 one year after hatching.
Age 2 Parr	The period from January 1 to December 31 two years after hatching.
Parr 8	Parr stocked at age 0 that migrate as 1 Smolts (8 months spent in freshwater).
Parr 20	Parr stocked at age 0 that migrate as 2 Smolts (20 months spent in freshwater).

Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
1 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	The period from July 1 to December 31 of the year the salmon became a smolt.
1SW Smolt	A salmon that survives past December 31 since becoming a smolt.
Grilse	A one-sea-winter (SW) salmon that returns to the river to spawn. These fish usually weigh less than five pounds.
Multi-Sea-Winter Salmon	All adult salmon, excluding grilse that return to the river to spawn. Includes terms such as two-sea-winter salmon, three-sea-winter salmon, and repeat spawners. May also be referred to as large salmon.
2SW Salmon	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31 four times since becoming a smolt.
Kelt	A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild

fish, this stage lasts until it returns to homewaters to spawn again.

Reconditioned Kelt

A kelt that has been restored to a feeding condition in captivity.

Repeat Spawners

Salmon that return numerous times to the river for the purpose of reproducing. Previous spawner.

8.5 Abstracts from Regional Atlantic Salmon Assessment Committee Meeting

During the summer of 2007, the USASAC determined that with the information technology available, there was no longer a need to assemble research abstracts through solicitation with all Atlantic salmon researchers in New England. With on-line searching capacity and e-mail communications, that produce was no longer of great utility. However, there are two annual Atlantic salmon meeting that are widely attended regionally. First, the Connecticut River Atlantic Salmon Commission holds a Connecticut River Migratory Fish Restoration Forum biannually (odd years). In Maine, NOAA organizes a workshop - Maine Atlantic Salmon and their Ecosystems Forum (MASEF) also biannually in even years. Because these workshops complement each other but draw primarily from either southern New England or Maine depending on location, the committee felt there was utility in disseminating meeting information in the form of the abstracts for those meetings.

8.5.1 Connecticut River Atlantic Salmon Commission Migratory Fish Restoration Research Forum (2009 Meeting 11 February 2009)

Diadromous Species Restoration Research Network (DSRRN): A New Five-year Collaborative Effort.

A.A. Elskus¹, K. Wilson², P. Vaux³, D. Hart³, and J. Trial⁴

¹U.S. Geological Survey, S.O. Conte Anadromous Fish Research Lab, Maine Toxicology Section, University of Maine, Orono, ME 04469; ²Aquatic Systems Group, University of Southern Maine, Portland, ME 04101; ³Mitchell Center for Environmental & Watershed Research, University of Maine, Orono, ME 04469; ⁴Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, 650 State Street, Bangor, ME 04401

Diadromous fish populations are undergoing steady declines in the US leading to threatened and endangered listings. The central goal of the Diadromous Species Restoration Research Network (DSRRN) is to leverage, expand, and integrate the diverse array of research and management activities focused on the restoration of diadromous fish species in ways that improve ecological understanding and enhance restoration outcomes. The strength of the DSRRN is its connection to and integration with the Penobscot River Restoration Project (Maine), the most ambitious restoration effort ever proposed for a watershed of this size. Within this context unparalleled opportunities exist to study questions fundamental to diadromous fish ecology and restoration, including: the role of diadromous fish in marine-freshwater linkages, the interdependency of co-evolved diadromous species, multi-species interactions in a restoration context, and the effects of multiple stressors on restoration results. DSRRN will work to coordinate the overlapping/interconnected research efforts of academic, government, tribe and watershed stakeholders, provide administrative structure, and support data management. This grant will support two scientific meetings to identify critical research areas in multi-species restoration (Year 1) and synthesize outcomes (Year 5), and three interactive workshops targeting critical research topics (Years 2, 3 and 4). We anticipate at least one synthesis paper per workshop and several master's

theses focused around workshop topics and diadromous species. The issue of diadromous fish restoration is complex and it is only through a broad collaborative approach drawing on data and knowledge from other systems, worldwide, that progress may be achieved and mis-steps minimized. Through RCN-facilitated research partnerships that place mission-driven restoration efforts in an integrated science context, key basic and applied research needs can be identified that might otherwise be overlooked. By actively engaging stakeholders, the RCN will facilitate public understanding of the critical role that science plays in guiding ecological restoration.

More on the Development and Testing of Bioindicator-Based Stated Preference Valuation of Aquatic Resources. Robert J. Johnston¹, Eric T. Schultz², K. Segerson³, and E.Y. Besedin⁴

¹George Perkins Marsh Institute and Department of Economics; ²Clark University, Worcester, MA 01610; ²Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269-3043; ³Department of Economics, University of Connecticut, Storrs, CT 06269-1063; ⁴Abt Associates, 55 Wheeler St., Cambridge, MA 02138

Determining the value of improvements to ecological services, such as the restoration of fish passage, has become an increasingly important component of many environmental policy and program decisions. A widely used approach to valuation of ecological services employs stated preference (SP) survey techniques to estimate willingness to pay (WTP) for those services, or for marginal changes to those services resulting from policy interventions. Typically SP surveys represent ecological systems in metrics that are poorly referable to attributes that would be used by ecologists. In such cases the results of the survey are of limited use. We present a novel approach to more appropriately model and communicate aquatic ecosystem change within SP valuation, focused on restoration of diadromous fish migrations. Survey results quantify tradeoffs the public is willing to make in the design of restoration alternatives, and identify the direct and indirect ecological outcomes of restoration that are most highly valued.

Large New England Rivers Project: Upper Connecticut River Survey

Bryan Apell

Kleinschmidt Associates, 35 Pratt Street, Suite 201, Essex, CT 06426

Kleinschmidt Associates (Kleinschmidt) and the Midwest Biodiversity Institute (MBI) (Principal Investigator) conducted a fish assemblage survey in the mainstem of the upper Connecticut River, from the First Connecticut Lake (New Hampshire) downstream to just above Turners Falls, MA. The data collected will be used to investigate the relative abundance and distribution of fish assemblages in relation to an accompanying qualitative habitat assessment and prevailing summer water quality of the Connecticut River. A total of 48, 1-km sections of Connecticut River mainstem were sampled utilizing pulsed D.C. boat electrofishing techniques during August and September, 2008. Sample locations were strategically located using an intensive pollution survey design (Yoder et al. 2005b) in areas of potential sources of pollution, key tributary

confluences, and in reaches of contrasting habitat quality (e.g., free-flowing riverine, impoundments, other hydrologic modifications). Few quantitative large-scale river fish assemblage surveys have been conducted in New England to date; the majority of studies have been conducted in the relatively species rich, warm water rivers of the Midwestern U.S. The aim of this study was to adapt the proven techniques developed in the Midwest to the relatively depauperate fish assemblages found in large, non-wadeable New England rivers. The Kleinschmidt/MBI team conducted a multi-year study in 2002-2007, to develop a regionalized application of large non-wadeable river bioassessment methods. These techniques have been utilized in a state-wide investigation in Maine and have demonstrated the applicability of a standardized, single-gear sampling protocol (Yoder et al. 2005a, 2006). In 2008, the project was adapted and expanded to include the mainstem of the upper Connecticut River. The purpose of this presentation is to summarize the methods and status of this program.

Passage of Lake Sturgeon and Riverine Fishes in a Spiral Side-Baffle Fish Ladder

Boyd Kynard and Don Pugh

Conte Anadromous Fish Research Center, USGS, Turners Falls, MA 01376

During three fall and three spring seasons, we observed the behavior, ascent, and descent of cultured lake sturgeon and wild riverine fishes in a spiral side-baffle fish ladder. During one spring and two fall periods, fish were tested in a 1-loop spiral, a 2-loop spiral was used in other tests. The spiral ladder was built on a 6% slope (1 ft rise/16 lineal ft) and had the following characteristics: 39 in wide channel on a 20 ft diameter circle resulting in 50 lineal ft per loop and a vertical rise per loop of 39 in (2-loop = 8 ft rise). Side-baffles, which alternated along the inside and outside walls of the channel, created a sinusoidal current and provided resting areas for fish: behind outside baffles for sturgeons or behind inside and outside baffles for riverine fish. Velocity at 2-loop baffle slots was 90–122 cm/s. Lake sturgeon were not migratory during tests, so initially, they were motivated to ascend the ladder by touching, crowding, or a mild electrical shock. No motivation technique improved performance. Fish were then kept in the introduction section of the ladder for an extended time (1–3 d) allowing volitional movement. Ascent of lake sturgeons in the 2-loop ladder ranged from 46 to 73% of the 22 fish tested. However, six fish (27%) never swam to the top in any 2-loop test. If these fish are removed, then the passage of fish with the potential to pass upstream ranged from 63 to 100%. Most upstream movement of sturgeons was at night, as it was for many riverine fishes. Sturgeons and riverine fishes moved to the top, and then downstream, and later returned to the top, showing they could move in the ladder without injury or loss of motivation to swim upstream. In wild populations of lake sturgeon, juveniles and adults migrate, and tests with these two life intervals (adult mean TL = 140 cm) showed similar results. Seven riverine species also ascended the ladder. The prototype side-baffle ladder shows promise for passing diverse species with a moderate swimming ability.

Break

Migratory Energetics of American Shad (*Alosa sapidissima*), an Iteroparous Anadromous Fish

Ted Castro-Santos and Ben Letcher

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The purpose of this presentation is to explore the importance of various aspects of the freshwater migration of adult American shad (*Alosa sapidissima*) on spawning success and survival. We present an individual-based model, in which migrants ascend the Connecticut River, spawn, and return to the marine environment. Our approach is integrative, incorporating data and assumptions of bioenergetics, reproductive biology, and behavior to improve our understanding of the effects of migratory distance and delays incurred at obstacles on distribution, spawning success, and survival. The model is complex, incorporating 66 fixed and varying covariates. We quantify the uncertainty within and among these covariates' effects, exploring both how they are likely to affect performance over a range of expected values, and how the uncertainty associated with each covariate influences its predicted effects. Migratory and reproductive behavior, physiology, and energetics strongly affected both the distribution of spawning effort and the likelihood of survival to the marine environment. Delays at dams (to both up- and downstream migrations) had dramatic effects on spawning success, driving a) total fecundity and its variance; and b) spatial extent of spawning. Delays, combined with cues for migratory reversal also determined the likelihood of survival to the marine environment. Spawning was largely restricted to the immediate vicinity of dams and increased with increased migratory distance and delays to downstream migration. More research is needed on reproductive biology, behavior, energetics, and barrier characteristics to adequately understand the interplay of the various components of this model; it does provide a framework, however, that suggests that provision of upstream passage at dams in the absence of expeditious downstream passage may increase spawning success – but at the expense of reduced iteroparity.

Recent activities of the Northeast Fishery Center in the Connecticut River Basin.

Bill Fletcher

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The Northeast Fishery Center (NEFC) Complex consists of the Lamar Fish Health Center, Lamar Fish Technology Center, Lamar National Fish Hatchery, Conservation Genetics Laboratory and Population Ecology Section. The Center's mission is to develop and transfer technology and scientific expertise in the fields of fish culture, fish health, population monitoring & assessment, and conservation genetics. The NEFC has recently or is currently participating in a number of collaborative efforts with partners in the Connecticut River Basin.

Fish Health Center work included: fish health inspections, biosecurity plan development, wild fish health surveys, pathogen screening for emerging threats such as Infectious Salmon Anemia virus and *Nucleospora salmonis*, and Atlantic salmon (ATS) immunization programs.

