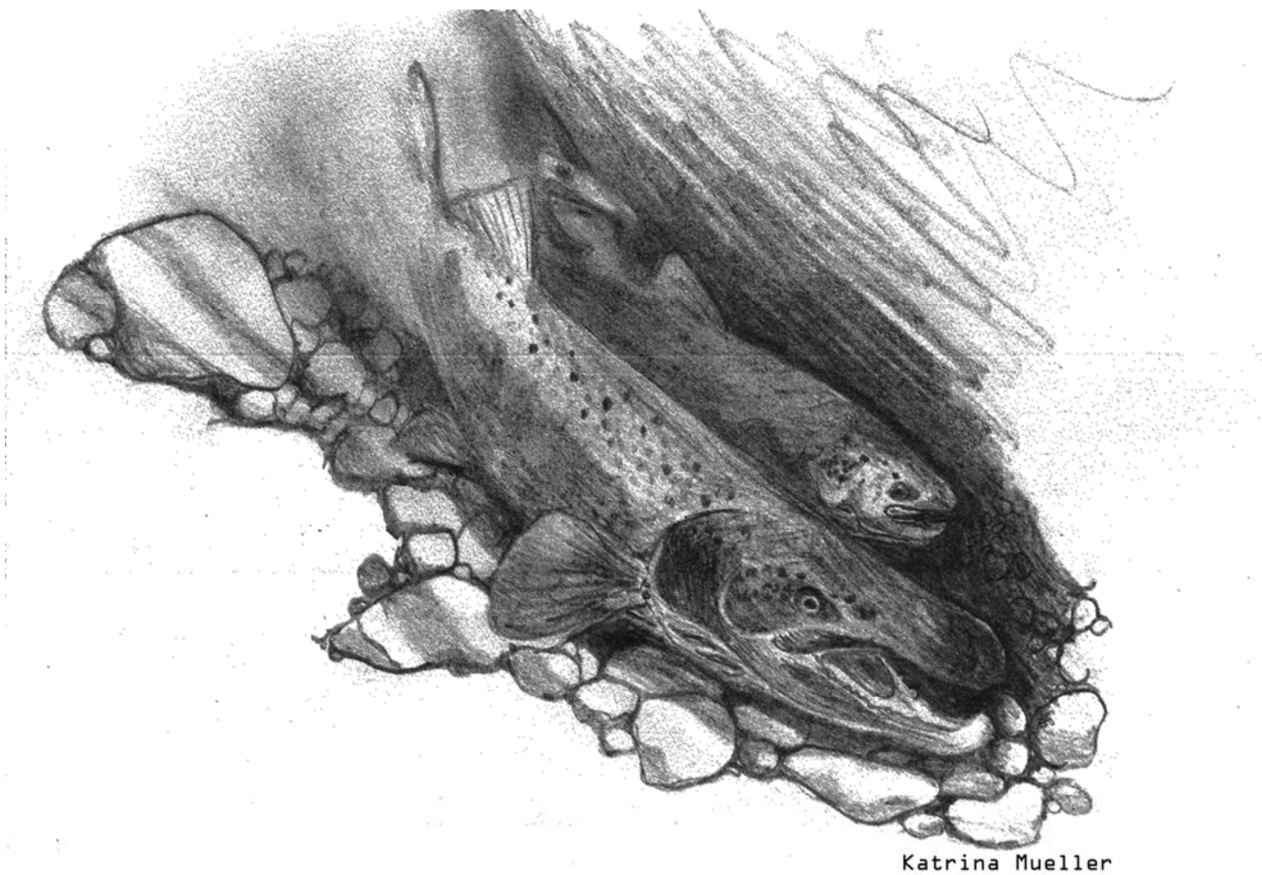
U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE

