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

REPORT NO. 19 - 2006 ACTIVITIES

GLOUCESTER, MASSACHUSETTS
March 5 – March 8, 2007

PREPARED FOR
U.S. SECTION TO NASCO

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1.0 EXECUTIVE SUMMARY

Total return to USA rivers was 1,480; 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 1,422 fish in 2006, 20% less than observed in 2004 and 13% more than returned in 2005. Seventy-nine adult (90% CI = 49 - 122) fish were estimated to return to the rivers with Endangered populations, the 4th lowest for the 1991-2006 time-series. Escapement to natural spawning areas was 1,048 (returns – broodstock + stocked pre-spawn adults). Most returns occurred in Maine, with the Penobscot River accounting for 71% of the total return. Overall, 30% of the adult returns to the USA were 1SW salmon and 70% were MSW salmon. Most (78%) returns were of hatchery smolt origin and the balance (22%) originated from either natural reproduction or hatchery fry. A total of 12,050,800 juvenile salmon (fry, parr, and smolts) and 3,755 adults were stocked, with 473,850 carrying a variety of marks and/or tags (e.g., PIT tags, visual implant elastomer tags, fin clips etc.). Eggs for USA hatchery programs were taken from 483 sea-run females, 3,024 captive/domestic females, and 96 female kelts. The number of females (3,603) contributing was more than 2005 (3,093); and total egg take (20,536,785) was more than in 2005 (17,811,000) and 2004 (20,486,000). Production of farmed salmon in Maine was estimated to be 3,580 metric tonnes in 2006, a decrease from the 5,263 metric tonnes produced in 2005.

1.1 Introduction to Report

Background

The U.S.A. became a charter member of the North Atlantic Salmon Conservation Organization (NASCO) in 1984. NASCO is charged with the international management of Atlantic salmon stocks on the high seas. Three Commissioners for the U.S. are appointed by the President of the United States and work under the auspices of the U.S. State Department. The Commissioners required advice and input from scientists involved in salmon research and management throughout New England and asked the New England Atlantic Salmon Committee (NEASC) to create an advisory committee. The NEASC, comprised of State and Federal fishery agency chiefs, designated personnel from their staff to serve on the "NASCO Research Committee", which was formed in 1985.

The Research Committee met semiannually to prepare data for upcoming meetings of the International Council for the Exploration of the Sea (ICES), North Atlantic Salmon Working Group, and NASCO. In July of 1988, the Research Committee for the U.S. Section to NASCO was restructured and renamed the U.S. Atlantic Salmon Assessment Committee (USASAC). The Committee was charged with the following tasks: 1) to conduct annual U.S. Atlantic salmon stock assessments, 2) to evaluate ongoing U.S. Atlantic salmon research programs and develop proposals for new research, and 3) to serve as scientific advisors to the U.S. Section of NASCO. The Committee began meeting annually to produce an Atlantic salmon program assessment document. The data summarized allows U.S. representatives to ICES to responds to Terms of Reference from NASCO to the North Atlantic Salmon Working Group. Further the USASAC responds to direct requests for information from the U.S. Commissioners.

Since the 1970s, ICES has provided scientific information and advice in response to requests by international and regional regulatory commissions, and the governments of its member countries, for purposes of fisheries conservation and the protection of the marine environment. ICES is responsible for providing scientific advice used by NASCO parties as a basis for formulating biologically sound management recommendations for the conservation of North Atlantic salmon stocks. ICES assigned the responsibility for the collecting and analyzing scientific data for Atlantic salmon stocks in the North Atlantic to the North Atlantic Salmon Working Group. Two or more U.S. representatives participate in the North Atlantic Salmon Working Group, forwarding data summarized by the USASAC. The advice provided by the North Atlantic Salmon Working Group is provided to the NASCO parties at an annual meeting each June.

Members of the U.S. Atlantic Salmon Assessment Committee (Section 5.1) met in Gloucester, Massachusetts from March 5 to March 8, 2007 to address the following Terms of Reference.

1.2 Terms of Reference for Report No. 19 - 2006 Activities

From U.S. Commissioners to NASCO

1. Report on significant new or emerging threats to, or opportunities for, salmon conservation and management.
   - Of particular interest are opportunities for coutnries to share their experiences on key issues and learn from each other.
2. Provide relevant information on activities under the US Implementation Plan.
3. Review information in the NASCO rivers database to ensure accuracy and input additional information as time allows.
4. Provide input to the US members of the WGNAS as requested to assist in the development of a framework of indicators to verify the stability of multi-annual catch advice.
5. Compile and analyze relevant data to assist the WGNAS in its examination of the associations between changes in biological characteristics of all life stages of Atlantic salmon and variations in marine survival.

From ICES

1. Describe the key events of the 2005 fisheries (including the fishery at St Pierre and Miquelon) and the status of the stocks;
2. Provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and production of farmed and ranched Atlantic salmon in 2006;
3. Provide a compilation of tag releases by country in 2005;

From NEASC

1. Prioritize fish passage blocks for improvement and/or removal across New England.

These Terms of Reference will be addressed in this report or in Working Papers (Appendix 5.2). Information related to ICES TOR will be carried to the ICES Working Group on North Atlantic Salmon. The Chair will brief the U.S. Section to NASCO on the report content before the Annual NASCO meeting.

2.0 STATUS OF STOCKS

2.1 Description of Fisheries

Except for a one-month experimental 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 unreported catch is zero (metric tonne). A total of 241 recreational licenses were sold for the experimental fishery, with 247 angler trips reported (3.4 hours/trip with 2.8 hours spent fishing). Anglers had the opportunity to fish over at least 29 Atlantic salmon, and one Atlantic salmon was captured and released. A fishery in the main stem of the Merrimack River and small reach of the Pemigewasset River was supported by the release of 1,232 fish surplus broodstock in 2006. Anglers purchased 1,447 licenses for this fishery in 2006.

2.2 Adult Returns

Total return to USA rivers was 1,480 (Table 1), a 13% increase from 2005 returns (Table 2). Changes from 2005 by river were: Connecticut (+15%), Merrimack (165%), Penobscot (+6%), Saco (+20%), and Narraguagus (+15%). In addition to catches at traps and weirs (1,422), 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 (returns) = 0.5699 ln(redd count) + 1.3945]. The relationship between these estimates and the returns to the Narraguagus River were used to estimate GOM DPS returns in 2006 because high flows precluded complete redd counts. Seventy-nine adult (90% CI = 49 - 122) fish were estimated to return to the rivers with Endangered populations.

The replacement rate for 11 generations of Atlantic salmon starting with returns in 1996 from the 1991 spawning cohort averaged 0.6 and the mean replacement rate has not exceeded 1 during this time period. However, in 5 of the 11 years the upper bound of the 90% confidence limits did exceed 1. The replacement rate for 2006 was 0.77 (0.46 - 1.21) and was the fourth highest in the time series.

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. Returns of 2SW fish from traps, weirs, and estimated returns were only 3.5 % of the 2SW conservation spawner requirements for USA, with individual river returns ranging from 0.0 to 10.2 % of spawner requirements (Table 3).

Most returns occurred in Maine, with the Penobscot River accounting for 70.5% of the total return. Overall, 30% of the adult returns to the USA were 1SW salmon (450) and 70% were MSW salmon (1,030). Returns of MSW salmon in 2006 were higher than those in 2004. Most (78%) returns were of hatchery smolt origin and the balance (22%) originated from either natural reproduction or hatchery fry (Figure 1). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2004 was 0.16%, with the 2SW fish return rate 0.12% (Figure 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 2004 cohort of wild smolts on the Narraguagus was 0.93%, mirroring trends on the Penobscot (Figure 2).

2.3 Stock Enhancement Programs

Durring 2006 about 12,050,800 juvenile salmon (91% fry) were released into 15 River systems (Table 4). The number of juveniles released was less than that in 2005 (13,811,600). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six rivers within the geographic range of the GOM DPS in Maine. The 363,379 parr released in 2006 were primarily the by-products of smolt production programs and included ages 0 and 1 fish. Smolts were stocked in the Penobscot (549,200), Merrimack (50,000), Connecticut (53,132), Dennys (56,500), Pleasant (15,200), and Pawcatuck (12,842) rivers. In addition to juveniles, 3,755 adult salmon were released into USA rivers (Table 5). 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 spawners. Thus, spawners exceeded returns in 2006 with USA spawners totaling 1,876. Escapement to natural spawning areas was 1,048 (returns – broodstock + stocked pre-spawn adults).

2.4 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 473,850 salmon released into USA waters in 2006 was marked or tagged. Tags used on parr, smolts and adults included: Floy, Carlin, HI-Z Turb'N, PIT, radio and acoustical, fin clips, and visual implant elastomer. About 14% of the marked fish were released into the Connecticut River watershed, 18% into the Dennys River watershed, and 57% into the Penobscot River (Table 6).

2.5 Farm Production

Production of farmed salmon in Maine was estimated at 3,580 metirc tonnes in 2006, a decrease from 5,263 t in 2005 and 8,515 t in 2004. Production in three the last five years has been less than half of the 13,202 t produced in 2001 (Table 7).

2.6 Developments in the Management of Atlantic Salmon

2.6.1 Anesthesia

Restoration efforts for Atlantic salmon (ATS) dictate that fish in various life stages must be handled. Use of anesthesia is critical for immobilizing individual fish so tagging, measuring, transporting, spawning, disease testing, and others sampling can be effectively and humanely performed. When properly administered to fish, anesthesia can also prevent stress responses that are responsible for depressing the immune system, causing electrolytic imbalance, and interfering with normal reproductive functions. There are only two drugs which are permitted by the U.S. Food and Drug Administration (FDA) for use on potential food fish: (1) MS-222 (Tricaine Methanesulfonate hydrochloride) and (2) Aqui-S (a eugenol-based drug). Metomidate Hydrochloride (trade name: Aquacalm, Syndell, International, Inc.) is an un-approved compound suitable for use with threatened and endangered stocks with appropriate documentation. Further information on these three anesthesia is included in Section 4.1.

2.6.2 Adult Handling Protocols

Adult Atlantic salmon transport and handling protocols were summarized and compared among three regional programs; Maine Rivers, Merrimack River, and Connecticut River. Adults are moved from trap to hatchery, from trap to river release location, between hatcheries, and from hatchery to river release locations. Specific topics discussed included temperature thresholds and change allowance, handling techniques and equipment, transport / holding tanks and equipment, holding water treatment, and transport / holding densities.

Equipment and handling protocols are similar between the regional programs. However, the programs had different temperature thresholds for handling and differed in the use of tempering to minimize large and rapid temperature changes. These differences were discussed, considering the appropriateness of the varying temperature threshold guidelines for different situations. The USASAC agreed to periodically review adult handling and transport protocols. Practices and procedures that are currently successful may not continue to be in the future, and there is a need to record current protocols.

Further information on adult handling protocols is included in Section 4.2.

2.6.3 Prioritizing fish passage projects in New England

NEASC requested the USASAC to provide a list of the top priority fish passage projects for New England. NEASC hopes to use this information to leverage funding from a variety of sources to implement these projects. Therefore, the list was not to include projects that would be required of FERC licensees or required by other regulatory agencies. The list was to include projects that would benefit Atlantic salmon as well as other diadromous species and the committee was to rank these projects in a regionally perspective. The USASAC reviewed projects forwarded by the New England states and Atlantic salmon programs, eliminated projects that were either FERC requirements or had received all necessary funding. It also consolidated several projects into single ‘block’ projects and questioned why other projects were not submitted. A preliminary ranking of the remaining list was developed that had the Penobscot River Restoration Project as top priority and repair of the Rainbow Dam fishway on the Farmington River second.

Further information on the interactions of USASAC and NEASC in 2006 and the task of prioritizing fish passage projects are included in Sections 4.3 and 4.4.

2.6.4 Information for US Implementation Plan to NASCO

Components to the USASC Annual Report 2006/19 and other available program reports were reviewed to ensure that information was available to report on the following activities in the US Implementation Plan to NASCO.

- MASC experimental recreational fishery
- State agency monitoring of incidental recreational catch
- NASCO Habitat Database
- Status of Fish Passage Agreements
- Data on escapees
- Data on genetic testing of parr taken as broodstock
- Diadromous fish restoration, passage, and habitat improvement

Information not readily available for NOAA staff compiling the report to NASCO were identified and compiled at the meeting. Section 4.5 reports on 2006 State agency monitoring for incidental recreational catch of Atlantic salmon. Section 4.6 provides an update on data entered into the NASCO Salmon Rivers Database in 2006.

2.6.5 Are northeastern USA coastal rivers undergoing “cultural oligotrophication” ?

Nutrient limitation can be an important control on salmonid production and population abundance. Phosphate (PO_4) is usually the limiting nutrient in surface waters, however nitrogen can be limiting or co-limiting. Carbon is generally not limiting (in the form of dissolved organic carbon DOC) in streamwater, and there is evidence that DOC concentrations are increasing regionally. The strongest evidence of a link between nutrient status and salmonid production comes from long-term nutrient addition studies conducted in the Pacific Northwest (Slaney et al. 2003). However, Weng et al. (2001) linked nutrients to Atlantic salmon production, noted that Atlantic salmon recovered more quickly following flooding in those streams with higher nutrient status.

Cultural oligotrophication (Stockner et al. 2000) refers to practices that reduce the nutrient concentrations in surface waters. In 2006 the USASAC explored the role of anadromous communities in delivering these nutrients from the marine system to New

England streams, and whether loss or decline of anadromous fish may be associated with cultural oligotrophication. Under some circumstances, changes in anadromous fish populations can cause nutrient declines. For example, Nislow et al. (2004) found down-spiraling freshwater nutrient budgets in a Scottish Atlantic salmon river, due to smolt outmigration with inadequate concurrent adult salmon escapement. Thus, our question for 2007 was: Are there other factors that may be influencing the productivity of Atlantic salmon rivers in the USA?

Further information on prioritizing fish passage projects is included in Section 4.7.

Table 1. Documented Atlantic salmon returns to USA rivers, 2006. "Natural" includes fish originating from natural spawning and hatchery fry. Returns to traps are compared to five-year averages in Table 10.

RIVER	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
Androscoggin	5	0	1	0	0	0	0	0	6
Connecticut	13	20	33	147	0	0	0	1	214
Kennebec	4	3	6	2	0	0	0	0	15
Merrimack	10	5	66	8	1	0	0	0	90
Dennys (DPS)	2	1	2	1	0	0	0	0	6
Narraguagus (DPS)	0	3	0	12	0	0	0	0	15
Other GOM DPS [1]	6	11	5	36	0	0	0	0	58
Pawcatuck	0	0	0	0	0	0	0	0	0
Penobscot	338	15	653	33	1	0	4	0	1044
Saco	8	4	15	3	0	0	0	0	30
Lamprey	0	2	0	0	0	0	0	0	2
Total	386	64	781	242	2	0	4	1	1480

[1] Numbers based on redds, ages and origins are pro-rated based upon distributions for DPS rivers with traps

Table 2. Documented Atlantic salmon returns to the USA, 1967-2006. "Natural" includes fish originating from natural spawning and hatchery fry.

	Sea age					Origin	
Year	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

[1]Starting in 2003 estimated returns based on redds are included in the table.

Table 3. Two sea winter (2SW) returns for 2006 in relation to spawner requirements for USA rivers

River	Spawner Requirement	2SW spawners-2006	Percentage of Requirement
Penobscot	6,838	686	10.03
Connecticut	9,727	180	1.85
Paucatuck	367	0	0.00
Merrimack	2,599	74	2.85
GOM-DPS	1564	79	5.05
Other Maine rivers	8104	27	0.33
Total	29,199	1046	3.58

Table 4. Number of juvenile Atlantic salmon stocked in USA, 2006.

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
Aroostook	324,000	0	0	0	0	0	324,000
Androscoggin	1,000	0	0	0	0	0	1,000
Dennys	295,000	27,600	0	0	56,500	0	379,100
East Machias	199,000	0	0	0	0	0	199,000
Kennebec	8,000	0	0	0	0	0	8,000
Machias	638,000	2,000	1,500	0	0	0	641,500
Narraguagus	478,000	17,500	0	0	0	0	495,500
Pleasant	284,000	0	0	0	0	15,200	299,200
Penobscot	1,509,000	293,500	0	0	549,200	0	2,351,700
Saco	106,000	0	0	0	0	0	106,000
Sheepscot	151,000	16,600	0	0	0	0	167,600
Union	2,000	0	0	0	0	0	2,000
Merrimack	1,011,000	0	0	0	50,000	0	1,061,000
Pawcatuck	85,000	0	0	0	12,800	0	97,800
Total for United States	10,939,000	360,900	1,500	12,600	669,500	67,300	12,050,800

Table 5. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2006 by river.

		Captive Reared Domestic		Sea Run	
River	Purpose	Post-spawn	Pre-spawn	Post-spawn	Total
Connecticut	Restoration	0	0	3	3
Dennys	Restoration	0	55	0	55
East Machias	Restoration	80	79	0	159
Hobart Stream	Restoration	170	0	0	170
Machias	Restoration	64	164	0	228
Merrimack	Restoration/Recreation	862	370	0	1,232
Narraguagus	Restoration	0	133	0	133
Pawcatuck	Recreation	0	100	0	100
Penobscot	Restoration	0	833	492	1,325
Pleasant	Restoration	0	199	0	199
Sheepscot	Restoration	82	69	0	151
Total United States		1,258	2,002	495	3,755

Table 6. Summary of tagged and marked Atlantic salmon released in USA, 2006. Additional data are in Table 9.1.

		Stock Origin										
Mark Code	Life Stage	Connecticut	Dennys	East Machias	Machias	Merrimack	Narraguagus	Pawcatuck	Penobscot	Pleasant	Sheepscot	Grand Total
AD	Parr	14,650	27,604				17,476		100,541		17,026	177,297
AD	Smolt	53,132	56,500					12,842	169,066			291,540
FLOY	Adult					1,232			25			1,257
HI_Z	Smolt								60			60
PING	Smolt								291			291
PIT	Adult	3	83	159	228		226		492	248	151	1,590
PIT	Parr	453										453
PIT	Smolt									1,348		1,348
RAD	Adult	14										14
Grand Total		68,252	84,187	159	228	1,232	17,702	12,842	270,475	1,596	17,177	473,850

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

HI-Z = HI-Z Turb'N tag

Table 7. Aquaculture production (metric tones) in New England from 1997 to 2006.

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	3,580

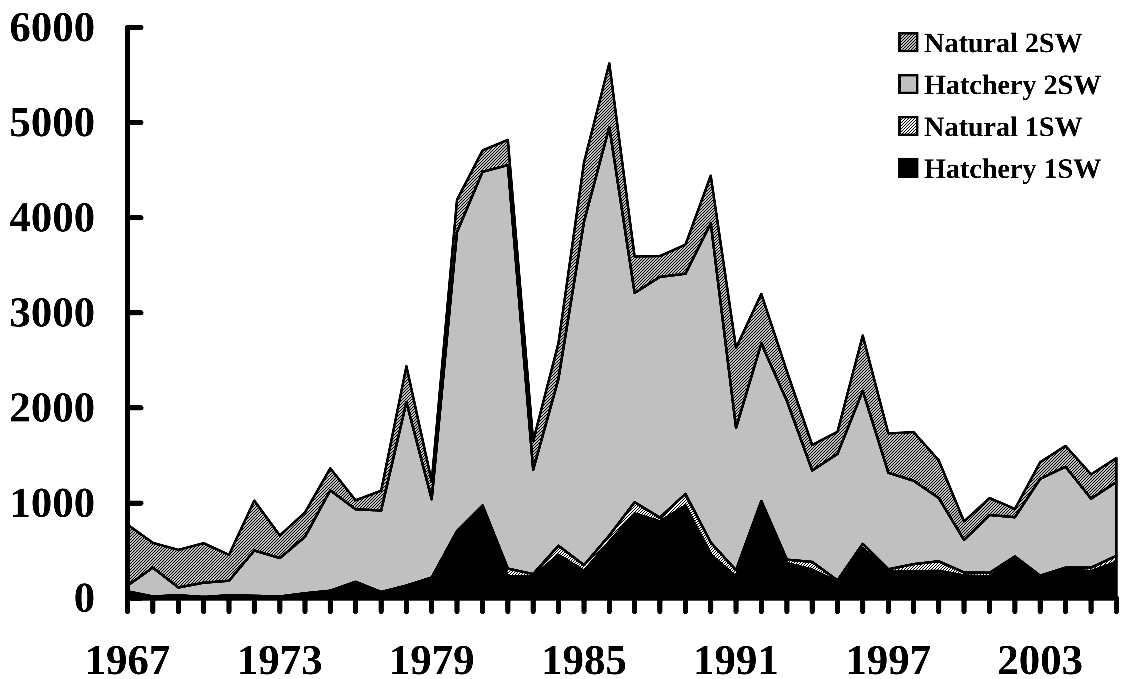


Figure 1. Number and sea age of Atlantic salmon returning to USA rivers.

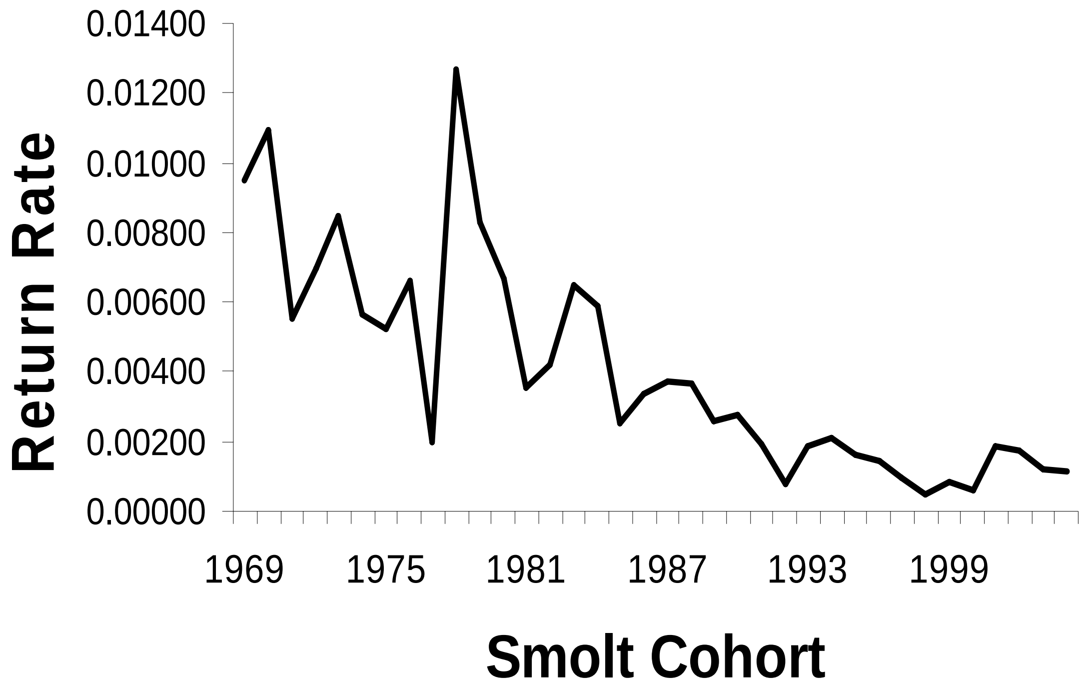


Figure 2. Return rate of 2SW adults by cohort of hatchery-reared Atlantic salmon smolts released into the Penobscot River (PN), Maine, USA.

2.7 Historical Data

Tables referred to in this section can be found in Section 5.3.

2.7.1 Egg Production

Total egg production for Atlantic salmon restoration and recovery programs in New England for the 2006 was 20,537,000 (Table 11). A summary by program and year (Table 12) and grand total of all historical Atlantic salmon egg production for New England salmon rivers (Table 13) is provided. Approximately 72,767 female Atlantic salmon have produced an estimated 482 million eggs for programs throughout the history of salmon enhancement, restoration, and recovery efforts.

2.7.2 Stocking

Approximately 249 million juvenile salmon have been released into the rivers of New England during the period, 1967 – 2006 (Table 14). About 82% of the total have been fry (Table 15). The majority of the juvenile releases have occurred in the Connecticut River (> 123 million), the Penobscot River (> 41 million), and the Merrimack River (> 37 million).

2.7.3 Adult Returns

The number and age structure of returns to New England rivers has varied from 1967 through 2006 (Table 16). Most returns occurred in Maine, with the Penobscot River accounting for 74% of the total return (Table 17).

Return rates for Atlantic salmon stocked as fry for southern New England rivers are tabulated in Tables 18.1 through 18.7. A summary of return rates and age distributions of Atlantic salmon stocked in New England rivers as fry are tabulated in Tables 19 and 20. Summaries of return rates and age distributions of adult salmon that were stocked as fry are not reported for rivers in the State of Maine. Adult salmon return rates and age distribution data for Maine rivers can not be accurately reported until returns from natural reproduction and fry stocking can be distinguished.

3.0 PROGRAM SUMMARIES

3.1 Connecticut River

3.1.1 Adult Returns

A total of 214 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 115 on the Connecticut River mainstem, 44 in the Farmington River, 20 in the Salmon River, 34 in the Westfield River, and one in the Eightmile River. The spring run lasted from April 21 to July 9. A total of 191 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS). The 2006 run was the largest return of salmon to the Connecticut River since 1998.

Two salmon were released into the upper Westfield River. Fourteen salmon were radio-tagged and released above Holyoke. One additional salmon was known to have escaped Holyoke but was captured for broodstock at Vernon. Of the fourteen radio-tagged fish, four passed the Turners Falls and Vernon fishways. Three of these salmon reached the USACE salmon trap and transport facility at Townshend Dam on the West River but did not enter it due to operational problems. One salmon entered the Bellows Falls fishway, but did not pass it, and ultimately was found in the Cold River. Seven radio-tagged salmon migrated to the Deerfield River and one to the Mill River.

Four of the Salmon River returns were observed by snorkeling and never captured and one was illegally retained by an angler. The Eightmile River return, the first documented to that tributary, was captured by electrofishing and released. One of the Farmington River salmon was seen on video in the Rainbow Fishway in the fall but not captured.

Forty-six of the salmon observed were of hatchery (smolt-stocked) origin, of which 13 were grilse and 33 were 2SW. This is the largest number of smolt-origin adults since 1996. The remaining 168 salmon were of wild (fry-stocked) origin. Sea-age distribution of the wild salmon was 20 grilse, 147 2SW, and one repeat spawner. Freshwater age distribution of wild salmon was 1+ (12%), 2^+ (81%) and 3^+ (7%).

One salmon was angled and illegally retained and one was angled but taken for broodstock. There were also several reports of salmon being caught and released.

3.1.2 Hatchery Operations

The program achieved 76% of egg production goals, 58% of fry stocking goals, and 51% of smolt stocking goals in 2006.

A fin condition survey was conducted in February at Pittsford National Fish Hatchery (PNFH) to evaluate smolts prior to stocking. Based on this evaluation, PNFH produced 12,616 parr (17% of total), 10,167 smolts with fatal fin condition (14%), and 51,165 viable smolts (69%). 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.

Currently, a total of 100,000 1+ pre-smolts is in production at PNFH. They were again marked with an adipose fin clip and vaccinated with a multi-valent vaccine for *Vibrio* and furunculosis in preparation for spring 2007 stocking. The presmolts will be evaluated for size and fin condition prior to stocking.

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

The USFWS initiated salmon production at the Berkshire National Fish Hatchery. Volunteers supervised by PNFH staff operate the facility. Target production is 25,000 two-year smolts.

Egg Collection
A total of 11.4 million green eggs was produced at five state and federal hatcheries within the program. Sea-run broodstock produced 896,000 eggs from 116 females held at the RCNSS. A sample of the fertilized eggs from all sea-run crosses was egg-banked at the White River National Fish Hatchery (WRNFH) for disease screening and subsequent production of future domestic brood stock. Domestic broodstock produced 10.0 million eggs from 1,782 females held at RCNSS, WRNFH, Kensington State Salmon Hatchery (KSSH), and Roger Reed State Fish Hatchery (RRSFH). Kelt broodstock produced 460,000 eggs from 47 females held at the North Attleboro National Fish Hatchery (NANFH). The entire 2003 year class of kelts (21 females and 3 males) at NANFH was lost prior to spawning when a pool was inadvertently dewatered. This incident and continued lower than anticipated production of domestic brood stock at WRNFH contributed to falling short of egg production goals again. WRNFH is addressing the situation by retaining additional females and adjusting rearing regimes.

3.1.3 Stocking

Juvenile Atlantic Salmon Releases
A total of 5.9 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2006. Totals of 807,000 fed fry and 5.0 million unfed fry were stocked into 41 tributary systems with the assistance of hundreds of volunteers. Totals of 51,165 smolts and 12,616 parr were released into the lower Connecticut River mainstem and the Farmington River. Reduced egg production and lower than normal eye-up rates led to the relatively low number of fry stocked, the fewest since 1993. Fry stocking densities were reduced in most areas and some of the least productive habitat was not stocked in 2006.

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
Northeast Generation Services and the USFWS/SOFA contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2006. This was the fourteenth consecutive year that a study has been conducted on the 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. High flows reduced the number of smolts marked and recaptured so no estimate was possible.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 271,000 smolts were produced in tributaries basin wide. Of these, 206,000 (76%) were produced above Holyoke in 2006. 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 219 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. Fry survival was impacted in portions of the upper basin by frequent spring flooding. Growth of both young of the year and yearling salmon was above average in many locations. 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 2007 calculated from expanding electrofishing data from index stations and assumed overwinter survival is 263,000. Electrofishing data from 2006 were added to the juvenile database for the Assessment Committee.

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.

Holyoke Dam - The new fish lifts and associated facilities at Holyoke continued to work well and no problems were noted with salmon passage this year. Operational changes were made to address the problem of salmon escaping from the facility at night.

Turners Falls Dam and Northfield Mountain Pumped Storage Plant- These projects were sold by Northeast Generation Services to Energy Capital Partners but license conditions will remain the same and staff is expected to be retained. Relicensing of these projects is scheduled for 2018.

Vernon Dam- TransCanada initiated construction of replacement turbines that will increase hydraulic capacity at the dam. Downstream passage of smolts will need to be reevaluated. This project, along with TransCanada projects at Bellows Falls and Wilder will also be relicensed in 2018.

Vermont Yankee Nuclear Power Plant- A discharge permit was issued which allows a one degree F increase to the existing thermal discharge limits in the "summer" period (May 16 to October 14) with the exception of May 16 to June 15 pending studies of impacts on salmon smolts. Concerns for smolts include river warming during migration and impacts of the discharge plume on behavior and physiology. Entergy, the plant's owner, is appealing the denial of the increase during the smolt run. The company is seeking to extend their operating license set to expire in 2012 an additional 20 years.