In 2008 the NEFC Conservation Genetics (CG) Laboratory began the transition of genotyping efforts for ATS sea-run genetic conservation breeding program from Conte Anadromous Fish Laboratory. The CG Lab is also assisting in the revision of the CRASC Atlantic Salmon Broodstock Management Plan. The CG Lab is investigating potential inheritance of “shark jaw” deformity of F2 Atlantic salmon broodstock. Additional studies in the Connecticut River basin include characterizing the genetic diversity of brook trout in Nash Stream both spatially throughout the drainage and related to potential effects of barriers to genetically isolate populations. A separate study is underway to assess bioelectric impedance analyses as a non-lethal fish condition assay for Atlantic salmon and lake trout.

The Fish Technology Center is evaluating calcein as a non-lethal mark which may be applied to ATS juveniles and identified in adult returns. Techniques for ATS milt cryopreservation were conducted for both small lot and production scale fertilizations. Additionally the Tech Center has assisted in efforts to reduce fishery program risks resulting from the 2007 discovery of *Didymosphenia geminata* in the Connecticut River drainage and the isolation of Infectious Pancreatic Necrosis virus at Richard Cronin National Salmon Station.

Possible Effects of Global Climate Change on Coldwater Resources in Massachusetts: A Draft Habitat Vulnerability Evaluation

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There is now general consensus that Global Climate Change due to anthropogenic carbon dioxide emissions is occurring. Using projections of future climate from recent modeling studies (e.g., Hayhoe et al., 2006) the Massachusetts Division of Fisheries and Wildlife is developing “Vulnerability Evaluations” for specific habitat types in the Commonwealth.

We are evaluating the possible effects of two future climate scenarios. A lower emissions scenario in which it was assumed that atmospheric CO₂ levels by the end of the century would be double those of pre-industrial levels. Under this scenario mean annual air temperature would increase by approximately 5-8°F. A high emissions scenario in which it was assumed that atmospheric CO₂ levels by the end of the century would be triple those of pre-industrial levels. Under this scenario mean annual air temperature would increase by 8-12°F. Under both scenarios there will also be significant changes in precipitation and snow and ice cover that will affect the physical, chemical and biological properties of freshwater ecosystems in the Commonwealth, with predominantly adverse impacts on many individual freshwater species, community composition, and water quality.

Vulnerability scores for each habitat type were derived based on projected percent loss of habitat under the two climate scenarios. We also assigned a confidence level to each score to reflect the degree of confidence we have in these predictions. Draft Habitat Vulnerability Scores for Coldwater Resources in Massachusetts and the rationale used to develop them will be discussed.

Lunch

Migration Timing of Atlantic Salmon Smolts from Smith Brook, VT: Implications for the Impacts of Climate Change

Stephen D. McCormick

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Advances in passive integrated transponder (PIT) tag technology offer the opportunity to locate and individually identify large numbers of fish without disrupting their natural habitat choice, activity, and behaviors. Using 23 mm TIRIS PIT tags that permit large read ranges (2 m), we have developed a method for passively monitoring downstream migration and movement of juvenile Atlantic salmon in the natural environment with only one initial handling. Estimates of detection efficiency using dummy tags and tagged hatchery smolts indicate that detection efficiency is 93-100%. Each autumn from 1998-2007, we PIT tagged 302-460 fry-stocked parr (9-17 cm fork length; 1+- and 2+-year olds) from Smith Brook, VT (a tributary of the Connecticut River) and continuously monitored their downstream movement. Each fall there was a substantial downstream movement of parr (5-20% of fish tagged that fall), with relatively little movement in winter and summer. The smolt migration began in mid-March and ended in mid-May, with 90% occurring between April 20 and May 12. The median date of smolt migration varied by only 12 days between 1999 and 2008. There was no obvious effect of flow on the median date of migration timing, though within some years there were increased numbers of fish with increased flow. There was a significant relationship between migration timing and stream degree days in April; cooler temperature resulted in a later median date of migration. Laboratory studies indicate that photoperiod can have a strong influence on smolt migration. The relative importance of photoperiod and temperature in controlling smolt migration will be critical in determining the response of Atlantic salmon populations to future warming events.

Timing of Downstream Migration of Atlantic Salmon Smolts: A Modeling Approach

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To understand the interaction of river conditions, dams, timing of Atlantic salmon smolt migration, and smolt success, we used temperature and discharge data from the Connecticut River as a template upon which we simulated downstream migration of smolts. We asked: first, given the present highly altered state of the flow of the river, what would be the consequence to smolt success of leaving at any given temperature or date, regardless of tributary, as compared to tributary-specific cues? Second, how do the presence of dams interact with migration timing to affect survival? Our results demonstrated the river temperatures at which smolts initiated their migration affected modeled smolt survival differentially across tributaries. The success of smolts

from upstream tributaries was highly variable across years, while smolts originating closer to the estuary were less affected by annual fluctuations in river temperatures. Dams potentially have a direct effect on survival as well as an indirect effect by delaying smolts until temperatures downstream reach lethal or near-lethal temperatures. Our simulations show that this indirect effect is at least as important as the direct effect in determining smolt downstream migration success in the presence of dams. Our approach has also identified several data needs relative to understanding variation in smolt survival (e.g., responses to high and low temperatures, how long fish are delayed at dams).

Atlantic Salmon Growth Modeling

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Individual growth can be affected by both abiotic (environmental variation) and biotic (population density) factors. Analysis of a long term data set from the West Brook, MA, USA using generalized linear models allowed us to estimate the effect of environmental variation (stream flow and water temperature) on Atlantic salmon growth rates. Growth rates corresponding to each season were calculated for fish that were recaptured during consecutive electrofishing sampling occasions. Our analysis found that Atlantic salmon growth rates were affected by environmental variation and were density dependent. Salmon growth rates declined with increasing salmon biomass and were also affected by the biomass of the other salmonids present in the West Brook. Additionally we found an interaction between stream discharge and biomass with the strength of the density dependent relationship affected by stream discharge. Our results highlight that density dependence is affected by environmental conditions.

Break

A watershed-scale assessment of proportional representation and migration timing of smolts stocked in known regions above Cabot Station.

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To date, it has been difficult to assess the relative production and migration timing of smolts from the many drainages in the Connecticut River basin because tagging large numbers of stocked fry has not been practical. Working with hatchery managers and personnel from the

states starting in 1997, we implemented a genetic identification program that allows assignment of large numbers of fry to stocking batches (regions). In 2002, seven batches of fry (grandoffspring from the 1997 return year) were stocked into seven regions of the Connecticut River above the Turners Falls dam. In total, about three million identifiable fry were stocked above Turners Falls in 2002 (57% of total stocked fry). Then, in the spring of 2004, 1300 smolts (age-2⁺) were sampled from the Cabot bypass at the Turners Falls dam. In addition, we genotyped the 209 adult returns from 2006, 137 of which could have been produced in our making program (2+ smolt/2-Sea Winter). Overall, 30% of the Cabot smolts and 10% of the 2006 returns were assigned back to a stocking batch, compared to expectations of 57% (smolts) and 30% (returns)(based on the ratio of identifiable fry/total fry, equal survival between fish in batches and ‘unallocated’ fish, and smolt and sea-winter ages). Out of three pulses of smolts that were generally related to river discharge, fish from further north tended to have higher proportions in the later pulses compared to the earlier pulses. Fish lengths did not vary substantially among regions, except the Millers River and the Saxtons River complex tended towards larger fish. There was a weak relationship between length and capture date that hinted at a positive relationship for southern fish and a negative relationship for northern fish. Patterns of proportional representation of smolts and sea-run returns for the regions were similar, except no returns came from the Saxtons River complex. The largest proportion of smolts and returns came from the Millers River. Overall, proportional production of smolts and returns varied at least three-fold among regions, suggesting strong variation in survival among regions.

Increased Population Density and Suppressed Prey Biomass: Relative Impacts on Juvenile Atlantic Salmon Growth

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Individual growth rates of fish often depend on both population density and resource availability, both of which are subject to anthropogenic impacts and can be manipulated in the interest of restoring or enhancing fish populations. However, direct tests of the relative contribution of these factors to growth variation are lacking for most populations and are critically needed to guide management. We used a large-scale field experiment to evaluate the relative effects of increased population density and suppressed

prey biomass on the growth of juvenile Atlantic salmon. We directly manipulated salmon population density by releasing newly hatched salmon fry from uniform initial conditions at three density treatments in natural streams (18 sites total, repeated over 2 years). We arrayed the density treatments across sites that encompassed a more than 10-fold range in the biomass of benthic invertebrate prey for salmon, a low prey biomass being associated with heavy shading from riparian forest canopy. This controlled approach clearly demonstrated the enormous growth plasticity of juvenile Atlantic salmon; their mean body mass ranging from 1.2 to 14 g across sites

after one growing season. Variation in prey biomass had the strongest effects on fish growth. The fish grew faster at sites with high prey biomass regardless of population density, and prey biomass alone accounted for 71% of the explained variation in their growth. Only after taking the variation explained by prey biomass into account was it apparent that the study fish grew faster at sites with low stocking density and at sites where high losses reduced Atlantic salmon population density. To maintain salmon growth and size-dependent life histories, restoration and management efforts clearly need to consider anthropogenic factors that suppress prey abundance.

Acid, Aluminum and Their Impact on Atlantic Salmon: Implications for Recovery and Restoration in New England

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Aluminum (Al) is a common, naturally occurring element in surface soils. It is present in small amounts in surface waters, and under normal pH conditions is poorly soluble and has minimal impact on fish physiology or stream ecosystems. However, low pH conditions increase the solubility and hence the bioavailability of Al, particularly inorganic monomeric (labile) species. Labile Al, even in minute amounts, affects fish directly via several mechanisms, primarily by damage to and accumulation in the gills, leading to impaired osmoregulatory and respiratory capacity. Sensitivity to acid/Al varies by species and life stage. In Atlantic salmon, the smolt stage appears to be the most sensitive as the fish undergo extensive physiological changes preparatory to entering the ocean. Short term exposure (6 days) to low pH (5.3) and moderate Al (11-43 $\mu\text{g L}^{-1}$) causes elevated gill Al levels, reduced or lost Cl⁻ cells in the gills, reduced Na⁺,K⁺-ATPase activity, alters ability to regulate plasma ions, leading to reduced adult return rates. The goals of this study were to determine the scope of acid/Al conditions in New England salmon rivers, assess Al sampling methods & new technology, and measure gill Al level in resident salmonids and migratory smolts. Seasonal sampling was conducted for two years at 66 sites in Vermont, New Hampshire, Massachusetts, and Maine. Recorded levels of acid/Al were sufficient to physiologically compromise smolts in a number of tributaries across the region. At a subset of 10 locations, electrofishing surveys were conducted to measure gill Al and Na⁺,K⁺-ATPase activity in resident salmonids and to record total species composition. Emigrating smolts were sampled at two downstream dams on the Connecticut and Merrimack Rivers to measure gill Al and Na⁺,K⁺-ATPase activity in ocean-bound fish. There was evidence of elevated gill Al both in fish residing in regional tributaries and in smolts emigrating from the Merrimack basin. The implication is that acid/Al may be impairing the survival and success of Atlantic salmon from New England rivers, particularly in the Merrimack watershed.