ANNUAL REPORT 2007/20
9 July 2008

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

REPORT NO. 20 - 2007 ACTIVITIES

PORTLAND, MAINE
March 11 – March 13, 2008



PREPARED FOR
U.S. SECTION TO NASCO

Table of Contents

List of Tables and Figures

List of Historical Tables

1.0 Executive Summary

1.1. Abstract

Total return to USA rivers was 1,255; 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 1,216 fish in 2007, 3% less than observed in 2005 and 14% less than returned in 2006. Fifty-three adult (90% CI = 39 - 72) salmon were estimated to return to the rivers with Endangered populations, the 2th lowest for the 1991-2007 time-series. Most returns occurred in Maine, with the Penobscot River accounting for 74% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (74%) returns were of hatchery smolt origin and the balance (26%) originated from either natural reproduction or hatchery fry. A total of 13,507,900 juvenile salmon (fry, parr, and smolts) and 3,877 adults were stocked, with 424,805 carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 447 sea-run females, 3,335 captive/domestic females, and 158 female kelts. The number of females (3,940) contributing was more than 2006 (3,603); and total egg take (22,074,000) was also more than in 2006 (20,537,000). Production of farmed salmon in Maine was reported to be 2,715 metric tonnes in 2007, about 60% of the 4,674 metric tonnes of production reported in 2006.

1.2 Description of Fisheries

Except for a one-month 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 90 licenses were sold, with about one third of the anglers complying with reporting requirements. A total of 83 angler trips were reported. Anglers had the opportunity to fish over at least 31 Atlantic salmon based on the catch of salmon at the Veazie trap. Three Atlantic salmon were 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 1,081 broodstock in 2007.

1.3 Adult Returns

Total return to USA rivers was 1,255 (Table 1.3.1), a 15% decrease from 2006 returns (Table 1.3.2). Changes from 2005 by river were: Connecticut (-34%), Merrimack (-18%), Penobscot (-11%), Saco (-20%), and Narraguagus (-27%). In addition to catches at traps and weirs (1,218), 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]. Fifty-three adult (90% CI = 39 - 72) fish were estimated to return to the rivers with Endangered populations.

The replacement rate for 12 generations of Atlantic salmon starting with returns in 1996 from the 1991 spawning cohort averaged 0.7 and the mean replacement rate has not exceeded 1 until this year. The replacement rate for 2007 was 1.47 (0.95 - 2.16) and was the fourth highest in the time series. In addition, in 6 of the 12 years the upper bound of the 90% confidence limits exceeded 1.

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 3.2 % of the 2SW conservation spawner requirements for USA, with individual river returns ranging from 0.5 to 9.7 % of spawner requirements (Table 1.3.3).

Most returns occurred in Maine, with the Penobscot River accounting for 74% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (74%) returns were of hatchery origin and the balance (26%) originated from either natural reproduction or hatchery fry (Figure 1.3.1). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2005 was 0.17%, with the 2SW fish return rate 0.11% (Figure 1.3.2). Smolt survival on the Penobscot River correlates well with other large restoration programs in the Connecticut and Merrimack rivers. The estimated return rate for 2SW adults from the 2005 cohort of wild smolts on the Narraguagus was 0.73%, mirroring trends on the Penobscot (Figure 1.3.2).

1.4 Stock Enhancement Programs

During 2007 about 12,372,000 juvenile salmon (92% fry) were released into 15 River systems (Table 1.4.1). The number of juveniles released was more than that in 2006 (12,050,800). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six rivers within the geographic range of the GOM DPS in Maine. The 363,500 parr released in 2007 were primarily the by-products of smolt production programs and included ages 0 and 1 fish. Smolts were stocked in the Penobscot (559,900), Merrimack (50,000), Connecticut (99,600), Dennys (56,500), and Pawcatuck (11,300) rivers. In addition to juveniles, 3,877 adult salmon were released into USA rivers (Table 1.4.2). Most were spent broodstock or broodstock excess to hatchery capacity. However, mature pre-spawn salmon released in the Sheepscot, East Machias, and Machias rivers and Hobart Stream produced redds. In the Merrimack River excess broodstock were released to support a recreational fishery and to enhance spawning in the watershed.

Mature adults stocked into Sheepscot, East Machias, and Machias rivers and Hobart Stream in the fall were added to USA 2SW returns to calculate spawners. Thus, spawners exceeded returns in 2007 with USA spawners totaling 1,490. Escapement to natural spawning areas was 687 (returns – broodstock + stocked pre-spawn adults).