Fifteen Mile Falls Project –TransCanada made modifications to improve attraction to the smolt sampler at Moore Dam. The facility was operated to evaluate the improvements and to collect data on seasonal and diurnal timing and smolt abundance as a precursor to passage facility development at Moore and Comerford. Over 2,300 wild smolts were captured and trucked below McIndoes Dam for release. Bypass efficiency of study hatchery smolts improved over previous years but was still only 45%. Smolts were captured starting on May 1 when the facility commenced operating and continued to be captured in significant numbers through late June. Additional facility modifications are needed to reduce delay and improve efficiency.

Deerfield River-A final downstream passage plan is under review for TransCanada dams on the Deerfield. The upstream passage construction trigger of radio-tagged adult salmon reaching the first dam was met. The Agencies and TransCanada are discussing how to proceed.

Fiske Mill Dam- A Denil fish ladder is being constructed at this Ashuelot River dam and is planned for operation in spring, 2008.

Homestead Dam (West Swanzey Dam)- The owner is planning to remove this Ashuelot River dam in 2007.

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

Brockways Mills- Improved temporary downstream passage was in place in 2006 and construction of a permanent facility is planned for 2007 at this Williams River dam.

Several fish passage improvement projects were completed with full or partial funding of the USFWS Connecticut River Coordinator's Office including removal of the Ballou Dam on Yokum Brook and culvert passage projects on the Mill River, Sandy Brook and Bronson Brook.

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 (microsatellite analysis). 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 Williams River, supplemented sea-run males. Mating of sea-run females utilized a 3 male: 1 female breeding matrix in which one cross was sent to the egg bank for future broodstock production and two crosses were incubated to produce genetically marked fry for stocking. Marked sea-run families from last year's egg take were stocked in the Williams (181,000) and Sawmill Rivers (63,000) in spring of 2006 for mature parr production.

A 1:1 spawning ratio was observed for domestic brood stock spawned at the WRNFH, KSSH, RCNSS 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 1,225 smolts sampled in downstream bypasses at Rainbow, Cabot Station (Turners Falls Dam) and Holyoke Dam in 2006.

Only partial results from the 2004 smolt and 2006 adult samples are available at this time. The nine loci used provided insufficient discriminatory power for grandparentage assignment. Population assignment was used instead, but it not as powerful. Additional loci will need to be added to allow grandparentage assignment. Additional funding is needed to finish the 2004 smolt/2006 adult analysis and to analyze the 2005 and 2006 smolt samples already collected as well as future samples.

3.1.7 General Program Information

Ongoing budget difficulties faced by program cooperators, particularly the USFWS, have hampered restoration efforts. Additional funding by Congress and reprogramming of maintenance funds to operations allowed production at USFWS facilities to continue near prior levels. Additional funding for salmon production at WRNFH was provided by the USFS through a cooperative agreement. Additional funding is still needed to meet salmon production goals, conduct needed evaluation and research, and to provide fish passage.

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) conducted their Fish Friends program at schools in Connecticut. Trout Unlimited carried a similar message to schools in Massachusetts. The Vermont Institute of Natural Science ceased involvement in their school program but other cooperators including CRSA, USFS, USFWS, NHFG, VTFW and the Southern Vermont Natural History Museum cooperatively conducted the program in Vermont and New Hampshire. For the 2006-2007 school year 153 schools representing about 7,600 students 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 2006. Habitat in the Cold River system was heavily impacted by flooding in the fall of 2005. NHFG surveyed the area this year and will start restoration activities starting with Warren Brook in 2007. The USFS completed six habitat restoration projects on 1,750 meters of stream on the Green Mountain National Forest. Program cooperators provided information for inclusion in the NASCO habitat database project.

3.2 Maine Program

3.2.1 Adult Returns

Adult Atlantic salmon returns reported for Maine are the sum of counts at fishways and weirs and estimates from redd surveys. No fish returned "to the rod", because 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, Aroostook, Narraguagus, Penobscot, Saco, St. Croix, Kennebec, and Union rivers, and at a semi-permanent weir on the Dennys River. The summer of 2006 was wet, resulting in likely optimal conditions for juvenile rearing through July and August. Fall conditions were suitable for adult dispersal throughout the rivers, however, conditions were very poor for comprehensive redd counting.

Because there was no rod catch, the number of spawners was assumed to equal returns plus released pre-spawn captive broodstock. In 2006, pre-spawn captive broodstock were stocked in the Sheepscot, East Machias and Machias Rivers, and in Hobart Stream. These 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.

Rivers with Native Atlantic Salmon

Dennys River. A redesigned Dennys River adult weir was operated from 9 May, 2006 to 8 November, 2006. We captured four adults from smolt stocking, identified by adipose clips. Visual implant elastomer tags were not visible in these fish. These included a male two sea-winter fish, two grilse, and a two sea-winter fish of unknown sex. The two wild fish captured were a two sea-winter male and a grilse. MASC also captured four suspected aquaculture escapees, identified by body morphology and condition, and scale reading (Table 3.2.1.1). One of these fish was a kelt captured in June that was likely a fish from the 2005 spawning season. The other three fish were bright fish captured between 25 August and 2 September. All four were screened for diseases by USDA-APHIS in Eastport and tests were negative.

MASC was unable to conduct redd counts on the Dennys River due to high water.

East Machias River. Two redds were counted during redd surveys in fall 2006 in Northern Stream, East Machias River. Heavy autumn rains and high water levels decreased the effectiveness of redd surveys this year.

Machias River. We counted a total of 42 redds, covering less than 20 % of the spawning habitat in the Machias drainage. Thirty-six of these redds were likely created by the 31 pre-spawn adult captive broodstock stocked in Mopang Stream, at the outlet of Second Mopang Lake. The remaining six redds were in different tributaries and likely from wild returns.

Pleasant River. The Pleasant River weir was not operated in 2006. Eight redds were found in the Pleasant River in 2006, five of which were in the upper watershed above Saco Falls. These are the first redds found in the Pleasant River since 2001.

Table 3.2.1.1. Numbers of suspected aquaculture escapes captured at traps on Maine Rivers. Blanks are no data.

YEAR	St Croix	Dennys	Narraguagus	Penobscot	Pleasant	Union
1997	42		0	0		
1998	25		0	0		
1999	23		8	0		63
2000	30	28	0	0	0	3
2001	58	62	1	1	0	2
2002	5	4	0	4	0	6
2003	9	2	0	0	0	0
2004	4	0	0	0	0	0
2005	35	8	0	0		4
2006	7	4	0	1		0

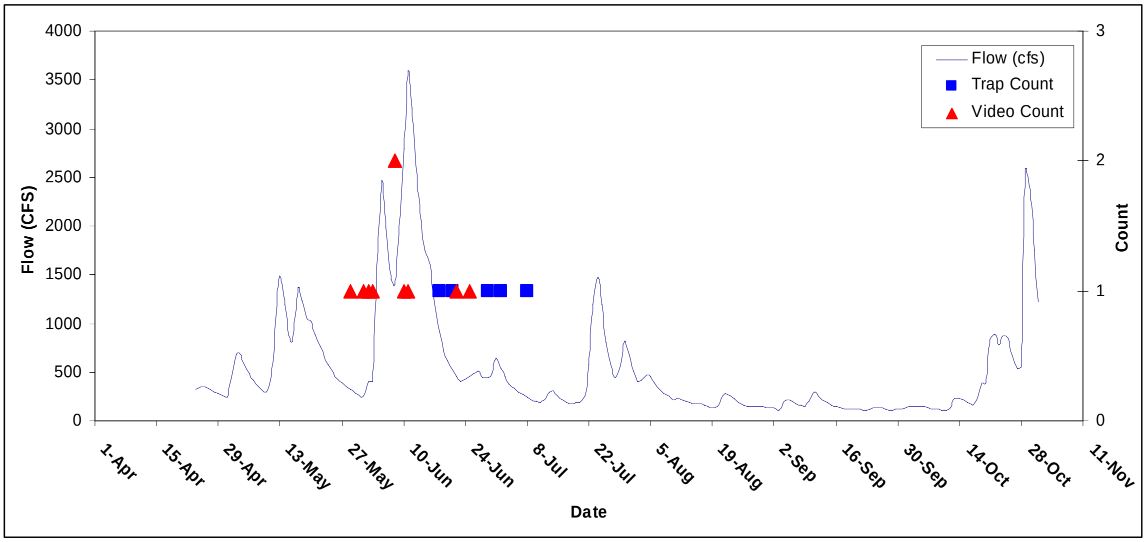
Narraguagus River. The Cherryfield trap on the Narraguagus was operated from 24 April, 2006 to 1 November, 2006. MASC captured two females and one male two sea-winter fish, and one grilse. None of these were PIT-tagged fish. High flows increased opportunity for salmon to jump the dam. Although we detected ten fish on video, the total of 15 salmon should be considered a minimal number due to very high flows in June (Figure 3.2.1). We are unable to determine sex of fish observed on video.

In 2006, we observe a total of 16 redds were counted during surveys by canoe and foot in the upper drainage and in two tributaries to the Narraguagus. As with other rivers counts were for only a portion of the spawning habitat because unusually high river flows reduced our ability to observe redds.

Ducktrap River. No redds were observed during a survey in the last week of November from river km 3.3 to km 8.6 that encompassed 72% of the spawning habitat in the Ducktrap River watershed.

Sheepscot River. Despite the high water in 2006, the river was surveyed on six dates, focusing on spawning habitat in the upper portion of the mainstem and West Branch. Ten redds were attributed to the stocked pre-spawn adults from CBNFH. Five additional redds were found in spawning areas distant from adult stocking location.

Cove Brook. No spawning activity was found in Cove Brook during one redd survey on 28 November 2006 that included all identified Atlantic salmon spawning habitat in the system. This year was the sixth consecutive year with of no spawning activity detected, despite repeated and extensive searches annually.



Trap Count = fish captured in Narraguagus trap
VideoCount = fish successfully ascending the Stillwater Dam

Figure 3.2.1. Narraguagus River fish arrivals relative to flows during the 2006 adult salmon trapping season.

Total Returns to DPS

Scientists estimate the total number of returning salmon to the Gulf of Maine Distinct Population Segment (DPS) using capture data on all DPS rivers with trapping facilities (Dennys, Pleasant, and Narraguagus Rivers) combined with redd count data from the other five rivers of this group. Estimated returns are extrapolated from redd count data using a return-redd regression [ln (returns) = 0.5699 ln(redd count) + 1.3945] based on redd and adult counts from 1991-2005 on the Narraguagus River, Dennys River and Pleasant River (USASAC 2006). Unfortunately, poor redd survey conditions precluded sufficient survey coverage to use the new regression for estimating the 2006 returns. As in 2005, the relationship between these estimates and the returns to the Narraguagus River were used to estimate GOM DPS returns. Total estimated return for the DPS was 79 (90% CI = 49 - 122) (Table 3.2.1.2).

Managers need a quantitative measure of recovery of the Gulf of Maine DPS that shows if overall population decline has been halted, and integrates the results of implemented recovery actions with changes in habitat and survival over time. One such measure is replacement rate (RPR). The RPR describes the demographics of each subsequent generation, or cohort, as it ages and replaces the previous one. Current redd-count-based assessments do not allow for cohort analysis that would track a given year-class from spawning through return as 1SW or 2SW fish over two years. But given the predominance of 2SW returns in these populations, a simple calculation of returning adults in year ***n*** divided by the number of returning adults in year n-5 is used. An RPR of 1 would indicate a stable population while below 1 is declining and above 1 growing. The replacement rate for 11 generations of Atlantic salmon starting with returns in 1996 from the 1991 spawning cohort averaged 0.6 and the mean replacement rate has not exceeded 1 during this time period. However, in 5 of the 11 years the upper bound of the 90% confidence limits did exceed 1. The replacement rate for 2006 was 0.77 (0.46 - 1.21) and was the fourth highest in the time series. It is important to note that this replacement rate is based on returns numbers and estimated spawning activity in the wild. As such, the subsidy contributions of juvenile hatchery products to this return rate are not accounted for in this calculation.

Table 3.2.1.2. Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the core GOM DPS rivers from 1991 to 2006.

Year	L CI	Average	U CL
1991	235	294	367
1992	200	247	306
1993	222	264	315
1994	154	192	238
1995	131	162	200
1996	230	284	351
1997	130	165	208
1998	153	200	258
1999	137	175	221
2000	79	100	127
2001	90	103	120
2002	28	37	48
2003	62	76	96
2004	60	82	113
2005	44	71	111
2006	**49**	**79**	**122**

Other Maine Atlantic Salmon Rivers

Penobscot River. MASC captured 1,044 sea-run salmon during 2006, returning 507 salmon back to the river marked with an adipose fin punch (AP), or a caudal fin punch (tail punch, UCP). Of these, 62 were recaptured after dropping downstream over the dam and ascending the fishway for a second time and two were recaptured twice. This year's total catch represents an increase of 59 fish from the 2005 total catch of 985 sea-run salmon. The median capture date for 2006 was June 18, four days earlier than 2005 and similar to the 1995-2000 time period, but 12-16 days earlier than what was observed in the late 1980's and early 1990's. Of the 1,044 sea-run salmon returning to the trap in 2006, 354 were 1 sea winter (1SW) fish, or 34% of the total run. The percent of 1SW fish of the total run fluctuates yearly, and while this years rate is above the mean of approximately 25% for the previous 17 years, it does fall within the normal range observed over this time period (11% - 48%). One salmon was suspected to be an aquaculture escapee based on the amount of fin deformity observed. The growth pattern on the scale confirmed aquaculture origin and the fish was then removed from the river and euthanized by MASC biologists.

All salmon handled at the Veazie trap are screened for marks, injuries, or any abnormality. Scraped-up-sides (SUS), banged-up nose (BUN), and brackish water lice (BWL) are some of the more common occurrences. Occasionally lamprey wounds (LW), seal bites (SB), and torn or split fins are observed. During the 2006 trapping season MASC, in cooperation with a NOAA Fisheries study, documented any suspected seal bites on each salmon handled. Using protocols provided by NOAA-Fisheries, typical data collected included type and location of suspected seal bite. Photos were taken of all fish with suspected seal bites for further analysis by NOAA staff. Twenty-seven fish with suspected seal bites were documented in 2006 at the Veazie trap, representing 2.6% of the year's return (Table 3.2.1.3.). As in the past five years an overwhelming majority of fish with suspected seal bites were early season returns, with 93% captured in May and June.

Table 3.2.1.3. Total returns to the Veazie Dam on the Penobscot River for the period 2001 to 2006, with monthly counts of suspected seal bites.

Year	Total Return	Suspected Seal Bites (SB)					Total with SB	% Returns with SB
		May	June	July	August	September		
2001	786	1	8	5	0	0	14	1.8%
2002	784	5	19	6	2	1	33	4.2%
2003	1114	2	28	2	1	0	33	3.0%
2004	1324	8	27	14	3	0	52	3.9%
2005	985	1	4	3	1	0	9	0.9%
2006	1044	14	11	2	0	0	27	2.6%

MASC assisted with a University of Maine study by providing twenty-five returning hatchery origin male salmon (20 2SW and 5 grilse) captured at the Veazie dam trap between June 2 and June 6. The adult salmon were surgically implanted with acoustic tags containing depth and temperature sensors (Vemco V-9). An array of acoustic receivers deployed by University of Maine and NOAA Fisheries provide time-stamped sequence of detections, recording movements over more than 150 km of the Penobscot and Piscataquis Rivers. Although all salmon were released in early June 2006, only three passed the second upstream dam (Great Works Dam; 12 km above head of tide) and only two passed the third upstream dam (Milford Dam; 15 km above head of tide) by early December. These results indicate that the Great Works Dam was a severe impediment to migrating salmon in 2006.

Great Lakes Hydro America, LLC (GLHA) continued operation of an Atlantic salmon trap at the fishway at the Weldon Dam in Mattawamkeag. The dam is located 60 miles upstream from Bangor and is the fifth and final mainstem dam encountered by salmon on their upstream migration into the East Branch, Penobscot River. This year, 24 multi-sea winter fish and 21 grilse (45 total) were captured, an increase of nine multi-sea winter salmon and a decrease of one grilse from the 2005.

St. Croix River. Four Atlantic salmon and seven escaped aquaculture salmon were captured from May 2 to October 27, 2006 at the Milltown fishway (Table 3.2.1.1). Four Atlantic salmon (two grilse, two multi-sea-winter fish) captured before mid-July had adipose fin clips, identifying them as parr stocked by the St. Croix International Waterway Commission. These fish were released to the river above the trap. The seven presumed aquaculture Atlantic salmon captured after mid-August were sacrificed for fish health studies. In 2005, 35 of the 42 salmon captured at the fishway were aquaculture escapes; the remaining seven were of restoration hatchery origin.

Androscoggin River. Maine Department of Marine Resources operates a fishway trap on the Androscoggin River in Brunswick. This fishway was also operational from early May to late October. In 2006, a total of six unmarked salmon were trapped and passed upstream. All of these fish were hatchery origin based on scale analysis. Because there are no smolts or parr stocked in the system these fish are assumed to be pioneering fish from other river systems.

Aroostook River. The Tinker Fish Trap on the Aroostook River was operated from June 26, 2006 through October 31, 2006 for a total of 66 days (no tend days due to high water and maintenance). The total trap catch for 2006 was 15 salmon with a fork length range of 21-26 inches (53-66cm). All 15 captured salmon was assigned as 1SW based on the observed length distribution and consultation with Canadian Dept. of Fisheries and Oceans (DFO) biologists. The 2006 catch was the highest in the past five years and nearly twice last year’s catch (8 salmon).

Kennebec River. A new fish lift was operated from May to October at the FPL Lockwood Project in Waterville. In this first season, 15 salmon were captured and successfully moved to the Sandy River. Of these salmon five were determined, from scale samples, to be wild and ten were of hatchery origin. In addition, Meredith Bartron of the USFWS compared genetic samples taken from the wild salmon to parents of the small number of fry release in 2003 in the Sandy River. Of the five wild salmon, one was confirmed to have come from the 2003 Sandy River cohort and the other wild salmon were confirmed to be from Maine but inconclusive on river of origin. Two of the ten hatchery origin salmon were marked. One multi-seawinter adult was adipose clipped and seemed to have a pink VIE tag near its left eye and one grilse was adipose clipped with no other visible marks. In cooperation with FPL the MASC moved all captured salmon around the four upriver dams and released them into the Sandy River, a tributary to the Kennebec River, as an interim passage measure.

Saco River. Florida Power and Light (FPL) 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. Thirty unmarked salmon were observed moving upriver through these facilities, thus, the documented return to the Saco River is 30 salmon. With only visual counts at Cataract, fish are handled at Skelton Dam, the third passage facility on the river. FPL transported 14 salmon from Skelton to a release site in the Ossipee River. Of these, one multi-seawinter adult had an adipose clip with no other visible marks. The proportion of wild and hatchery origin salmon, determined from scale samples taken at this facility, were used to prorate the origin for the 30 salmon counted at Cataract. The estimated breakdown of the run was 23 hatchery origin and 7 wild.

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 8th through the end of June and again from October 3rd until October 23rd.

3.2.2 Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 7 million eggs (5.9 million in 2005) for the Maine program in 2006: 3 million eggs from Penobscot sea-run broodstock; 2.6 million eggs from six captive broodstock populations; and 1.4 million eggs from Penobscot domestic broodstock.

Spawning protocols for river specific DPS broodstock continued to give priority to first-time spawners and utilized 1:1 paired matings. Deviation from this protocol occurred when egg requests exceeded estimated production from gravid first-time females; in 2006 this occurred for the Machias and Narraguagus rivers. Spawning protocols for Penobscot sea run broodstock continue to utilize 1:1 paired matings.

The first Pleasant River pedigree broodstock line, composed of pedigree-domestic (genetically selected broodstock reared entirely at hatchery) and captive reared components, was spawned for the second time at CBNFH in 2006. These spawning efforts were augmented by three year old captive broodstocks. The second pedigree broodstock line will be available for spawning in the fall of 2007.

Mean daily water temperatures at CBNFH during spawning ranged from 7.6 to 12.0 and averaged 9.0 C from Oct. 28 to Nov. 20 2006. This is significantly warmer than last years daily mean water temperature of 8.2 C (range 7.1-9.4) over the same time period (t-test $P<0.01$). Above average air temperatures and frequent rain events elevated water temperatures during the early egg incubation period at CBNFH. However, water temperatures after Jan. 11, 2007 have been up to 2 C cooler than last year.

The mean daily water temperature from Nov. 20, 2006 to Feb. 15, 2007 (4.1 C) was not significantly higher than last year (3.9 C) (t-test P=0.68). However, the elevated December values and the rapid cooling trend in January precipitated a significant difference in the variance between the two years (F-test P<0.01, variance 5.9 (2006) vs. 1.7 (2005)).

Egg Transfers

All three egg sources (sea-run, captive, and domestic) were used for the Salmon-in-Schools (FWS) and Atlantic Salmon Federation Fish Friends programs. Domestic Penobscot eggs from GLNFH were transferred to: Saco River Hatchery (460,807); 396,500 to CBNFH for fry supplementation in the Penobscot sub-basin; 74,028 to the MASC for egg planting studies.

In January 2006, Penobscot sea-run eyed eggs (300) were transferred to the USDA National Cold Water Marine Aquaculture Center located in Franklin, ME. See hatchery research section.

The Wild Salmon Resource Center, located in Columbia Falls, received approximately 50,000 Pleasant River eyed eggs from CBNFH in 2006. CBNFH transferred eyed Sheepscot eggs to the MASC in December 2006 for egg planting projects.

In 2006, the Dug Brook Hatchery, operated by Atlantic Salmon for Northern Maine, received 462,000 eyeg eggs from the Mactaquac Biodiversity Facility located in Frenchville, New Brunswick. These eggs were reared to the fry stage for the Aroostook River Supplementation Program.

Hatchery Research Activities

The USFWS Maine Complex staff cooperated with research faculty and graduate students from the University of Maine and Unity College. Collaboration with two other research facilities was also continued in 2006.

Dr. Michael Kinnison continued a fifth year of a study on phenotypic trait variation in GOM DPS salmon. In 2006 pre-spawn fish were photographed from Narraguagus, Pleasant and Sheepscot river stocks to obtain data on fish size and morphology. Data on egg size and fecundity were also takenNate Wilke's, M.S. Thesis was accepted in August 2006:

Michael Bailey, Ph. D. candidate (also with M. Kinnison), worked with CBNFH staff during 2006 in regard to a multi-year study to correlate characteristics of newly released hatchery fry to relative survival in the first 30-60 days in the wild. In this study, Narraguagus and Penobscot River fry were thermally marked at the hatchery, stocked into natal waters and later collected to measure fitness-type parameters.

A student from Unity College used three adult carcasses at CBNFH in 2006 to compare otolith size among wild, landlocked, and farm-raised salmon. No differences were reported among the groups in the senior thesis (Schnackenberg, 2006).

The National Cold Water Marine Aquaculture Center continued USDA efforts to develop a biological and economically suitable North American Atlantic salmon strain for U.S. aquaculture production. The primary research objective is to genetically improve the existing North American stocks through a family-based selective breeding program. This program has received sea-run Penobscot eyed eggs annually since 2004 for this effort.

CBNFH personnel continued use of spawning software developed in cooperation with researchers from the Conte Anadromous Fish Research Center (Turners Falls, MA) and FWS geneticists (Lamar, PA). The software is designed to optimize matings based on the frequency of shared alleles, where lower percentages of shared alleles are sought to maximize genetic diversity. The software optimized matings (were genetic information was available) and recorded all GOM DPS matings at CBNFH in 2006.

CBNFH Broodstock Collection

Collection of juvenile Atlantic salmon from six DPS rivers for the captive broodstock program at CBNFH continued in 2006. Juvenile Atlantic salmon are collected annually from their native rivers and brought to CBNFH for rearing. In 2006, 1,205 parr were collected from the following rivers: 219 from the Dennys; 197 from the East Machias; 221 from the Machias; 106 from the Pleasant; 256 from the Narraguagus; and 206 from the Sheepscot. Target numbers for the Dennys and East Machias were increased from 150 to 200 parr this year to compensate for poor collection numbers in 2004, resulting from high water in the early fall. The Dennys increase was also a hedge against potential broodstock collection limitations in the future due to aquaculture escapes in 2005.

In 2006, GLNFH retained 1,000 fish from the 2005 year class of sea run Penobscot-strain Atlantic salmon. These fish will be used for F_2 domestic egg production and held at GLNFH for 2-3 years.

A total of 537 sea-run adult salmon (330 females and 207 males, 20% of which were grilse) was collected from the Penobscot River (Veazie Dam) and spawned at CBNFH in 2006 (compared to 475 in 2005). 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.

3.2.3. 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

Thirty six fry stocking trips departed CBNFH from Apr. 21st to Jun. 1st 2006, as compared to May 9th to Jun. 6th in 2005. All GOM DPS fry were released by May 9th (Table 3.2.3.1). Stocking began earlier because fry developed faster as result of warmer hatchery incubation temperatures as well as warmer river water temperatures due to the drought conditions in early spring. River discharge during fry stocking was considerably lower than the last two years. In the GOM DPS rivers, flows averaged 35% of the long-term mean during fry stocking, ranging from 11% to 74% as determined from the nearest USGS stream gage. Significant rain events occurred during the May 18th Penobscot River stocking trips, but water levels decreased rapidly, such that by the end of May, flows were once again below average (70%).

Water temperatures were slightly warmer at CBNFH compared to the actual river temperature as measured at the start of the daily stocking trip (t-test P=0.01). Water temperatures at CBNFH ranged from 8.4 to 15.2 C (mean 12.2), while river temperatures were 7.8 to 16.0 C (10.8) over the duration of fry stocking. Hatchery and river water temperatures were very similar in April and early May, but became variable by mid-May. Conditions in the Wassataquoik River continued to be highest hatchery vs. river water temperature outlier where a difference of -7.2 C

was observed on May 18th. However, this high elevation river warmed quite rapidly (virtually no temperature difference on June 1st), suggesting that later season stocking trips may provide similar hatchery-river thermal conditions for fry.

Fry development as calculated by the Developmental Index (DI) (Kane 1987) ranged from 82-173 during the CBNFH stocking efforts (86-132 in 2005). Because Penobscot progeny are normally spawned earlier and stocked later in favor of lower river discharges, these fry have consistently higher DI's (123-173) over the captive reared DPS fish (82-114). Mean DI's in 2006 were similar to last years fry releases for the GOM DPS fry 2006 (99), and 2005 (102) (t-test P=0.24). Although the DI values were not

reported for several of the Penobscot fry releases, fry development were higher in 2006 (151) compared to 2005 (116) (t-test P<0.01).

Eggs, Fry, Parr, and Smolt Stocking

During 2006, approximately 5 million Atlantic salmon were stocked into the rivers of Maine as fertilized eggs, fry, parr and smolts. A complete summary of stocking efforts by life stage and river can be found in Table 5. Of this total, fry accounted for 3.9 million of the life stages stocked. The six DPS rivers received 2 million, the Penobscot sub-basin 1.5 million, Aroostook 324,000, Saco 106,000, and Union 2,000 fry.

The Penobscot River sub-basin received 549,200 age-1 smolts and 293,500 parr.

Table 3.2.2.1. Fry development index (DI) and environmental conditions for stocking events from CBNFS in 2007.

River	Primary Areas Stocked	Release Date (2006)	D.I	CBNFH Water Temp (C)	River Temp (C)	Actual Discharge (CFS)	Mean Discharge (CFS)	% of Mean Flow	Discharge Area (sq. miles)	USGS Discharge Location	USGS Years record
Dennys	Gilman, Curry, Weir, Lower Cathance	24-Apr	99	8.4	11.0	96	411	23%	92.9	1021200	48
	Upper Cathance	1-May	93,101	11.4	11.6	72	407	18%	92.9	1021200	48
East Machias	Crawford, Rocky Brk, Village	25-Apr	92-100	9.2	8.0						
	Round L, Rocky L., Hadley	26-Apr	94	10.9	10.0						
	Many Small Tribs	27-Apr	101	10.7	10.2						
Machias	Crooked, New Strm, small tribs	26-Apr	91	10.9	8.9	696	2,570	27%	458	1021500	69
	WB to Rt. 11	27-Apr	89	10.7	9.0	668	2,490	27%	458	1021500	69
	Wigwams, Holmes	3-May	96,109	11.5	9.2	1,410	2,480	57%	458	1021500	69
	Mopang, Great Falls, Whitneyville	4-May	104	11.9	10.8	1,260	2,450	51%	458	1021500	69
	6th Lake, Old Stream, Longfellow	5-May	106	14.0	12.0	1,040	2,360	44%	458	1021500	69
	West Branch	8-May	111	14.6	14.0	701	1,970	36%	458	1021500	69
	Old Stream, Mopang, West Branch	9-May	114	14.2	14.2	634	1,910	33%	458	1021500	69
Narraguagus	Bracey, Baker, Gould	21-Apr	91	9.1	9.5	423	1,120	38%	227	1022500	58
	Beddington Lake- Below	24-Apr	94	8.4	9.0	325	1,120	29%	227	1022500	58
	Beddington Braids, The Ford	25-Apr	95	9.2	9.3	351	1,170	30%	227	1022500	58
	Power Line, Honeymooners	1-May		11.4	11.0	241	942	26%	227	1022500	58
	W. Branch, Little Falls	2-May	96,103	11.4	10.4	433	889	49%	227	1022500	58
	Powerline, Honeymooners, L. Falls	5-May	102,109	14.0	12.7	583	792	74%	227	1022500	58
Pleasant	Saco Falls to Weit	2-May	108	11.4	8.0						
	Pleasant River Lake to Crebo	3-May	103	11.5	9.0						
	Columbia Falls Area	4-May	98	11.9	8.0						
Sheepscot	Above N. Whitefield	21-Apr	82-94	9.1	11.2	236	677	35%	145	1038000	67
	N. Whitefield down, Trout Brk	24-Apr	92-97	8.4	7.8	205	653	31%	145	1038000	67
EBPenobscot	Seboeis	9-May	F2's	14.2	12.5	439	600	73%	173	1029200	8
	Wassataquoik	18-May	N/A	15.2	8.0	8,440	4,280	197%	1,086	1029500	86
	Seboeis	18-May	N/A	15.2	11.0	1,040	381	273%	173	1029200	8
	Bowlin-Lunksoos	30-May	173	13.7	16.0	2,560	3,190	80%	1086	1029500	86
	Bowlin-Lunksoos	31-May	174	12.8		2,290	3,100	74%	1086	1029500	86
	Grindstone	1-Jun	177	13.1		2,110	3,020	70%	1086	1029500	86
	Wassataquoik	1-Jun	177	13.1	13.0	2,110	3,020	70%	1086	1029500	86
Mattawamkeag	East and West Branches	18-May	F2's	15.2	13.3	8,350	4,740	176%	1418	1030500	71
Piscataquis	East Branch Pleasant	8-May	F2's	14.6	13.0	169	1,560	11%	298	1031500	103
	Barrows Falls, Blanchard	10-May	123-	14.2	12.7	141	1,480	10%	298	1031500	103

Approximately 2,400 Penobscot sea-run origin smolts were released from stocks reared at the USDA National Coldwater Marine Aquaculture Center. The Dennys River received 56,500 age-1 smolts and 27,600 parr reared at GLNFH. Approximately 15,200 2 smolts reared at CBNFH were stocked into the Pleasant River. Additional parr releases occurred in the Narraguagus (17,500) and Sheepscot Rivers (16,600).