8.6 Historical Tables

This section of the report contains legacy tables that have traditionally been published in the USASAC Report. It is important to note that all data from this report is available in database form to USASAC members. The following tables are generated as Access query reports from official databases and table numbering sequences have generally been retained for comparisons between years. Pagination of the report is table specific for tables 7 and beyond due to table length and quirks of using Access. Please note that some of these tables are redundant to tables in section 1 but are also placed here for easy access.

Table 1 Documented Atlantic salmon returns to USA rivers, 2008. "Natural" includes fish originating from natural spawning and hatchery fry.

NUMBER OF RETURNS BY SEA AGE AND ORIGIN									
RIVER	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
Androscoggin	8	2	5	1	0	0	0	0	16
Connecticut	7	3	10	118	0	1	0	2	141
Kennebec	6	0	15	0	0	0	0	0	21
Merrimack	6	5	77	29	0	1	0	0	118
Dennys DPS	0	1	1	3	0	0	0	3	8
Narraguagus DPS	0	4	0	17	0	1	0	1	23
Other GOM DPS 1		17		73		3		14	107
Pawcatuck	0	0	0	0	0	0	0	0	0
Penobscot	713	23	1297	80	0	0	4	0	2117
Saco	11	8	26	12	2	3	0	0	62

Documented Atlantic salmon returns to the USA, 1967-2008. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Table 2 Documented Atlantic salmon returns to the USA, 1967-2008. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1SW	2SW	3SW	Repeat	Total	Hatcher	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1764	11	24	2613	2188	425

Table 3 Two sea winter (2SW) returns for 2008 in relation to spawner requirements for USA rivers.

River	Spawner Requirement	2SW spawners-2008	Percentage of Requirement
Penobscot	6,838	1377	20.14
Connecticut	9,727	128	1.32
Pawcatuck	367	0	0.00
Merrimack	2599	106	4.08
GOM-DPS	1,564	94	6.01
Other Maine rivers	8,104	59	0.73
Total	29199	1764	6.04

Table 4a Number of juvenile Atlantic salmon stocked in USA, 2008. Numbers are rounded to 1,000.

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,041,000	0	0	2,000	0	50,000	6,093,000
Aroostook	365,000	0	0	0	0	0	365,000
Androscoggin	1,000	0	0	0	0	0	1,000
Dennys	292,000	0	0	0	0	0	292,000
East Machias	261,000	0	0	0	0	0	261,000
Kennebec	3,000	0	0	0	0	0	3,000
Machias	585,000	0	0	0	0	0	586,000
Narraguagus	485,000	21,000	0	0	54,000	0	560,000
Pleasant	171,000	0	0	0	0	0	171,000
Penobscot	1,248,000	217,000	0	0	513,000	0	1,394,000
Saco	358,000	9,000	0	0	0	0	367,000
Sheepscot	218,000	13,000	0	0	0	0	231,000
Union	23,000	0	0	0	0	0	23,000
Merrimack	1,766,000	3,000	10,000	0	89,000	0	1,868,000
Pawcatuck	313,000	0	0	0	6,000	0	319,000
Total for USA	12,127,000	263,000	10,000	2,000	662,000	50,000	12,534,000

Table 4b Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2008 by river.

River	Purpose	Captive Reared Domestic		Sea Run	Total
		Pre-spawn	Post-spawn	Post-spawn	
Connecticut	Restoration			1	1
Dennys	Restoration		147		147
East Machias	Restoration	72	73		145
Hobart Stream	Restoration	116			116
Kennebec	Restoration	106			106
Machias	Restoration	68	148		216
Merrimack	Restoration/Recreation	800	1,572		2,372
Narraguagus	Restoration		188		188
Penobscot	Restoration		1,738	640	2,378
Pleasant	Restoration		43		43
Sheepscot	Restoration	71	65		136

Table 5 Summary of tagged and marked Atlantic salmon released in USA, 2008.

Mark	Life Stage	Stock Origin									Grand Total
		Connecticut	Dennys	East Machias	Machias	Merrimack	Narraguagus	Pawcatuck	Penobscot	Sheepscot	
FLOY	Adult					2,372					2,372
PIT	Adult	1	202	146	216		199		640	93	1,497
RAD	Adult	10									10
AD	Parr	2,426					20,990			13046	36,462
LV	Parr								130,561		130,561
AD	Smolt	49,657				38,900		5,994			94,551
VIE	Smolt						54,116		147,789		201,905
PING	Smolt								200		200
PIT	Smolt		218								218
RAD	Smolt	470									470
Grand Total		52,564	420	146	216	41,272	75,305	5,994	279,190	13,139	468,246

AD = Adipose Clip, fish often have other marks

VIE = visual implant elastomer; all fish tagged with VIE also had adipose fin clipped

LV = left ventral

RV = right ventral

RAD = radio tag

PIT = passive integrated transponder

PING = ultrasonic acoustic tag

Table 6 Aquaculture production (metric tonnes) in New England from 1997 to 2008.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014

Table 7. Juvenile Atlantic salmon stocking summary for New England in 2008.

United States

		No. of fish stocked by lifestage						
River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total	
Connecticut	6,041,000	0	0	2,400	0	50,000	6,093,400	
Total for Connecticut Program								6,093,400
Androscoggin	1,000	0	0	0	0	0	1,000	
Aroostook	365,000	0	0	0	0	0	365,000	
Dennys	292,000	0	0	0	0	200	292,200	
East Machias	261,000	0	0	0	0	0	261,000	
Kennebec	3,000	0	0	0	0	0	3,000	
Machias	585,000	100	400	0	0	0	585,500	
Narraguagus	485,000	21,000	0	0	54,100	0	560,100	
Penobscot	1,248,000	216,600	0	0	512,500	0	1,977,100	
Pleasant	171,000	0	0	0	0	0	171,000	
Saco	358,000	9,100	0	0	0	0	367,100	
Sheepscot	218,000	13,000	0	0	0	0	231,000	
Union	23,000	0	0	0	0	0	23,000	
Total for Maine Program								4,837,000
Merrimack	1,766,000	3,400	9,600	0	88,900	0	1,867,900	
Total for Merrimack Program								1,867,900
Pawcatuck	313,000	0	0	0	6,000	0	319,000	
Total for Pawcatuck Program								319,000
Total for United States								13,117,300
Grand Total								13,117,300

Distinction between US and CAN stocking is based on source of eggs or fish.

Table 8. Number of adult Atlantic salmon stocked in New England rivers in 2008.

Drainage	Purpose	Captive/Domestic		Sea Run	Total
		Pre-Spawn	Post-Spawn	Post-Spawn	
Connecticut	Restoration	0	0	1	1
Dennys	Restoration	0	147	0	147
East Machias	Restoration	72	73	0	145
Hobart Stream	Restoration	116	0	0	116
Kennebec	Restoration	106	0	0	106
Machias	Restoration	68	148	0	216
Merrimack	Restoration/Recreation	800	1,572	0	2,372
Narraguagus	Restoration	0	188	0	188
Penobscot	Restoration	0	1,738	640	2,378
Pleasant	Restoration	0	43	0	43
Sheepscot	Restoration	71	65	0	136
Total		1,233	3,974	641	5,848

Pre-spawn refers to adults that are stocked prior to spawning of that year. Post-spawn refers to fish that are stocked after they have been spawned in the hatchery.

Table 9.1. Atlantic salmon marking database for New England; marked fish released in 2008 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
BSRFH		Adult	H		carlin	71		Oct	East Machias
Klein	2	Smolt	H	Connecticut	RAD	90	AD	May	Connecticut
NAI	4	Adult	W	Connecticut	RAD	9	PIT	May	Connecticut
NAI	5	Adult	W	Connecticut	RAD	1	PIT	May	Connecticut
NAI	2	Smolt	H	Connecticut	RAD	380	AD	May	Connecticut
USFWS	4	Adult	W	Connecticut	PIT	1		Dec	Connecticut
USFWS	2	Parr	H	Connecticut	AD	2,426	calcein	Mar	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	49,657	calcein	April	Connecticut
USFWS	5	Adult	H	Dennys	PIT	147		Nov	Dennys
USFWS	5	Adult	H	Dennys	PIT	55		Oct	Dennys
USFWS	2	Smolt	H	Dennys	PIT	218		April	Dennys
USFWS	5	Adult	H	East Machias	PIT	73		Dec	East Machias
USFWS	5	Adult	H	East Machias	PIT	73	Carlin	Oct	East Machias
USFWS	5	Adult	H	Machias	PIT	148		Dec	Machias
USFWS	5	Adult	H	Machias	PIT	68		Oct	Machias
NHFG	2	Adult	H	Merrimack	FLOY	800		Oct	Merrimack
NHFG	4-5	Adult	H	Merrimack	FLOY	1,220		June	Merrimack
NHFG	4-5	Adult	H	Merrimack	FLOY	352		May	Merrimack
NNHF	1	Smolt	H	Merrimack	AD	38,900		April	Merrimack
BSRFH	0	Parr	H	Narraguagus	AD	20,990		Sept	Narraguagus
NOAA	1	Smolt	H	Narraguagus	VIE	54,116	AD	May	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	188		Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	11		Oct	Narraguagus
RIF&W	1	Smolt	H	Pawcatuck	AD	5,994		Mar	Pawcatuck
BSRFH	0	Parr	H	Penobscot	LV	65,561	AD	Oct	Penobscot

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
BSRFH	0	Parr	H	Penobscot	LV	65,000	AD	Sept	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	81		May	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	18	LV	May	Penobscot
NOAA	1	Smolt	H	Penobscot	VIE	147,789	AD	April	Penobscot
NOAA	2	Smolt	H	Penobscot	PING	12	A/LV	May	Penobscot
NOAA	2	Smolt	W	Penobscot	PING	46		May	Penobscot
UOM	1	Smolt	H	Penobscot	pinger	43		May	Penobscot
USFWS	5	Adult	H	Penobscot	PIT	640		Nov	Penobscot
USFWS	5	Adult	H	Pleasant	PIT	50		Oct	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	43		Nov	Pleasant
BSRFH	0	Parr	H	Sheepscot	AD	13,046		Sept	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	19	Radio	Oct	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	65		Dec	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	52		Oct	Sheepscot

TAG/MARK CODES: AD = adipose clip; RAD = radio tag; AP = adipose punch; RV = RV Clip; BAL = Balloon tag; VIA = visible implant, alphanumeric; CAL = Calcein immersion; VIE = visible implant elastomer; FLOY = floy tag; VIEAC = visible implant elastomer and anal clip; DYE = MetaJet Dye; PIT = PIT tag; VPP = VIE tag, PIT tag, and ultrasonic pinger; PTC = PIT tag and Carlin tag; TEMP = temperature mark on otolith or other hard part; VPT = VIE tag and PIT tag; ANL = anal clip/punch; HI-Z = HI-Z Turb'N tag

Table 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2008.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,372		4,075
Hatchery Juvenile	463,967	463,949	464,321
Wild Adult			11
Wild Juvenile			46

Page 1 of 1 for Table 9.2.

Table 10. Documented Atlantic salmon returns to New England rivers in 2008.