1.5 Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 424,805 salmon released into USA waters in 2007 was marked or tagged. Tags and marks for parr, smolts and adults included: Floy, Carlin, HI-Z Turb'N, PIT, radio, acoustical, fin clips, and visual implant elastomer. In addition, approximately 37,000 fry had thermally marked otoliths. About 24% of the marked fish were released into the Connecticut River watershed and 68% into the Penobscot River (Table 1.5.1).

1.6 Farm Production

Production of farmed salmon in Maine was reported to be 2,715 metric tonnes in 2007, about 60% of the 4,674 metric tonnes of production reported in 2006. Production in four the last six years has been less than half of the 13,202 t produced in 2001 (Table 1.6.1).

1.7 Highlights

1.7.1 IPNV

The viral pathogen Infectious Pancreatic Necrosis Virus (IPNV) was isolated from Connecticut River Atlantic salmon during routine brood stock health screening by the US Fish and Wildlife Service. No clinical signs of disease were noted in the fish. Two ovarian fluid samples were confirmed positive for IPNV using cell culture and polymerase chain reaction (PCR) assays. Each sample represented a pool of broodstock spawned at the Richard Cronin National Salmon Station. Thus, a minimum of two sea-run salmon females were infected. All the eggs and broodstock at the facility and eggs transferred to another facility were destroyed. This resulted in the loss of the entire year class of sea-run Connecticut River Atlantic salmon brood stock. Follow-up cell culture assays, PCR assays and histology were conducted on kidney, spleen, blood and pancreatic tissues from the killed brood stock. Infection and prevalence levels were low (3 of 121 positive) in the population and large scale horizontal transmission had not occurred while the fish were held in captivity at the station for eight months.

The US Geologic Survey Western Fisheries Research Center identified the isolate to be most similar in base pair structure to the Canada 3 genotype, which is significantly different from most other North American IPNV genotypes studied (Cutrin et al. 2004). Because this is not a typical North American isolate, pathologists speculate that the salmon were exposed during ocean migration.

IPNV represents a critical threat to Atlantic salmon recovery in the USA. The discovery of IPNV at any USA Atlantic salmon hatcheries will result in loss of genetic diversity for one or more stocks and from one to three spawning cohorts for a stock. Current procedures for screening and isolating fish at all the hatcheries are inadequate to protect against an IPNV outbreak. Enhancing bio-security protocols at each of the hatcheries seem to be the only way to reduce the risk of loses. A new bio-security plan for the sea run brood stock population at Richard Cronin includes: isolating and increasing the number of holding tanks. Isolation will involve separate equipment, footbaths, barriers to prevent direct transfer of water from tank to tank, and using separate spawning and egg rinsing equipment for in each holding tank. Discrete egg incubation isolation units (fitted with enclosures for isolation) will be maintained for each brood stock pool and separate egg equipment (rinsing counting shocking picking) will be used for each incubation unit. If there is mating of individuals in different pools, discrete paired pooled incubation isolation units will be utilized. Should IPN virus be isolated in a particular tank, broodstock and all resulting spawn from that tank will be destroyed. Eggs from broodstock tanks where spawners all tested negative will be carried through to hatch. Fry from these units will also be tested for all listed viruses prior to transfer/release.

1.7.2 Didymo

Didymosphenia geminate (didymo or rock snot) was detected in the White River upstream of the White River National Fish Hatchery in 2007. Before this discovery, the hatchery used that river water for fry production. Salmon production was immediately shifted to well water to mitigate the potential of didymo affecting hatchery production or being dispersed during fry stocking.

Literature Cited

Cutrín, J.M. J. L. Barja, B. L. Nicholson, I. Bandín, S. Blake, and C. P. Dopazo. 2004. Restriction Fragment Length Polymorphisms and Sequence Analysis: an Approach for Genotyping Infectious Pancreatic Necrosis Virus Reference Strains and Other Aquabirnaviruses Isolated from Northwestern Spain. Applied and Environmental Microbiology. Feb: 1059–1067.

Table 1.3.1. Documented Atlantic salmon returns to USA rivers, 2007. "Natural" includes fish originating from natural spawning and hatchery fry.