Several privately owned, volunteer operated hatcheries were involved in releasing Atlantic salmon into Maine waters. Approximately 50,000 Pleasant River-origin fry, obtained from eggs produced by broodstock at CBNFH. In this partnership, volunteers from the Wild Salmon Resource Center (in Columbia Falls) receive eyed eggs, rear fry, and distribute them into the Pleasant River and its tributaries.

The Saco River Hatchery, operated by volunteers from the Saco River Salmon Club, reared and released approximately 106,000 fry. The Saco River Hatchery annually receives domestic-origin eyed eggs produced at GLNFH.

Dug Brook Hatchery, operated by Atlantic Salmon for Northern Maine Inc., reared Saint John-origin eggs and stocked 322,000 fry into the Aroostook River and it's tributaries from May 26-31, 2006. Stocked fry originated from sea-run, 1SW captive, and MSW captive reared St. John River salmon spawned at the Mactaquac Biodiversity Facility located in Frenchville, NB.

Instream egg incubation projects in the Sheepscot (river specific) and Kennebec (Penobscot captive reared) rivers by MASC staff in 2006 used 9,800 and 21,000 eggs, respectively.

In addition to Atlantic salmon reared at federal and private hatcheries, approximately 135 schools and businesses participated in the FWS Salmon-in-Schools and Atlantic Salmon Federation Fish Friends programs. Through these programs, participants receive approximately
200 DPS or Penobscot (sea-run or domestic) origin eyed eggs and a curriculum to help educate students and the public about Atlantic salmon. Participants released fry in May and June into designated segments of appropriate rivers as permitted by the MASC.

Adults

River-specific broodstock reared at CBNFH are routinely released into their natal rivers based on water constraints at the hatchery, the 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 2006, excess broodstock were released pre-spawn to the Sheepscot (82), East Machias (80), and Machias (64). MASC also conducted an experimental pre-spawn release of gravid adults into Hobart Stream. The composition of this pre-spawn release was Dennys (28), Narraguagus (93), and Pleasant (49) captive broodstock.

Following spawning, 492 Penobscot sea-run broodstock were released at the Brewer boat ramp. 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 833 excess adults, comprised of four and three year old domestic broodstock, into the Penobscot River. A complete summary of adult stocking is found in Table 6.

In addition to release of post-spawn Penobscot sea run and domestic broodstocks, the remaining 5 and 6 year old DPS fish were released into their natal rivers: Dennys, 55; East Machias, 79;
Machias, 164; Narraguagus, 133; Pleasant, 199; Sheepscot, 69.

3.2.4 Juvenile Population Status

MASC 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 new catch per unit effort (CPUE) method based on standardized wand sweeping protocols for a specified time period, typically 300 seconds of wand time. Fish abundance is presented as fish per unit, where one unit equals 100 m^2 and relative abundance (CPUE) is resented in fish/minute. Data for 2006 were added to the USASAC Juvenile Salmon database.

MASC estimated parr and/or YOY density 218 sites (Table 3.2.4.1). Of these, 109 have been sampled in multiple years, either because they were established as index sites (39 sites) or were part of BGEST sampling described below (70). MASC also determined relative abundance at 162 sites using the CPUE method (Table 3.2.4.2). Special projects included: repeated CPUE trips from July through October on Northern Stream to estimate the spatial distribution of young of the year stocked as fry (119) and a 28-site CPUE assessment of stocking in the Pleasant River in the Penobscot drainage. Juvenile densities and CPUE varied considerably among sites in Maine rivers, within and outside the GOM DPS, in 2006 (Table 3.2.4.1 and 3.2.4.2).

Table 3.2.4.1. Minimum (min), median, and maximum (max) juvenile Atlantic salmon population densities (fish/100m^2) based on multiple pass electrofishing estimates in selected Maine Rivers, 2006.

Drainage	PARR/ 100m 2				YOY / 100 m2			
	Min	Median	Max	n	Min	Median	Max	n
Dennys	1.4	4.1	6.3	8	4.0	4.9	8.0	8
East Machias	1.7	6.0	35.2	11	0.0	1.4	51.5	11
Machias	0.0	3.5	16.3	12	0.2	2.8	18.2	12
Pleasant	0.0	5.7	29.8	5	0.3	9.7	40.6	5
Narraguagus	0.0	1.4	15.3	43	0.0	1.7	17.8	43
Penobscot	0.0	0.2	7.0	54	0.0	0.0	4.1	30
Mattawamkeag	0.3	0.5	2.6	6	0.0	2.2	11.9	6
East Branch Penobscot	0.0	0.8	4.0	15	0.0	2.6	13.1	15
Piscataquis	0.0	8.8	23.3	12	0.0	15.5	34.5	12
Ducktrap	0.4	2.7	26.9	3	2.1	11.2	22.0	4
Passagassawakeag	0.0	0.3	0.7	2	0.0	0.0	0.0	1
Sheepscot	0.0	1.6	23.4	27	0.0	0.5	25.3	27
Lower Kennebec	0.0	1.1	8.8	18	0.0	0.0	10.8	18
Saco	1.0	1.4	1.8	2	1.8	2.0	2.1	2

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). The parr abundance data will be incorporated into the BGEST model to continue a time series of basin-wide large parr (ages 1+ and 2+) population estimates.

Table 3.2.4.2. Minimum (min), median, and maximum (max) relative abundance of juvenile Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2006.

Drainage	Parr / minute				YOY / minute			
	Min	Median	Max	n	Min	Median	Max	n
Pennamaquan	0.00	0.00	0.00	1	0.00	0.00	0.00	1
Wilson	0.00	0.00	0.00	5	0.00	0.00	0.00	1
Hobart	0.00	0.00	0.00	1	0.00	0.00	0.00	1
Orange	0.00	0.00	0.00	2	0.00	0.00	0.00	2
East Machias	0.00	1.18	3.46	109	0.00	1.54	4.19	122
Middle	0.00	0.00	0.00	1	0.00	0.00	0.00	1
Machias	0.00	0.00	0.82	7	0.00	0.24	3.54	8
Penobscot	0.00	0.20	1.60	17	0.00	0.00	2.20	26

Smolt Abundance
NOAA-National Marine Fisheries Service (NOAA) and the Maine Atlantic Salmon Commission (ASC), conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in many of Maine's coastal rivers. Summaries for each river follow.

Penobscot River. The Penobscot River was sampled with RSTs from 2000-2005 by NOAA staff. Due to a shift of the focus of assessments on the Penobscot River, NOAA RST sampling was discontinued. RST operations in the Penobscot basin for 2006 were conducted by MASC on the Pleasant River, a tributary of the Piscataquis River. Two RSTs were fished from 5 April to 2 June, 2006. A total of 1,080 smolts were captured, 803 (74%) had a ventral clip, indicating that the fish were stocked as age 0+ parr. Naturally reared smolts averaged 175.1 ± 13.85 mm fork length (n = 269) and 45.72 ± 9.13 g wet weight (n = 269). These fish were considerably larger than in previous years, and were larger than the smolts that were stocked as fall parr in 2005. Of the 803 marked hatchery fish captured, 17% were released as fall parr in 2004 and 83% were released as fall parr in 2005. Age determination of the naturally reared portion of the catch [277 smolts (26%)], has not been completed. Genetic samples (n = 204), and gill biopsies (n = 34) were also collected from fish trapped during field operations. Blood plasma samples, also collected from fish trapped, and gill biopsies are being analyzed by USGS.

Sheepscot River. Two RSTs were deployed on the Sheepscot River in 2001, 2002, and 2004-2006. The two RSTs below Head of Tide Dam in 2006 captured 641 smolts, 19 of which were released in 2005 as age 0+ fall parr with an adipose clip. Fall parr released prior to 2005 were unmarked. Differentiating between naturally reared smolts and smolts stocked as unmarked fall parr has proved difficult and their proportions have not been determined. Therefore, data from all 2+ smolts were used to determine mean fork length and weight (Tables 3.2.4.3 and 3.2.4.4, Figures 3.2.4.1 and 3.2.4.2). Historically, the Sheepscot River smolt run has been composed of 0.5% age 1+, 97.0% age 2+, and 2.5% age 3+ smolts (Table 3.2.4.5). Genetic samples (n = 623), gill biopsies (n = 150), and scale samples (n = 610) were collected from fish trapped during field operations.

Narraguagus River. Atlantic salmon smolts have been monitored on the Narraguagus River since 1996, with NOAA staff generating population estimates since 1997. In 2006, assessments continued using four RSTs by NOAA field staff and two RSTs by MASC field staff at four different sites. The MASC sites were located above Beddington Lake (river km 47.69 and 46.06). The NOAA sites were below the lake (river km 11.16 and 7.65). Using a Darroch maximum likelihood model, an estimate of 3,275 ± 1,482 above Beddington Lake was made using mark/recapture data. A population estimate of 2,612 ± 734 at the NOAA sites was derived which is the highest estimate since 2001 (Figure 3.2.4.3). MASC marked and released 343 smolts above Beddington Lake, 61 of which were recaptured at NOAA rotary screw trapping sites, approximately 40 km downstream. These data were used to calculate a stratified mark/recapture estimate of 183 ± 81. Survival of the 343 marked smolts was between 30% and 77% to the lower site.

A total of 969 smolts was handled, measured and sampled by NOAA staff. Smolts (n = 364) handled by MASC staff were enumerated and tissue sampled during the marking procedure. Of the 220 scale samples collected, 214 (97.3 %) were readable, producing the following age distribution: 1+ (3.7 %), 2+ (88.8 %) and 3+ (7.3 %). Age 2+ smolts averaged 171.4 ±15.6 mm fork length and 50.3± 14.6g wet weight (Tables 3.2.4.3 and 3.2.4.4, Figures 3.2.4.1 and 3.2.4.2). All Narraguagus River smolts were naturally reared and were of comparable size to smolts collected in previous years. Genetic (n = 856) and gill biopsy samples (n = 111) were also collected from a sub-sample of the fish trapped during field operations.

Smolt Run Timing In 2006, smolts on the Narraguagus River began migration earlier than the previous two years (Figure 3.2.4.4). Naturally reared smolts from the Sheepscot River began migration sooner and ended earlier than the Narraguagus River.

Table 3.2.4.3. Mean fork length (mm) by origin of smolts captured in Rotary Screw Traps in Maine.

	Age 1+ hatchery-origin		Age 2+	
River	2006	5 year average (2001-2005)	2006	5 year average (2001-2005)
Narraguagus	N/A	N/A	171.4±15.6 n=578	167.0±13.9 n= 2553
Penobscot*	140.3±12.9 n=663	156.5±14.3 n=669	Data unavailable	171.0±17.1 n=141
Sheepscot**	144.7±8.4 n=19	164.6±32.0 n=65 (2005 only)	192.7±15.8 n=600	161.7±21.3 n=390

* Years 2004-2005
** Not sampled in 2003

Table 3.2.4.4. Mean smolt weight (g) by origin of smolts captured in Rotary Screw Traps in Maine.

	Age 1+ hatchery-origin		Age 2+	
River	2006	5 year average (2001-2005)	2006	5 year average (2001-2005)
Narraguagus	N/A	N/A	50.3± 14.6 n=568	46.9± 13.1 n=1420
Penobscot*	22.1±6.6 n=421	37.7±12.1 n=669	Data unavailable	53.3±14.8 n=141
Sheepscot**	32.7±7.1 n=19	50.9±28.8 n=64 (2005 only)	74.4±19.2 n=599	62.1±19.9 n=390

* Years 2004-2005
** Not sampled in 2003

Table 3.2.4.5. Freshwater age of naturally reared smolts collected in Rotary Screw Traps on selected Maine rivers.

	2006			5 year average (2001-2005)		
River	1+	2+	3+	1+	2+	3+
Narraguagus	3.7%	88.8%	7.5%	0.4%	90.3%	9.3%
Penobscot*	Information not available			0.0%	90.5%	9.5%
Sheepscot**	Information not available			0.5%	97.0%	2.5%

* Years 2004-2005
** Not sampled in 2003

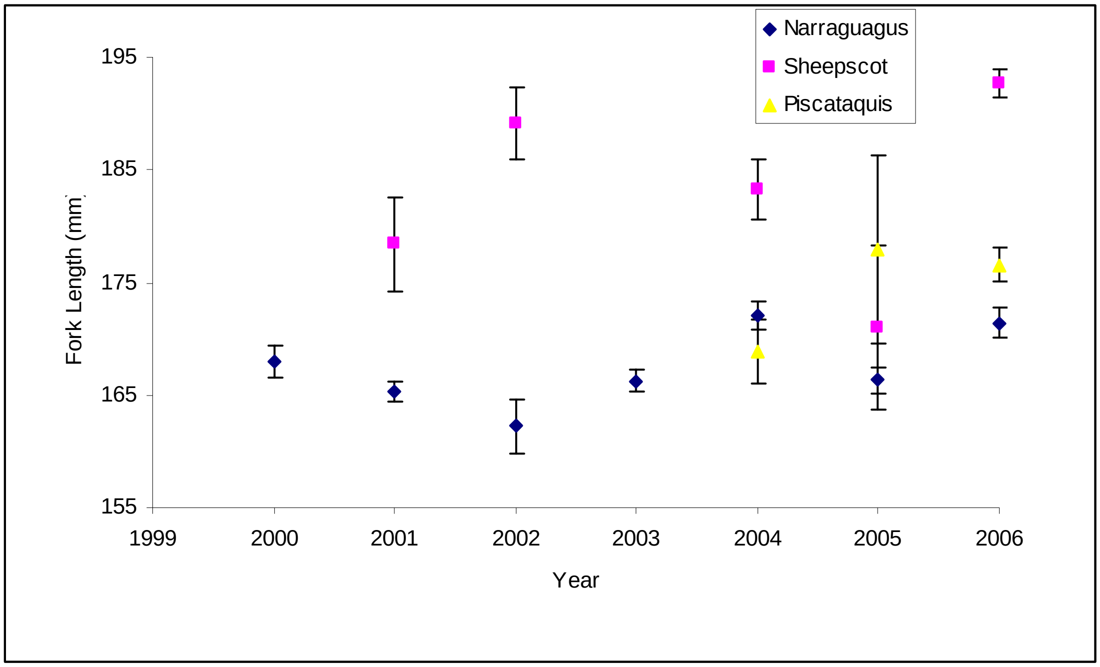


Figure 3.2.4.1. Mean fork length (mm) of age 2+ smolts collected in selected Maine Rivers, 2000-2006.

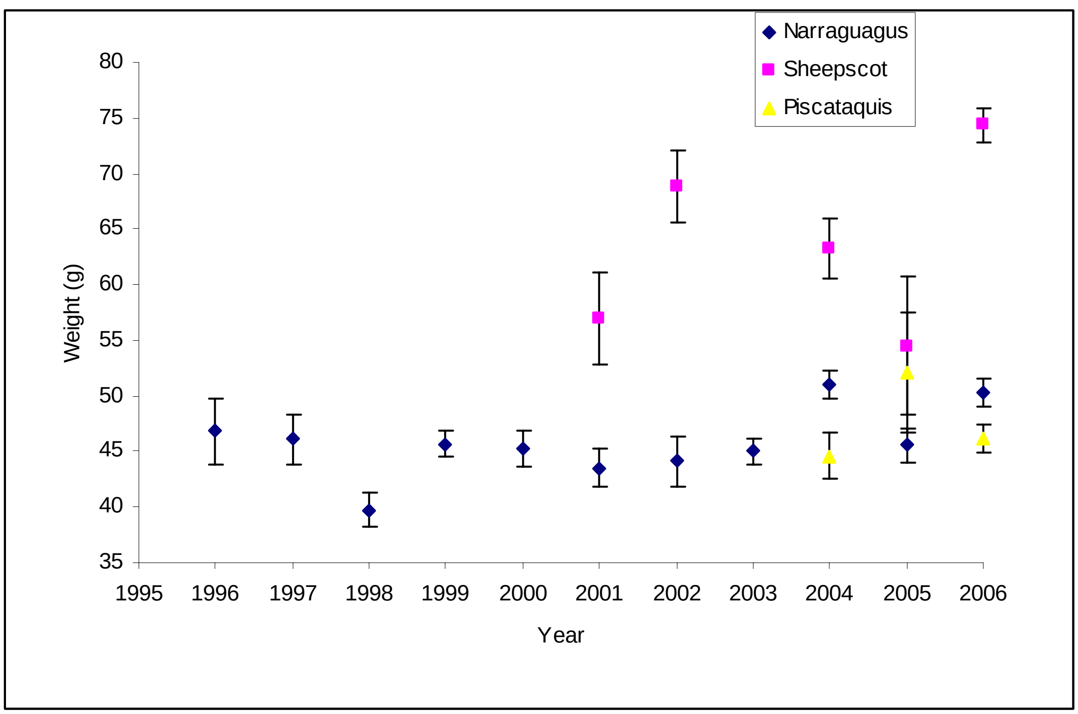


Figure 3.2.4.2. Mean wet weight (g) of age 2+ smolts, collected in selected Maine Rivers 1996-2006.

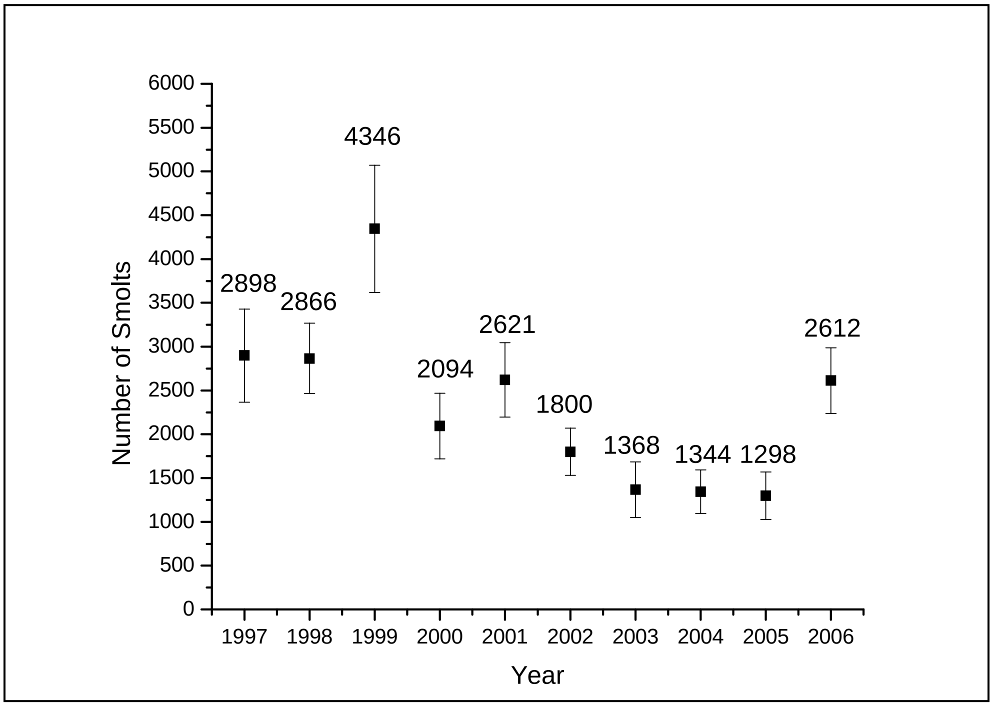


Figure 3.2.4.3. Population estimates (± Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to 2006.

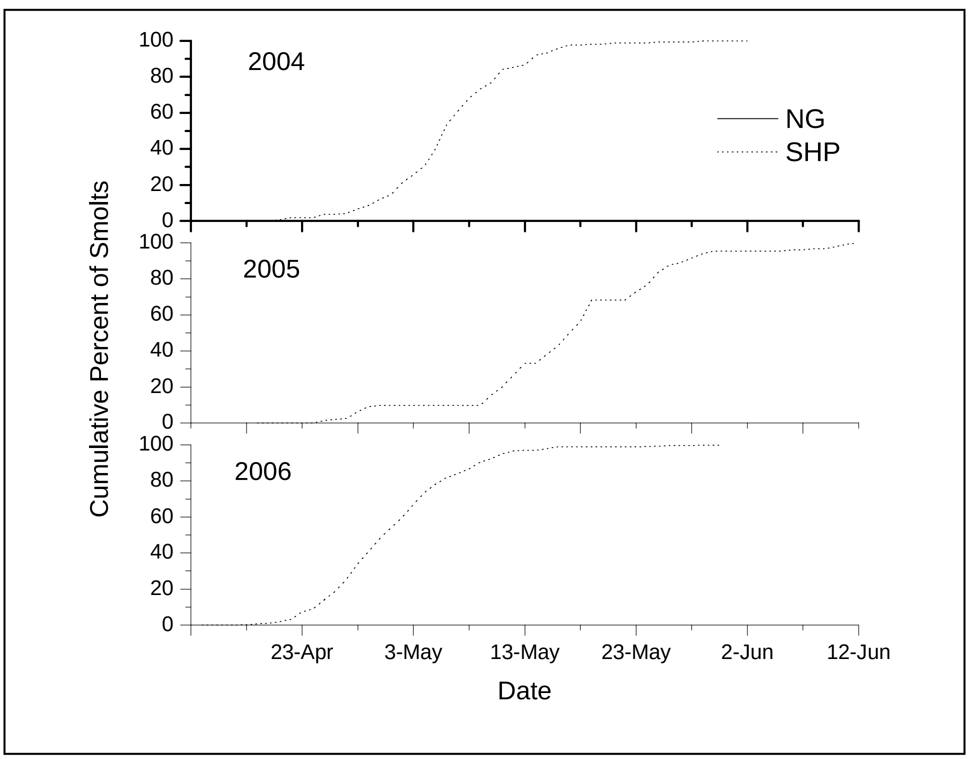


Figure 3.2.4.4. Cumulative percentage of smolt catch in Rotary Screw Traps by date (run timing) on the Narraguagus and Sheepscot Rivers, Maine, for years 2004 to 2006.

Smolt Telemetry Studies

NOAA's National Marine Fisheries Service (NOAA) has used ultrasonic telemetry to assess Atlantic salmon smolt migration since 1997. In 2006, naturally reared (n = 25) and hatchery reared (n = 25) smolts were tagged and released into the Penobscot River estuary. Fish migration dynamics was passively monitored with ultrasonic receivers moored throughout the estuarine and near-shore marine environment. Survivorship to the furthermost quantitative marine array was 32.0% for hatchery and 56.0% for naturally reared smolts.

Smolts sometimes reverse direction during emigration; initially moving downstream, reversing direction upstream, then continuing emigration downstream. 44% of naturally reared smolts made reversals and 73% of hatchery reared smolts made reversals. The average distance for reversals was 3.18 km for naturally reared and 4.64 km for hatchery reared smolts. Total migration time for successful emigrants was shorter for naturally reared smolts (3.54 days) than for hatchery-reared smolts (4.39 days).

In addition to differing in total migration duration, wild and hatchery smolts travel at different times of day. Naturally reared smolts utilized non-daytime hours for travel more often while hatchery smolts preferred daylight hours through the estuary portion of the migration. Upon entering the open bay, daytime travel made up the largest portion of arrival times for both groups.

3.2.5 Fish Passage

Unimpounded portions of New England rivers may not be free of impediments to successful fish migration in the future. Two applications for preliminary permits were submitted to FERC for constructing tidal power projects in the lower Penobscot and Kennebec rivers. The applicant, Maine Tidal Energy Company, is proposing to use proprietary underwater tidal power generating units not yet commercially available. The locations of the projects are near Verona Island in the Penobscot where 100 Tidal In Stream Energy Conversion (TISEC) devices would be located, and for the Kennebec, 50 TISEC units would be placed in the area known as The Chops. FERC has accepted the applications for processing but has yet to issue preliminary permits.

Fisheries agencies in Maine continue to work to improve existing up- and down-stream fish passage, to have fish passage at dams where none exist, and to remove dams and other blocks of habitat connectivity. Thus, fish passage work in Maine focuses on FERC licensed dams on the Penobscot, Kennebec, and Saco rivers and on opportunities to enhance passage throughout historic Atlantic salmon habitat. This includes participating in activities associated with: the Penobscot River Restoration Project, passage facility at the Lockwood (Florida Power and Light), Benton Falls (Benton Falls Hydro Associates), Burnham (Ridgewood Maine Hydro Partners), Anson and Abenaki (Madison Paper Industries) and Fort Halifax (Florida Power and Light) projects, removing Sandy River (Town of Madison), and replacing culverts on highways and logging roads. On the Narraguagus River, MASC has been working with the Town of Cherryfield to repair the fishway at the ice control dam. The town has consulted with FWS for engineering plans and the most affordable plan, to line the wood fishway with aluminum, is being persued. There has been progress resolving the conflicts associated with providing fish passage at the West Winterport Dam on the Marsh River, a tributary to the Penobscot River estuary, and Coopers Mills Dam on the Sheepscot River.

3.2.6 Genetic sampling

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 2006, 972 DPS broodstock (collected in 2005) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

3.2.7 General Program Information

Salmon In Maine Archaeological Sites

Arthur Spiess, Maine Historic Preservation presented the following information to salmon biologists and historians in June and to MASC in December 2006. Atlantic salmon bone is present in interior Maine archaeological deposits beginning at least 6000 years ago, and lasting until the arrival of Europeans. In the estuaries, where historic records show that salmon were caught occasionally, the prehistoric Native American archaeological record shows the same thing. Salmon bone is preserved as burned bone that is resistant to soil acid in camp sites buried in river alluvium in interior Maine. In camp sites along the coast salmon bone is preserved because discarded clam shells buffer soil acid and preserves all kinds of food animal bone in an unburned state. Most salmonid archeological identifications are based on vertebrae fragments. Atlantic salmon are indicated if the vertebrae size is large enough to preclude a large trout. For example, some of these vertebrae are 2 cm or more in diameter, indicating a fish of 10 to 15 pounds or more. Data from smaller salmonids that could be trout or immature salmon smolts and large salmonid bone from lake-side Indian campsites that where probably lake trout were excluded. Although salmon have been in Maine for 6000 years or more their numbers were modest numbers, compared to shad, alewife, sturgeon and striped bass.

Aquaculture Escapes Spawn in Dennys River
MASC counted over 100 redds in the Dennys River from the 2005 spawn year that were probably dug by aquaculture escapees. The redds were concentrated in upper Cathance Stream in Nowhere Rips. No pre-emergent fry were captured while excavating two redds on 11 May and five redds on 22 May 2006. MASC collected non-lethal tissue samples for genetic analyses from 218 YOY across six sites each in the mainstem Dennys and Cathance Stream. Samples, of a piece of caudal fin stored in 95% ethano, were collected 29 September through 4 October. Fins from 100 YOY were collected in Nowhere Rips in Cathance Stream. Fry were stocked in all areas of the Dennys in 2006; therefore, these samples probably include stocked restoration fry, as well as any progeny of aquaculture escapees that may have been present. Genotyping of these samples will be used to estimate the reproductive success of aquaculture escapees and to allow managers to adjust broodstock collection for the Dennys River.

Hatchery Review
The MASC, USFWS, and NOAA Fisheries contracted Sustainable Ecosystems Institute (http://www.sei.org/) to conduct an independent program review to determine if current hatchery operations, protocols, and practices are scientifically sound, have potential to further recovery, and are integrated with population assessment and evaluation programs. The focus question was: Is there integrated adaptive management of Atlantic salmon in Maine? A team of six scientists (Ian Fleming, Kerry Naish, David Secor, Scott McKinley, Lee Blankenship, Deborah Brosnan) was convened to review the Maine program. The agencies provided information to the review team (http://www.nero.noaa.gov/nero/dropoff/ATS%20hatchery%20information/) prior to a three-day visit to Maine in February 2007. The visit will included a tour of CBNFH and two days of presentations by and discussions with agency staff and interested scientists (i.e. researchers, managers from other programs, and retirees). Meetings will be facilitated Steven Courtney of SEI and panel support provided by Lisa Sztukowski of SEI as well as MASC, NOAA, and USFWS. The program review document is expected by summer 2007.

Recovery Team for GOM DPS Plan
The Recovery Team is charged with advising the Federal Agencies on implementing *Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (Salmo salar* (http://www.nmfs.noaa.gov/pr/readingrm/Recoverplans/atlantic_salmon_rp.pdf). The principal tasks under taken by the Recovery Team were to:

1. Select key actions from those identified in the implementation schedule of the Plan
2. Assess the likelihood that actions can be undertaken
3. Recommend a sequence of the key actions

A three three-tiered process was developed to accomplish these tasks.

1. Work groups were used to identify needed actions within areas of expertise (habitat complexity, disease, etc.) and to suggest a sequence for implementing these actions (noting also those actions that should be implemented concurrently). Each work group supplied the Recovery Team with a preliminary set of

recommended actions and an order for implementation that was linked to the Recovery Plan implementation schedule. Form these, changes to the recovery plan were recommended and a list of 30 key actions were identified from the 152 listed in the plan.

2. The Recovery Team forwarded these 30 key recovery actions to the Services for implementation. The Services are currently reviewing these recommendations to provide guidance to the Recovery Team.
3. Once the Recovery Team receives feedback from the Services, a 5-year DPS-wide implementation plan will be developed.

Questions can be directed to Jessica Pruden, NMFS (Jessica.Pruden@noaa.gov), Melissa Laser, Maine Atlantic Salmon Commission, (melissa.laser@maine.gov) or Willa Nehlsen, U.S. Fish and Wildlife Service, (Willa_Nehlsen@fws.gov).

Penobscot Fishery

An experimental one-month fishery occurred on the Penobscot River, Maine from 15 September to 15 October 2006. The MASC 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). The 2006 experimental had the following regulations:

- 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 241 licenses were sold, with 147 anglers complying with reporting requirements. Non-reporting anglers will not be permitted to fish if there is a 2007 season. A total of 247 angler trips were reported (3.4 hours/trip with 2.8 hours spent fishing). Anglers had the opportunity to fish over at least 29 Atlantic salmon based on the catch of salmon at the Veazie trap. One Atlantic salmon was captured and released just after 7 a.m. on September 27th and an additional 14 Atlantic salmon raised/observed.