	1SW		2SW		3SW		Repeat		2004-2008	
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	8	2	5	1	0	0	0	0	16	13
Connecticut	7	3	10	118	0	1	0	2	141	150
Dennys	0	1	1	3	0	0	0	3	8	5
Kennebec	6	0	15	0	0	0	0	0	21	17
Merrimack	6	5	77	29	0	1	0	0	118	89
Narraguagus	0	4	0	17	0	1	0	1	23	15
Pawcatuck	0	0	0	0	0	0	0	0	0	1
Penobscot	713	23	1297	80	0	0	4	0	2117	1,279
Saco	11	8	26	12	2	3	0	0	62	32
Total	751	46	1,431	260	2	6	4	6	2,506	1,600

Table 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2008.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	1633	8,980,000
Penobscot	Captive/Domestic	352	1,420,000
Pleasant	Captive/Domestic	47	205,000
Dennys	Captive	105	450,000
East Machias	Captive	85	350,000
Machias	Captive	141	650,000
Narraguagus	Captive	169	820,000
Sheepscot	Captive	75	340,000
Total Captive/Domestic		2,607	13,215,000
Merrimack	Domestic	275	1,018,000
Total Domestic		275	1,018,000
Connecticut	Kelt	101	1,190,000
Merrimack	Kelt	47	511,000
Total Kelt		148	1,701,000
Connecticut	Sea Run	85	602,000
Merrimack	Sea Run	66	533,000
Penobscot	Sea Run	297	2,500,000
Pawcatuck	Kelt	2	10,000
Total Sea Run		450	3,645,000
Grand Total for Year 2008		3,480	19,579,000

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.

Table 12. Summary of Atlantic salmon egg production in New England facilities.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
Cocheco															
1993-1998	3	21,000	7,100	0	0		0	0		0	0		3	21,000	7,100
Total Cocheco	3	21,000	7,100	0	0	0	0	0		0	0		3	21,000	7,100
Connecticut															
1977-1998	1,227	15,063,000	8,200	9,460	73,227,000	6,200	0	0		1,310	18,120,000	10,400	11,997	106,409,000	6,900
1999	83	622,000	7,500	1,862	11,173,000	6,000	0	0		193	1,813,000	9,400	2,138	13,608,000	6,400
2000	49	300,000	6,100	2,471	12,200,000	4,900	0	0		142	1,350,000	9,500	2,662	13,850,000	5,200
2001	20	162,000	8,100	1,955	9,870,000	5,000	0	0		102	1,003,000	9,800	2,077	11,036,000	5,300
2002	25	181,000	7,300	1,974	10,826,000	5,500	0	0		83	827,000	10,000	2,082	11,835,000	5,700
2003	34	245,000	7,200	2,152	11,600,000	5,400	0	0		67	660,000	9,800	2,253	12,505,000	5,600
2004	37	280,000	7,600	1,875	11,750,000	6,300	0	0		53	489,000	9,200	1,965	12,519,000	6,400
2005	102	758,000	7,400	1,382	9,050,000	6,500	0	0		37	384,000	10,400	1,521	10,192,000	6,700
2006	116	896,000	7,700	1,782	10,020,000	5,600	0	0		47	460,000	9,800	1,945	11,376,000	5,800
2007	95	723,000	7,600	1,598	9,390,000	5,900	0	0		113	1,190,000	10,500	1,806	11,303,000	6,300
2008	85	602,000	7,100	1,633	8,980,000	5,500	0	0		101	1,190,000	11,800	1,819	10,772,000	5,900
Total Connecticut	1,873	19,832,000	7,400	28,144	178,086,000	5,700	0	0		2,248	27,486,000	10,100	32,265	225,405,000	6,000
Dennys															
1939-1998	26	214,000	7,600	0	0		439	1,492,000	3,300	33	273,000	7,600	498	1,979,000	5,100
1999	0	0		0	0		48	249,000	5,200	7	58,000	8,200	55	306,000	5,600
2000	0	0		0	0		64	283,000	4,400	0	0		64	283,000	4,400
2001	0	0		0	0		82	359,000	4,400	0	0		82	359,000	4,400
2002	0	0		0	0		68	352,000	5,200	0	0		68	352,000	5,200

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.

Note: Totals of eggs/female includes only the years for which information on number of females is available. It is a simple ratio of eggs/female and should not be used as an age specific fecundity measure because this can vary with age composition and broodstock type.

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300
Total Dennys	26	214,000	7,600	0	0	0	1,238	5,214,000	4,582	40	331,000	7,900	1,304	5,758,000	4,800
East Machias															
1995-1998	0	0		0	0		375	1,121,000	2,900	0	0		375	1,121,000	2,900
1999	0	0		0	0		57	296,000	5,200	0	0		57	296,000	5,200
2000	0	0		0	0		68	394,000	5,800	0	0		68	394,000	5,800
2001	0	0		0	0		67	400,000	6,000	0	0		67	400,000	6,000
2002	0	0		0	0		92	466,000	5,100	0	0		92	466,000	5,100
2003	0	0		0	0		93	456,000	4,900	0	0		93	456,000	4,900
2004	0	0		0	0		65	252,000	3,900	0	0		65	252,000	3,900
2005	0	0		0	0		88	281,000	3,200	0	0		88	281,000	3,200
2006	0	0		0	0		82	328,000	4,000	0	0		82	328,000	4,000
2007	0	0		0	0		78	456,000	5,800	0	0		78	456,000	5,800
2008	0	0		0	0		85	350,000	4,100	0	0		85	350,000	4,100
Total East Machias	0	0		0	0	0	1,150	4,800,000	4,627	0	0		1,150	4,800,000	4,600
Kennebec															
1979-1998	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Total Kennebec	5	50,000	10,000	0	0	0	0	0		0	0		5	50,000	10,000

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Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
Lamprey															
1992-1998	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Total Lamprey	6	32,000	4,800	0	0	0	0	0		0	0		6	32,000	4,800
Machias															
1941-1998	456	3,263,000	7,300	0	0		742	2,343,000	3,100	8	52,000	6,400	1,206	5,658,000	6,400
1999	0	0		0	0		121	550,000	4,500	0	0		121	550,000	4,500
2000	0	0		0	0		110	417,000	3,800	0	0		110	417,000	3,800
2001	0	0		0	0		108	672,000	6,200	0	0		108	672,000	6,200
2002	0	0		0	0		111	533,000	4,800	0	0		111	533,000	4,800
2003	0	0		0	0		121	763,000	6,300	0	0		121	763,000	6,300
2004	0	0		0	0		120	613,000	5,100	0	0		120	613,000	5,100
2005	0	0		0	0		160	677,000	4,200	0	0		160	677,000	4,200
2006	0	0		0	0		160	720,000	4,500	0	0		160	720,000	4,500
2007	0	0		0	0		150	714,000	4,800	0	0		150	714,000	4,800
2008	0	0		0	0		141	650,000	4,600	0	0		141	650,000	4,600
Total Machias	456	3,263,000	7,300	0	0	0	2,044	8,652,000	4,718	8	52,000	6,400	2,508	11,967,000	5,000
Merrimack															
1983-1998	868	6,367,000	7,400	6,064	34,951,000	5,600	0	0		5	64,000	12,900	6,937	41,383,000	6,600
1999	88	737,000	8,400	520	2,659,000	5,100	0	0		50	540,000	10,800	658	3,935,000	6,000
2000	38	311,000	8,200	596	2,625,000	4,400	0	0		62	748,000	12,100	696	3,683,000	5,300
2001	37	296,000	8,000	726	2,585,000	3,600	0	0		22	294,000	13,400	785	3,176,000	4,000
2002	16	232,000	14,500	361	1,816,000	5,000	0	0		21	232,000	11,000	398	2,279,000	5,700
2003	60	499,000	8,300	489	1,914,000	3,900	0	0		20	236,000	11,800	569	2,649,000	4,700
2004	59	494,000	8,400	229	811,000	3,500	0	0		42	48,000	1,200	330	1,353,000	4,100

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Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
2005	13	111,000	8,500	191	691,000	3,600	0	0		65	697,000	10,700	269	1,499,000	5,600
2006	42	377,000	9,000	269	1,097,000	4,100	0	0		49	582,000	11,900	360	2,056,000	5,700
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
Total Merrimack	1,322	10,256,000	8,900	10,407	52,754,000	4,200	0	0		428	4,463,000	10,700	12,157	67,473,000	5,200
Narraguagus															
1962-1998	0	1,303,000		0	0		649	1,981,000	3,100	0	0		649	3,284,000	3,100
1999	0	0		0	0		134	542,000	4,000	0	0		134	542,000	4,000
2000	0	0		0	0		137	432,000	3,200	0	0		137	432,000	3,200
2001	0	0		0	0		93	404,000	4,300	0	0		93	404,000	4,300
2002	0	0		0	0		159	704,000	4,400	0	0		159	704,000	4,400
2003	0	0		0	0		120	624,000	5,200	0	0		120	624,000	5,200
2004	0	0		0	0		119	453,000	3,800	0	0		119	453,000	3,800
2005	0	0		0	0		146	449,000	3,100	0	0		146	449,000	3,100
2006	0	0		0	0		165	702,000	4,300	0	0		165	702,000	4,300
2007	0	0		0	0		186	854,000	4,600	0	0		186	854,000	4,600
2008	0	0		0	0		169	820,000	4,900	0	0		169	820,000	4,900
Total Narraguagus	0	1,303,000		0	0	0	2,077	7,965,000	4,082	0	0		2,077	9,268,000	4,100
Orland															
1967-1998	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Total Orland	39	270,000	7,300	0	0	0	0	0		0	0		39	270,000	7,300
Pawcatuck															
1992-1998	8	76,000	9,800	0	0		0	0		0	0		8	76,000	9,800

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Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
1999	6	61,000	10,200	0	0		0	0		0	0		6	61,000	10,200
2000	0	0		0	0		0	0		5	43,000	8,600	5	43,000	8,600
2001	0	0		2	2,000	1,100	0	0		1	8,000	7,800	3	10,000	3,300
2002	0	0		0	0		0	0		3	10,000	3,300	3	10,000	3,300
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
2006	0	0		4	4,000	1,000	0	0		0	0		4	4,000	1,000
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
2008	0	0		0	0		0	0		2	10,000	5,000	2	10,000	5,000
Total Pawcatuck	18	152,000	6,900	6	6,000	1,000	0	0		11	71,000	6,200	35	229,000	5,400
Penobscot															
1871-1998	16,585	142,033,000	7,800	3,344	8,303,000	2,500	0	0		0	0		19,929	150,335,000	7,600
1999	286	2,418,000	8,500	371	1,300,000	3,500	0	0		0	0		657	3,719,000	5,700
2000	196	1,559,000	8,000	540	1,334,000	2,500	0	0		0	0		736	2,893,000	3,900
2001	282	2,451,000	8,700	453	1,206,000	2,700	0	0		0	0		735	3,657,000	5,000
2002	218	2,001,000	9,200	484	1,300,000	2,700	0	0		0	0		702	3,301,000	4,700
2003	362	3,194,000	8,800	0	0		0	0		0	0		362	3,194,000	8,800
2004	353	3,229,000	9,100	477	1,200,000	2,500	0	0		0	0		830	4,429,000	5,300
2005	296	2,458,000	8,300	359	1,314,000	3,700	0	0		0	0		655	3,772,000	5,800
2006	325	3,034,000	9,300	0	0		329	1,400,000	4,300	0	0		654	4,434,000	6,800
2007	315	2,697,000	8,600	394	1,595,000	4,000	0	0		0	0		709	4,292,000	6,100
2008	297	2,500,000	8,400	0	0		0	0		0	0		297	2,500,000	8,400
Total Penobscot	19,515	167,574,000	8,600	6,422	17,552,000	3,000	329	1,400,000	4,300	0	0		26,266	186,526,000	6,200
Pleasant															
2001	0	0		0	0		13	46,000	3,500	0	0		13	46,000	3,500

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.