RIVER	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
Androscoggin	6	1	11	2	0	0	0	0	20
Connecticut	0	1	19	120	0	1	0	0	141
Kennebec	2	2	6	5	1	0	0	0	16
Merrimack	8	1	52	12	0	1	0	0	74
Dennys (DPS)	1	0	1	1	0	0	0	0	3
Narraguagus (DPS)	0	2	0	9	0	0	0	0	11
Other GOM DPS [1]	0	8	0	31	0	0	0	0	39
Pawcatuck	0	0	2	0	0	0	0	0	2
Penobscot	226	35	575	88	0	0	1	0	925
Saco	4	0	16	4	0	0	0	0	24

[1] Numbers based on redds, ages and origins are pro-rated based

Table 1.3.2. Documented Atlantic salmon returns to the USA, 1967-2007. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

	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
2007	297	954	3	1	1,255	931	324

Table 1.3.4. Two sea winter (2SW) returns for 2007 in relation to spawner requirements for USA rivers.

River	Spawner Requirement	2SW spawners-2007	Percentage of Requirement
Penobscot	6,838	663	9.70
Connecticut	9,727	139	1.43
Pawcatuck	367	2	0.54
Merrimack	2599	64	2.46
GOM-DPS	1,564	31	1.98
Other Maine rivers	8,104	44	0.54
Total	29199	943	3.23

Table 1.4.1. Number of juvenile Atlantic salmon stocked in USA, 2007.

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,345,000	0	600	2,300	600	99,000	6,447,500
Aroostook	854,000	0	0	0	0	0	854,000
Androscoggin	1,000	0	0	0	0	0	1,000
Dennys	257,000	0	0	0	56,500	0	313,500
East Machias	245,000	0	0	0	0	0	245,000
Kennebec	20,000	0	0	0	0	0	20,000
Machias	470,000	0	2,200	0	0	0	472,200
Narraguagus	346,000	15,700	0	0	0	0	361,700
Pleasant	177,000	0	0	0	0	0	177,000
Penobscot	1,606,000	337,800	0	0	559,900	0	2,503,700
Saco	576,000	0	0	0	0	0	576,000
Sheepscot	198,000	0	0	0	0	0	198,000
Union	22,000	0	0	0	0	0	22,000
Merrimack	1,140,000	0	0	0	50,000	0	1,190,000
Pawcatuck	115,000	0	4,900	0	6,400	0	126,300
Total for United States	12,372,000	353,500	7,700	2,300	673,400	99,000	13,507,900

Table 1.4.2. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2007 by river.

		Captive Reared Domestic		Sea Run	
River	Purpose	Pre-spawn	Post-spawn	Post-spawn	Total
Connecticut	Restoration	0	0	0	0
Dennys	Restoration	0	31	0	31
East Machias	Restoration	44	100	0	144
Hobart Stream	Restoration	80	0	0	80
Kennebec	Restoration	0	26	0	26
Machias	Restoration	59	178	0	237
Merrimack	Restoration/Recreation	1081	479	0	1,560
Narraguagus	Restoration	0	179	0	179
Penobscot	Restoration	0	905	567	1,472
Sheepscot	Restoration	61	87	0	148
Total United States		1,325	1,985	567	3,877

Table 1.5.1. Summary of tagged and marked Atlantic salmon released in USA, 2007.

		Stock Origin									
Mark	Life Stage	Connecticut	Dennys	East Machias	Machias	Merrimack	Narraguagus	Pawcatuck	Penobscot	Sheepscot	Grand Total
AD	Adult								909		909
FLOY	Adult					1510					1,510
PIT	Adult		62	144	237		228		567	148	1,386
RAD	Adult	10							19		29
TEMP	Fry						3916		33397		37,313
AD	Parr	2996						4908			7,904
PIT	Parr	747									747
AD	Parr						15687				15,687
LV	Parr								105577		105,577
AD	Smolt	99600						6352			105,952
PING	Smolt	108									108
RAD	Smolt								64		64
VIE	Smolt								147619		147,619
Grand Total		103,461	62	144	237	1,510	19,831	11,260	288,152	148	424,805

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
TEMP = thermal otolith mark

Table 1.6.1. Aquaculture production (metric tones) in New England from 1997 to 2007.