3.2.8 Salmon Habitat Enhancement and Conservation

Habitat Connectivity

In 2006 USFWS and Project SHARE completed 106 stream-road crossing surveys using the 2005 Vermont Bridge and Culvert Assessment protocol. The following crossings structure types were surveyed: 74 culverts, 15 newly constructed open bottom arches, 4 bridges, 9 abandoned (nonexistent), and 4 recently (2006) decommissioned stream-road locations. The primary focus area for the survey was Old Stream (above Rt. 9) in the Machias River, but other locations were opportunistically evaluated, such as the 2006 habitat improvement sites (see below). Of 74 culverts surveyed and assessed for Aquatic Organism Passage (AOP) 18 (24%) were barriers to adult salmonids, 3 (4%) were barriers to juvenile salmonids, and 52 (72%) were classified as being potential AOP barriers. No culverts could be placed in the category of "not impeding AOP".

In 2006, 18 stream habitat connectivity projects were completed in three of the Downeast Rivers. The principle funding sources were USDA-WHIP, USFWS, MASC-SCEP, Project SHARE, Washington County Soil and Water Conservation District , and private landowner contributions. Four stream-road crossings (culverts) were completely removed in the Machias River watershed. The remaining 14 projects replaced undersized culverts with open bottom arches that spanned 1.2 times bankfull stream width in the Machias, Narraguagus, East Machias watersheds (Table 3.2.8.1).

Table 3.2.8.1. Stream connectivity projects in Atlantic salmon watersheds in Downeast Maine.

Watershed	Stream	New Culvert Width (m)	Stream above (Km)	Long (W)	Lat (N)
REPLACE WITH OPEN BOTTOM ARCH					
Machias	Old Stream and tributaries	1.2	0.80	67.7437	44.9485
		1.2	0.80	67.7514	44.9493
		1.5	0.80	67.7535	44.9494
		1.2	0.80	67.7608	44.9537
		1.5	0.80	67.7730	44.9656
		2.7	0.80	67.7761	44.9890
		2.4	0.80	67.7663	45.0007
		1.8	1.13	67.7693	45.0109
	Chain Lake Stream and tributaries	1.2	0.80	67.7739	45.0274
		2.7	0.80	67.7786	45.0445
West Branch Narraguagus	Unnamed tributary	3.7	2.25	68.1839	44.9730
	Pork Brook	4.3	3.38	68.0890	44.7713
	Jimmy Pond tributary	3.7	2.57	68.1755	44.9741
East Machias	Huntley Brook	4.9	3.38	67.6330	45.1025
REMOVAL					
Machias	West Branch tributary		0.80	67.8732	44.9581
	4th Machias Lake tributary		1.6	68.0123	45.1678
	Pembroke Stream		1.0	67.7996	44.9124
	Mopang Stream tributary		0.3	67.9476	44.9048

Although these projects were located above currently mapped Atlantic salmon habitat, and pre-construction electrofishing did not collect salmon parr, all sites had brook trout above and below the road crossing. 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. Future monitoring will determine if the projects withstand natural flood and or beaver activity.

Sandy River Dam Removed

The Sandy River Dam, located between the towns of Norridgewock and Starks, was decommissioned and the dam/spillway completely breached in 2006. Total cost of the project was $500,000. This dam was one of the first power stations in Maine built solely to generate power, and at one time generated all the electricity used in the town of Madison. The powerhouse structure was built in 1893 remains because it is in the National Historic Register. The dam was 95.4 m long and 4.9 m high with the splashboards and in recent years it has generated less than 2% of the Town of Madison' power. Removal of this dam will allow for 84 km of unimpeded passage for Atlantic salmon and other migratory fish on the Sandy River to Smalls Falls. The Atlantic Salmon Commission has estimated that the Sandy River can provide up to 80 percent of the salmon spawning habitat on the Kennebec River Basin. Removal of the Madison Electric Works dam also offers significant benefits to American eels, which now have almost full access to the Sandy River thanks to recent improvements on downstream hydroelectric stations. An extensive partnership accomplished the removal including: Madison Electric Works (MEW), Maine Atlantic Salmon Commission (MASC), National Oceanic and Atmospheric Administration (NOAA) Community-based Restoration Program, Trout Unlimited (TU), Kennebec Valley TU Chapter, Somerset County TU Chapter, Trout Unlimited Embrace-a-Stream Program, USDA Natural Resources Conservation Service (NRCS)- Wildlife Habitat Incentives Program, Maine Council Atlantic Salmon Federation, Evergreens Campground, Maine Department of Inland Fisheries and Wildlife, Maine Department of Marine Resources, and Maine State Planning Office.

Habitat Complexity

LWD

Maine's rivers have experienced dramatic changes over the last 300 years. One of the most sweeping is the removal, lack of recruitment, and subsequent attrition of large woody debris (LWD). The result is that the rivers that likely have very low loading of LWD, and thus have less complex fish habitat compared to the past. LWD creates pools, retains gravel, retains nutrients, supports benthic macroinvertebrates, influences current velocities and water depth, provides cover for fishes, and refugia during high water. The value of LWD in Atlantic salmon habitat is undocumented. This project tries to enhance habitat at a scale that will have population-level benefits, with a design that allows powerful evaluation of the effects of LWD additions on stream geomorphology. LWD was added to two sites, each with a paired control site, in Creamer Brook, East Machias Drainage in October, 2006. Streams in the Narraguagus, Machias and East Machias drainages were also evaluated for potential LWD additions in 2007 or 2008. The Creamer Brook sites were scouted and surveyed for similarity and all four sites were surveyed for fish populations immediately prior to the habitat work. Each site was electrofished using multiple pass depletion and fish were weighed, measured and released into their site. LWD was added at a rate of approximately 12 pieces per 100m by cutting trees in the riparian zone and adjusting their placement to achieve either stability or geomorphologic effect. In addition, all LWD (existing and added) in the treatment sites was tagged with metal numeric tags and marked with spray paint. The site was surveyed with a total station before and after LWD placements. Trees were also felled in the riparian zone to increase roughness to minimize channel migration as a result to the LWD additions.

References:

Kane, T. R. 1987. Monitoring Development of Atlantic Salmon from Fertilization through Yolksac Absorption. USFWS. Northeast Fishery Center. Lamar Fish Technology Center, Information Leaflet 88-02, Lamar, PA.

Schnackenberg, K. 2006. Otolith size among Wild, Landlocked, and Farm-raised Atlantic salmon (Salmo salar). Senior Thesis. Unity College, Unity. 24 p.

Wilke, N.F. 2006. Phenotypic and genetic variation within and among seven populations six endangered) of Maine Atlantic salmon, Salmo salar. MS Thesis. University of Maine, Orono.

3.3 Merrimack River

3.3.1 Adult Returns

Ninety-one sea-run Atlantic salmon returned to the Essex Dam, Lawrence, Massachusetts, and were captured either in the fish lift (51) at the dam or via electrofishing (40) in the river immediately below the dam. Volunteers from New Hampshire Trout Unlimited and Manchester Fly Fishers assisted MADFW and USFWS personnel in trapping and counting returning fish at the fish lift and electrofishing downstream of the dam. Captured salmon were transported to the Nashua National Fish Hatchery (NNFH). Sex determination was made for 87 of the salmon, with 40 (46.0%) being male and 47 (54.0%) female. One salmon died at the dam and ten died at the hatchery prior to spawning. Ultimately, 78 salmon were spawned. Of those, 42 (53.8%) were male and 36 (46.2%) female. After being tested to ensure the absence of pathogens, 66 salmon were transported to the North Attleboro National Fish Hatchery (NANFH) in fall for reconditioning.

Scales from 90 of the 91 sea-run Atlantic salmon were analyzed to determine age and origin. A scale sample was not collected from one salmon and its origin and age remains unknown. Of the remaining 90 salmon, 77 (85.6%) were of hatchery smolt origin and 13 (14.4%) were of fry origin. Of the hatchery smolt origin salmon, 10 (12.8%) were grilse (1SW), 66 (85.7%) were two sea-winter fish (2SW) and one (1.3%) was a three sea-winter fish (3SW). Of the fry origin salmon, 11 (84.6%) had spent two winters in fresh water, and two (15.4%) had spent three winters in freshwater. Salmon that had spent two winters in freshwater consisted of five (45.5%) grilse (1SW) and six (55.5%) two sea-winter fish (2SW). Both salmon that had spent three winters in freshwater were two sea-winter fish.

In 2006, adult salmon returned that were stocked as fry in three different years: 2001 - 2003. The rate of return, per 10,000, for fry stocked in these years was: 0.027, 0.042, and 0.037, respectively (Table 3.3.1). These low rates of return continue the trend of low returns that started in 1997 and are far below the returns of the 1970's to the mid 1980's, when returns exceeded one per 10,000.

Also in 2006, adult salmon of hatchery smolt origin returned that had been stocked in three different years: 2003 - 2005. The rate of return, per 1,000, for smolts stocked in these years was: 0.87, 1.48, and 0.20, respectively (Table 3.3.2). These return rates are comparable to rates of return in previous years.

Many Atlantic salmon were observed downstream of the dam during the summer months, so returns may well have been higher. High water levels in spring and much of the summer and fall made it difficult for fish to find the entrance to the fish lift. Additionally, the fish lift was closed much of the spring due to excessive water and debris. This has been the case in each of the last two years.

Table 3.3.1. Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2003.

Stocking Year	**Adult Sea Run Returns of 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	0.19
1995	19	63	0	5	0	87	2,827,000	0.31
1996	4	23	0	0	0	27	1,795,000	0.15
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	0.045
2000	0	11	0	0	0	11	2,217,000	0.050
2001	2	1	0	0	2	5	1,708,000	0.027
2002	0	6	-	0	-	6	1,414,000	0.042
2003	5	-	-	-	-	5	1,335,000	0.037
2004	-	-	-	-	-	-	1,541,500	-
2005	-	-	-	-	-	-	962,500	-
2006	-	-	-	-	-	-	1,009,325	-

Table 3.3.2. Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 - 2005.

Stocking Year	Adult Sea Run Returns				Number of Smolts 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	-	74	50,000	1.48
2005	10	-	-	10	50,000	0.20
2006	-	-	-	-	50,000	-

3.3.2. Hatchery Operations

North Attleboro NFH incubated green salmon eggs collected from sea-run and domestic broodstock at NNFH and eggs collected from reconditioned kelts that are held onsite. Sea-run and kelt broodstock are PIT tagged and all eggs and resultant fry are identifiable and are released in known rivers and streams. In total, 372,300 eyed eggs from domestic parents were transferred to the Warren State Fish Hatchery (WSFH), New Hampshire on 16 March. Fry produced at WSFH are released unmarked in the upper Merrimack River watershed. NANFH released 593,135 genetically identifiable fry into the watershed between 17 April and 26 April 2006. These unfed fry consisted of 101,892 from sea-run origin and 491,243 were from reconditioned kelts. Warren SFH stocked 517,100 unfed fry in the watershed during the period 24 April - 2 June 2006.

Egg Collection

Sea-Run Broodstock

Fifty-one sea-run Atlantic salmon were trapped at the Essex Dam and 40 salmon were caught by electroshock fishing in 2006. Forty-two females and 36 males were spawned during fall spawning operations. Fish were spawned between 19 October and 9 November 2006, and produced 376,947 eggs. The 42 females produced an average of 8,975 eggs each. Approximately 329,912 (87.5% of total) green eggs were shipped to NANFH for incubation and fry production and subsequent release in the lower Merrimack River watershed. Approximately 47,035 (12.5% of total) sea-run eggs were retained at NNFH for future broodstock and for smolt production. Initial figures indicate 84% eye-up rates for eggs retained at NNFH.

Captive/Domestic Broodstock

A total of 269 female domestic broodstock spawned at NNFH provided an estimated 1,097,009 eggs in 2006. Of the 269 females, 54 were four-year-old broodstock and 215 were three-year-old broodstock. The domestic broodstock spawning season began on 2 November and ended 22 December 2006, encompassing 15 spawn events. Approximately 1,058,567 (96.5%) eggs were shipped to NANFH between 2 November and 12 December. Egg eye-up should approach 70%. When eggs reach the eyed developmental stage, approximately 80% will be transferred to WSFH for fry production and release in the upper Merrimack River watershed. The remaining 20% of the eggs will be retained at NANFH for fry production, use in education programs, and release in the Pawcatuck River, RI. Approximately 38,442 (3.5%) domestic broodstock eggs were retained at NNFH for fry production to support outreach programs and for smolt production.

NANFH spawned 49 female kelts and 23 male kelts for a total of 581,740 green eggs during the fall 2006. Egg eye-up is usually about 85%. Eggs and milt were collected from year classes 2001- 2005 during the period 31 October - 27 November. There were no reconditioned kelts from the 2004 year class due to previous concerns regarding furunculosis infection. The 2001 and 2002 year classes were held and spawned an additional season to offset the loss in contribution from the 2004 year class. Twenty-five sea-run kelts (2005) were received from NNFH for reconditioning on 19 January 2006.

3.3.3. Stocking

Approximately one million juvenile Atlantic salmon were released in the Merrimack River watershed during the period April - June 2006. The release included approximately 1,009,325 unfed fry (NANFH), 1,500 fed fry (NNFH), and 50,000 yearling smolts (GLNFH). Although smolts were not marked or tagged, 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 Winnipesaukee and Contoocook rivers, were stocked with fry. Numerous small tributaries to the Merrimack River and its principal tributary system, the Pemigewasset River, also were stocked.

3.3.4 Juvenile Population Status

The majority of smolts were released into the main stem of the Merrimack River a short distance downstream from the Essex Dam, MA 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 in mid to late April. In addition, 60 smolts (HI-Z Turb'N Tag) were released in the Merrimack River (NH) as part of downstream fish passage studies at hydroelectric sites.

Yearling Fry / Parr Assessment

Seven sites, one in each of seven rivers, were sampled in 2006. In previous years, during the period 1994 – 2003, a stratified sampling scheme was used to determine the abundance of yearling parr in the Merrimack River watershed. This sampling scheme provided the opportunity to develop parr estimates for the basin, regions, and geostrata. However, recent studies have shown that basinwide population estimates for juvenile salmon developed for the Merrimack River may be negatively biased and lack precision. An increase in sampling effort, greater than that of the 30 sites previously sampled, would be required to minimize bias in estimates, and economic constraints now limit the level of sampling effort. Accordingly, sampling effort has been redirected to the seven traditional sites located within the watershed. Sampling continues to be directed at yearling parr and involves electrofishing during late summer and early fall. Data collection involved a cooperative effort and included staff from the NHFG, USFS, USFWS, USACOE and volunteers.

The seven sites represent "index sites" (IS) established as early as 1982 in some rivers, and data derived from sampling at sites provides an extensive time series of catch-per-unit effort, relative parr abundance, and parr density at sites among years. The seven sites included a total of approximately 165.4 units (one unit = 100 m^2) of juvenile 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 different stocking rates. Stocking densities had generally ranged from 36 fry/unit to 96 fry/unit among sites, but in recent years from 1999 - 2006 the numbers have generally ranged from 18 fry/unit to 48 fry/unit among sites. The results of evaluations of age 1 parr at index 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 shifts in stocking densities at sites, parr abundance presented in Table 3.3.4.1 for index sites are not representative of a standardized stocking effort.

3.3.5. Fish Passage

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 continuing 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 mainstem dams that include Northeast Utilities - Public Service Company of New Hampshire [five (5) NH mainstem dams] and Enel North America, Inc. [two (2) MA mainstem dams]. Comprehensive fish passage plans identifying necessary

Table 3.3.4.1. Estimated statistics for age 1 parr per habitat unit at index sites (IS) and sample sites in the Merrimack River watershed, 1994 – 2006.

Sample Site		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	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*	***(IS)***	*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*	3.2	2.8	87
S.B. Piscat.*	***(IS)***	*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*	3.0	2.3	76
U. S.B. 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	2.4	85
Stoney*		*1.0*	*3.3*	*6.7*	*1.2*	*8.0*	*1.2*	*0.2*	*0.3*	*3.0*					2.8	2.8	102
Souhegan*	***(IS)***	*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*	2.2	3.1	144
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*	***(IS)***	*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*	2.9	2.4	80
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*	***(IS)***	*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*	2.2	1.4	61
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
L. S.B. 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*	***(IS)***	*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*	1.8	0.7	41
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
E.B Pemi*	***(IS)***	*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*	0.7	1.0	129
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	2.3	2.0	88.5
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	0.9	36.5
CV*		*63*	*48*	*92*	*75*	*79*	*82*	*90*	*72*	*38*	63	76	84	60	37	48	41
Mean															**2.4**	**1.7**	**80**

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, predation) and that seaward migration is impeded or delayed at dams. 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 in the watershed, 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 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 will minimize 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 decreased fish passage efficiency at the Essex Dam. The flood in 2006 halted fish lift operations in early May with near record flows approaching 100,000 cfs at the Essex Dam. Continued high water throughout May and June precluded efforts to clear the fish lift of debris and limited operation of the lift until late June and early July near the end of the period of upstream migration. As a result of the problems with the fish lift, many salmon returning to the river were intercepted and captured during field operations conducted downstream of the Essex Dam and aimed at the capture of American shad. Of the 91 observed salmon that returned to the river in 2006, 40 were captured by electrofishing and were essentially a bycatch associated with shad capture operations.

In response to the problems associated with high water and debris loading at the Essex Dam fish lift, Enel North America, Inc. (Enel), owner and operator of the Lawrence Hydroelectric Company, recently proposed to replace the 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 would provide a number of operational and environmental benefits including: elimination of impoundment drawdowns 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 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. Enel has submitted their proposal to FERC as well as state permitting agencies, and the fishery resource agencies support the project. Pending timely approval, it is anticipated that construction of the system could occur outside the period of fish passage between July 15 and September 15, 2007.

PSNH completed consultation and reached a settlement with fishery resource agencies regarding future prescriptions for fishway construction at the project. Renewal of the operating license for the Merrimack River Project (Amoskeag, Hooksett and Garvins Falls dams - FERC No. 1893) is moving forward and prescriptions, provisions, and plans are in place to benefit a number of fish species. The installation of upstream fish passage facilities on the east side of the dam, opposite the existing powerhouse and fish ladder entrance on the west side of the river, will be required in future years when the target spawning stock biomass of migratory fish including salmon, herring, and shad is achieved.

Studies at Amoskeag Dam in Spring 2006 focused on smolt passage survival using the HI-Z Turb'N Tag recapture technique. The study was undertaken to determine if injuries/mortality were occurring during smolt passage through the crest gate into a downstream plunge pool. The sample size for this investigation was set at 60 fish (30 treatment and 30 controls).

Recapture rate (physical retrieval of fish) of both treatment and control groups was100%. All treatment and control fish were alive upon recapture. The one hour and 48 hour survival for smolts passing the fish bypass were identical (100%). None of the 30 control fish had injuries and all treatment and control fish were actively swimming at the end of the 48 hour post-passage assessment period.

PSNH will work cooperatively with the USFWS and NHFGD to operate the Ayers Island Dam (Pemigewasset River) fish sampler during the 2007 downstream smolt migration and 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.

3.3.6. 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 2006 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 (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, have not met program expectations. The first genetically marked year class should return in Spring 2007, and at this time results from the genetic marking program are inconclusive with respect to stocking location.

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 will 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 addition to using river specific broodstock, the Merrimack River program continues to stock Penobscot River smolts (50,000) annually 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, Connectictut, 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 population, 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 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 will maintain genetic similarities between the 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.

3.3.7. General Program Information

Atlantic Salmon Domestic Broodstock Sport Fishery

The NHFG via a permit system manages an Atlantic salmon broodstock fishery in the mainstem Merrimack River 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 2006, 592 (age 2 and 3) domestic broodstock were released for the fishery. In Fall 2006, an additional 640 (age 2) broodstock were released for a combined total release of 1,232 fish to support the fishery in the main stem of the Merrimack River and the lower portion of the Pemigewasset River.

Anglers continue to submit catch and harvest reporting diaries on a voluntary basis. There is a one year lag time in reporting from angler diaries which results in this summary characterizing the 2005 fishery. There were 1,395 salmon stocked, 1,271 permits sold in 2005 and an estimated 476 anglers actually fished for salmon. The majority of the anglers were NH residents, 13% were nonresidents. Anglers fished an estimated 5,966 hours during fishing trips. They caught an estimated 434 fish, released 424, and kept 10 salmon. Catch-per-unit-effort indicates that anglers fished approximately 13.8 hours before catching a salmon. Above average flows were observed in the Merrimack River watershed in Spring 2005 which resulted in less than desirable angling conditions throughout much of the early spring. These conditions likely contributed to a decrease in the number of anglers that fished for salmon and a decrease in fishing effort and number of fish captured.

Broodstock are known to be captured and killed in the fishery for consumption. 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. The time series of creel data for this fishery suggests that the majority of anglers practice catch and release.

Education / Outreach

Adopt-A-Salmon Family

The 2006 school year marked the fourteenth year in which the Adopt-A-Salmon Family Program has been providing outreach and education to school groups in Maine, New Hampshire, and Massachusetts, in support of Atlantic salmon recovery and restoration efforts. The great success of the program can be attributed to the cooperative effort among the NNFH, Central New England Fishery Resources Office (CNEFRO), and a core group of dedicated volunteers. The program continues to use a diversified approach during school visits to the hatchery to not only give students a hands-on experience with Atlantic salmon, but also to introduce students to the broader issues of diadromous fish restoration.

In November, 1800 students and 120 teachers and parents from 24 schools throughout central New England participated in tours of the NNFH. During the tour, participants observed spawning demonstrations and had the opportunity to handle fish and fertilized eggs.

Approximately 41 schools will receive about 15,910 salmon eggs in 2006 to be reared in classroom incubators. Throughout the winter and spring, salmon eggs are monitored by students until they hatch. In late spring, the fry are released into the Merrimack River watershed.

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 Public Service of New Hampshire -The Northeast Utilities System, 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 2006 was 20,113, including 12,422 students and 9,691 adults. Since its inception Fishways has documented greater than one half-million visitors and about 6,200 school programs have been delivered to date. 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. Fishways has been actively working on two grants this year: the Urban Wildlife Grant through the NHFG and the Merrimack River Stewardship Program through the EPA. The EPA grant was made possible through the combined efforts of USFWS and Fishways staff. This educational grant will extend through September 2007. It is linked to the Adopt-A-Salmon Family Program and will offer teacher training as well as environmental education in the regional schools.

3.3.8. Salmon Habitat Enhancement and Conservation

Habitat Restoration
In 2006,the multi-agency New Hampshire River Restoration Task Force continued to work on identifying dams for removal in the state and pursuing strategic alterations and/or modifications of dams.

Information meetings to address removal issues pertaining to the Merrimack Village Dam, Souhegan River, NH were convened in 2006. Phase 1 of the feasibility analysis to remove the dam has been completed and included the cultural resources assessment. Efforts continued to obtain funding for Phase II of the study that would focus on engineering feasibility. The project proponent, Pennichuk Water Works, is committed to funding the non-federal share of the cost of this project. The applicant is currently applying for several grants to obtain the federal share of funding for the project and CNEFRO has provided National Fish Passage Program funds to support the project. It is anticipated that the dam will be removed in 2007.

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 rearing habit. In addition, two habitat restoration and protection projects are being coordinated with the staff of the White Mountain National Forest. One 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. These bridges could be used on many timber sales over several years. 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.

3.4. Pawcatuck River

3.4.1. Adult Returns

No Atlantic salmon were captured at the Potter Hill Fishway in 2006. High rains and high water levels restricted access to the fishway. Precipitation in May and June of 2006 was two times higher than normal. While access to the fishway was limited at best, the height of the falls at Potter Hill was reduced because of the large flow of water, potentially allowing Atlantic salmon and other anadromous species to jump the falls and bypass the fishway.

3.4.2. Hatchery Operations

Egg Collection

Sea-Run Broodstock

Currently, the Rhode Island Division of Fish and Wildlife (RIDFW) has no sea run broodstock.

Captive/Domestic Broodstock

In order to develop our own source of broodstock, RIDFW has been holding back some of the fish from our smolt stocking program. We currently have 7, three year old fish at the Perryville Hatchery and 47 two year old fish at the Lafayette Hatchery. Three of the three year fish were spawned in November 2006 resulting in approximately 6200 eggs. Milt was provided by North Attleboro National Fish Hatchery from Merrimack strain kelts from the display pool.

3.4.3. Stocking

Approximately 84,700 Atlantic salmon fry were stocked in the Pawcatuck River watershed in 2006. The Salmon in the Classroom program had 23 participating schools and each stocked approximately 200 fry, which were hatched in their classrooms. Also, in 2006, 12,860 smolts were stocked into the Pawcatuck River.

Juvenile Atlantic Salmon Releases
Atlantic salmon fry from the North Attleboro National Fish Hatchery were stocked on May 2, 2006. A total of 71,708 fry were released in the tributaries and mainstem of the Pawcatuck River watershed excluding the Wood River and its tributaries. Eyed eggs from kelts at the North Attleboro National Fish Hatchery were acquired on March 24, 2006 and were raised as feeding fry and as smolts for release in 2007. Eight thousand feeding fry were released in April, 2006 in Acid Factory Brook. The remaining fish are being raised at the Arcadia Warmwater Research Hatchery and at the Lafayette Trout Hatchery and will be released in March 2007.

The *Salmon in the Classroom* program was responsible for stocking 5,000 Atlantic salmon fry into the Pawcatuck River watershed in May, 2007. The locations and school groups are listed in Table 3.4.3.1.

Approximately, 12,842 1 year old smolts were raised at the Arcadia Warmwater Research Hatchery. These smolts were adipose fin-clipped and released in March, April and May 2005 at various locations in the Pawcatuck River (Table 3.4.3.2). For the hatchery raised fish the average smolt length was 205mm and average weight was 0.12lbs. Fort he pond raised fish average length was 178mm and weight was Construction of a new hatchery building at the Lafayette Trout Hatchery will enable RI to raise more fish to smolt size.

Adult Salmon Releases
Approximately 100 adult broodstock acquired from the Nashua National Fish Hatchery were released into Carbuncle Pond in December 2006.

3.4.4. Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were conducted in the fall of 2006 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 August and September, 2006. All fish were measured to fork length.

Table 3.4.3.1. Summary of fry stocking by the Rhode Island *Salmon in the Classroom* program.

School	Stocking location	Number stocked
Bain Middle School	Queens River	200
Bishop Hendricken	Wood River (Arcadia)	200
Bridgeham Middle School	Breakheart Brook	200
Chariho Middle School	Meadow Brook	200
Coventry High School	Wood River (WPWA)	200
Cranston Area Career & Tech	Queens River (William Reynolds)	400
Cranston High School East	Parris Brook (Mt. Tom Road)	200
Cranston High School West	Locke Brook (William Reynolds)	200
Davisville Middle School	Falls River	200
Exeter-West Greenwich	Beaver River (BR Schoolhouse Road)	200
Feinstein High School	Falls River (Stepping Stone Falls)	200
Gallagher Middle School	Roaring Brook	200
Jamestown Middle School	Falls River (Frosty Hollow)	200
Middletown Alt. Learning Prog.	Queens River (Mail Road)	200
Mt. St. Charles High School	Ashaway River (Ash. Line & Twine)	200
Narragansett High School	Wood River (off Mechanic Street)	200
N. Providence High School	Tomaquag Brook	200
Rogers High School	Beaver River (off Route 138)	200
South Kingstown High School	Meadow Brook (Carolina Man. Area.)	200
Thompson Middle School	Wood River (Rt. 3 Park)	400
Warwick Vet. Mem. HS	Phillips Brook	200
Winman Junior High School	Roaring Brook	200
Woonsocket High School	Ashaway River (Ash. Line & Twine)	200
Total		5000

Table 3.4.3.2 Locations of smolt stocking in the Pawcatuck River, Rhode Island.

Date	Origin and rearing hatchery	Location of stocking	Number stocked
2/23/2006	Merrimack domestic - Arcadia	Barber Dam	1000
3/15/2006	Merrimack domestic - Arcadia	Westerly Bridge	4671
3/16/2006	Merrimack domestic - Arcadia	Below Alton Dam	1171
3/16/2006	Merrimack domestic - Arcadia	Ashaway River	1000
9/16/2006	Merrimack domestic - Arcadia pond	Roaring Brook	5000
Total			12842

Parr, 0 years old, ranged in length from 43 mm to 99 mm, with an average of 66.7 mm, and 1 year old parr ranged in length from 125 mm to 215 mm, averaging 152.4 mm. Mean lengths in 2006 were lower in 0 year old fish and greater in 1 year old fish than those found in 2005. Mean densities of 0 year old parr and age 1 year old parr were 1.7 and 0.8 per 100 m^2, respectively (Tables 2 and 3). These densities represent an increase in densities of 0 year old and a decrease of 1 year old parr. There was a significant decrease in densities of 1 year old parr because large quantities of fry were not stocked in 2005. Overall the densities of 0 year old parr were lower than in past years, but the amount of fry stocked and also limiting the amount of available habitat decreases density.

Smolt Monitoring

No work was conducted on this topic during 2006.

Tagging

All smolts released were adipose fin clipped.

3.4.5. 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.

3.4.6. Genetics

No genetics samples were collected in 2006.

3.4.7. General Program Information

No dam removal or fishway construction work was conducted during 2006.

3.4.8. Salmon Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2006.

4.0 DEVELOPMENTS IN THE MANAGEMENT OF ATLANTIC SALMON

4.1 Anesthesia

Restoration efforts for Atlantic salmon (ATS) dictate that fish in various life stages must be handled for purposes of tagging, measuring, transporting, and spawning, among others. Use of anesthesia is critical for immobilizing individual fish so these tasks can be effectively and humanely performed. When properly administered to fish, anesthesia can also prevent stress responses which are responsible for depressing the immune system, causing electrolytic imbalance, and interfering with normal reproductive functions. Therefore, it becomes important for biologists and managers involved in ATS restoration efforts to capitalize on the benefits of proper anesthesia selection and use.

There are many types of anesthesia which have been used on fish, but there are only two drugs which are permitted by the U.S. Food and Drug Administration (FDA) for use on potential food fish: (1) MS-222 (Tricaine Methanesulfonate hydrochloride) and (2) Aqui-S (a eugenol-based drug). MS-222 is an approved new animal drug (NAD) and can be used with no reporting forms and no withdrawal time if used on ATS 10 inches or less or any other size fish provided they are not legally-harvestable within 21 days of liberation. Aqui-S is currently permitted for use under an Investigative New Animal Drug permit (INAD) and requires registration of study plans and annual reporting responsibilities for the users. ATS treated with Aqui-S can also be released immediately after exposure (no withdrawal time) provided they are not legally-harvestable within 21 days of liberation. Published studies with ATS have shown Aqui-S to prevent stress responses when properly administered but no published studies specific to the effect of MS-222 on the stress response of ATS were found. However, published studies with rainbow trout showed MS-222 as effective as clove oil in reduction of stress. At recommended doses, knock out time is slightly greater for Aqui-S vs. MS-222, but recovery times are similar. When exposed to the recommended knock-out dose of Aqui-S, ATS may display more agitated behavior than those exposed to properly buffered MS-222.