Note: Totals of eggs/female includes only the years for which information on number of females is available. It is a simple ratio of eggs/female and should not be used as an age specific fecundity measure because this can vary with age composition and broodstock type.

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female	No. females	Egg production	Eggs/female
2002	0	0		0	0		19	84,000	4,400	0	0		19	84,000	4,400
2003	0	0		0	0		11	92,000	8,300	0	0		11	92,000	8,300
2004	0	0		0	0		23	179,000	7,800	0	0		23	179,000	7,800
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		0	0		0	0		0	0		0	0	
Total Pleasant	0	0		0	0	0	296	1,220,000	5,014	0	0		296	1,220,000	5,000
Sheepscot															
1995-1998	18	125,000	6,900	0	0		231	711,000	2,700	37	346,000	9,400	286	1,183,000	4,000
1999	0	0		0	0		49	218,000	4,500	8	92,000	11,500	57	310,000	5,400
2000	0	0		0	0		60	246,000	4,100	0	0		60	246,000	4,100
2001	0	0		0	0		56	351,000	6,300	0	0		56	351,000	6,300
2002	0	0		0	0		100	455,000	4,600	0	0		100	455,000	4,600
2003	0	0		0	0		92	433,000	4,700	0	0		92	433,000	4,700
2004	0	0		0	0		78	308,000	3,900	0	0		78	308,000	3,900
2005	0	0		0	0		70	251,000	3,600	0	0		70	251,000	3,600
2006	0	0		0	0		83	277,000	3,300	0	0		83	277,000	3,300
2007	0	0		0	0		81	349,000	4,300	0	0		81	349,000	4,300
2008	0	0		0	0		75	340,000	4,500	0	0		75	340,000	4,500
Total Sheepscot	18	125,000	6,900	0	0	0	975	3,939,000	4,227	45	438,000	10,400	1,038	4,503,000	4,400
St Croix															
1993-1998	36	271,000	7,500	0	0		0	0		0	0		36	271,000	7,500
2003	3	21,000	6,900	0	0		0	0		0	0		3	21,000	6,900

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.

Note: Totals of eggs/female includes only the years for which information on number of females is available. It is a simple ratio of eggs/female and should not be used as an age specific fecundity measure because this can vary with age composition and broodstock type.

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Total St Croix	39	292,000	7,200	0	0	0	0	0		0	0		39	292,000	7,200
Union															
1974-1998	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Total Union	600	4,611,000	7,900	0	0	0	0	0		0	0		600	4,611,000	7,900

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.

Note: Totals of eggs/female includes only the years for which information on number of females is available. It is a simple ratio of eggs/female and should not be used as an age specific fecundity measure because this can vary with age composition and broodstock type.

Note: Connecticut data are preliminary prior to 1990.

Table 13. Summary of all historical Atlantic salmon egg production in hatcheries for New England rivers.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco	3	21,000	7,100	0	0		0	0		0	0		3	21,000	7,100
Connecticut	1,873	19,833,000	7,400	28,144	178,086,000	5,700	0	0		2,248	27,486,000	10,100	32,265	225,404,000	6,000
Dennys	26	214,000	7,600	0	0		1,238	5,213,000	4,600	40	330,000	7,900	1,304	5,757,000	4,800
East Machias	0	0		0	0		1,150	4,800,000	4,600	0	0		1,150	4,800,000	4,600
Kennebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Machias	456	3,263,000	7,300	0	0		2,044	8,651,000	4,700	8	52,000	6,400	2,508	11,966,000	5,000
Merrimack	1,322	10,255,000	8,800	10,407	52,754,000	4,200	0	0		428	4,463,000	10,700	12,157	67,472,000	5,200
Narraguagus	0	1,303,000		0	0		2,077	7,965,000	4,100	0	0		2,077	9,268,000	4,100
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	18	152,000	6,900	6	6,000	1,100	0	0		11	71,000	6,200	35	229,000	5,400
Penobscot	19,515	167,574,000	8,600	6,422	17,551,000	3,000	329	1,400,000	4,300	0	0		26,266	186,526,000	6,200
Pleasant	0	0		0	0		296	1,220,000	5,000	0	0		296	1,220,000	5,000
Sheepscot	18	125,000	6,900	0	0		975	3,938,000	4,200	45	438,000	10,400	1,038	4,502,000	4,400
St Croix	39	291,000	7,200	0	0		0	0		0	0		39	291,000	7,200
Union	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Grand Total	23,920	207,994,000	8,700	44,979	248,397,000	5,500	8,109	33,187,000	4,100	2,780	32,840,000	11,800	79,788	522,419,000	6,500

Note: Eggs/female represents the overall average number of eggs produced per female and includes only years for which information on the number of females is available.

Table 14. Atlantic salmon stocking summary for New England, by river.

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin							
2001	3,000	0	0	0	0	0	3,000
2002	0	0	0	0	0	0	0
2003	1,000	0	0	0	0	0	1,000
2004	2,000	0	0	0	0	0	2,000
2005	0	0	0	0	0	0	0
2006	1,000	0	0	0	0	0	1,000
2007	1,000	0	0	0	0	0	1,000
2008	1,000	0	0	0	0	0	1,000
Totals:Androscoggin	9,000	0	0	0	0	0	9,000
Aroostook							
1978-1998	1,348,000	317,100	38,600	0	32,600	29,800	1,766,100
1999	163,000	0	0	0	0	0	163,000
2000	0	0	0	0	0	0	0
2001	182,000	300	0	0	0	0	182,300
2002	122,000	0	0	0	0	0	122,000
2003	138,000	0	0	0	0	0	138,000
2004	169,000	0	0	0	0	0	169,000
2005	133,000	0	0	0	0	0	133,000
2006	324,000	0	0	0	0	0	324,000
2007	854,000	0	0	0	0	0	854,000
2008	365,000	0	0	0	0	0	365,000
Totals:Aroostook	3,798,000	317,400	38,600	0	32,600	29,800	4,216,400
Cocheco							
1988-1998	1,146,000	50,000	10,500	0	5,300	0	1,211,800
1999	157,000	0	0	0	0	0	157,000
2000	146,000	0	0	0	0	0	146,000
2001	165,000	0	0	0	0	0	165,000
2002	181,000	0	0	0	0	0	181,000
2003	163,000	0	0	0	0	0	163,000
Totals:Cocheco	1,958,000	50,000	10,500	0	5,300	0	2,023,800
Connecticut							
1967-1998	53,054,000	2,823,600	1,810,300	0	3,745,200	963,200	62,396,300
1999	6,428,000	1,000	0	0	22,600	0	6,451,600
2000	9,325,000	600	0	0	700	48,200	9,374,500
2001	9,591,000	1,600	0	0	700	0	9,593,300
2002	7,283,000	700	0	0	500	0	7,284,200
2003	7,038,000	0	0	0	0	90,100	7,128,100
2004	7,683,000	3,100	2,500	0	0	96,400	7,785,000
2005	7,805,000	0	0	0	0	85,100	7,890,100
2006	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
2007	6,345,000	0	600	2,300	600	99,000	6,447,500
2008	6,041,000	0	0	2,400	0	50,000	6,093,400

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Totals:Connecticut	126,441,000	2,834,300	1,813,400	17,300	3,771,300	1,484,100	136,361,400
Dennys							
1975-1998	856,000	18,700	3,400	0	152,700	29,200	1,060,000
1999	172,000	3,000	0	0	0	0	175,000
2000	96,000	30,500	0	0	0	0	126,500
2001	59,000	16,500	1,400	0	49,800	0	126,700
2002	84,000	33,000	1,900	0	49,000	0	167,900
2003	133,000	30,400	600	0	55,200	0	219,200
2004	219,000	44,000	0	0	56,300	0	319,300
2005	215,000	21,700	0	0	56,700	0	293,400
2006	295,000	27,600	0	0	56,500	0	379,100
2007	257,000	0	0	0	56,500	0	313,500
2008	292,000	0	0	0	0	200	292,200
Totals:Dennys	2,678,000	225,400	7,300	0	532,700	29,400	3,472,800
Ducktrap							
1986-1998	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	68,000	0	0	0	0	0	68,000
East Machias							
1973-1998	558,000	6,500	42,600	0	108,400	30,400	745,900
1999	210,000	1,000	0	0	0	0	211,000
2000	197,000	0	0	0	0	0	197,000
2001	242,000	0	0	0	0	0	242,000
2002	236,000	0	0	0	0	0	236,000
2003	314,000	0	0	0	0	0	314,000
2004	319,000	0	0	0	0	0	319,000
2005	216,000	0	0	0	0	0	216,000
2006	199,000	0	0	0	0	0	199,000
2007	245,000	0	0	0	0	0	245,000
2008	261,000	0	0	0	0	0	261,000
Totals:East Machias	2,997,000	7,500	42,600	0	108,400	30,400	3,185,900
Kennebec							
2001	3,000	0	0	0	0	0	3,000
2002	7,000	0	0	0	0	0	7,000
2003	42,000	0	0	0	0	0	42,000
2004	52,000	0	0	0	0	0	52,000
2005	30,000	0	0	0	0	0	30,000
2006	8,000	0	0	0	0	0	8,000
2007	20,000	0	0	0	0	0	20,000
2008	3,000	0	0	0	0	0	3,000
Totals:Kennebec	165,000	0	0	0	0	0	165,000
Lamprey							
1978-1998	1,041,000	427,700	58,500	0	141,400	32,800	1,701,400
1999	127,000	0	0	0	0	0	127,000
2000	104,000	0	0	0	0	0	104,000

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
2001	111,000	0	300	0	0	0	111,300
2002	103,000	0	0	0	60,000	0	163,000
2003	106,000	0	0	0	0	0	106,000
Totals:Lamprey	1,592,000	427,700	58,800	0	201,400	32,800	2,312,700
Machias							
1970-1998	1,158,000	92,800	117,800	0	191,300	44,100	1,604,000
1999	169,000	1,000	0	0	0	0	170,000
2000	209,000	0	0	0	0	0	209,000
2001	267,000	0	0	0	0	0	267,000
2002	327,000	0	0	0	0	0	327,000
2003	341,000	0	300	0	0	0	341,300
2004	379,000	3,100	0	0	0	0	382,100
2005	476,000	0	200	0	0	0	476,200
2006	638,000	2,000	1,500	0	0	0	641,500
2007	470,000	0	2,200	0	0	0	472,200
2008	585,000	100	400	0	0	0	585,500
Totals:Machias	5,019,000	99,000	122,400	0	191,300	44,100	5,475,800
Merrimack							
1975-1998	22,359,000	227,500	590,500	0	1,161,000	635,900	24,973,900
1999	1,756,000	0	4,400	0	56,400	0	1,816,800
2000	2,217,000	0	0	0	52,500	0	2,269,500
2001	1,708,000	0	0	0	49,500	0	1,757,500
2002	1,414,000	0	1,900	0	50,000	1,200	1,467,100
2003	1,335,000	0	900	0	49,600	1,000	1,386,500
2004	1,556,000	3,700	0	0	50,000	0	1,609,700
2005	962,000	1,400	400	0	50,000	0	1,013,800
2006	1,011,000	0	0	0	50,000	0	1,061,000
2007	1,140,000	0	0	0	50,000	0	1,190,000
2008	1,766,000	3,400	9,600	0	88,900	0	1,867,900
Totals:Merrimack	37,224,000	236,000	607,700	0	1,707,900	638,100	40,413,700
Narraguagus							
1970-1998	858,000	44,700	14,600	0	106,800	84,000	1,108,100
1999	155,000	18,200	0	0	1,000	0	174,200
2000	252,000	0	0	0	0	0	252,000
2001	353,000	0	0	0	0	0	353,000
2002	261,000	0	0	0	0	0	261,000
2003	623,000	0	0	0	0	0	623,000
2004	468,000	0	0	0	0	0	468,000
2005	352,000	0	0	0	0	0	352,000
2006	478,000	17,500	0	0	0	0	495,500
2007	346,000	15,700	0	0	0	0	361,700
2008	485,000	21,000	0	0	54,100	0	560,100
Totals:Narraguagus	4,631,000	117,100	14,600	0	161,900	84,000	5,008,600
Pawcatuck							
1979-1998	2,769,000	1,209,200	263,200	0	52,700	500	4,294,600