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

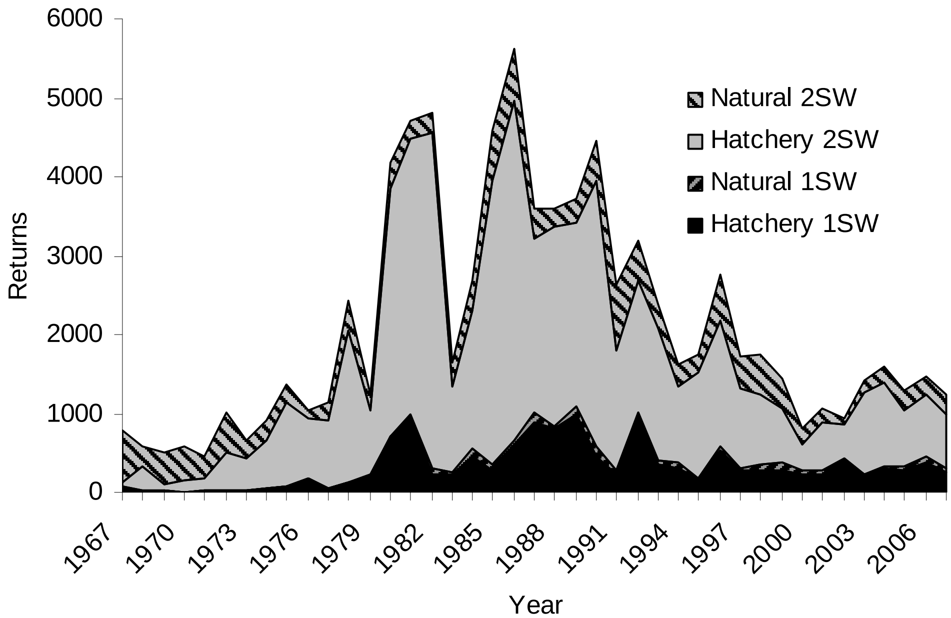


Figure 1.3.1. Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2007.

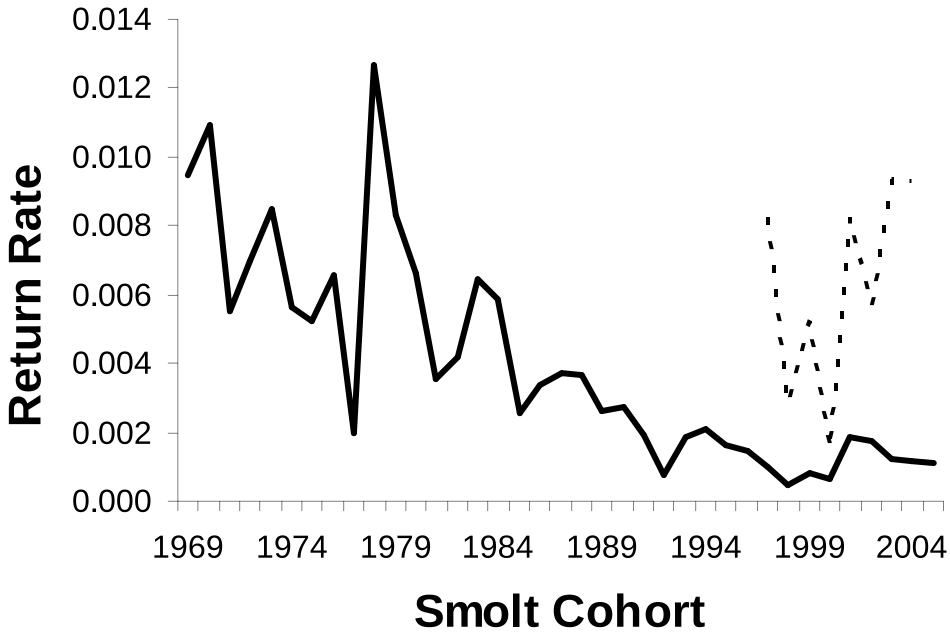


Figure 1.3.2. Return rate of 2SW adults by cohort of hatchery-reared Atlantic salmon smolts released into the Penobscot River (solid line) and wild smolt emigration estimated on the Narraguagus River (dashed line), Maine, USA.