For ATS stocks considered threatened or endangered under the Endangered Species Act, other types of anesthesia can be used under an FDA “low regulatory priority” (LRP) status. There is no withdrawal period required for threatened and endangered ATS exposed to these other types of compounds. If any LRP compound is used on these stocks, a 2-page documentation form must be registered with the U.S. Fish & Wildlife-Aquatic Animal Drug Approval Partnership (AADAP) program in Bozeman, MT. One un-approved compound suitable for use with threatened and endangered stocks is Metomidate Hydrochloride (trade name: Aquacalm, Syndell, International, Inc.). Several published studies have shown it to be an anesthesia which is safe, effective, and also good at preventing a stress response in ATS. Fish take longer to recover after anesthesia with Metomidate than with MS-222 or Aqui-S and the cost is higher. ATS parr are not visibly irritated when exposed to an effective knock-out dose (10 mg/L) of Metomidate.

When considering knock-out time, recovery time, stress-response prevention, cost, and associated paperwork required, MS-222 appears to be a good choice for biologists and managers involved in ATS restoration activities. Finally, in a study with coho salmon, Bouck and Johnson (1979) showed that immediate transfer of smolts to 28 ppt seawater after freshwater anesthesia with 100 mg/L MS-222 caused 100% mortality over a 10-day period. Mortality decreased with decreasing concentrations of MS-222 along with more gradual acclimation to seawater. The potential for this effect on ATS smolts should be considered or tested if future management activities include anesthesia with MS-222 and immediate release of out-migrating fish.

Literature Cited

Bouck, G.R. and D.A. Johnson. 1979. Medication inhibits tolerance to seawater in coho salmon smolts. Transactions of the American Fisheries Society 108:63-66.

4.2 Adult Handling Protocols

Adult Atlantic salmon transport and handling protocols were compared and discussed. Protocols were summarized within three regional programs; Maine Rivers, Merrimack River, and Connecticut River. Adults are moved from trap to hatchery, from trap to river release location, between hatcheries, and from hatchery to river release locations. Specific topics discussed included temperature thresholds and change allowance, handling techniques and equipment, transport / holding tanks and equipment, holding water treatment, and transport / holding densities.

Equipment and handling protocols are similar between the regional programs (Table 4.2.1) and the hatcheries (Table 4.2.2). The equipment is appropriate and adequate, transport tank oxygen delivery and aeration meet accepted standards, holding time in transport tanks is minimized, and handling focuses on using fish-friendly tubes, bags, and stretchers. When possible, salt is appropriately used in holding tanks to minimize the effects of stress. Tank loading rates are kept to low and accepted densities during transportation. Protocols are successful in minimizing observed handling caused mortality at both hatchery and river release sites.

A major topic of discussion was the different temperature thresholds and the use of tempering to minimize large and rapid temperature changes. The Connecticut River program follows a 6^{o} rule, tempering the fish in a holding tank for 0.5 – 8 hours anytime the source and receiving waters were greater than 6C, while the Merrimack River and Maine programs allow a greater than a 6C decrease from river source to hatchery receiving water with no resultant observable mortality. The Maine Rivers program uses temperature threshold guidelines to determine handling and transport protocols (reduced handling and workup at 22-25C, no transport to river release locations above 22C), while the Connecticut and Merrimack River programs have no upper temperature threshold guidelines for handling and transport. Managers from the Connecticut and Merrimack rivers expressed their intent to handle and transport adults regardless of temperature. Although very little fish movement is seen above 25C in all the regions, the Maine program has handled and transported adults to the hatchery up to 26C. Committee members discussed the appropriateness of the Maine temperature threshold guidelines, especially the 22C threshold for truck transport to river release locations and the potential impact exerted on in-river natural spawning. More discussion is needed to determine if these threshold guidelines are appropriate, and whether the can be relaxed or removed.

The Committee agreed that there was a need for continued scrutiny of adult handling and transport protocols. Practices and procedures that are currently successful may not continue to be in the future, and there is a need to record current protocols. Each program now has specific Standard Operating Procedures documented for individual sub-programs within the region, as well as the summary found in this document (Table 4.2.1).

Table 4.2.1. Comparison of handling protocols for adult Atlantic salmon at fishway traps, during transport, and at hatcheries across New England. (in three panes)

Trapping Adults					Handling Adults		
State	**River**	**Location**	**Fishway Type**	**Tending Schedule**	**In trap**	**Trap to Truck**	**Truck to Release**
ME	Penobscot	Veazie Dam	Vertical Slot	Daily - May-Oct	Clear plexy-tube (40" X 7.5ID)	Rubber Sock	Rubber Sock
ME	Narraguagus	Stillwater Dam	Denil	Daily - May-Oct	Clear plexy-tube (40" X 7.5ID)	NA	NA
ME	Dennys	Edmunds - Weir	Weir	Daily - May-Oct	Clear plexy-tube (40" X 7.5ID)	NA	NA
ME	Kennebec	Lockwood Dam	Fish Lift	Daily - May-Oct	Fine mesh net 20 foot circular tank to 250 gallon salmon tank	Rubber Sock	Rubber Sock
ME	Saco	Cataract Dam	Fish Lift	Daily - May-Oct	Fine mesh net 20 foot circular tank to 250 gallon salmon tank	Piped	Fine mesh knotless net
ME	Saco	Skelton Dam	Fish Lift	Daily - May-Oct	Fine mesh net 20 foot circular tank to 250 gallon salmon tank	Piped	Fine mesh knotless net
ME	Union	Ellsworth Dam	Vertical Slot	Daily - May-Oct	On-site holding tank	Rubber Sock	Rubber Sock
CT	Farmington & Salmon	Rainbow & Leesville Fishways	Rainbow (Vertical Slot); Leesville (Denil)	Daily: April 15 - July 15; Oct. 1 - Nov. 15	2 people: Vinyl sling (44" long). Salmon are guided into sling, which is then zipped shut and suspended by rings from overhead ropes with 6" water in bottom.	vinyl sling	vinyl sling
MA	Connecticut	Holyoke	Fish Lift	Daily: April 15 - July 15; Oct. 1 - Nov. 15	2 people: Vinyl sling (44" long). Trap is raised to 1-2 feet of water. Salmon are guided into sling, which is then clipped shut.	vinyl sling	vinyl sling
MA	Westfield	West Springfield	Denil	Daily: April 15 - July 15; Oct. 1 - Nov. 15	2 people: Vinyl sling (44" long). Trap is raised to 1-2 feet of water. Salmon are guided into sling, which is then zipped shut.	vinyl sling	vinyl sling
MA	Merrimack	Essex Dam	Fish Lift	Daily: May- mid July; & Mid-Sept - Oct.	2 people: Vinyl sling (44" long). Trap is raised to 1-2 feet of water. Salmon are guided into sling, which is then zipped shut, and salmon are carried to 50' holding tank.	Vinyl sling	Vinyl sling

Table 4.2.1 Continued.

State	River	Location	On site	Truck to Hatchery	Truck to upriver release site
ME	Penobscot	Veazie Dam	Barge Tank (8 X 3.5 X 2 = 56ft3 (419 gallons) when full, operate at 8 X 3.5 X 1.5 = 42 ft3 (~300 gallons). Mechanical aerator, Supplemental O2 = >90% saturated. No more than 20 fish in tank at one time. ~0.66 pounds of fish per gallon when at full capacity. Barge water is tempered with ice, max temperature change = 5 C	PVC insulated tank (200 gallons), mechanical aerator and supplemental O2 = 90% O2 saturation. No more than 20 fish per haul. ~ 1.0 pound of fish per gallon when at full capacity. About 45 minute transport time to CBNFH. Tank is drained and refilled at CBNFH between each trip. Water temp is ~ 15 C. NaCl added (1% concentration). Truck stops once during each transport to ensure life support is functional and fish look OK.	PVC insulated tank (200 gallons), mechanical aerator and supplemental O2 = 90% O2 saturation. No more than 20 fish per haul. ~ 1.0 pound of fish per gallon when at full capacity. Tank water is tempered to no more than 3 C less than river water. Transport time is about 20 minutes. 2 scoops of salt added to each tank.
ME	Narraguagus	Stillwater Dam	NA	NA	NA
ME	Dennys	Edmunds - Weir	NA	NA	NA
ME	Kennebec	Lockwood Dam	250 gallon stainless steel insulated square tank. Recirculate water (flow through available), supplemental O2 >90% saturation. Fish held on site until ASC crew is notified (< 1 hour).	NA	PVC insulated tank (200 gallons), mechanical aerator and supplemental O2 = 90% O2 saturation. No more than 20 fish per haul. Max of ~ 1.0 pound of fish per gallon when at full capacity. Tank water is tempered to no more than 3 C less than river water. Transport time is about 2 hours. Truck stops once during each transport to ensure life support in functional and fish look OK.
ME	Saco	Cataract Dam	20 foot circular tank with flow through capacity	NA	PVC insulated tank (200 gallons), mechanical aerator and supplemental O2 = 90% O2 saturation. No more than 20 fish per haul. Max of ~ 1.0 pound of fish per gallon when at full capacity. Tank water is tempered to no more than 3 C less than river water. Transport time is about 2 hours. Truck stops once during each transport to ensure life support in functional and fish look OK.
ME	Saco	Skelton Dam	20 foot circular tank with flow through capacity	NA	PVC insulated tank (200 gallons), mechanical aerator and supplemental O2 = 90% O2 saturation. No more than 20 fish per haul. Max of ~ 1.0 pound of fish per gallon when at full capacity. Tank water is tempered to no more than 3 C less than river water. Truck stops once during each transport to ensure life support in functional and fish look OK.
ME	Union	Ellsworth Dam	300 gal mechanical aerator and oxygen supplied to achieve > 90% saturation.	NA	300 gallon fiberglass insulated tank. mechanical aerator and supplemental O2 = 90% O2 saturation
CT	Farmington & Salmon	Rainbow & Leesville Fishways	Circular 5-foot, 264 gal non-insulated poly tank. Mechanical aerator and 1-hp chiller (4-6 C colder than fishway temp). Max 8 salmon / load. Temp change will not exceed 6C (1 hr acclimation). Salt added to the tank at 1% concentration. Max holding time 8 hr. Overnight holding is generally in the trap vs. in tank.	Flat bed truck with three compartment insulated fiberglass tank. Each compartment = 175 gallons, mechanical aerator and oxygen supplied. Max capacity = 6 salmon per compartment. Maintain 6 C temperature rule, transport temp is 9-15 C (hatchery = 9 C). Salt added (1% concentration) if fish appear stressed. Transport time = 1-2 hours.	NA
MA	Connecticut	Holyoke	424 gal six foot circular holding tank, maximum of 25 to 30 salmon. Tank filled with river water and held at ambient temp with 1-hp chiller. Mechanical aerator (Fresh-Flo model DT. Max holding time is 11 hours.	200 gallon insulated PVC tank, mechanical aerator, capacity = 15 salmon. Transport time = 40 minutes.	10% of fish radio tagged and transported upriver. Salt added to truck tank (0.5% concentration) and fish held at ambient river temp for minimum of 1 hour. Salmon monitored for 1 hour post release with hand-held directional antenna.
MA	Westfield	West Springfield	Circular 5-foot dia 264 gal non-insulated poly tank. Mechanical aerator and 1-hp chiller (tank temp held constant at 15 C). Maximum of 8 salmon / load. Salmon transported to hatchery in 15C temp water. Tank will be refilled with ambient temp river water if salmon are to be released upriver.	200 gallon insulated PVC tank, mechanical aerator, capacity = 15 salmon. Transport time = 40 minutes.	10% of fish radio tagged and transported upriver. Fish held at ambient river temp for minimum of 1 hour. Tank outfitted with mechanical aerator and microbubble diffuser supplied with compressed oxygen.
MA	Merrimack	Essex Dam	300 gal circular tank with mechanical aeration and chiller. Tank temperature set at 15C. Holding time < 8 hr.	300 gallon insulated fiberglass tank, mechanical aerator, oxygen, O2> 90%; max 20 fish per load.	NA

Table 4.2.1 Continued.

State	River	Location	Trap Temp	Transport Temp	Broodstock Temp	Trap Cool Water (< 22)	Trap Warm Water (22 -25)	Hatchery
ME	Penobscot	Veazie Dam	25 (minimal handling)	23.5	25	Fork length, gender, fin condition (score), examined for tags, fin clips, VIE, injuries, external parasites; adipose or upper caudal fin punch applied and retained for genetics sample; pit tags applied to broodstock, and for other research fish.	At the discretion of the crew leader, handling salmon will be minimized to reduce stress on the fish. At a minimum each salmon will be visually classified as aquaculture or non-aquaculture origin and given an adipose punch (or upper caudal punch) in order to identify recaptured salmon. The punch will be retained as a genetic sample.	Broodstock treated with formalin (ich and fungus).
ME	Narraguagus	Stillwater Dam	25 (minimal handling)	NA	NA			NA
ME	Dennys	Edmunds - Weir	25 (minimal handling)	NA	NA			NA
ME	Kennebec	Lockwood Dam	25	recipient water > 22	NA			NA
ME	Saco	Cataract Dam	22	22	NA			NA
ME	Saco	Skelton Dam	22	22	NA			NA
ME	Union	Ellsworth Dam	25	22	NA			NA
CT	Farmington & Salmon	Rainbow & Leesville Fishways	No temperature criteria	No temperature criteria	NA	Total length, size class (MSW, grilse), gender, brightness; inspection for wounds/scars, external parasites, fin damage, hatchery clips; tag(s) applied		Anesthetized (MS-222). Weight, total length, scales, vaccinated (ERM/furnculosis) and antibiotics (oxylinic acid), scanned for pit tag (if none then inserted), genetics sample, blood sample for disease screening. Fish quarantined if badly injured or suspect for disease.
MA	Connecticut	Holyoke	No temperature criteria	No temperature criteria	NA	Size class (MSW, grilse), gender, brightness; inspection for wounds/scars. 10% of run radio tagged (anesthetized in MS-222), transported upriver and released; once sedated: length, weight, scales, genetic sample, inspection for wounds/scars, pit tagged, radio tagged, green dye injected in anal fin.		Anesthetized (MS-222). Weight, total length, scales, vaccinated (ERM/furnculosis) and antibiotics (oxylinic acid), scanned for pit tag (if none then inserted), genetics sample, blood sample for disease screening. Fish quarantined if badly injured or suspect for disease.
MA	Westfield	West Springfield	No temperature criteria	No temperature criteria	NA	Total length, size class (MSW, grilse), gender, brightness; inspection for wounds/scars, external parasites, fin damage, hatchery clips. 10% of returns transported and released upriver: salmon are weighed in sling and scale sample taken.		NA
MA	Merrimack	Essex Dam	No temperature criteria	No temperature criteria	Transport to hatchery at 15C	NA		Total length, size class (MSW, grilse), gender, brightness; inspection for wounds/scars, external parasites, fin damage, hatchery clips, vaccination (furunculosis), PIT tagged. Disease (full range disease & pathogens). Kelts - hydrogen peroxide treatment at 75ppm / 1 hr. Broodstock treatment 75-100ppm /3 days.

Table 4.2.2 Summary of handling protocols for adult Atlantic salmon transported from hatcheries in New England.

Location	Description	Tank to Truck	Fish Prep	Loading Rates	Life support	Stock-out temp	Truck to River
Craig Brook & Green Lake NFH	Captive, domestic, or sea-run adult salmon are generally stocked out from the hatcheries in the fall pre or post-spawn.	Fine mesh long handled net	No feed 1 + month prior to stocking	1.25 -2.0 lb's / gal	mechanical aerator, air scoops, oxygen to maintain >90% saturation	38 -45 C	Fine mesh long handled net
Nashua & North Attleboro NFH	Captive, domestic, or sea-run adult salmon are generally stocked out from the hatcheries in the fall pre or post-spawn.	Vinyl bag	No prep prior to transport	0.5 -1.00 lb's /gal	mechanical aerator, air scoops, oxygen to maintain >90% saturation	38 -45 C	Vinyl bag or piped directly from truck tank
Nashua & North Attleboro NFH (recreational angling releases)	Captive, domestic, or sea-run adult salmon are generally stocked out from the hatcheries in the fall pre or post-spawn.	Vinyl bag	Each fish receives colored floy tag alpha-numeric text.	0.5 -1.00 lb's /gal	mechanical aerator, air scoops, oxygen to maintain >90% saturation	38 -45 C	Vinyl bag or piped directly from truck tank
Cooke Aquaculture (Industry)	Transport of broodfish from salt water rearing pens to freshwater hatchery	Fish are crowded (seined), netted with a knotless fine mesh handled net, and put into 1000 liter polyethyle tanks (exactic)	No feed for 14 days prior to transfer to freshwater	150 kg / 1000 liters water (1.25 - 2.0 lb's / gal)	Oxygen supplied and maintained at 100-200% during transport	Ocean = ambient; Hatchery = ?	Fine mesh long handled net

4.3 NEASC and USASC Interactions

The New England Atlantic Salmon Committee (NEASC) was established in the early 1980s to facilitate restoration and recovery of Atlantic salmon and associated diadromous fish species to New England rivers. In January 2006 representatives from the six New England states reaffirmed their agreement to work together as the NEASC with the goals to: a) restore and maintain self sustaining populations of Atlantic salmon and associated diadromous species throughout their historic range in New England; 2) develop and implement unified approaches to address and resolve major obstacles that impede Atlantic salmon restoration; 3) identify and seek resolution of common problems that hinder the Atlantic salmon management across the region; and 4) create a joint venture involving other governmental agencies, nongovernmental organizations and interested parties who support the goals of the NEASC.

In 2006 the NEASC engaged the USASAC and requested assistance in developing and identifying priority research and management activities in Atlantic salmon watersheds throughout New England. USASAC produced the following summary for the group.

NEW ENGLAND ATLANTIC SALMON RECOVERY AND RESTORATION ACTIONS

Prepared by: U.S. Atlantic Salmon Assessment Committee, Submitted: August 18, 2006.

PRODUCE ATLANTIC SALMON

Atlantic salmon recovery, restoration, conservation, and research require significant support from fish culture facilities including hatcheries, rearing stations, and broodstock holding facilities. The majority of adult salmon returning to U.S. waters begin their lives in a hatchery. Erosion of hatchery capacity at this stage of the program would result in fewer adults returning; less public and political support, and reduced ability to engage in scientifically valid research assessing the program. The priority is to maintain existing capacity, not to increasing hatchery capacity. This will require support for hatcheries in the budget process, resisting the temptation to divert money from hatcheries to fund exciting new research initiatives, and, in some cases, restoring previously eliminated positions in the hatcheries.

1. Produce salmon at varying life stages in numbers sufficient to maximize smolt production in rivers, realize adult returns, and support critical research.

2. Manage and monitor genetic quality, diversity, and appropriateness of stock complexes maintained at fish culture facilities.

EVALUATE THE PROGRAM

There are many unanswered questions about Atlantic salmon in the U.S. and the efficacy of present-day restoration techniques. Research is needed to answer these questions, assess the current program, and guide management decisions. Depending on the question research may need to be conducted in: selected rivers spanning the species' range in New England; only one river; or every Atlantic salmon watershed in New England. Maximizing the benefit of the research to the New England program requires careful prioritization, coordination, and pooling of resources for both conducting the research and integrating the results. Existing resources are unlikely to meet the needs for a comprehensive New England program evaluation and additional funding must be identified.

3. Assess the effects of hatchery product quality and stocking strategies on long-term juvenile survival and smolt production.

4. Assess the effects of habitat quality on long-term juvenile survival and smolt production.

5. Study smolt emigration through streams, estuaries, and inshore marine waters, assessing behavior and survival to identify and quantify key components of natural mortality during the migration.

6. Assess marine survival of salmon, distinguish it from mortality that occurs in estuarine and coastal waters.

7. Study the relationship between salmon survival and the status of other diadromous fish populations within the watershed and region.

RESTORE HABITAT AND ECOSYSTEMS

The goal to restore wild populations of Atlantic salmon requires viable habitat to support such populations. Hatcheries are valuable tools for recovery and restoration but cannot take the place of natural habitat. Habitat degradation was the principal cause for the decimation of Atlantic salmon in the U.S. and it must be reversed if salmon are to be restored. Atlantic salmon share common habitat with other diadromous fish species and these other species interact synergistically with the physical habitat to maintain an ecosystem capable of supporting wild Atlantic salmon. The loss of these linked species can have as much of a deleterious effect on salmon as the degradation of habitat. The actions listed below are currently being pursued, but efforts are inadequate to restore access to and the productivity of Atlantic salmon habitat. Additional resources must be directed to these efforts.

8. Restore habitat connectivity through an aggressive fish passage program that addresses upstream and downstream passage at barriers.

9. Enhance design and engineering support for fish passage and habitat restoration.

10. Restore degraded habitat that limits salmon production.

Table 4.3.1. New England Atlantic salmon recovery and restoration needs for 2007.

Issues	Action	Lead Agencies	Projected Additional Annual Need	
A. PRODUCE ATLANTIC SALMON				
Eroding Hatchery Production Capacity	1. Produce salmon, maintain staff and facilities.	USFWS, CTDEP, NHFG, RIDFW, NGO	Connecticut River:	$510,000
Production and Stocking			Maine Rivers:	$815,000
Genetics	2. Manage and monitor genetic resources of population.	USFWS, USGS	Merrimack/Pawcatuck Rivers:	$400,000
Fish Health				
Water Quality Compliance			Totals:	$1,725,000
B. EVALUATE THE PROGRAM				
Data and Analyses for Adaptive Management	3. Assess effect of hatchery product quality on long-term survival.	ASC, USFWS, USFS, NHFG, RIDFW USACOE, CTDEP, MAFW, VTFW,	Connecticut River:	$250,000
			Maine Rivers:	$282,000
	4. Assess effect of habitat quality on long-term survival.	USGS, MEDEP, CTDEP, USFS, NOAA	Merrimack/Pawcatuck	$100,000
			Total:	$632,000
Estuarine and Marine Mortality				
Evaluate Hatchery Product	5. Study smolt emigration.			
Evaluate Habitat Quality			Connecticut River:	$635,000
Smolt Emigration	6. Assess marine survival.	ASC, NOAA, USGS	Maine Rivers:	$500,000
Diadromous Species Interactions			Merrimack/Pawcatuck	$300,000
		NOAA	Total:	$1,435,000
	7. Study relationship with other diadromous species.		Connecticut River:	$300,000
			Maine Rivers:	$1,430,000
			Merrimack/Pawcatuck Rivers:	$100,000
			Total:	$1,830,000
C. RESTORE HABITAT AND ECOSYSTEMS				
Accomplish Multi-Species Passage and Habitat Restoration Projects	8. Pursue fish passage at barriers	MEDEP, MEIFW, MEDMR, NOAA, USFWS, NHFG, CTDEP, MAFW, MADMR, USFS, VTFW, RIDFW	Connecticut River:	$2,800,000
Fish Passage Engineering	9. Engineering design support.		Maine Rivers:	$3,250,000
Fishway Construction	10. Restore degraded habitat.		Merrimack/Pawcatuck Rivers:	$1,250,000
Barrier Removal			Total:	$7,300,000
Habitat Restoration Connectivity				
Diadromous Species Restoration				
			Grand Total	$12,922,000

This compilation of primary activities and needs to support activities were presented to the New England Congressional Delegation at a briefing held in Washington, DC on February 27, 2007. The briefing described an initiative where nine New England state fishery agencies and three federal services including the USFWS, NOAA-Fisheries, and USFS joined together to facilitate the recovery and restoration of Atlantic salmon and other diadromous species to New England rivers. The cooperation has provided a venue where action can be initiated in a collaborative manner. The New England states and federal agencies share a common desire to restore Atlantic salmon – a keystone species - to their historic rivers. With a goal of restoring salmon populations by addressing major obstacles that hinder management objectives, the parties of this venture intend to continue efforts to identify funding and enhance public awareness of the need for critical research and management activities. The USASC will continue to support the initiatives proposed by NEASC.

Information presented at the February 2007, Congressional Delegation briefing stated that mortality of salmon at sea had doubled in recent years compared to the 1970s. Ocean fisheries for Atlantic salmon have been greatly reduced but salmon populations have not responded as expected. Mortality at sea has increased but there is a lack of understanding of the factors responsible. The New England states have begun to address the aspect of survival by partitioning the marine environment into three areas (estuary, bay and ocean). Plans are now finalized to address survival in these areas over the next five years. Research has begun in near shore areas and the North Atlantic Salmon Conservation Organization (NASCO) will coordinate a North Atlantic wide effort among all partnering countries starting in 2008. Research is focused on the effects hatcheries have on long-term salmon survival; how habitat characteristics relate to freshwater and marine survival; and on the aspect of smolt emigration and the relationship other diadromous species have with salmon and their survival.

Conservation hatcheries operated by the USFWS are intended to facilitate restoration and recovery efforts and are essential to all facets of salmon recovery. Annual stocking programs are required until self-sustained populations are established. At this time, naturally occurring populations are augmented with hatchery products to maintain the viability of the populations. Loss of hatcheries equates to the loss of the species.

Due to current research directed at freshwater and marine survival, it is essential that hatcheries are able to perform their mission. This ensures that adequate numbers of fish reach critical habitat to support the runs and provide enough fish to test the hypothesis and identify factors limiting restoration and recovery. Hatchery funding has not been sufficient to keep up with rising inflation and energy costs. Staffing levels and facility maintenance has effected. Fish production is currently at the lowest possible level able to support Atlantic salmon programs in New England. Core services must be restored and maintained to sustain at-risk salmon populations and support necessary research and evaluation.

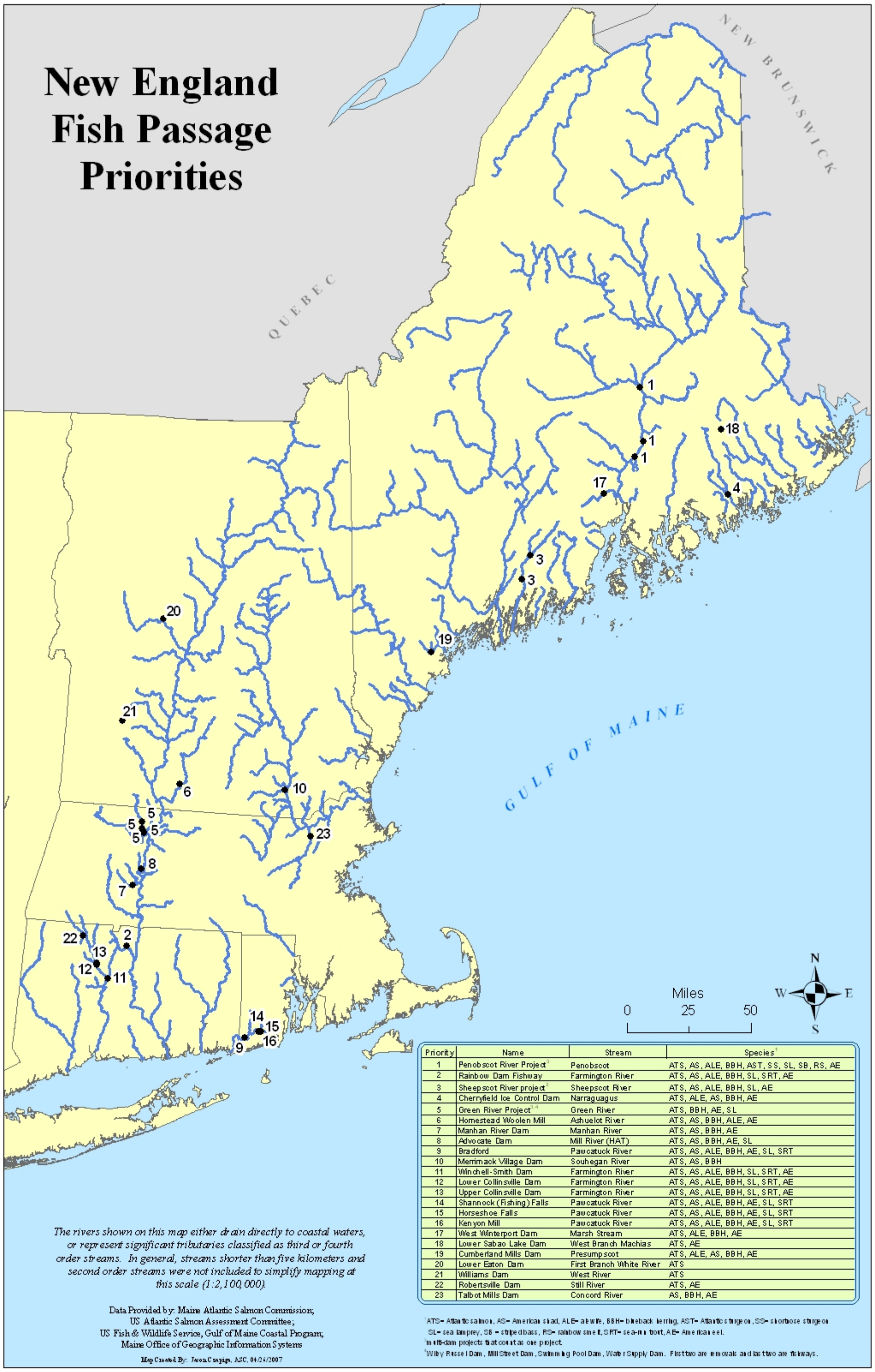
4.4 Prioritizing fish passage projects at dams in New England

NEASC requested the USASAC to provide a list of the top priority fish passage projects at dams (with/without hydro generation) for New England. NEASC hopes to use this information to leverage funding from a variety of sources to implement these projects. Therefore, the list was not to include projects that would be required of FERC licensees or required by other regulatory agencies. The list was to include projects that would benefit Atlantic salmon as well as other diadromous species and the committee was to rank these projects in a regionally perspective. In advance of the 2007 meeting, representatives from state agencies in CT, RI, MA, VT, NH, and ME were asked to provide basic information on five top priority projects in their state. A blank spreadsheet was provided to allow all responding to provide data in a standardized format. All states responded and 25 projects were listed. At the meeting, the USASAC reviewed the information and eliminated some projects because they were either FERC requirements or had received all necessary funding. It also consolidated several projects into single 'block' projects and questioned why other projects were not submitted. A preliminary ranking of the remaining projects was agreed upon. However, agency staff not attending the meeting were contacted to provide additional information requested by the committee and another ranking of the projects was provided and circulated via email among members (Table 4.4.1). The projects listed for the exercise are distributed across New England (Figure 4.4.1).