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
1999	591,000	0	0	0	3,900	0	594,900
2000	326,000	0	0	0	0	0	326,000
2001	423,000	0	0	0	8,500	0	431,500
2002	403,000	0	0	0	0	0	403,000
2003	313,000	0	0	0	5,200	0	318,200
2004	557,000	0	0	0	6,100	0	563,100
2005	5,000	0	0	0	16,600	0	21,600
2006	85,000	0	0	0	12,800	0	97,800
2007	115,000	0	4,900	0	6,400	0	126,300
2008	313,000	0	0	0	6,000	0	319,000
Totals:Pawcatuck	5,900,000	1,209,200	268,100	0	118,200	500	7,496,000
Penobscot							
1970-1998	10,073,000	2,432,000	1,386,200	0	9,371,700	2,508,200	25,771,100
1999	1,498,000	229,600	1,500	0	567,300	0	2,296,400
2000	513,000	288,800	700	0	563,200	0	1,365,700
2001	364,000	235,800	2,100	0	544,000	0	1,145,900
2002	746,000	396,700	1,800	0	547,000	0	1,691,500
2003	741,000	320,700	2,100	0	547,300	0	1,611,100
2004	1,812,000	369,200	0	0	566,000	0	2,747,200
2005	1,899,000	295,400	0	0	530,600	0	2,725,000
2006	1,509,000	293,500	0	0	549,200	0	2,351,700
2007	1,606,000	337,800	0	0	559,900	0	2,503,700
2008	1,248,000	216,600	0	0	512,500	0	1,977,100
Totals:Penobscot	22,009,000	5,416,100	1,394,400	0	14,858,700	2,508,200	46,186,400
Pleasant							
1975-1998	187,000	2,500	1,800	0	54,700	18,100	264,100
1999	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0
2002	0	13,500	0	0	0	0	13,500
2003	82,000	0	0	0	2,800	0	84,800
2004	47,000	0	0	0	0	8,800	55,800
2005	76,000	0	0	0	5,900	0	81,900
2006	284,000	0	0	0	0	15,200	299,200
2007	177,000	0	0	0	0	0	177,000
2008	171,000	0	0	0	0	0	171,000
Totals:Pleasant	1,024,000	16,000	1,800	0	63,400	42,100	1,147,300
Saco							
1975-1998	1,571,000	323,500	201,200	0	284,700	9,500	2,389,900
1999	688,000	47,000	0	0	20,100	0	755,100
2000	599,000	48,200	0	0	22,600	0	669,800
2001	479,000	0	0	0	4,000	0	483,000
2002	597,000	0	0	0	4,100	0	601,100
2003	501,000	20,000	0	0	3,200	0	524,200
2004	375,000	0	0	0	5,400	0	380,400

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
2005	340,000	0	18,000	0	1,700	0	359,700
2006	106,000	0	0	0	0	0	106,000
2007	576,000	0	0	0	0	0	576,000
2008	358,000	9,100	0	0	0	0	367,100
Totals:Saco	6,190,000	447,800	219,200	0	345,800	9,500	7,212,300
Sheepscot							
1971-1998	581,000	80,100	20,600	0	92,200	7,100	781,000
1999	302,000	4,700	0	0	0	0	306,700
2000	211,000	0	0	0	0	0	211,000
2001	171,000	0	0	0	0	0	171,000
2002	172,000	0	0	0	0	0	172,000
2003	323,000	0	0	0	0	0	323,000
2004	298,000	15,600	0	0	0	0	313,600
2005	201,000	15,900	0	0	0	0	216,900
2006	151,000	16,600	0	0	0	0	167,600
2007	198,000	0	0	0	0	0	198,000
2008	218,000	13,000	0	0	0	0	231,000
Totals:Sheepscot	2,826,000	145,900	20,600	0	92,200	7,100	3,091,800
St Croix							
1981-1998	1,263,000	387,600	158,300	0	747,200	20,100	2,576,200
1999	1,000	22,500	0	0	21,300	0	44,800
2000	1,000	19,000	0	0	20,000	0	40,000
2001	1,000	6,300	0	0	8,100	0	15,400
2002	1,000	15,400	0	0	4,100	0	20,500
2003	1,000	16,800	0	0	3,200	0	21,000
2004	0	2,800	0	0	4,100	0	6,900
2006	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0
Totals:St Croix	1,268,000	470,400	158,300	0	808,000	20,100	2,724,800
Union							
1971-1998	258,000	289,300	0	0	379,700	251,000	1,178,000
1999	165,000	82,100	0	0	0	0	247,100
2001	2,000	0	0	0	0	0	2,000
2002	5,000	0	0	0	0	0	5,000
2003	3,000	0	0	0	0	0	3,000
2004	3,000	0	0	0	0	0	3,000
2005	2,000	0	0	0	0	0	2,000
2006	2,000	0	0	0	0	0	2,000
2007	22,000	0	0	0	0	0	22,000
2008	23,000	0	0	0	0	0	23,000
Totals:Union	485,000	371,400	0	0	379,700	251,000	1,487,100
Upper StJohn							
1979-1998	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Totals:Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200

Table 15. Overall summary of Atlantic salmon stocking for New England, by river.

Totals reflect the entirety of the historical time series for each river.

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin	8,000	0	0	0	0	0	8,400
Aroostook	3,798,000	317,400	38,600	0	32,600	29,800	4,216,500
Cocheco	1,958,000	50,000	10,500	0	5,300	0	2,024,200
Connecticut	126,439,000	2,834,300	1,813,500	17,400	3,771,300	1,484,100	136,342,600
Dennys	2,678,000	225,400	7,300	0	532,800	29,400	3,473,200
Ducktrap	68,000	0	0	0	0	0	68,000
East Machias	2,996,000	7,500	42,600	0	108,400	30,400	3,185,300
Kennebec	165,000	0	0	0	0	0	164,900
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	2,313,700
Machias	5,018,000	99,000	122,300	0	191,300	44,100	5,474,600
Merrimack	37,224,000	235,900	607,700	0	1,707,900	638,100	40,413,200
Narraguagus	4,632,000	117,100	14,600	0	161,900	84,000	5,009,300
Pawcatuck	5,900,000	1,209,200	268,100	0	118,200	500	7,495,700
Penobscot	22,008,000	5,416,100	1,394,400	0	14,858,800	2,508,200	46,185,400
Pleasant	1,025,000	16,000	1,800	0	63,400	42,100	1,147,800
Saco	6,189,000	447,800	219,200	0	345,800	9,500	7,211,600
Sheepscot	2,826,000	145,900	20,600	0	92,200	7,100	3,091,600
St Croix	1,269,000	470,400	158,300	0	808,000	20,100	2,725,900
Union	484,000	371,400	0	0	379,700	251,000	1,486,200
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
TOTALS	228,444,000	13,847,700	4,792,900	17,400	23,384,100	5,239,000	275,707,400

Summaries for each river vary by length of time series.

Table 16. Documented Atlantic salmon returns to New England rivers.

Documented returns include rod and trap caught fish. Returns are unknown where blanks occur.									
Returns from juveniles of hatchery origin include age 0 and 1 parr, and age 1 and 2 smolt releases.									
Returns of wild origin include adults produced from natural reproduction and adults produced from fry releases.									
	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	
Androscoggin									
1983-1998	26	503	6	2	5	80	0	1	623
1999	0	1	0	0	1	3	0	0	5
2000	0	3	0	0	0	0	0	0	3
2001	1	4	0	0	0	0	0	0	5
2002	0	2	0	0	0	0	0	0	2
2003	0	3	0	0	0	0	0	0	3
2004	3	7	0	0	0	1	0	0	11
2005	2	8	0	0	0	0	0	0	10
2006	5	1	0	0	0	0	0	0	6
2007	6	11	0	0	1	2	0	0	20
2008	8	5	0	0	2	1	0	0	16
Total for Androscoggin	51	548	6	2	9	87	0	1	704
Cocheco									
1992-1998	0	0	1	1	3	4	0	0	9
1999	0	0	0	0	2	1	0	0	3
2000	0	0	0	0	0	2	0	0	2
2003	0	0	0	0	1	3	0	0	4
Total for Cocheco	0	0	1	1	6	10	0	0	18
Connecticut									
1974-1998	35	3,500	28	2	29	1,075	9	0	4,678
1999	0	0	0	0	11	142	0	0	153
2000	0	0	0	0	1	76	0	0	77
2001	1	0	0	0	4	34	1	0	40
2002	0	3	0	0	2	38	1	0	44
2003	0	0	0	0	0	42	1	0	43
2004	0	0	0	0	5	64	0	0	69
2005	0	4	0	0	23	159	0	0	186
2006	13	33	0	0	20	147	0	1	214
2007	0	19	0	0	1	120	1	0	141
2008	7	10	0	0	3	118	1	2	141
Total for Connecticut	56	3,569	28	2	99	2015	14	3	5,786
Dennys									
1967-1998	20	305	0	1	30	733	3	31	1,123

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	
2000	0	1	0	0	0	1	0	0	2
2001	9	2	0	0	1	9	0	0	21
2002	2	0	0	0	0	0	0	0	2
2003	4	5	0	0	0	1	0	0	10
2004	0	1	0	0	0	0	0	0	1
2006	2	2	0	0	1	1	0	0	6
2007	1	1	0	0	0	1	0	0	3
2008	0	1	0	0	1	3	0	3	8
Total for Dennys	38	318	0	1	33	749	3	34	1,176
Ducktrap									
1985-1998	0	0	0	0	3	30	0	0	33
Total for Ducktrap	0	0	0	0	3	30	0	0	33
East Machias									
1967-1998	21	250	1	2	12	329	1	10	626
Total for East Machias	21	250	1	2	12	329	1	10	626
Kennebec									
1975-1998	12	189	5	1	0	9	0	0	216
2006	4	6	0	0	3	2	0	0	15
2007	2	5	1	0	2	6	0	0	16
2008	6	15	0	0	0	0	0	0	21
Total for Kennebec	24	215	6	1	5	17	0	0	268
Lamprey									
1979-1998	10	17	1	0	1	14	0	0	43
1999	0	0	0	0	6	0	0	0	6
2000	0	0	0	0	2	2	0	0	4
2003	0	0	0	0	2	0	0	0	2
2004	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	2	0	0	0	2
Total for Lamprey	10	17	1	0	13	16	0	0	57
Machias									
1967-1998	32	329	9	2	33	1,592	41	131	2,169
Total for Machias	32	329	9	2	33	1592	41	131	2,169
Merrimack									
1982-1998	170	803	18	8	106	874	26	0	2,005
1999	46	65	1	0	9	64	0	0	185
2000	26	32	0	0	1	23	0	0	82
2001	5	73	0	0	2	3	0	0	83