Table 4.4.1. List of USASAC rankings for priority fish passage projects at dams (with/without hydro generation) on New England Atlantic salmon rivers.

	Name	Stream	Species[1]	Fish Below?	miles[2]
1	Penobscot River Project[3]	Penobscot	ATS, AS, ALE, BBH, AST, SS, SL, S	Yes	90+
2	Rainbow Dam Fhwy	Farmington Rive	ATS,AS,ALE,BBH,SL,SRT,AE	Yes	26+
3	Sheepscot River project[3]	Sheepscot R.	ATS, AS, ALE,BBH, SL, AE	Yes	30+
4	Cherryfield Ice Control Da	Narraguagus	ATS, ALE, AS, BBH, AE	Yes	30+
5	Green River Project[3,4]	Green River	ATS, BBH, AE, SL	Only for lowermost	~14
6	Homestead Woolen Mill	Ashuelot River	ATS, AS, BBH, ALE,AE	No	10
7	Manhan River Dam	Manhan River	ATS, AS, BBH, AE	Yes	?
8	Advocate Dam	Mill River (HAT)	ATS,AS,BBH,AE, SL	Yes	~ 3
9	Bradford	Pawcatuck Rive	ATS, AS, ALE, BBH, AE, SL, SRT	yes	?
10	Merrimack Village Dam	Souhegan River	ATS, AS, BBH	yes	14
11	Winchell-Smith Dam	Farmington Rive	ATS,AS,ALE,BBH,SL,SRT,AE	Yes	10
12	Lower Collinsville Dam	Farmington Rive	ATS,AS,ALE,BBH,SL,SRT,AE	Yes	1
13	Upper Collinsville Dam	Farmington Rive	ATS,AS,ALE,BBH,SL,SRT,AE	No	>15
14	Shannock (Fishing) Falls	Pawcatuck Rive	ATS, AS, ALE, BBH, AE, SL, SRT	yes	12
15	Horseshoe Falls	Pawcatuck Rive	ATS, AS, ALE, BBH, AE, SL, SRT	no	0.5
16	Kenyon Mill	Pawcatuck Rive	ATS, AS, ALE, BBH, AE, SL, SRT	no	0.5
17	West Winterport Dam	Marsh Stream	ATS, ALE, BBH, AE	Some years	15+
18	Lower Sabao Lake Dam	West Branch Ma	ATS, AE	Some years	5+
19	Cumberland Mills Dam	Presumpscot	ATS, ALE, AS, BBH, AE	Yes	25+
20	Lower Eaton Dam	First Br White R	ATS	Yes	6
21	Williams Dam	West River	ATS	No	6
22	Robertsville Dam	Still River	ATS, AE	Yes	~10
23	Talbot Mills Dam	Concord River	AS, BBH, AE	Yes	?

[1]ATS= Atlantic salmon, AS= American shad, ALE= alewife, BBH= blueback herring, AST= Atlantic sturgeon, SS= shortnose sturgeon SL= sea lamprey, SB = striped bass, RS= rainbow smelt, SRT= sea-run trout, AE= American eel.
[2]Number of miles upstream of the project that would become accessible to the targeted species.
[3]multi-dam projects that count as one project.
[4]Wiley Russel Dam, Mill Street Dam, Swimming Pool Dam, Water Supply Dam. First two are removals and last two are fishways. Costs and miles lumped.



Priority	Name	Stream	Species[1]
1	Penobscot River Project[3]	Penobscot	ATS, AS, ALE, BBH, AST, SS, SL, SB, RS, AE
2	Rainbow Dam Fishway	Farmington River	ATS, AS, ALE, BBH, SL, SRT, AE
3	Sheepscot River project[3]	Sheepscot River	ATS, AS, ALE, BBH, SL, AE
4	Cherryfield Ice Control Dam	Narraguagus	ATS, ALE, AS, BBH, AE
5	Green River Project[3,4]	Green River	ATS, BBH, AE, SL
6	Homestead Woolen Mill	Ashuelot River	ATS, AS, BBH, ALE, AE
7	Manhan River Dam	Manhan River	ATS, AS, BBH, AE
8	Advocate Dam	Mill River (HAT)	ATS, AS, BBH, AE, SL
9	Bradford	Pawcatuck River	ATS, AS, ALE, BBH, AE, SL, SRT
10	Merrimack Village Dam	Souhegan River	ATS, AS, BBH
11	Winchell-Smith Dam	Farmington River	ATS, AS, ALE, BBH, SL, SRT, AE
12	Lower Collinsville Dam	Farmington River	ATS, AS, ALE, BBH, SL, SRT, AE
13	Upper Collinsville Dam	Farmington River	ATS, AS, ALE, BBH, SL, SRT, AE
14	Shannock (Fishing) Falls	Pawcatuck River	ATS, AS, ALE, BBH, AE, SL, SRT
15	Horseshoe Falls	Pawcatuck River	ATS, AS, ALE, BBH, AE, SL, SRT
16	Kenyon Mill	Pawcatuck River	ATS, AS, ALE, BBH, AE, SL, SRT
17	West Winterport Dam	Marsh Stream	ATS, ALE, BBH, AE
18	Lower Sabao Lake Dam	West Branch Machias	ATS, AE
19	Cumberland Mills Dam	Presumpscot	ATS, ALE, AS, BBH, AE
20	Lower Eaton Dam	First Branch White River	ATS
21	Williams Dam	West River	ATS
22	Robertsville Dam	Still River	ATS, AE
23	Talbot Mills Dam	Concord River	AS, BBH, AE

[1] ATS= Atlantic salmon, AS= American shad, ALE= alewife, BBH= blueback herring, AST= Atlantic sturgeon, SS= shortnose sturgeon SL= sea lamprey, SB = striped bass, RS= rainbow smelt, SRT= sea-run trout, AE= American eel.
[3] multi-dam projects that count as one project.
[4] Wiley Russel Dam, Mill Street Dam, Swimming Pool Dam, Water Supply Dam. First two are removals and last two are fishways.

Figure 4.4.1. Map of USASAC top priority fish passage projects at dams (with/without hydro generation) on New England Atlantic salmon rivers.

4.5 State Agency Monitoring for Incidental Recreational Catch

Typically, there are very few reports of incidental catch of adult Atlantic salmon in New England. Reported incidental catch usually come from State and Federal agency law enforcement or agency bologists, concerned citizens, anglers, or groups (salmon clubs, watershed councils, and coalitions). More recently, monitoring of angling and conservation web-site chat rooms has proved useful in documenting illegal adult salmon capture and identifying areas where salmon seem to be more susceptible to incidental catch.

Each state uses a variety of methods to collect incidental catch data:

Connecticut

- Monitor Internet sites where anglers have documented catch
- Law enforcement staff patrol recreational fisheries and American shad commercial gillnet fishery sites for incidental salmon catch
- Biologists monitor recreational shad, striper, and trout fisheries and learn of salmon catches. In some cases, they may intercept angler catches at river-side and take possession of fish
- Most reported catches of salmon are released by the angler but biologists often obtain helpful data (sometimes scales) from the released fish

New Hampshire

- Consulting company documents catch when anglers return radio-tag for reward
- NHFG Law Enforcement monitors anglers periodically for license and salmon permits to regulate broodstock fishery (Merrimack R)

Massachusetts

- Track radio-tags to angler's freezer and to snow piles along roadside (CTR)
- Follow-up on reports from anglers
- Observe catch and kill in Merrimack River estuary and advised law enforcement

Vermont

Along with other state agencies in Connecticut River basin, Vermont Fish and Wildlife use location information from radio-tag studies to monitor welfare and incidental catch of salmon from tributaries. Vermont law enforcement pays particular attention to reaches when salmon are known to be present.

Maine

Recent estimates of incidental catch include:

- Penobscot - striper anglers below Veazie dam (1 or 2 salmon caught and released annually)
- Penobscot – anglers catching and taking adult salmon in the Medway / Mattawamkeag areas (note: there is a landlocked salmon fishery in the river, but landlocked salmon typically have a maximum length less than 25 inches)
- Narraguagus - shad anglers in Cherryfield (0-5 caught and released annually)

- Schoodic Lake (Penobscot Drainage) & Beddington Lake (Narraguagus Drainage) – ice fishing anglers capture and take of adult sea-run salmon (1-2 reports annually)

Sources of incidental catch data include:
- District Game Wardens
- Marine Patrol
- Citizens and public organizations (salmon clubs, watershed councils)
- Web-site monitoring: angling and conservation chat rooms

Typically, there are very few reports of incidental catch of adult Atlantic salmon in Maine each year. Reports of incidental catch usually come from Maine Warden Service, Maine Marine Patrol, and Federal Wardens stationed in Maine, concerned citizens, anglers, or groups (salmon clubs, watershed councils, and coalitions). More recently, monitoring of angling and conservation web-site chat rooms has proven useful for identifying incidences of adult salmon capture and areas where salmon seem to be more susceptible to incidental catch. When these areas are identified, MASC works with MIFW to develop and implement regulations that will protection to adult salmon in the future. A recent example: In response to a Maine District Game Warden concern of incidental capture of adult sea-run Atlantic salmon in the Penobscot River in the towns of Medway and Mattawamkeag, new regulations will be implemented in 2008. The new regulations for this area include a 25” length maximum on landlocked salmon, which should provide protection to multi-sea winter salmon, as well as a closure of all fishing 150’ below the Medway Dam on the West Branch Penobscot River. Adult salmon (new sea run and kelts) tend to hold in the tailrace below the Medway Dam during spring and summer. The dam does not have a fishway and therefore is not subject to the typical closure 150-foot downstream of the dam.

USFWS
- Has no authority to enforce state harvest regulations in Southern New England
- Law Enforcement patrol and enforce regulations in selected areas in Maine in cooperation with Maine authorities to protect endangered Atlantic salmon

4.6 Update on the NASCO Salmon Rivers Database

NASCO wishes to maintain a comprehensive database on the Atlantic salmon rivers of the world on its website. The U.S. volunteered to take the lead on the development of a data entry system and former USASAC member Ed Baum (retired) developed an Access program for that purpose. USASAC members from various agencies entered some data for some rivers within their jurisdiction during this development period to help test it. The Access database was turned over to the NASCO Secretariat in 2006 to launch on its website. This was accomplished late in 2006. USASAC members were charged with continuing data entry for U.S. salmon rivers into the web-based database.

At its 2006 meeting, the USASAC worked with USFWS GIS specialists to develop a map entitled “Historic Atlantic Salmon Rivers of New England”. This map includes 196 streams in the six states and is considered ~99% complete. It was decided that the NASCO database for U.S. rivers would include the rivers on this map except that the NASCO database would be limited to streams that are no smaller than 'tributaries-of-tributaries-to-mainstems', whereas the USASAC map includes some smaller tributaries. USASAC members may decide not to include some of the 'tributaries-of-tributaries-to-mainstems' on the NASCO database, based upon the relative importance of the streams. The initial goal of the USASAC was to enter in the name and basic geographic data for every stream desired to be in the database. This is to include not only the streams that currently have Atlantic salmon or are part of a restoration/ recovery program, but also the streams that historically supported salmon runs that are now lost.

Data entry was limited in 2006 because there was a period between the time Baum relinquished control of the database and the time the database was successfully launched on NASCO's website during which the database was inaccessible. Once it was launched, there were some technical problems with the database that USASAC members discussed with Secretariat staff and most have been resolved. Subsequently, staff from the Maine Atlantic Salmon Commission entered considerable data, staff from the U.S. Fish & Wildlife Service and others entered data for Merrimack River streams, and other staff entered data for coastal New Hampshire and Rhode Island streams. By the close of the 2007 USASAC meeting, 118 rivers were entered into the database and it is estimated that another 22 streams (mostly minor) need to be entered and a few need to be deleted. It is anticipated that this first step will be finished by the 2007 Annual NASCO meeting. At that time, the list of U.S. Atlantic salmon rivers will be considered complete. The next goal for the USASAC will be to enter juvenile habitat data for these rivers into the database by the 2008 USASAC meeting.

4.7 Are northeastern USA coastal rivers undergoing "cultural oligotrophication" ?

Nutrient limitation can be an important control on salmonid production and population abundance. Phosphate (PO_4) is usually the limiting nutrient in surface waters, however nitrogen can be limiting or co-limiting. Carbon is generally not limiting (in the form of dissolved organic carbon DOC) in streamwater, and there is evidence that DOC concentrations are increasing regionally. The strongest evidence of a link between nutrient status and salmonid production comes from long-term nutrient addition studies conducted in the Pacific Northwest (Slaney et al. 2003). However, Weng et al. (2001) linked nutrients to Atlantic salmon production, noted that Atlantic salmon recovered more quickly following flooding in those streams with higher nutrient status.

Cultural oligotrophication (Stockner et al. 2000) refers to practices that reduce the nutrient concentrations in surface waters. In 2006 the USASAC explored the role of anadromous communities in delivering these nutrients from the marine system to New England streams, and whether loss or decline of anadromous fish may be associated with cultural oligotrophication. Under some circumstances, changes in anadromous fish populations can cause nutrient declines. For example, Nislow et al. (2004) found down-spiraling freshwater nutrient budgets in a Scottish Atlantic salmon river, due to smolt outmigration with inadequate concurrent adult salmon escapement. Thus, our question for 2007 was: Are there other factors that may be influencing the productivity of Atlantic salmon rivers in the USA? Pollution abatement programs are intended to remove domestic and industrial wastes from New England waters, and were not considered.

Essential nutrients and materials in streams are all ultimately derived from, or pass through, the terrestrial environment. In the short- and mid-term, stream productivity depends on upstream/upslope inefficiency in nutrient processing and retention. In the long-term, reductions in nutrients in forests and soils will be reflected in stream dynamics. Acidification and forest practices emerged as potential sources of cultural oligotrophication in small coastal rivers from discussions of a working group of the USASAC. These two sources of cultural oligotrophication may interact because both result in depleted soil cations.

The term "acid rain" is commonly used to mean the deposition of acidic components from air-born pollutants in precipitation and dry particles. Burning fossil fuels cause acid rain because the sulfur in the fuel combines with oxygen and becomes sulfur dioxide (SO_2) and the nitrogen becomes nitrogen oxide (Nox). Prevailing wind patterns and other factors have resulted in acid rain and dry deposition of acid in the eastern half of North America, including New England. In addition to these sources of sulfates and nitrates, many coastal New England waters are more susceptible to acidification because they are high in natural organic acidity (DOC), base cations are diluted when discharge increases, they receive aerosol ocean salt, and other anthropogenic sources of nitrates (Kahl et al. 1992). Acid conditions, in the absence of neutralizing base cations (Ca), mobilize aluminum (always abundant in New England soils), which binds with and precipitates SRP (soluble reactive phosphorus) and makes it unavailable for primary production (Norton et al. 2006).

In spruce-fir dominated forests in Maine, densely-stocked stands are harvested at short (~ 40 year) rotations. Nutrients and Ca^+ are removed as trees and wood products are harvested and removed from the forest. The short-term effects of harvest are instream increases in nutrients and cations following removal of vegetation due to leaching losses from the terrestrial ecosystem. Over longer periods, harvesting can deplete the soil cation pool (Hornbeck et al. 1990), decreasing availability to receiving surface waters. More importantly, with short rotation harvest strategy forest stands are constantly aggrading (increasing total stand biomass) and have a very high nutrient demand, which will affect both P and N availability. Growing trees are removing nutrients from the soils, leaving little available for streams. Further, the positive effects of natural disturbance (blowdown, insect outbreaks, fire) on nutrient availability to and retention in streams are prevented by forestry practices (i.e. salvage logging). Finally, forest practices that reduce overall habitat complexity (log drives using splash dam methods, clearing and snagging of stream channels, and reduced availability of large trees capable of providing stable LWD) simplify flowpaths, reduce transient storage (water stored temporarily in pools and meanders) decreasing nutrient retention and uptake.

One major question is the extent to which these mechanisms of nutrient depletion will be manifest in small (2^{nd} – 3^{rd} order), shaded salmon rearing streams. Rand et al. (1992)

found that light availability, and not nutrients, provided the primary limitation to stream production in small streams in southern Ontario. Further, many small shaded stream systems are dominated by allochthonous inputs (e.g. leaf litter, DOC). However, because this material tends to have high C:N and C:P ratios, breakdown and uptake rates are significantly increased by N and P availability in stream water (Robinson and Gessner 2000). Effects of variation in riparian forest structure and composition (as the sources of leaf litter) may also play an important role in the nutrient dynamics of these systems. The presence of alder (*Alnus* sp.) in the riparian zone of southeastern Alaskan streams was associated with greater nutrient availability and higher riparian and aquatic invertebrate biomass (Wipfli and Musselwhite 2004). It may therefore be important to understand the current and historic distribution of alder-dominated riparian zones, the processes which favor alder recruitment and establishment, and the effects of forest practices on riparian community composition.

The possibility that cultural oligotrophication has decreased nutrient availability, with associated negative potential effects on Atlantic salmon production, brings up the issue of nutrient addition/restoration. The feasibility and advisability of nutrient additions/restoration depends largely on the logic and justification underlying these actions, the extent to which they can contribute to scientific understanding as well as management goals, and their potential to overlap with other potential restoration efforts. For example, restoration/addition of base cations to watersheds may be an effective way to restore nutrients as well as to protect fish from the direct, toxic effects of labile aluminum. In 2007, the working group intends to continue investigating the causes and consequences of cultural oligotrophication, with the hope of producing a journal manuscript.

Literature Cited

Hornbeck, J.W, C.T. Smith, Q.W. Martin, L.M. Tritton, and R.S Pierce. 1990. Effects of intensive harvesting on nutrient capital of three forest types in New England. Forest Ecology and Management. 30:55-64.

Kahl, J. S., S. A. Norton, T. A. Haines, E. A. Rochette, R. H. Heath, and S. C. Nodvin. 1992. Mechanisms of episodic acidification in low-order streams in Maine, USA. Environmental Pollution 78: 37-44.

Stockner, J.G., E. Rydin, P. Hyenstrand. 2000. Cultural Oligotrophication: Causes and Consequences for Fisheries Resources. *Fisheries.* 25:7–14

Scheuerell, M. D., P. S. Levin, R. W. Zabel, J. G. Williams, and B. L. Sanderson. 2005. A new perspective on the importance of marine-derived nutrients to threatened stocks of Pacific salmon (*Oncorhynchus* spp.). Canadian Journal of Fisheries and Aquatic Sciences 62: 961-964.

Slaney, P.A., Ward, B.R. & Wightman, J.C. 2003. Experimental nutrient additions to the Keogh River and application to the salmon river in British Columbia. Pages 111-

126 in Nutrients in salmonid ecosystems: sustaining production and biodiversity. Ed Stockner, J.G. American Fisheries Society, Symposium 34. Bethesda, Maryland.

Nislow, K. H., J. D. Armstrong, and S. McKelvey. 2004. Phosphorus flux due to Atlantic salmon (Salmo salar L.) in an oligotrophic upland stream: effects of management and demography. Canadian Journal of Fisheries and Aquatic Sciences. 61: 2401-2410.

Norton, S., Fernandez, I., Amirbhaman, A., Coolidge, K. and T. Navratil 2006. Aluminum, phosphorus and oligotrophy – assembling the pieces of the puzzle Verh.Internat. Verein. Limnol. 29: 1877-1886.

Rand, P.S., Hall, C.A.S., McDowell, W.H., Ringler, N.H. & Kennen, J.G. (1992). Factors limiting primary productivity in Lake Ontario tributaries receiving salmon migrations. Canadian Journal of Fisheries and Aquatic Sciences. 49: 2377-2385.

Robinson, C.T. and M.O. Gessner. 2000. Nutrient addition accelerated leaf litter breakdown in an Alpine springbrook. Oecologia. 122:258-263

Weng, Z., N. Mookerji, and A. Mazumder. 2001. Nutrient-dependent recovery of Atlantic salmon streams from a catastrophic flood. Canadian Journal of Fisheries and Aquatic Sciences. 58(8): 1672-1682.

Wipfli, M.S. and J. Musselwhite. 2004. Density of red alder in headwaters influences detritus and invertebrate subsidies to downstream fish habitats in Alaska. Hydrobiologia. 520:153-163.

4.8 Research

4.8.1 Current Research Activities

Research abstracts were compiled into a single Microsoft Word Document this year instead of using Procite software due to the inability to export the data to a Microsoft Access database as intended. The goal remains to place abstracts into a common database accessible through the Website both for submission as well as key word searching and subsequent use. This would be maintained as a continuing database over the years.

In reviewing the current format of abstracts, a recommendation was made in 2004 to categorize the abstracts by the source of information, e.g. peer review paper, abstract of current work, poster presentation, etc. It was agreed that this would be incorporated into the database.

Efforts will continue to design and implement a Website enabled database with appropriate fields including the source of the abstract as noted above. The prototype database would first be circulated to the Committee for review.

CONSERVATION OR MANAGEMENT

Effects of Slimy Sculpin on Juvenile Atlantic Salmon on Population Dynamics

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We evaluated the effects of sympatric fish species on survival of stocked Atlantic salmon (*Salmo salar*) in the Connecticut River basin. In 1997, 2003, and 2004, we sampled stocking sites across Connecticut River tributaries, which varied with respect to fish community composition (N=18 site-years). We found that one fish species, slimy sculpin (*Cottus cognatus*), was associated with limited recruitment of reintroduced salmon. Salmon first-summer mortality rate increased with increased sculpin density across sites. Stomach sampling showed that sculpin prey on newly stocked salmon fry, and the effect of sculpin on salmon mortality was most severe when availability of suitable habitat for early fry was low, suggesting sculpin exacerbate salmon habitat limitation. In 2005 and 2006, we conducted an additional manipulative field experiment to determine how sculpin affect salmon density-dependent mortality. We stocked salmon fry at three population density treatments in streams with and without sculpin. Salmon mortality was higher in streams with sculpin. However, sculpin reversed the direction of the relationship between salmon stocking density and salmon mortality. In streams without sculpin salmon mortality rate increased with stocking density, while in streams where sculpin were abundant salmon mortality rate declined with stocking density. Our results suggest that population spatial variation in fish community characteristics influences salmon population dynamics and has important implications for management strategies such as determining optimal stocking densities.

Factors Affecting Mercury Accumulation in Stocked Atlantic Salmon in the Connecticut River Basin

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We evaluated ecological controls of mercury accumulation in stream-dwelling juvenile Atlantic salmon (*Salmo salar*) at the individual to ecosystem level. We tested three specific hypotheses based on previous models of accumulation in fish: 1) mercury is diluted in fast-growing relative to slow-growing individuals, 2) increased population density reduces average individual growth and leads to higher mercury concentrations in fish 3) high-productivity sites have lower mercury concentrations in fish and their prey. To test these hypotheses, we stocked newly hatched Atlantic salmon from controlled initial conditions into natural streams at three population density treatments (N=15 sites), then collected fish after one growing season to evaluate mercury accumulation. Mercury concentrations in age-0 salmon were high (0.058 ppm wet weight) and varied significantly across streams and stocking sites. Final mercury concentrations in fish declined with increased individual growth and increased productivity at the release site. Mercury accumulation was also density dependent, but was not linearly related to population density. Mean final mercury concentration in salmon was 40% higher for intermediate density treatments than high or low-density treatments, likely due to interactive effects of increased population density on salmon consumption rates and growth efficiency. Our results highlight the important role of local, ecological factors in control of mercury accumulation in fish.

Testing The Effects of Stocking Time on Survival, Size, and Dispersal of Age-0 Atlantic Salmon Using Genetic Marks

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Field experiments were used to determine the effects of timing of stocking on dispersal, growth and survival of age-0 Atlantic salmon (*Salmo salar*) during their first spring and summer. We scatter-stocked known families in specific locations (100 m sections along 1 km study reaches) at three stocking times (early, middle and late spring), then used parentage assignment to match individuals captured at the end of summer with their stocking time and location. Fry dispersal was strongly biased downstream, with <1% found upstream of their original stocking points. The extent of downstream dispersal differed between the two study streams with 79% of recaptured juvenile salmon found within 200 m of their original stocking points in West Brook but only 41% within 200 m of the original stocking point in Four-Mile Brook. There was no relationship between stocking time or fish size and dispersal distance in either stream. However, we found a strong effect of stocking time on survival with middle-stocked fish having higher survival rates, and being longer and heavier compared to early and late stocked fish, in spite of very little variation in environmental conditions (flow and temperature) among the stocking times. Our results suggest that strong downstream bias may limit initial colonization of areas upstream of stocking sites. Further, higher growth and survival of middle-stocked fish suggest that the timing of stocking may influence overall age-0 production.

Narraguagus River Point-Stocking, an Alternative Fry Stocking Strategy

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In 2005, the Maine Atlantic Salmon Commission began a three-year study to assess point-stocking Atlantic salmon fry as an alternative to distributing (sprinkling) them throughout a river reach. The Commission currently stocks hatchery-produced fry in Maine salmon rivers at approximately 100 fry per habitat unit ($100m^2$). Fry are typically stocked by foot or canoe using small aquarium nets to release them evenly throughout a river section containing salmon rearing habitat. Fry were point stocked at the top of one mainstem and one tributary reach and allowed to disperse into the non-stocked habitat immediately adjacent (downstream) to the stocking site. The mainstem study site extends approximately 9.13 kilometers downstream of the stocking site, and the tributary study site extends 3.37 kilometers downstream of the stocking site. Results from fall 2005 juvenile salmon surveys indicate that young-of-year (YOY) Atlantic salmon were present at all mainstem sites sampled throughout the point-stocked sections at densities consistent or slightly higher than the average density of those sites for the previous five years (2000-2004). In 2005, the mainstem site densities ranged from 0.5 to 17.8 YOY/unit, and averaged 1.4 YOY/unit higher than past average densities. YOY were present at both tributary electrofishing index sites as well, with 15.3 and 21.1 YOY/unit observed. This was almost 6.5 more YOY/unit than the average YOY density for the previous five years. Mainstem YOY densities in 2006 ranged from 0.2 to 10.3 YOY/unit, and averaged 1.5 YOY/unit lower than past surveys and 2.9 YOY/unit lower than the 2005 densities. YOY densities in the tributary sites were lower in 2006 as well, ranging from 8.1 to 12.9 YOY/unit. This was approximately 7.7 YOY/unit lower than the 2005 densities and 1.3 YOY/unit lower than and the average for the previous five years. In 2006, age 1+ parr population data was collected in addition to the YOY data. These data were compared with the average densities from these sites from 2000 to 2005, where available. The densities of 1+ parr in 2006 in most mainstem sites were observed to be consistent with the past averages. Parr densities at the two tributary sites averaged 5.8 parr/unit greater (1.5 times greater) than the average at these two sites for the previous 5 years. 2007 will be the final year of the point stocking study and 2008 will be the final year of assessment of age 1+ parr. A final report of this study will be completed in winter of 2009.

Comparative Performance of Green and Eyed Eggs Incubated in Instream Incubators

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The Maine Atlantic Salmon Commission (MASC), over the past several years, has been investigating the feasibility of instream incubation as a low-cost enhancement technique for use by volunteers. These projects have targeted solving several problems necessary to elevate instream incubation to a restoration tool. In the 2005-2006 project we focused on comparing three different handling techniques (two treatments and one control) in order to minimize mortality. The two treatments chosen for this project were green eggs transported and fertilized streamside and green eggs fertilized at the hatchery prior to transportation. Due to successes from previous projects, eyed eggs were placed at each site as a control. In 2005, 15 wire cage instream incubators with a capacity of 3000 Atlantic salmon eggs each were divided between 5 sites in appropriate spawning habitat in the Sandy River drainage Maine. Each site had two treatments and an eyed egg incubator. After loading, all incubators were buried in the gravel in pre-placed wire cages and secured in place. In June 2006, all incubators were removed and remaining eggs were counted. Unfortunately no green egg development was observed at two of the five locations. However, green eggs and eyed eggs at all other locations produced alevin. The streamside-fertilized treatment averaged 26%, hatchery fertilized averaged 27% and the eyed eggs averaged 41% escapement. Overall no difference in performance was observed between the two treatments however eyed eggs produced considerably more alevin. Due to observations of sediment intrusion into the incubators and the time constraints of burying incubators, direct plants in gravel could produce more alevin and allow greater number of eggs to be planted in a season.

Assessment of Watershed Scale Habitat Features on the Survival of Juvenile Atlantic Salmon

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Current Atlantic salmon recovery efforts rely heavily on the stocking of juvenile Atlantic salmon with the majority of fish being stocked as fry. In order for recovery efforts to be successful there is a need to identify areas of watersheds that yield the greatest fry to parr survival and contribute most to the out migrating smolt population. Identification of such areas will allow managers to refine fry stocking practices to increase survival to the parr stage and optimize the number of out-migrating smolts per the number of fry stocked. Also, identification of critical juvenile Atlantic salmon production areas will help guide future salmon habitat enhancement and restoration efforts. The objectives of this study are: (1) determine quantitative relationships between inter-stage survival of juvenile Atlantic salmon and macrohabitat variables such as watershed area, temperature, pH, conductivity, watershed area, stream gradient, abundance of non-salmon species, and abundance of predatory species, and (2) use genetically marked fry to identify the rearing locations of out migrating Atlantic salmon smolts and assess relative survival to the smolt stage from various stocking locations. Sheepscot River broodstock spawned at Craig Brook National Fish Hatchery in 2004 were genotyped using highly polymorphic microsatellite DNA markers. Using genetic parentage analysis as a "mark", we will be able to identify stocking location, and use the recapture and abundance of the marked fish to evaluate survival. Within a given river reach, a single genetic group of fry was stocked in May 2005. Estimation of survival to parr stages began in the September 2005. Age-0 parr survival was assessed at 27 electrofishing sites throughout the watershed. A subsample of parr had a fin clip taken for genetic analysis to determine the degree of immigration from fish stocked in other river reaches. Preliminary results showed the highest densities of age-0 parr were found at sites having the highest pH and specific conductivity and smallest watershed sizes. The same sites were sampled again in September 2006 to assess survival to the age-1 parr stage. Results are pending data audit and statistical analysis. Survival to the smolt stage will be assessed using a rotary screw trap near the Head Tide Dam on the mainstem of the Sheepscot River in the spring 2007. Upon collection, tissue samples will be obtained from smolts for genetic parentage analysis to identify the fry stocking location. Correlation analysis will be used to determine if there is a significant relationship between parr densities in the various river reaches, the factors affecting parr density, and their relative contribution to the out migrating smolt population.

Spawning Preferences of Adults released in the Sheepscot River

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The decreasing abundance of Atlantic salmon on the east coast of the United States has fueled the need to explore novel techniques of reestablishing and enhancing salmon populations. One technique not widely used is releasing post-spawn adults, reared partially or wholly in a holding facility. Theoretically, if adults are released and spawning is successful the net result would be an increased numbers of juveniles. In an effort to explore this possibility a multi-year project made up of several smaller components were initiated. The Maine Atlantic Salmon Commission began one component of this research by investigating the overall spawning preferences of released adults. On October 19, 2006, 82 pre-spawn adults, (49 of which were females, originating from 1+ parr collection in 2002 and held at Craig Brook National Fish Hatchery), were released into the Sheepscot River below the Palermo fish Hatchery. All adults were thought to be gravid. To document spawning preferences we measured width and length of redds, velocity at upper boundary at 12cm from the substrate and .6 total depth, and depth at the lateral edges and upper boundary and position in channel. The three depths were averaged to establish redd depth. Of the nine redds documented during spawning surveys the average width was 1.01m (.82-1.22m), length 3.03m (1.83-4.11m) and depth .45m (.27-.64m). Average velocities at 12cm were .72m/s (.43-.92m/s) and at .6 total depth .81m/s (.49-1m/s). The average redd was 3.39m from the stream edge and the average width of stream was 13.26m. Additionally, we compared these measurements to 1970's data taken from 100 redds of wild adult returns to Maine. Each characteristic was well within the range of data from the 1970's data set and very close to the averages. Overall post spawn adult release spawning preferences seems to be consistent with wild adult returns spawning preferences.

Narraguagus River Hatchery 0+ Fall Parr Stocking Study

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In 2006, ASC began a three-year experimental stocking of hatchery 0+ fall parr in the Narraguagus River. The objective of this study is to test the survivability of hatchery 0+ parr released into habitat that has historically been fry stocked and recently exhibits a decreased parr density over time. Eggs of Narraguagus River origin broodstock were raised to the 0+ parr stage at Craig Brook National Fish Hatchery. Approximately 17,476 hatchery 0+ parr were marked with an adipose clip and released at two mainstem river sites. 8,938 parr were released on September 8 at the snowmobile bridge crossing just above Rt.9 (river km 47.78), and 8,538 parr were stocked-out on September 11 at Hemlock Dam (river km 49.69). Fork length of the hatchery 0+ parr ranged from 44 to 133mm with a mean of 86mm. Weight ranged from 0.8 to 16.2g, with a mean weight of 7.6g. In comparison, wild 0+ parr captured during 2006 Narraguagus electrofishing surveys in the same area (capture date between 8/7 and 9/28) ranged in fork length from 44 to 86mm, with a mean of 62mm. Weight of wild 0+ parr ranged from 0.9 to 7.5g, with a mean of 3.1g. ASC staff conducted follow-up electrofishing between October 3 and October 10, or about one month post stocking. Results indicate upstream dispersal of hatchery parr of 5.36km from the Hemlock Dam (49.69) stocking point. Downstream movement of stocked parr appears to be slowed by Beddington Lake, as stocked parr were captured at the lake inlet (river km 46.29), approximately 1.5 kilometers below the lower stocking site, while none were observed below the lake outlet (river km 41.81).

CULTURE OR LIFE HISTORY

Effect of volume upon cryopreservation of Atlantic salmon spermatozoa with methanol and egg yolk as cryoprotectants

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Atlantic salmon cryo-preservation trials conducted in 2003 at White River NFH utilized glucose extender with 10% methanol supplemented with 13.3% egg yolk in 0.5ml straws, at a ratio of 1:4 (sperm : extender), and produced egg eye-up results of 83.5% (similar to hatchery production rates). The present 2006 study was expanded to include production scale 5.0 ml straws. Respective numbers of Atlantic salmon sampled, ranges of initial sperm motility, and number of males wherein viability of conserved milt was evaluated by fertilization against pooled White River NFH captive eggs were as follows: Richard S. Cronin NSS (40 males, motilities 25 - 90%, ten fertilization trials); North Attleboro NFH (11 males, motilities 85 – 90%, ten fertilization trials); and White River NFH (20 males, motilities 40 – 90%, seven fertilization trials). Analysis of variance for a Randomized Complete Block design examined differences in treatment means for controls, 0.5ml, and 5.0 ml straws. Results showed that 0.5 ml straws produced percent eye-ups equivalent to controls and may be used to conserve genetic material for small family groups. Poor results with 5.0 ml straws indicated that production scale cryopreservation is not feasible with the techniques used in this study.

FISH HEALTH

Contaminant residues and enzyme activity in brook trout from two Atlantic salmon rivers in Maine

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As surrogates for assessing contaminant exposure and uptake in Atlantic salmon, thirty-six brook trout (Ages I+ and II+) from Cove Brook and two tributaries of the Sheepscot River (Finn Brook, Weaver Brook) in Maine were analyzed individually, whole-body for selected organochlorine compounds and trace elements. Ethoxyresorufine o-deethylase (EROD), a biomarker of exposure and enzymatic response to planar organic compounds, was also measured in gill and liver tissue. Except for low levels of p,p'-DDE detected in two of 36 fish - one from Cove Brook (0.004 µg/g, wet weight) and one from Finn Brook (0.015 µg/g, ww) - levels of 19 organochlorine compounds, including total polychlorinated biphenyls, were below detection. Several trace elements were detected in fish tissue. Mercury concentrations ranged from non-detect to 0.11 µg/g ww; well below the suggested tissue threshold-effect level of 0.20 µg/g. Similarly, arsenic, cadmium, selenium, and zinc levels in brook trout were not elevated and were similar to concentrations reported in national and regional biomonitoring programs. Beryllium, molybdenum, and vanadium concentrations were below detection in all samples. Gill EROD activities were low from all sites, but were within the range associated with chemical exposure reported in laboratory and field studies, suggesting these populations may experience some level of chemical exposure. Liver EROD values supported these findings. No significant differences were found in EROD levels between the two Sheepscot tributaries or between the two Cove Brook sites.

Physiological effects of atrazine, hexazinone, chlorothalonil and phosmet at pH 6.5 or 5 on Atlantic salmon (*Salmo salar*) yolk-sac larvae

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The impact of contaminants is often evaluated under optimal rearing conditions, but this is rarely what occurs in nature. In the present study we examined the impact of pesticides and reduced pH on survival and physiology of Atlantic salmon yolk-sac larvae (YSL). YSL were exposed to 10 μg l^{-1} atrazine (ATZ), hexazinone (HEX), phosmet (PHO) and chlorothalonil (CTL) at pH 6.5 or 5.0 for 12 d at 10 ºC. Exposure to pH 5.0 for 12 d decreased whole YSL Ca^{2+} content, length, weight, and increased the rate of opercular movements. Whole larvae Ca^{2+}, Na^+, protein, length and weight were unaffected by HEX and ATZ exposure, however, ATZ and low pH interacted to increase the rate of opercular movements. Exposure to 10 μg l^{-1} CTL decreased opercular movement and length, and increased whole larvae Na^+,K^+-ATPase activity, Na^+, and protein levels. There was a significant interaction of CTL and low pH to decrease whole larvae Ca^+ content. Exposure to 10 μg l^{-1} PHO alone reduced cholinesterase activity, Ca^{2+} content, length, weight and opercular movements. PHO and low pH interact to decrease whole larvae Na^+ content. We conclude that under the conditions imposed in this study, there was usually an additive effect of pH and pesticide exposure, but in some instances low pH and pesticides acted synergistically to affect sub lethal impacts on YSL. The interaction of low pH with CTL or PHO reduced growth of YSL. Regardless of pH, the insecticide PHO disrupted enzymes associated with nerve transmission, which can impact metabolism and locomotor behavior. Our results demonstrate that exposure of Atlantic salmon yolk-sac larvae to environmentally relevant concentrations of pesticides at low pH has the capacity to alter normal physiological functions, which can affect competitive ability and survival in the wild.

MARKING

Application of calcein as a dietary component for fish marking to enhance product evaluation and management capabilities

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Calcein chemically binds to calcified structures and emits a detectible mark when exposed to the proper wavelength of ultraviolet light. It has proved successful in marking fin rays, scales, otoliths, and other calcified tissues within fish as well as other marine organisms such as mussels and gastropods. Recently, calcein has been approved as an Investigative New Animal Drug via immersion delivery on fish weighting less than 2 grams. The ability to administer calcein to larger fish would also serve as a valuable tool for fishery researchers and managers. However, because of the weight and delivery restrictions mandated under the INAD permit for calcein, another form of delivery warrants investigation. This study is part of a Science Support Partnership program with partners from the U.S.G.S. Leetown Science Center Northern Appalachian Research Laboratory U.S.F.W.S. Aquatic Animal Drug Approval Partnership and, Northeast Fishery Center. The objectives of this 3-year study are **(1)** determine and compare scale luminosity between brook and rainbow trout using six different dosages of encapsulated and powdered calcein via extruded feed as a delivery method **(2)** using the results from objective #1, determine calcein dosage and delivery method to be used to evaluate longevity of calcein mark within other fish species. **(3)** Investigate calcein mark longevity differences between exposure to natural and simulated natural light. Results from objective #1 indicated greatest mark intensities belonged to fish that consumed feed containing 8.0g powdered calcein /kg of feed and 8.0g encapsulated calcein/kg of feed, respectively. In response, long term marking studies were initiated with lake and brook trout, Atlantic salmon, Snake River Cutthroat trout, shovelnose sturgeon, bluegill, and striped bass. One hundred eighty Atlantic salmon fry were given 5-day feeding dosages of 8.0g powdered calcein /kg of feed, 8.0g encapsulated calcein/kg of feed, and feed with no calcein serving as a control. Day 1 post treatment was August 7, 2006 and regularly scheduled collection periods will last till December 7, 2009. Three scales will be removed from each collected Atlantic salmon specimen and digitally photographed using a compound microscope equipped with epi-fluorescence. Mark intensity will be evaluated using Adobe® Photoshop software and tracked over time. Regarding objective #3, one thousand one hundred and ninety-three lake trout were fed a dosage of 8.0g powdered calcein/kg feed for 10 days and were placed in an outside pond and raceway, and an inside rearing unit. Specimen collection did not occur yet. These studies are ongoing.

POPULATION ESTIMATES OR TRACKING

Smolt Migration and Fall Movement of Juvenile Atlantic Salmon in a Restoration Stream of the Connecticut River, USA

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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 1998-2006, we have 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. Most of the smolt migration occurred at night. From spring 1999-2003 the median date of migration varied by only 6 days over the 6 years, perhaps indicative of the photoperiodic control of smolt migration. Smolt migration in spring 2004 and 2005 was earlier by 6 days than in any previous year, and although warmer than most other years was a nonlinear response to temperature. There was no apparent relationship of smolt migration to flow. There was a strong relationship between degree-days in April and the median date of migration, whereas the relationship between first date of 10 ^{o}C and median date of migration was weaker. There was a strong positive relationship between size at tagging in the fall and probability of smolting, with immature fish larger than 11.5 cm fork length having a probability of smolting nearly 100%. Estimates of winter survival for immature fish > 11.5% varied substantially from year-to-year and were between 27-69%. Estimates of smolt recruitment for all fish (mature and immature fish) also varied from year-to-year and were between 19-42%.

Narraguagus River Smolt Trapping Above Beddington Lake

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The mainstem Narraguagus River consists of approximately 5,000 units of Atlantic salmon rearing/production habitat, of which approximately 1,440 units, or one-third of the total amount available, are located above Beddington Lake. Based on the physical characteristics, and connectivity of the habitat, the Maine Atlantic Salmon Commission

(MASC) has identified the upper Narraguagus (above Beddington Lake) as having the greatest potential with regard to juvenile salmon productivity, and therefore of highest priority, however, the extent to which the upper Narraguagus River contributes to the overall smolt run is currently not known. In 2005, the Commission operated a single five-foot rotary screw smolt trap above the inlet of Beddington Lake (river km 46.06) to assess the feasibility of capturing smolts from the upper river. Despite unusual high flows, a total of 24 trap days of effort were expended resulting in the capture of 60 Atlantic salmon smolts. Smolts collected in the trap were counted, marked with a small dorsal punch, and released. Nine of the 60 smolts (15%) were recaptured downstream at the NOAA-Fisheries traps located at Little Falls (river km 11.16) and Crane Camp (river km 7.65), approximately 35-39 kilometers downstream. In 2006, the Commission added a second five-foot rotary screw trap to its' upstream effort, this one being located just above the Route 9 bridge crossing (river km 47.62). The second trap was deployed to increase the capture of smolts from the upper drainage, and to estimate the out-migrating smolt population from the upper river using mark-recapture techniques. A total of 343 smolts were captured and marked at two smolt traps (223 in the upper trap and 120 in the lower trap). Eleven of the smolts originally marked in the upriver trap were recaptured in the lower trap, resulting in a Pooled Peterson mark- recapture estimate of 2,463 (+/-634) smolts, and an ML Darroch estimate of 3,275 (+/-1,482) smolts (both analysis conducted by NOAA-Fisheries, Orono). While the standard error around the estimates is large, they do provide us with the some insight of smolt production from the upper river. Similar to 2005, about 16% of the smolts (56 of 343 smolts) originally captured above Beddington Lake were recaptured downstream at the NOAA-Fisheries traps either at Little Falls or Crane Camp. MASC will operate the traps again in 2007, with some modification to the traps and/or the trapping sites in attempts to increase capture efficiency's, which should result more precise estimates of smolt numbers.

Riverine passage success for pre-spawn adult Atlantic salmon in the Penobscot River, Maine

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Migrating adult Atlantic salmon may incur significant mortality or delay at dams or through other sections of the river, representing critical impediments to restoration. In this study, we used acoustic telemetry to describe patterns of upstream movement and quantify migratory success over more than 150 km of the Penobscot River and tributaries. Twenty-five adult male salmon of hatchery origin were surgically implanted with acoustic transmitters and released above head of tide. An array of acoustic telemetry receivers provided detailed information on movement rates and passage success, including depth and temperature at detection. Although all salmon were released in early

June 2006, only three passed the second upstream dam (Great Works Dam; 12 km above head of tide) and only two passed the third upstream dam (Milford Dam; 15 km above head of tide) by early December. These results indicate that the Great Works Dam was a severe impediment to migrating salmon in 2006.

Assessments of migrating Atlantic salmon *(Salmo salar)* smolts
in the Penobscot River using acoustic telemetry

J. Zydewski[1] and M. Kinnison[2]

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An array of acoustic telemetry receivers was used to determine path choice, transit times, and losses (mortality) for both hatchery and wild smolts over more than 200 km of the Penobscot River and estuary. Results include assessments of 1) behavior and survival relative to hatchery supplementation practices (i.e., date and location of release), 2) losses and delays incurred at dams, and 3) comparative condition, behavior, and survival of wild and hatchery smolts. A total of 291 smolts (218 hatchery, 73 wild) were released in the spring of 2006. Results indicate that survival to the sea was 16 % for wild smolts, and ranged from 33 to 47% for hatchery smolts. Losses at the Milford, Howland and West Enfield Dams ranged from 11 to 29%, while losses at the Great Works and Veazie Dams ranged from 0 to 8%. Results indicate that migrating smolts were likely delayed at the Milford, Howland, and West Enfield Dams, but probably not at the Great Works and Veazie Dams. Estuarine survival was high, ranging from 92 to 96% over 36 km. The proportion of smolts detected in the Stillwater Branch ranged from 0 to 19%. Use of the Stillwater was higher for smolts released in the main stem compared to smolts released at Milo. Hatchery and wild smolts exhibited significant differences in smolt characteristics (gill Na^+,K^+-ATPase activity and condition factor) at time of release. These results indicate differences in performance between hatchery and wild smolts and show that significant mortality occurs for both groups in the vicinity of dams.

SMOLTIFICATION AND SMOLT ECOLOGY

Long-term Seawater Performance of Atlantic Salmon

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Representative, Narragansett, RI; [4]Maine Cooperative Fish and Wildlife Research Unit, USGS

In May 2006, gill Na^+,K^+-ATPase activity from biopsies of 940 individually PIT tagged, Penobscot strain Atlantic salmon smolts from Green Lake National Fish Hatchery was measured. From the resulting range of activities, individuals were classified as having low, middle, or high enzyme activities. All individuals were transferred isothermally to 33 ppt seawater. Individual growth (fork length and weight) was recorded on days 0, 1, 3, 14, 44 and monthly for four months. Gill Na^+,K^+-ATPase activities were also measured from a subset of sampled fish. Fish grew throughout the experiment, but differences (fish size, growth rate, and gill Na^+,K^+-ATPase activity in saltwater) among groups with initially different gill Na^+,K^+-ATPase activities (prior to seawater entry) were not evident. Variation in gill Na^+,K^+-ATPase activity at the time of smolting does not appear to be predictive of long-term growth in seawater.

Field studies on the impacts of acid and aluminum on Atlantic salmon smolts in southern Vermont, USA

S.D. McCormick[1,2], A. Keyes[1], M. Monette[1,2], and K. Nislow[2,3]

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Previous work has established that smolts are more sensitive to acid and aluminum than other life stages of Atlantic salmon. We conducted field studies to determine the levels of acid and aluminum that affect survival, smolt development, ion homeostasis and stress in Atlantic salmon smolts in restoration streams of the Connecticut River in southern Vermont, USA. Atlantic salmon smolts were held in cages in 5 streams with a range of acid and aluminum levels for two 6-day intervals during the peak of smolt development in late April and early May of 2005. With the exception of increased plasma glucose, all other physiological parameters remained relatively constant from initial sampling at the hatchery after 3 and 6 days at the high water quality reference site. Mortality, substantial loss of plasma chloride and gill Na^+,K^+-ATPase activity, and elevated gill aluminum occurred at sites with the lowest pH (5.4-5.6) and highest inorganic aluminum (50-80 µg/l). Moderate loss of plasma ions, increased plasma cortisol and glucose without detectably elevated gill aluminum occurred at less severely impacted sites. The results indicate that an interaction of aluminum and low pH causes mortality and loss of smolt development in juvenile Atlantic salmon within 6 days, and less severe conditions are physiological stressful. The results provide evidence that anthropogenic acidification is impacting conservation and recovery of Atlantic salmon in some regions of the northeastern US.

Physiological smolt status of naturally reared fish from the Pemigewasset River

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The release of Atlantic salmon fry in the Merrimack River has been a key component of the program to restore the species to this watershed; however the rate of return for fry-origin adult fish has remained at low levels. Greater than 60 % of fry released are distributed in the Pemigewasset River upriver from Ayers Island Dam, Bristol, NH. This dam, a Public Service Company of New Hampshire (PSNH) facility, is the first of seven main-stem dams that smolts encounter during their seaward migration. We captured migrating smolts at Ayers Island Dam to evaluate the physiological condition of naturally reared Atlantic salmon smolts from the Pemigewasset River. We measured gill Na^+, K^+-ATPase activity and plasma thyroxine as indices of normal smolt development, and gill aluminum as a measure of impact of acid rain and its associated aluminum toxicity. Plasma thyroxine increased early in the migratory period (early May) and declined throughout the remainder of the 2004 migration. Gill Na^+, K^+-ATPase activity increased during the migratory period for each year sampled (2004-2006) and were slightly lower than levels of naturally reared smolts captured in the Connecticut River (Cabot Station). Gill aluminum of smolts collected at Ayers dam in 2005 and 2006 were approximately 5 times higher than in smolts sampled at the hatchery or naturally-reared smolts captured in the Connecticut River. Continued sampling is planned for Atlantic salmon smolt migration in 2007.

Direct comparison of short-term impacts of acid and aluminum on the physiology of Atlantic salmon parr and smolts

M. Monette[1,2] and S.D. McCormick[1]

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We examined the effects of short-term acid and aluminum (Al) exposure on Atlantic (*Salmo salar*) salmon parr and smolt physiology. In the lab, parr and smolts were exposed to control (pH 6.3-6.6, 12-38 µg L^{-1} Al_i) and acid plus Al (pH 5.0-5.4, 49-73 µg L^{-1} Al_i) conditions for 2 and 6 d. Parr and smolts were also held in cages for 2 and 6 d in a reference (Rock River) and acid and Al-impacted tributary (Ball Mountain Brook) of the West River. In the lab, smolts exposed to acid and Al experienced a loss in plasma Cl^- and an increase in plasma glucose after 6 d, whereas both were unaffected in parr. Gill Na^+,K^+-ATPase activity and plasma cortisol remained unaffected in both life stages. In the field, parr and smolts held at Ball Mountain Brook experienced losses in plasma Cl^- and increases in plasma glucose however, impacts on both parameters were greater in smolts after 2 d. Gill Na^+,K^+-ATPase activity was reduced in both life stages after 6 d, but the absolute decrease was greater in smolts. Exposure to acid and Al resulted in gill Al accumulation in parr and smolts, and after 6 d, gill Al of parr was 2-fold greater than smolts in both the lab and the field. We conclude that smolts are more sensitive to acid and Al, and that this sensitivity is not due to accumulation of gill aluminum, which was greater in parr. The greater sensitivity of smolts may be the result of both morphological changes in the gill and heightened stress responsiveness in preparation for SW entry and residence.

Smolt migration and fall movement of juvenile Atlantic salmon in a restoration stream of the Connecticut River, USA

S.D. McCormick, A.M. Regish, G. Barbin Zydlewski, K.G. Whalen, A.J. Haro, and M.F. O'Dea

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

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 1998-2006, we have 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. Most of the smolt migration occurred at night. From spring 1999-2003 the median date of migration varied by only 6 days over the 6 years, perhaps indicative of the photoperiodic control of smolt migration. Smolt migration in spring 2004 and 2005 was earlier by 6 days than in any previous year, and although warmer than most other years was a nonlinear response to temperature. There was no apparent relationship of smolt migration to flow. There was a strong relationship between degree days in April and the median date of migration, whereas the relationship between first date of 10 ^{o}C and median date of migration was weaker. There was a strong positive relationship between size at tagging in the fall and probability of smolting, with immature fish larger than 11.5 cm fork length having a probability of smolting nearly 100%. Estimates of winter survival for immature fish > 11.5% varied substantially from year-to-year and were between 27-69%. Estimates of smolt recruitment for all fish (mature and immature fish) also varied from year-to-year and were between 19-42%.

The effect of calcium sensing receptor (CaSR) activation on the movement and behavior of hatchery Atlantic salmon smolt released in the Penobscot River

T. Linley and S. Jury

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Rebuilding Atlantic salmon (*Salmo salar*) populations in the northeastern U.S. depends, in part, on stocking of hatchery smolt, which often fail to grow and survive in the ocean at rates comparable to those of wild fish, reducing the potential benefits from stock supplementation. Recent evidence suggests that lower ocean growth and survival of hatchery salmon may involve antagonistic modulation of calcium sensing receptor proteins (CaSRs), which function as salinity sensors to regulate specific cations and L-amino acids in osmoregulatory, sensory and nutrient absorbing tissues during smoltification. We hypothesized that in contrast to the natural conditions experienced by wild salmon, the water chemistry and nutrition encountered in hatcheries may constrain completion of parr-smolt transformation in the appropriate time frame and thereby delay ocean entry, reducing early ocean growth and subsequent marine survival. To establish if CaSR modulation influenced parr-smolt transformation in Atlantic salmon, we tested the effects of CaSR reactive compounds added to the feed and rearing water to “pre-adapt” the salmon to seawater while they remained in fresh water. Our objective was to determine if such pre-adaptation produced behavioral alterations in smolt that would lead to more rapid downstream and estuarine migration and reduce freshwater residualization.

Atlantic salmon (n=200) at GLNFH were cultured using standard practices, but for 6 weeks prior to stocking were also given twice daily exposures (1 hr) of $CaCl_2$ (3.0 mM) and $MgCl_2$ (1.2 mM) in their rearing water, and fed a commercial diet supplemented with 7% by weight NaCl and 0.2% by weight L-tryptophan. A corresponding pool of fish from the general hatchery population was designated as a control. During treatment period, fish from both groups were sampled bi-weekly for length, weight and gill Na^+K^+ATPase activity. An additional sample was collected 10 days later in a subset of each group retained at the hatchery after treatment ended and smolts were released into the river. In early May, n=20 treated and n=25 control smolt were surgically implanted with acoustic tags immediately before release below Veazie Dam, and then tracked using the NMFS telemetry array deployed from the release site to the ocean entrance on Penobscot Bay.

Na^+K^+ATPase activity increased earlier and was significantly higher ($P < 0.05$) in treated fish than in control fish at the end of the treatment and the day of release. This difference persisted for at least 10 days suggesting that the treated fish maintained elevated Na^+K^+ATPase relative to controls throughout estuarine migration. Moreover, treated fish moved downstream more rapidly than did control smolt and took significantly less time ($P = 0.05$) to reach the first line of inner arrays in Penobscot Bay. A higher percentage of treated fish (90%) than control fish (68%) passed the lower most receiver line in the river prior to entering the bay, but the difference was not significant ($P = 0.08$). Fewer (6 of 20 = 30%) treated smolt than control smolt (10 of 25 = 40%) reversed direction before or upon entering Penobscot Bay and either remained in fresh water, died, or were not detected thereafter by the receivers. Finally, the numbers of fish detected at the eastern (n=9 SeaReady™ and n=5 control) and western (n=3 SeaReady™ and n=6 control) lines of the inner array differed slightly between the groups, possibly in response to an east (higher) to west (lower) salinity gradient in the bay. These findings support the hypothesis that "pre-adaptation" of hatchery smolt to seawater prior to release influences migratory behavior. Further studies involving a larger number of acoustically tagged fish may aid in confirming these preliminary results.

STOCK IDENTIFICATION OR GENETICS

No abstracts submitted.

5.0 APPENDICES
5.1 List of Attendees

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5.2 List of Program Summary and Technical Working Papers (including PowerPoint Presentation Reports)

Number	Lead Author	Title
PS07-01	Veronica Mason	Pawcatuck River Atlantic salmon Program Summary Annual (PPT)
PS07-02	Jay McMenamy	Connecticut River Atlantic salmon Program Summary Annual (PPT)
PS07-03	Joseph McKeon	Merrimack River Atlantic salmon Program Summary Annual (PPT)
PS07-04	Joan Trial	Maine Atlantic salmon Program Summary Annual (PPT)
WP07-01	Graham Goulette	Preliminary Comparison of Naturally and Hatchery Reared Atlantic Salmon Smolt Performance and Behavior Through Penobscot Estuary and Bay (WP and PPT)
WP07-02	Christine A. Lipsky	Update on Maine River Atlantic Salmon Smolt Studies: 2006 (WP)
WP07-03	Timothy Sheehan	2006 ICES North Atlantic Salmon Working Group Meeting Report (PPT)
WP07-04	Timothy Sheehan	An Overview of the 2006 West Greenland Atlantic Salmon fishery (PPT)
WP07-05	Jessica Pruden	USA Implementation Plan (PPT)
WP07-06	Mary Colligan	NASCO 2007 Meeting and News from NASCO (PPT)
WP07-07	Greg Mackey	Catch per unite Effort: increasing knowledge of salmon populations (PPT)
WP07-08	Joan Trial	Fry Stocking Atlantic Salmon in Maine (PPT)
WP07-09	Steve Mierzykowski	Contaminant Residues and Enzyme Activity in Brook Trout From Two Atlantic Salmon Rivers in Maine (PPT)
WP07-10	Steve Gephardt	Summary of the Quality of the 2007 Year Class of Atlantic salmon smolts (PPT)
WP07-11	Keith Nislow	GIS based Atlantic salmon habitat model (PPT)
WP07-12	Jerre Mohler	Anesthesia considerations for Atlantic salmon restoration (PPT)
WP07-13	Joe McKeon	Merrimack Program Fish Handling Protocols (PPT)
WP07-14	Bruce Williams	Atlantic Salmon Handling Protocols- Connecticut River Program (PPT)
WP07-15	Richard Dill	Maine Program Salmon Handling and Transport Protocols (PPT)
WP07-16	David Bean	Maine and neighboring Canadian Commercial Aquaculture Activities and Production (WP)
WP07-17	Timothy Linley	Osmoregulation, Behavior and Survival of SeaReadyTM treated Atlantic salmon smolt from Green Lake National Fish Hatchery (WP)
WP07-18	Timothy Sheehan	Probabilistic-based Genetic Assignment model (PGA): Results from the 2004-2005 West Greenland fisheries and the 2004 Saint Pierre et Miquelon fishery (WP)
WP07-19	Timothy Sheehan	Probabilistic-based Genetic Assignment model (PGA): Sub-continent of origin assignments of the West Greenland Atlantic salmon catch (WP)
WP07-20	Keith Nislow	Nutrient Status of Maine Rivers: Implications for Atlantic salmon (PPT)

5.3 Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
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 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 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 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

5.4 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.

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 31four 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.