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	
2002	31	17	0	0	1	6	0	0	55
2003	12	129	0	0	0	4	0	0	145
2004	17	92	2	0	2	15	0	0	128
2005	8	25	0	0	0	1	0	0	34
2006	9	64	1	0	6	9	0	0	89
2007	8	52	0	0	1	12	1	0	74
2008	6	77	0	0	5	29	1	0	118
Total for Merrimack	338	1,429	22	8	133	1040	28	0	2,998
Narraguagus									
1967-1998	92	645	19	53	60	2,311	68	151	3,399
1999	0	2	0	0	6	23	0	1	32
2000	0	1	0	0	13	8	0	1	23
2001	0	2	0	0	5	22	2	1	32
2002	0	0	0	1	4	3	0	0	8
2003	0	0	0	0	0	21	0	0	21
2004	0	0	0	0	1	10	0	1	12
2005	0	0	0	0	1	12	0	0	13
2006	0	0	0	0	3	12	0	0	15
2007	0	0	0	0	2	9	0	0	11
2008	0	0	0	0	4	17	1	1	23
Total for Narraguagus	92	650	19	54	99	2448	71	156	3,589
Pawcatuck									
1982-1998	1	141	1	0	1	5	0	0	149
1999	1	6	0	0	0	4	0	0	11
2000	0	1	0	0	0	0	0	0	1
2003	0	0	0	0	0	5	1	0	6
2004	0	0	0	0	0	1	0	0	1
2005	0	0	0	0	0	2	0	0	2
2006	0	0	0	0	0	0	0	0	0
2007	0	2	0	0	0	0	0	0	2
2008	0	0	0	0	0	0	0	0	0
Total for Pawcatuck	2	150	1	0	1	17	1	0	172
Penobscot									
1968-1998	9,043	39,065	276	633	559	3,268	29	80	52,953
1999	223	568	0	11	49	108	0	9	968
2000	167	265	0	15	16	69	0	2	534
2001	195	466	0	3	21	98	2	0	785
2002	363	344	0	15	14	41	1	2	780
2003	196	847	1	4	6	56	0	2	1,112

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	
2004	276	952	10	16	5	59	3	2	1,323
2005	269	678	0	8	6	22	0	2	985
2006	338	653	1	4	15	33	0	0	1,044
2007	226	575	0	1	35	88	0	0	925
2008	713	1,297	0	4	23	80	0	0	2,117
Total for Penobscot	12,009	45,710	288	714	749	3922	35	99	63,526
Pleasant									
1967-1998	5	12	0	0	11	215	2	2	247
2000	0	0	0	0	1	2	0	0	3
2001	0	0	0	0	1	9	1	0	11
2003	0	0	0	0	1	1	0	0	2
2004	0	0	0	0	0	1	0	0	1
Total for Pleasant	5	12	0	0	14	228	3	2	264
Saco									
1985-1998	48	427	3	5	4	9	1	0	497
1999	10	11	0	0	12	31	2	0	66
2000	31	14	0	0	0	4	0	0	49
2001	15	49	0	0	0	5	0	0	69
2002	3	37	0	2	3	2	0	0	47
2003	2	23	0	0	2	12	0	0	39
2004	3	10	0	0	2	4	0	0	19
2005	5	12	0	0	1	7	0	0	25
2006	8	15	0	0	4	3	0	0	30
2007	4	16	0	0	0	4	0	0	24
2008	11	26	2	0	8	12	3	0	62
Total for Saco	140	640	5	7	36	93	6	0	927
Sheepscot									
1967-1998	6	38	0	0	30	358	10	0	442
Total for Sheepscot	6	38	0	0	30	358	10	0	442
Union									
1973-1998	298	1,811	9	28	1	12	0	0	2,159
1999	3	3	0	0	0	3	0	0	9
2000	1	1	0	0	0	0	0	0	2
2002	0	5	0	0	0	0	0	0	5
2003	1	0	0	0	0	0	0	0	1
2004	0	1	0	0	0	1	0	0	2
Total for Union	303	1,821	9	28	1	16	0	0	2,178

Table 17. Summary of documented Atlantic salmon returns to New England rivers.

Totals reflect the entirety of the available historical time series for each river. Earliest year of data for Penobscot, Narraguagus, Machias, East Machias, Dennys, and Sheepscot rivers is 1967.

	Grand Total by River								Total
	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	
Androscoggin	51	548	6	2	9	87	0	1	704
Cocheco	0	0	1	1	6	10	0	0	18
Connecticut	56	3,569	28	2	99	2,015	14	3	5,786
Dennys	38	318	0	1	33	749	3	34	1,176
Ducktrap	0	0	0	0	3	30	0	0	33
East Machias	21	250	1	2	12	329	1	10	626
Kennebec	24	215	6	1	5	17	0	0	268
Lamprey	10	17	1	0	13	16	0	0	57
Machias	32	329	9	2	33	1,592	41	131	2,169
Merrimack	338	1,429	22	8	133	1,040	28	0	2,998
Narraguagus	92	650	19	54	99	2,448	71	156	3,589
Pawcatuck	2	150	1	0	1	17	1	0	172
Penobscot	12,009	45,710	288	714	749	3,922	35	99	63,526
Pleasant	5	12	0	0	14	228	3	2	264
Saco	140	640	5	7	36	93	6	0	927
Sheepscot	6	38	0	0	30	358	10	0	442
Union	303	1,821	9	28	1	16	0	0	2,178

Table 18.1: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .

Year	Total Fry (10,000s)	Total Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)											Age (years) dist'n (%)					
			1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6		
1974	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1979	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1980	9	18	2.022	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1981	15	19	1.261	0	0	0	11	89	0	0	0	0	0	0	0	11	89	0	0
1982	13	31	2.429	0	0	0	0	90	10	0	0	0	0	0	0	0	90	10	0
1983	7	1	0.143	0	100	0	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	46	1	0.022	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0
1985	29	35	1.224	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1986	10	27	2.791	0	0	0	4	96	0	0	0	0	0	0	0	4	96	0	0
1987	98	44	0.449	0	16	0	0	68	2	0	14	0	0	0	0	16	68	16	0
1988	93	92	0.992	0	0	0	0	97	1	0	2	0	0	0	0	0	97	3	0
1989	75	47	0.629	0	6	0	6	85	0	0	2	0	0	0	0	13	85	2	0
1990	76	53	0.693	0	13	0	0	87	0	0	0	0	0	0	0	13	87	0	0
1991	98	25	0.255	0	20	0	0	64	0	0	16	0	0	0	0	20	64	16	0
1992	93	84	0.904	0	1	0	0	85	1	0	13	0	0	0	0	1	85	14	0
1993	261	94	0.361	0	0	0	2	87	0	0	11	0	0	0	0	2	87	11	0
1994	393	197	0.502	0	0	0	1	93	0	0	6	0	0	0	0	1	93	6	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 1 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.1: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .

1995	451	83	0.184	0	2	0	6	89	0	0	2	0	0	0	8	89	2	0
1996	478	55	0.115	0	4	0	5	89	2	0	0	0	0	0	9	89	2	0
1997	589	24	0.041	0	0	0	4	88	4	0	4	0	0	0	4	88	8	0
1998	661	33	0.050	0	0	0	6	88	0	0	3	0	3	0	6	88	3	3
1999	456	33	0.072	0	0	3	6	79	0	0	12	0	0	0	6	82	12	0
2000	693	43	0.062	0	0	0	0	86	0	0	14	0	0	0	0	86	14	0
2001	699	115	0.165	0	2	0	1	89	0	2	7	0	0	0	3	90	7	0
2002	490	88	0.179	0	10	0	11	69	1	2	6	0	0	0	22	72	7	0
2003	482	102	0.211	0	7	0	12	75	1	0	5			0	19	75	6	
2004	526	72	0.137	1	10	0	0	89		0				1	10	89		
2005	542	3	0.006	33	33		33							33	67			
2006	397	0	0.000	0										0				
Total	7,798	1,426																
Mean		0.524		1	7	0	3	67	4	0	4	0	0	1	10	67	8	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 2 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

Year	Total Fry (10,000s)	Total Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)											Age (years) dist'n (%)					
			1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6		
1974	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1979	5	3	0.561	0	100	0	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	29	18	0.630	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1981	17	19	1.129	0	0	0	11	89	0	0	0	0	0	0	0	11	89	0	0
1982	29	46	1.565	0	0	0	0	89	11	0	0	0	0	0	0	0	89	11	0
1983	23	2	0.088	0	100	0	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	58	3	0.051	0	0	0	0	33	33	0	33	0	0	0	0	0	33	67	0
1985	42	47	1.113	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1986	18	28	1.592	0	0	0	4	96	0	0	0	0	0	0	0	4	96	0	0
1987	117	51	0.436	0	18	0	0	67	2	0	14	0	0	0	0	18	67	16	0
1988	131	108	0.825	0	0	0	0	97	1	0	2	0	0	0	0	0	97	3	0
1989	124	67	0.539	0	22	0	7	69	0	0	1	0	0	0	0	30	69	1	0
1990	135	68	0.505	0	19	0	0	79	0	0	1	0	0	0	0	19	79	1	0
1991	221	35	0.159	0	17	0	0	63	0	0	20	0	0	0	0	17	63	20	0
1992	201	118	0.587	0	5	0	0	82	1	0	12	0	0	0	0	5	82	13	0
1993	415	185	0.446	0	4	0	3	87	0	0	6	0	0	0	0	6	87	6	0
1994	594	294	0.495	0	5	0	2	88	0	0	5	0	0	0	0	7	88	5	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 3 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

1995	678	143	0.211	1	13	0	7	78	0	0	2	0	0	1	20	78	2	0
1996	664	101	0.152	0	16	0	11	71	1	0	1	0	0	0	27	71	2	0
1997	850	37	0.044	0	3	0	3	89	3	0	3	0	0	0	5	89	5	0
1998	908	44	0.048	0	0	0	9	84	0	0	5	0	2	0	9	84	5	2
1999	639	45	0.070	0	0	2	4	80	0	0	13	0	0	0	4	82	13	0
2000	929	66	0.071	0	6	0	0	80	0	0	14	0	0	0	6	80	14	0
2001	956	151	0.158	0	3	0	3	88	0	1	5	0	0	0	5	89	5	0
2002	725	165	0.228	1	10	0	12	72	1	1	3	0	0	1	22	73	4	0
2003	700	146	0.208	1	13	0	12	70	1	0	4			1	25	70	5	
2004	765	118	0.154	1	11	0	0	88		0				1	11	88		
2005	776	12	0.015	8	67		25							8	92			
2006	581	0	0.000	0										0				
Total	11,348	2,127																
Mean		0.409		0	13	0	3	66	2	0	5	0	0	0	17	66	7	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 4 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