5.6 Tables Supporting the Document

Table 7. Juvenile Atlantic salmon stocking summary for New England in2006.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
Total for Connecticut Program							**5,917,400**
Androscoggin	1,000	0	0	0	0	0	1,000
Aroostook	324,000	0	0	0	0	0	324,000
Dennys	295,000	27,600	0	0	56,500	0	379,100
East Machias	199,000	0	0	0	0	0	199,000
Kennebec	8,000	0	0	0	0	0	8,000
Machias	638,000	2,000	1,500	0	0	0	641,500
Narraguagus	478,000	17,500	0	0	0	0	495,500
Penobscot	1,509,000	293,500	0	0	549,200	0	2,351,700
Pleasant	284,000	0	0	0	0	15,200	299,200
Saco	106,000	0	0	0	0	0	106,000
Sheepscot	151,000	16,600	0	0	0	0	167,600
Union	2,000	0	0	0	0	0	2,000
Total for Maine Program							**4,974,600**
Merrimack	1,011,000	0	0	0	50,000	0	1,061,000
Total for Merrimack Program							**1,061,000**
Pawcatuck	85,000	0	0	0	12,800	0	97,800
Total for Pawcatuck Program							**97,800**
Total for United States							**12,050,800**
Grand Total							**12,050,800**

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 2006.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Post-Spawn	Total
Connecticut	Restoration	0	0	3	3
Dennys	Restoration	0	55	0	55
East Machias	Restoration	80	79	0	159
Hobart Stream	Restoration	170	0	0	170
Machias	Restoration	64	164	0	228
Merrimack	Restoration/Recreation	862	370	0	1,232
Narraguagus	Restoration	0	133	0	133
Pawcatuck	Recreation	0	100	0	100
Penobscot	Restoration	0	833	492	1,325
Pleasant	Restoration	0	199	0	199
Sheepscot	Restoration	82	69	0	151
Total		1,258	2,002	495	3,755

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 2006 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
NAI	4	Adult	W	Connecticut	RAD	11	PIT	May	Connecticut
NAI	5	Adult	W	Connecticut	RAD	2	PIT	May	Connecticut
NAI	3	Adult	W	Connecticut	RAD	1	PIT	June	Connecticut
NAI	2	Smolt	H	Connecticut	AD	855	VIE	May	Connecticut
USFWS	5	Adult	H	Connecticut	PIT	1		Nov	Connecticut
USFWS	3	Adult	W	Connecticut	PIT	1		Nov	Connecticut
USFWS	4	Adult	W	Connecticut	PIT	1		Nov	Connecticut
USFWS	0	Parr	H	Connecticut	AD	2,035		Nov	Connecticut
USFWS	2	Parr	H	Connecticut	AD	12,615		Mar	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	51,165		Mar	Connecticut
USFWS	1	Smolt	H	Connecticut	AD	1,000		April	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	112		April	Connecticut
USGS	1	Parr	W	Connecticut	PIT	453		Oct	Connecticut
NOAA/ASC	0	Parr	H	Dennys	LV	27,604	AD	Oct	Dennys
NOAA/ASC	1	Smolt	H	Dennys	AD	56,500		April	Dennys
USFWS	5	Adult	H	Dennys	PIT	35		Dec	Dennys
USFWS	6	Adult	H	Dennys	PIT	20		Dec	Dennys
USFWS	6	Adult	H	Dennys	PIT	28		Oct	Grand Manan
USFWS	5	Adult	H	East Machias	PIT	93		Dec	East Machias
USFWS	5	Adult	H	East Machias	PIT	66		Oct	East Machias
USFWS	5	Adult	H	Machias	PIT	164		Dec	Machias
USFWS	5	Adult	H	Machias	PIT	64		Oct	Machias
NHFG	3	Adult	H	Merrimack	FLOY	252		April	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	340		April	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	640		Oct	Merrimack

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
ASC	0	Parr	H	Narraguagus	AD	17,476		Sept	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	133		Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	93		Oct	Grand Manan
RIF&W	1	Smolt	H	Pawcatuck	AD	5,000		Sept	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	6,842		Mar	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	1,000		Feb	Pawcatuck
NOAA	1	Smolt	H	Penobscot	PING	45		May	Penobscot
NOAA	2	Smolt	W	Penobscot	PING	25		May	Penobscot
NOAA/ASC	0	Parr	H	Penobscot	LV	100,541	AD	Sept	Piscataquis
NOAA/ASC	1	Smolt	H	Penobscot	VIE	169,066	AD	May	Penobscot
PSNH	1	Smolt	H	Penobscot	HI_Z	60		May	Merrimack
UOM		Adult	H	Penobscot	PING	25	Floy	June	Penobscot
UOM	1	Smolt	H	Penobscot	PING	72		April	Piscataquis
UOM	1	Smolt	H	Penobscot	PING	73		April	Penobscot
UOM	1	Smolt	H	Penobscot	PING	73		May	Penobscot
UOM	2	Smolt	W	Penobscot	PING	73		April	Penobscot
USFWS		Adult	H	Penobscot	PIT	492		Nov	Penobscot
USFWS	6	Adult	H	Pleasant	PIT	49		Oct	Grand Manan
USFWS	6	Adult	H	Pleasant	PIT	87		Dec	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	112		Dec	Pleasant
USFWS	2	Smolt	H	Pleasant	PIT	1,348		April	Pleasant
ASC	0	Parr	H	Sheepscot	AD	17,026		Sept	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	82		Oct	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	69		Dec	Sheepscot

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location

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; 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 2006.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	1,257		2,845
Hatchery Juvenile	468,837	468,837	470,508
Wild Adult			16
Wild Juvenile			551

Page 1 of 1 for Table 9.2.

Table 10. Documented Atlantic salmon returns to New England rivers in 2006.

	1SW		2SW		3SW		Repeat			2002-2006
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	5	0	1	0	0	0	0	0	6	6
Connecticut	13	20	33	147	0	0	0	1	214	111
Dennys	2	1	2	1	0	0	0	0	6	5
Kennebec	4	3	6	2	0	0	0	0	15	15
Lamprey	0	2	0	0	0	0	0	0	2	1
Merrimack	10	5	66	8	1	0	0	0	90	90
Narraguagus	0	3	0	12	0	0	0	0	15	14
Pawcatuck	0	0	0	0	0	0	0	0	0	2
Penobscot	338	15	653	33	1	0	4	0	1044	1,049
Saco	8	4	15	3	0	0	0	0	30	32
Total	380	53	776	206	2	0	4	1	1,422	1,326

Table 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2006.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	1782	10,020,000
Merrimack	Domestic	269	1,097,000
Pawcatuck	Domestic	4	4,000
Dennys	Captive	96	400,000
East Machias	Captive	82	328,000
Machias	Captive	160	720,000
Narraguagus	Captive	165	702,000
Penobscot	Captive	329	1,400,000
Pleasant	Captive	54	240,000
Sheepscot	Captive	83	277,000
Total	**Captive/Domestic**	**3,024**	**15,188,000**
Connecticut	Kelt	47	460,000
Merrimack	Kelt	49	582,000
Total	**Kelt**	**96**	**1,042,000**
Connecticut	Sea Run	116	896,000
Merrimack	Sea Run	42	377,000
Penobscot	Sea Run	325	3,034,000
Total	**Sea Run**	**483**	**4,307,000**
Grand Total for Year	**2006**	**3,603**	**20,537,000**

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															
1993-1996	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															
1977-1996	932	12,839,000	8,500	6,511	54,595,000	6,100	0	0		966	14,623,000	10,500	8,409	82,057,000	6,900
1997	110	771,000	7,000	1,809	11,602,000	6,400	0	0		188	2,003,000	10,700	2,107	14,376,000	6,800
1998	185	1,452,000	7,900	1,140	7,030,000	6,200	0	0		156	1,494,000	9,600	1,481	9,976,000	6,700
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
Total Connecticut	1,693	18,506,000	7,500	24,913	159,716,000	5,800	0	0		2,034	25,106,000	9,900	28,640	203,330,000	6,100
Dennys															
1939-1996	26	214,000	7,600	0	0		247	725,000	2,800	16	102,000	6,500	289	1,042,000	5,300
1997	0	0		0	0		113	430,000	3,800	7	64,000	9,200	120	494,000	4,100
1998	0	0		0	0		79	338,000	4,300	10	106,000	10,600	89	443,000	5,000
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

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 No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
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
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
Total Dennys	26	214,000	7,600	0	0	0	1,049	4,340,000	4,418	40	330,000	8,600	1,115	4,883,000	4,800
East Machias															
1995-1996	0	0		0	0		161	365,000	2,300	0	0		161	365,000	2,300
1997	0	0		0	0		111	394,000	3,500	0	0		111	394,000	3,500
1998	0	0		0	0		103	362,000	3,500	0	0		103	362,000	3,500
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
Total East Machias	0	0		0	0	0	987	3,994,000	4,309	0	0		987	3,994,000	4,300
Kennebec															
1979-1996	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

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
Lamprey															
1992-1996	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															
1941-1996	456	3,263,000	7,300	0	0		400	1,193,000	2,900	8	52,000	6,400	864	4,508,000	6,700
1997	0	0		0	0		176	603,000	3,400	0	0		176	603,000	3,400
1998	0	0		0	0		166	548,000	3,300	0	0		166	548,000	3,300
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
Total Machias	456	3,263,000	7,300	0	0	0	1,753	7,289,000	4,455	8	52,000	6,400	2,217	10,604,000	4,800
Merrimack															
1983-1996	774	5,565,000	7,200	4,750	27,640,000	5,700	0	0		0	0		5,524	33,205,000	6,700
1997	31	284,000	9,200	754	4,642,000	6,200	0	0		0	0		785	4,926,000	6,300
1998	63	518,000	8,200	560	2,669,000	4,800	0	0		5	64,000	12,900	628	3,252,000	5,200
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

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 No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
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
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
Total Merrimack	1,221	9,424,000	8,900	9,445	49,149,000	4,500	0	0		336	3,441,000	10,600	11,002	62,013,000	5,400
Narraguagus															
1962-1996	0	1,303,000		0	0		291	974,000	3,200	0	0		291	2,278,000	3,200
1997	0	0		0	0		172	517,000	3,000	0	0		172	517,000	3,000
1998	0	0		0	0		186	490,000	2,600	0	0		186	490,000	2,600
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
Total Narraguagus	0	1,303,000		0	0	0	1,722	6,291,000	3,736	0	0		1,722	7,595,000	3,700
Orland															
1967-1996	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															
1992-1996	7	67,000	10,200	0	0		0	0		0	0		7	67,000	10,200

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
1997	1	8,000	8,200	0	0		0	0		0	0		1	8,000	8,200
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
Total Pawcatuck	16	142,000	7,900	6	6,000	1,000	0	0		9	61,000	6,600	31	209,000	6,000
Penobscot															
1871-1996	15,880	137,004,000	7,800	2,145	5,465,000	2,500	0	0		0	0		18,025	142,469,000	7,700
1997	313	2,225,000	7,100	639	1,381,000	2,200	0	0		0	0		952	3,606,000	3,800
1998	392	2,804,000	7,200	560	1,456,000	2,600	0	0		0	0		952	4,260,000	4,500
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
Total Penobscot	18,903	162,377,000	8,400	6,028	15,956,000	2,800	329	1,400,000	4,300	0	0		25,260	179,734,000	5,600
Pleasant															
2001	0	0		0	0		13	46,000	3,500	0	0		13	46,000	3,500
2002	0	0		0	0		19	84,000	4,400	0	0		19	84,000	4,400

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 No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
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
Total Pleasant	0	0		0	0	0	219	945,000	5,250	0	0		219	945,000	5,200
Sheepscot															
1995-1996	18	125,000	6,900	0	0		58	110,000	1,900	7	66,000	9,400	83	302,000	3,700
1997	0	0		0	0		75	257,000	3,400	13	118,000	9,100	88	376,000	4,300
1998	0	0		0	0		98	343,000	3,500	17	162,000	9,500	115	505,000	4,400
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
Total Sheepscot	18	125,000	6,900	0	0	0	819	3,249,000	3,982	45	438,000	9,900	882	3,814,000	4,400
St Croix															
1993-1996	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
Total St Croix	39	292,000	7,200	0	0	0	0	0		0	0		39	292,000	7,200
Union															

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.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	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
1974-1996	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	1,693	18,508,000	10,900	24,913	159,716,000	6,400	0	0		2,034	25,106,000	12,300	28,640	203,329,000	7,100
Dennys	26	214,000	8,200	0	0		1,049	4,338,000	4,100	40	330,000	8,300	1,115	4,882,000	4,400
East Machias	0	0		0	0		987	3,994,000	4,000	0	0		987	3,994,000	4,000
Kennebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	5,300	0	0		0	0		0	0		6	32,000	5,300
Machias	456	3,263,000	7,200	0	0		1,753	7,287,000	4,200	8	52,000	6,500	2,217	10,602,000	4,800
Merrimack	1,221	9,423,000	7,700	9,445	49,149,000	5,200	0	0		336	3,441,000	10,200	11,002	62,013,000	5,600
Narraguagus	0	1,303,000		0	0		1,722	6,291,000	3,700	0	0		1,722	7,594,000	4,400
Orland	39	270,000	6,900	0	0		0	0		0	0		39	270,000	6,900
Pawcatuck	16	143,000	8,900	6	6,000	1,000	0	0		9	61,000	6,800	31	210,000	6,800
Penobscot	18,903	162,377,000	8,600	6,028	15,956,000	2,600	329	1,400,000	4,300	0	0		25,260	179,734,000	7,100
Pleasant	0	0		0	0		219	945,000	4,300	0	0		219	945,000	4,300
Sheepscot	18	125,000	7,000	0	0		819	3,249,000	4,000	45	438,000	9,700	882	3,813,000	4,300
St Croix	39	291,000	7,500	0	0		0	0		0	0		39	291,000	7,500
Union	600	4,611,000	7,700	0	0		0	0		0	0		600	4,611,000	7,700
Grand Total	**23,025**	**200,631,000**	**8,700**	**40,392**	**224,827,000**	**5,600**	**6,878**	**27,504,000**	**4,000**	**2,472**	**29,428,000**	**11,900**	**72,767**	**482,391,000**	**6,600**

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

	Number of fish stocked by life stage						
	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
Totals:Androscoggin	**7,000**	**0**	**0**	**0**	**0**	**0**	**7,000**
Aroostook							
1978-1996	628,000	317,100	38,600	0	32,600	29,800	1,046,100
1997	578,000	0	0	0	0	0	578,000
1998	142,000	0	0	0	0	0	142,000
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
Totals:Aroostook	**2,579,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**2,997,400**
Cocheco							
1988-1996	922,000	50,000	10,500	0	5,300	0	987,800
1997	128,000	0	0	0	0	0	128,000
1998	96,000	0	0	0	0	0	96,000
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							
1967-1996	35,409,000	2,811,800	1,802,600	0	3,742,100	963,200	44,728,700
1997	8,526,000	8,800	0	0	1,400	0	8,536,200
1998	9,119,000	3,000	7,700	0	1,700	0	9,131,400
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

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Connecticut	**114,055,000**	**2,834,300**	**1,812,800**	**12,600**	**3,770,700**	**1,335,100**	**123,820,500**
Dennys							
1975-1996	410,000	8,300	3,400	0	143,100	29,200	594,000
1997	213,000	0	0	0	0	0	213,000
1998	233,000	10,400	0	0	9,600	0	253,000
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
Totals:Dennys	**2,129,000**	**225,400**	**7,300**	**0**	**476,200**	**29,200**	**2,867,100**
Ducktrap							
1986-1996	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-1996	255,000	6,500	42,600	0	97,600	30,400	432,100
1997	113,000	0	0	0	0	0	113,000
1998	190,000	0	0	0	10,800	0	200,800
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
Totals:East Machias	**2,491,000**	**7,500**	**42,600**	**0**	**108,400**	**30,400**	**2,679,900**
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
Totals:Kennebec	**142,000**	**0**	**0**	**0**	**0**	**0**	**142,000**
Lamprey							
1978-1996	805,000	374,800	58,500	0	138,100	32,800	1,409,200
1997	141,000	52,900	0	0	0	0	193,900
1998	95,000	0	0	0	3,300	0	98,300
1999	127,000	0	0	0	0	0	127,000
2000	104,000	0	0	0	0	0	104,000

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Number of fish stocked by life stage							
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							
1970-1996	622,000	86,900	117,800	0	180,500	44,100	1,051,300
1997	236,000	0	0	0	0	0	236,000
1998	300,000	5,900	0	0	10,800	0	316,700
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
Totals:Machias	**3,964,000**	**98,900**	**119,800**	**0**	**191,300**	**44,100**	**4,418,100**
Merrimack							
1975-1996	17,770,000	222,500	573,700	0	1,056,600	630,500	20,253,300
1997	2,000,000	5,000	10,000	0	52,500	5,400	2,072,900
1998	2,589,000	0	6,800	0	51,900	0	2,647,700
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
Totals:Merrimack	**34,318,000**	**232,600**	**598,100**	**0**	**1,569,000**	**638,100**	**37,355,800**
Narraguagus							
1970-1996	375,000	30,300	12,600	0	106,100	84,000	608,000
1997	209,000	0	2,000	0	700	0	211,700
1998	274,000	14,400	0	0	0	0	288,400
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
Totals:Narraguagus	**3,800,000**	**80,400**	**14,600**	**0**	**107,800**	**84,000**	**4,086,800**
Pawcatuck							
1979-1996	1,759,000	1,209,200	234,500	0	35,500	500	3,238,700

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1997	100,000	0	14,000	0	11,500	0	125,500
1998	910,000	0	14,700	0	5,700	0	930,400
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
Totals:Pawcatuck	**5,472,000**	**1,209,200**	**263,200**	**0**	**105,800**	**500**	**7,050,700**
Penobscot							
1970-1996	7,671,000	1,783,700	1,368,600	0	8,219,700	2,508,200	21,551,200
1997	1,472,000	310,900	4,200	0	580,200	0	2,367,300
1998	930,000	337,400	13,400	0	571,800	0	1,852,600
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
Totals:Penobscot	**19,155,000**	**4,861,700**	**1,394,400**	**0**	**13,786,300**	**2,508,200**	**41,705,600**
Pleasant							
1975-1996	187,000	2,500	1,800	0	54,700	18,100	264,100
1997	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0
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
Totals:Pleasant	**676,000**	**16,000**	**1,800**	**0**	**63,400**	**42,100**	**799,300**
Saco							
1975-1996	1,045,000	210,200	201,200	0	243,200	9,500	1,709,100
1997	97,000	63,300	0	0	20,200	0	180,500
1998	429,000	50,000	0	0	21,300	0	500,300
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	400	0	479,400
2002	597,000	0	0	0	4,100	0	601,100

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2003	501,000	20,000	0	0	3,200	0	524,200
2004	375,000	0	0	0	5,400	0	380,400
2005	340,000	0	18,000	0	1,700	0	359,700
2006	106,000	0	0	0	0	0	106,000
Totals:Saco	**5,256,000**	**438,700**	**219,200**	**0**	**342,200**	**9,500**	**6,265,600**
Sheepscot							
1971-1996	261,000	70,800	20,600	0	92,200	7,100	451,700
1997	64,000	0	0	0	0	0	64,000
1998	256,000	9,300	0	0	0	0	265,300
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
Totals:Sheepscot	**2,410,000**	**132,900**	**20,600**	**0**	**92,200**	**7,100**	**2,662,800**
St Croix							
1981-1996	1,260,000	355,500	158,100	0	747,200	20,100	2,540,900
1997	1,000	400	0	0	0	0	1,400
1998	2,000	31,700	200	0	0	0	33,900
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
Totals:St Croix	**1,268,000**	**470,400**	**158,300**	**0**	**808,000**	**20,100**	**2,724,800**
Union							
1971-1996	81,000	220,000	0	0	379,700	251,000	931,700
1997	12,000	69,300	0	0	0	0	81,300
1998	165,000	0	0	0	0	0	165,000
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
Totals:Union	**440,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,442,100**
Upper StJohn							
1979-1996	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200

	Number of fish stocked by life stage						
	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	7,000	0	0	0	0	0	**6,700**
Aroostook	2,579,000	317,400	38,600	0	32,600	29,800	**2,997,800**
Cocheco	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	114,054,000	2,834,300	1,812,800	12,600	3,770,700	1,335,200	**123,807,000**
Dennys	2,129,000	225,400	7,300	0	476,300	29,200	**2,867,300**
Ducktrap	68,000	0	0	0	0	0	**68,000**
East Machias	2,491,000	7,500	42,600	0	108,400	30,400	**2,679,800**
Kennebec	142,000	0	0	0	0	0	**142,300**
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	3,964,000	98,900	119,800	0	191,300	44,100	**4,417,800**
Merrimack	34,318,000	232,500	598,100	0	1,569,000	638,100	**37,355,600**
Narraguagus	3,801,000	80,400	14,600	0	107,800	84,000	**4,087,500**
Pawcatuck	5,472,000	1,209,200	263,200	0	105,900	500	**7,050,300**
Penobscot	19,154,000	4,861,700	1,394,400	0	13,786,300	2,508,200	**41,704,700**
Pleasant	677,000	16,000	1,800	0	63,400	42,100	**799,900**
Saco	5,256,000	438,700	219,200	0	342,200	9,500	**6,265,300**
Sheepscot	2,410,000	132,900	20,600	0	92,200	7,100	**2,663,000**
St Croix	1,268,000	470,400	158,300	0	808,000	20,100	**2,725,200**
Union	439,000	371,400	0	0	379,700	251,000	**1,441,000**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**203,945,000**	**13,231,100**	**4,775,300**	**12,600**	**22,045,500**	**5,089,900**	**249,086,400**

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				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin									
1983-1996	26	499	6	2	5	79	0	1	**618**
1997	0	0	0	0	0	1	0	0	**1**
1998	0	4	0	0	0	0	0	0	**4**
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**
Total for Androscoggin	37	532	6	2	6	84	0	1	**668**
Cocheco									
1992-1996	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									
1974-1996	35	3,500	28	1	13	596	8	0	**4,181**
1997	0	0	0	1	6	191	1	0	**199**
1998	0	0	0	0	10	288	0	0	**298**
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**
Total for Connecticut	49	3,540	28	2	95	1777	12	1	**5,504**
Dennys									
1967-1996	19	305	0	1	30	733	3	31	**1,122**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1998	1	0	0	0	0	0	0	0	**1**
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**
Total for Dennys	37	316	0	1	32	745	3	31	**1,165**
Ducktrap									
1985-1996	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-1996	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-1996	12	189	5	1	0	9	0	0	**216**
2006	4	6	0	0	3	2	0	0	**15**
Total for Kennebec	16	195	5	1	3	11	0	0	**231**
Lamprey									
1979-1996	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									
1967-1996	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									
1982-1996	150	715	17	4	81	836	25	0	**1,828**
1997	9	43	0	4	9	5	1	0	**71**
1998	11	45	1	0	19	47	0	0	**123**
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**
2002	31	17	0	0	1	6	0	0	**55**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
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	10	66	1	0	5	8	0	0	**90**
Total for Merrimack	325	1,302	22	8	129	1012	26	0	**2,824**
Narraguagus									
1967-1996	92	643	19	52	58	2,263	68	145	**3,340**
1997	0	2	0	0	1	30	0	4	**37**
1998	0	0	0	1	1	18	0	2	**22**
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**
Total for Narraguagus	92	650	19	54	93	2422	70	155	**3,555**
Pawcatuck									
1982-1996	1	141	1	0	0	0	0	0	**143**
1997	0	0	0	0	0	3	0	0	**3**
1998	0	0	0	0	1	2	0	0	**3**
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**
Total for Pawcatuck	2	148	1	0	1	17	1	0	**170**
Penobscot									
1968-1996	8,562	37,338	272	609	524	2,982	26	75	**50,388**
1997	243	934	4	14	4	153	2	1	**1,355**
1998	238	793	0	10	31	133	1	4	**1,210**
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**
2004	276	952	10	16	5	59	3	2	**1,323**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2005	269	678	0	8	6	22	0	2	**985**
2006	338	653	1	4	15	33	0	0	**1,044**
Total for Penobscot	11,070	43,838	288	709	691	3754	35	99	**60,484**
Pleasant									
1967-1996	5	12	0	0	11	214	2	2	**246**
1997	0	0	0	0	0	1	0	0	**1**
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									
1985-1996	34	397	3	5	0	2	0	0	**441**
1997	5	23	0	0	0	0	0	0	**28**
1998	9	7	0	0	4	7	1	0	**28**
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**
Total for Saco	125	598	3	7	28	77	3	0	**841**
Sheepscot									
1967-1996	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-1996	296	1,796	9	24	1	12	0	0	**2,138**
1997	0	8	0	0	0	0	0	0	**8**
1998	2	7	0	4	0	0	0	0	**13**
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								
	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin	37	532	6	2	6	84	0	1	668
Cocheco	0	0	1	1	6	10	0	0	18
Connecticut	49	3,540	28	2	95	1,777	12	1	5,504
Dennys	37	316	0	1	32	745	3	31	1,165
Ducktrap	0	0	0	0	3	30	0	0	33
East Machias	21	250	1	2	12	329	1	10	626
Kennebec	16	195	5	1	3	11	0	0	231
Lamprey	10	17	1	0	13	16	0	0	57
Machias	32	329	9	2	33	1,592	41	131	2,169
Merrimack	325	1,302	22	8	129	1,012	26	0	2,824
Narraguagus	92	650	19	54	93	2,422	70	155	3,555
Pawcatuck	2	148	1	0	1	17	1	0	170
Penobscot	11,070	43,838	288	709	691	3,754	35	99	60,484
Pleasant	5	12	0	0	14	228	3	2	264
Saco	125	598	3	7	28	77	3	0	841
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 (1000s)	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
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	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	100	0	0
1981	15	19	1.261	0	0	0	11	89	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	90	10	0
1983	7	1	0.143	0	100	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	100	0
1985	29	35	1.224	0	0	0	0	100	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	4	96	0	0
1987	98	44	0.449	0	16	0	0	68	2	0	14	0	0	0	16	68	16	0
1988	93	92	0.992	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	75	47	0.629	0	6	0	6	85	0	0	2	0	0	0	13	85	2	0
1990	76	53	0.693	0	13	0	0	87	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	20	64	16	0
1992	93	84	0.904	0	1	0	0	85	1	0	13	0	0	0	1	85	14	0
1993	261	94	0.361	0	0	0	2	87	0	0	11	0	0	0	2	87	11	0
1994	393	197	0.502	0	0	0	1	93	0	0	6	0	0	0	1	93	6	0

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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	3	90	7	
2002	490	82	0.167	0	11	0	12	74		2				0	23	77		
2003	482	19	0.039	0	37		63							0	100			
2004	526	1	0.002	100										100				
Total	**6,859**	**1,263**																
Mean			**0.548**	**3**	**7**	**0**	**4**	**66**	**4**	**0**	**4**	**0**	**0**	**3**	**11**	**67**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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 (1000s)	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
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	100	0	0
1979	5	3	0.561	0	100	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	100	0	0
1981	17	19	1.129	0	0	0	11	89	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	89	11	0
1983	23	2	0.088	0	100	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	33	67	0
1985	42	47	1.113	0	0	0	0	100	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	4	96	0	0
1987	117	51	0.436	0	18	0	0	67	2	0	14	0	0	0	18	67	16	0
1988	131	108	0.825	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	124	67	0.539	0	22	0	7	69	0	0	1	0	0	0	30	69	1	0
1990	135	68	0.505	0	19	0	0	79	0	0	1	0	0	0	19	79	1	0
1991	221	35	0.159	0	17	0	0	63	0	0	20	0	0	0	17	63	20	0
1992	201	118	0.587	0	5	0	0	82	1	0	12	0	0	0	5	82	13	0
1993	415	185	0.446	0	4	0	3	87	0	0	6	0	0	0	6	87	6	0
1994	594	294	0.495	0	5	0	2	88	0	0	5	0	0	0	7	88	5	0

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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	5	89	5	
2002	725	159	0.219	1	11	0	13	75		1				1	23	76		
2003	700	37	0.053	3	51		46							3	97			
2004	765	1	0.001	100										100				
Total	**9,991**	**1,883**																
Mean			**0.424**	**3**	**13**	**0**	**4**	**65**	**2**	**0**	**5**	**0**	**0**	**3**	**17**	**65**	**7**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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 (1000s)	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
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 2001 - 2004 year class fish.

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	25	75	0	
2002	119	22	0.185	5	5	0	14	77		0				5	18	77		
2003	112	5	0.045	0	60		40							0	100			
2004	118	0	0.000	0										0				
Total	**1,636**	**317**																
Mean			**0.302**	**0**	**24**	**0**	**4**	**57**	**1**	**0**	**9**	**0**	**0**	**0**	**28**	**57**	**10**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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 (1000s)	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	43	3.413	0	0	0	0	19	5	21	51	5	0	0	0	40	56	5
1981	6	81	14.211	0	0	0	10	78	0	5	7	0	0	0	10	83	7	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	110	2.095	0	11	0	0	78	1	0	8	0	2	0	11	78	9	2
1987	108	278	2.579	0	2	0	8	86	0	0	4	0	0	0	10	86	4	0
1988	172	95	0.553	1	5	0	0	91	0	0	3	0	0	1	5	91	3	0
1989	103	43	0.416	0	7	0	30	63	0	0	0	0	0	0	37	63	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	14	0.125	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	54	0.192	0	0	0	15	83	0	0	2	0	0	0	15	83	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 2001 - 2004 year class fish.

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	40	20	40	
2002	141	6	0.042	0	0	0	0	100		0				0	0	100		
2003	133	5	0.037	0	0		100							0	100			
2004	156	0	0.000	0										0				
Total	**3,234**	**1,167**																
Mean			**2.466**	**0**	**2**	**0**	**13**	**63**	**3**	**2**	**9**	**0**	**0**	**0**	**15**	**65**	**12**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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 (1000s)	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	20	80	0	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	100	0	0
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
2001	42	2	0.047	0	0	0	0	100	0	0	0			0	0	100	0	
2002	40	0	0.000	0	0	0	0	0		0				0	0	0		
2003	31	0	0.000	0	0		0							0	0			
2004	56	0	0.000	0										0				
Total	**522**	**19**																
Mean			**0.037**	**0**	**5**	**2**	**2**	**51**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**53**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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 (1000s)	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
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	100	0	
2002	26	21	0.799	0	10	0	24	67		0				0	33	67		
2003	25	7	0.283	14	71		14							14	86			
2004	28	0	0.000	0										0				
Total	**325**	**76**																
Mean			**0.231**	**1**	**24**	**0**	**4**	**57**	**0**	**0**	**0**	**0**	**0**	**1**	**28**	**57**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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

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

Year	Total Fry (1000s)	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
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	100	0	0
1990	27	4	0.146	0	25	0	0	75	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	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	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	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	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	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	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	25	63	13	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0			0	10	90	0	
2002	89	34	0.381	0	15	0	6	79		0				0	21	79		
2003	81	6	0.074	0	67		33							0	100			
2004	93	0	0.000	0										0				
Total	**1,170**	**227**																
Mean			**0.192**	**0**	**8**	**0**	**6**	**79**	**0**	**0**	**7**	**0**	**0**	**0**	**14**	**79**	**7**	**0**

Mean return rate computation includes incomplete return rates for 2001 - 2004 year class fish.

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	3.413		0.630	2.022		0.000	
1981	14.211		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	2.095		1.592	2.791		0.126	
1987	2.579		0.436	0.449	0.165	0.740	
1988	0.553		0.825	0.992	0.693	0.391	0.000
1989	0.416		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	0.125		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	0.192	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	0.042	0.000	0.219	0.167	0.799	0.185	0.381
2003	0.037	0.000	0.053	0.039	0.283	0.045	0.074
2004	0.000	0.000	0.001	0.002	0.000	0.000	0.000
Mean	**2.466**	**0.037**	**0.424**	**0.548**	**0.231**	**0.302**	**0.192**
StndDev	**5.696**	**0.045**	**0.483**	**0.753**	**0.250**	**0.323**	**0.190**

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	0.05	0.81	0.01	0.00	0.05	0.00	0.00	0.00	0.13	0.81	0.05	0.00
Connecticut (above Holyoke)	0.00	0.04	0.00	0.04	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	0.25	0.00	0.06	0.64	0.01	0.00	0.04	0.00	0.00	0.01	0.31	0.64	0.05	0.00
Salmon	0.01	0.25	0.00	0.14	0.59	0.00	0.00	0.00	0.00	0.00	0.01	0.39	0.59	0.00	0.00
Westfield	0.00	0.05	0.00	0.05	0.85	0.00	0.00	0.04	0.00	0.00	0.00	0.11	0.85	0.04	0.00
Merrimack	0.00	0.03	0.00	0.09	0.76	0.02	0.02	0.08	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**	**0.07**	**0.77**	**0.01**	**0.00**	**0.04**	**0.00**	**0.00**	**0.00**	**0.18**	**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.