Year	Total Fry (10,000s)	Total Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)											Age (years) dist'n (%)				
			1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6	
1979	3	3	1.034	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	20	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	17	15	0.902	0	0	0	0	87	13	0	0	0	0	0	0	87	13	0
1983	16	1	0.064	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	13	2	0.156	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0
1985	14	12	0.881	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	8	1	0.126	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
1988	33	13	0.391	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	28	19	0.680	0	63	0	11	26	0	0	0	0	0	0	74	26	0	0
1990	27	11	0.407	0	45	0	0	45	0	0	9	0	0	0	45	45	9	0
1991	37	2	0.054	0	50	0	0	0	0	0	50	0	0	0	50	0	50	0
1992	55	15	0.271	0	20	0	0	67	0	0	13	0	0	0	20	67	13	0
1993	77	52	0.673	0	13	0	6	77	0	0	4	0	0	0	19	77	4	0
1994	110	49	0.447	0	31	0	4	63	0	0	2	0	0	0	35	63	2	0
1995	115	42	0.367	2	38	0	5	52	0	0	2	0	0	2	43	52	2	0
1996	91	19	0.208	0	58	0	11	26	0	0	5	0	0	0	68	26	5	0
1997	148	4	0.027	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	119	2	0.017	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	99	2	0.020	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 5 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

2000	125	9	0.072	0	0	0	0	89	0	0	11	0	0	0	0	89	11	0	
2001	125	12	0.096	0	8	0	17	75	0	0	0	0	0	0	0	25	75	0	0
2002	119	22	0.185	5	5	0	14	77	0	0	0	0	0	5	18	77	0	0	
2003	112	8	0.071	0	38	0	25	38	0	0	0			0	63	38	0		
2004	118	11	0.093	0	18	0	0	82		0				0	18	82			
2005	124	8	0.065	0	88		13							0	100				
2006	86	0	0.000	0										0					
Total	1,846	339																	
Mean		0.287		0	25	0	4	57	1	0	9	0	0	0	29	57	9	0	

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 6 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.4: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1975	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	6	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	7	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	11	18	1.698	0	0	0	0	11	33	22	28	6	0	0	0	33	61	6
1979	8	43	5.584	0	0	0	0	84	5	2	9	0	0	0	0	86	14	0
1980	13	42	3.333	0	0	0	0	19	5	19	52	5	0	0	0	38	57	5
1981	6	78	13.684	0	0	0	6	81	0	5	8	0	0	0	6	86	8	0
1982	5	48	9.600	0	0	2	2	77	8	0	10	0	0	0	2	79	19	0
1983	1	23	27.479	0	4	4	17	65	4	0	4	0	0	0	22	70	9	0
1984	53	47	0.894	0	13	0	4	77	2	0	4	0	0	0	17	77	6	0
1985	15	59	3.986	0	2	0	7	69	2	0	20	0	0	0	8	69	22	0
1986	53	111	2.114	0	11	0	0	77	1	0	9	0	2	0	11	77	10	2
1987	108	264	2.449	0	2	0	9	85	0	0	4	0	0	0	11	85	4	0
1988	172	93	0.541	1	5	0	0	90	0	0	3	0	0	1	5	90	3	0
1989	103	45	0.435	2	7	0	31	60	0	0	0	0	0	2	38	60	0	0
1990	98	21	0.215	5	0	0	10	81	0	0	5	0	0	5	10	81	5	0
1991	146	17	0.117	0	6	0	6	76	12	0	0	0	0	0	12	76	12	0
1992	112	15	0.134	0	0	0	0	93	7	0	0	0	0	0	0	93	7	0
1993	116	11	0.095	0	0	0	27	45	0	9	18	0	0	0	27	55	18	0
1994	282	53	0.188	0	0	0	13	85	0	0	2	0	0	0	13	85	2	0
1995	283	87	0.308	0	0	0	22	72	0	6	0	0	0	0	22	78	0	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 7 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.4: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .

1996	180	27	0.150	0	0	0	15	85	0	0	0	0	0	0	15	85	0	0				
1997	200	4	0.020	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0				
1998	259	8	0.031	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0				
1999	176	8	0.046	0	0	0	13	50	0	0	38	0	0	0	13	50	38	0				
2000	222	12	0.054	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0				
2001	171	5	0.029	0	0	0	40	20	0	0	40	0	0	0	40	20	40	0				
2002	141	8	0.057	0	0	0	0	88	13	0	0	0	0	0	0	88	13	0				
2003	133	19	0.142	0	0	0	32	63	5	0	0											
2004	156	32	0.206	0	0	0	3	91	6													
2005	96	3	0.031	0	0	100								0 100								
2006	101	0	0.000	0										0								
Total		3,432		1,201																		
Mean		2.301		0	2	0	13	63	3	2	9	0	0	0 15 66 12 0								

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 8 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.5: Return rates for Atlantic salmon that were stocked as fry in the Pawcatuck River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)										Age (years) dist'n (%)								
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6				
1993	38	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0				
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0				
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	0	20	80	0				
1996	29	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1997	10	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1998	91	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1999	59	5	0.085	0	0	20	0	80	0	0	0	0	0	0	0	0	100	0				
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	0	50	50	0				
2001	42	2	0.047	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0				
2002	40	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
2003	31	0	0.000	0	0	0	0	0	0	0	0				0	0	0	0				
2004	56	0	0.000	0	0	0	0	0				0						0	0	0		
2005	1	0	0.000	0	0									0					0	0		
2006	8	0	0.000	0															0			
Total	531	19																				
Mean		0.032		0	4	2	2	43	0	0	0	0	0	0	0	5	44	0	0			

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 9 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.6: Return rates for Atlantic salmon that were stocked as fry in the Salmon River .

Year	Total Fry (10,000s)	Total Returns (per 10,000)	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	12	2	0.165	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0	0	0	0	33	67	0	0
2003	25	13	0.526	8	38	0	8	46	0	0	0			8	46	46	0	
2004	28	0	0.000	0	0	0	0	0		0				0	0	0		
2005	26	0	0.000	0	0		0							0	0			
2006	25	0	0.000	0										0				

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 10 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 18.6: Return rates for Atlantic salmon that were stocked as fry in the Salmon River .

Total	377	82															
Mean		0.220	0	20	0	3	53	0	0	0	0	0	0	23	53	0	0

Table 18.7: Return rates for Atlantic salmon that were stocked as fry in the Westfield River .

Year	Total Fry (10,000s)	Total Returns (per 10,000)	Age class (smolt age:sea age) distribution (%)											Age (years) dist'n (%)					
			1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6		
1988	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	63	0	0	13	0	0	0	0	25	63	13	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4				0	26	70	4	
2004	93	35	0.378	0	11	0	0	89		0					0	11	89		
2005	84	1	0.012	0	0		100								0	100			
2006	73	0	0.000	0											0				
Total	1,327	280																	
Mean		0.203		0	5	0	10	79	0	0	6	0	0		0	14	79	6	0

Mean return rate computation includes incomplete return rates for 2002 - 2005 year class fish.

Page 12 of 12 for Table 18.

NOTE: Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Table 19. Summary return rates in southern New England for Atlantic salmon that were stocked as fry.

Year Stocked	Number of adult returns per 10,000 fry stocked						
	Merrimack	Pawcatuck	CT Basin	Connecticut (above Holyoke)	Salmon	Farmington	Westfield
1974			0.000	0.000			
1975	0.000		0.000	0.000			
1976	0.000		0.000	0.000			
1977	0.000		0.000	0.000			
1978	1.698		1.400	1.400			
1979	5.584		0.561	0.000		1.034	
1980	3.333		0.630	2.022		0.000	
1981	13.684		1.129	1.261		0.000	
1982	9.600		1.565	2.429		0.902	
1983	27.479		0.088	0.143		0.064	
1984	0.894		0.051	0.022		0.156	
1985	3.986		1.113	1.224		0.881	
1986	2.114		1.592	2.791		0.126	
1987	2.449		0.436	0.449	0.165	0.740	
1988	0.541		0.825	0.992	0.693	0.391	0.000
1989	0.435		0.539	0.629	0.000	0.680	0.095
1990	0.215		0.505	0.693	0.000	0.407	0.146
1991	0.117		0.159	0.255	0.000	0.054	0.099
1992	0.134		0.587	0.904	0.322	0.271	0.373
1993	0.095	0.078	0.446	0.361	0.190	0.673	0.559
1994	0.188	0.036	0.495	0.502	0.166	0.447	0.652
1995	0.308	0.136	0.211	0.184	0.041	0.367	0.192
1996	0.150	0.000	0.152	0.115	0.607	0.208	0.170
1997	0.020	0.000	0.044	0.041	0.134	0.027	0.066

Year Stocked	Number of adult returns per 10,000 fry stocked						
	Merrimack	Pawcatuck	CT Basin	Connecticut (above Holyoke)	Salmon	Farmington	Westfield
1998	0.031	0.000	0.048	0.050	0.039	0.017	0.078
1999	0.046	0.085	0.070	0.072	0.454	0.020	0.056
2000	0.054	0.061	0.071	0.062	0.108	0.072	0.131
2001	0.029	0.047	0.158	0.165	0.160	0.096	0.188
2002	0.057	0.000	0.228	0.179	0.799	0.185	0.381
2003	0.142	0.000	0.208	0.211	0.526	0.071	0.284
2004	0.206	0.000	0.154	0.137	0.000	0.093	0.378
2005	0.031	0.000	0.015	0.006	0.000	0.065	0.012
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean	2.301	0.032	0.409	0.524	0.220	0.287	0.203
StdDev	5.502	0.044	0.472	0.735	0.257	0.316	0.188

Note: Maine rivers not included in this table until adult returns from natural reproduction and fry stocking can be distinguished.

Note: Summary mean and standard deviation computations includes incomplete return rates from 2002 (5 year olds), 2003 (4 year olds), 2004 (3 year olds), and 2005 (2 year olds).

Table 20. Summary of age distributions of adult Atlantic salmon that were stocked in southern New England as fry.

	Mean age class (smolt age.sea age) distribution (%)										Mean age (years) (%)				
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
Connecticut (basin)	0.00	0.08	0.00	0.04	0.82	0.01	0.00	0.05	0.00	0.00	0.00	0.13	0.82	0.05	0.00
Connecticut (above Holyoke)	0.00	0.04	0.00	0.03	0.86	0.01	0.00	0.05	0.00	0.00	0.00	0.07	0.87	0.06	0.00
Farmington	0.01	0.26	0.00	0.06	0.63	0.01	0.00	0.04	0.00	0.00	0.01	0.32	0.63	0.04	0.00
Salmon	0.01	0.23	0.00	0.13	0.62	0.00	0.00	0.00	0.00	0.00	0.01	0.37	0.62	0.00	0.00
Westfield	0.00	0.06	0.00	0.05	0.86	0.00	0.00	0.04	0.00	0.00	0.00	0.10	0.86	0.04	0.00
Merrimack	0.00	0.03	0.00	0.09	0.76	0.02	0.02	0.07	0.00	0.00	0.00	0.12	0.78	0.09	0.00
Pawcatuck	0.00	0.05	0.05	0.05	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.89	0.00	0.00
Overall Mean:	0.00	0.11	0.01	0.06	0.77	0.01	0.00	0.04	0.00	0.00	0.00	0.17	0.78	0.04	0.00

Program summary age distributions vary in time series length; refer to specific tables for numbers of years utilized.

Note: Maine rivers not reported until adult returns from natural reproduction and fry stocking can be distinguished.