2.0 Status of Stocks

US Atlantic salmon populations are assessed by the US Atlantic Salmon Assessment Committee, a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status.

Currently population status of salmon is determined by counting returning adults either directly, at traps and weirs, or indirectly using redd surveys. Total returns also include retained fish from angling in other regions but US river fisheries where all closed with exception of Penobscot River catch and release in 2007. Catch numbers are low enough that catch and release mortality is not used to adjust escapement. Some mortality can and does occur between trap counts and actual spawning – the actual number of spawners is termed spawning escapement and is not estimated for US populations, though redd counts provide a reasonable proxy for some rivers. A unique element of Atlantic salmon populations in New England is the dependence on hatcheries. Since most US salmon are products of stocking, it is important to understand the magnitude of these inputs to understand salmon assessment results.

US Atlantic salmon hatcheries are run by the US Fish and Wildlife Service and state agencies. Hatchery programs in the US take two forms; 1) conservation hatcheries that produce fish from remnant local stocks within a stock complex and stock them into natal rivers or 2) restoration hatcheries that produce salmon from broodstock established from donor populations outside their native stock complex. Hatchery programs for the Gulf of Maine DPS are conservation hatcheries. All other New England hatcheries are restoration hatcheries. These restoration hatcheries developed broodstock primarily from donor stocks of Penobscot River origin. However, because these programs have been ongoing for more that 25 years they have been able to develop domestic broodstock from fish that returned to that system. As such, the majority of fish reared for Long Island Sound and Central New England stock complexes are progeny of fish that completed their life cycle in these waters for 3 or more generations.

A total of 13.5 million juvenile salmon were stocked in 2007 across 15 river systems, a numbers typical of the decade. Fry stocking dominates numerically overall with 12.4 million stocked; fry were used in all systems stocked. Five river systems were stocked with parr and five with smolts. Managers stocked around 675,000 age-1 smolts in US waters with 560,000 of them stocked in the Penobscot River. This total and the percentage stocked in the Penobscot River is typical for the last decade. Penobscot River smolts consistently produce over 70% of the adult salmon returns to the US. Cost and logistical issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits and naturally-reared smolts typically have a higher marine survival rate than hatchery smolts. Rebuilding Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems and using hatchery production to optimally maintain population diversity, distribution, and abundance.

The modern time series of salmon returns to US rivers starts in 1967. Average annual Atlantic salmon returns to US rivers from 1969 to present is 2,155 and the median is 1,636. The time series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figure 2.1). Because many of the populations in southern New England were extirpated and the Penobscot River was at very low levels, the salmon returns graph illustrates the sequential rebuilding of the populations through restoration efforts in the 1970s – with increased abundance first in the Penobscot River then the Merrimack and Connecticut Rivers. The remnant populations of the smaller rivers in the Gulf of Maine DPS and the Penobscot River were the donor material for all rebuilding programs during this time. Unfortunately, the trajectory of this recovery did not continue in the late 1980s and early 1990s. Starting in the early 1990s there was a phase shift in marine survival and an overall reduction in marine survival occurred in all US and most Canadian populations. Average annual Atlantic salmon returns to US rivers from 1991 to present is 1,817 and the median is identical to the time series median at 1,636. There has been a downward trend in production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish) that have affected US populations. In addition, recovery from historical impacts was never sufficient so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters were 1,255 fish – this ranks 27 out of the 41 year time series and is nearly 400 fish below the median. However, relative to the average during the current marine phase returns in 2007 were ranked 14 out of the 17 years. To gain a better sense of the relative status of the stocks, it is informative to examine target spawning escapements. Because juvenile rearing habitat can be measured or estimated efficiently, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed Conservation Spawning Escapement (CSE). These values have been calculated for US populations and total just over 29,000 spawners. In the last decade, total returns have accounted for less than 2 percent of these target values in Long Island Sound and Central New England stock complexes. However, salmon returns to the Penobscot River have been as high as 10% of CSE during this period and smaller rivers in Gulf of Maine stock complex ranged from 3-4 percent for other populations. These CSE levels are minimal recovery targets since they are based on spawning escapement that could fully seed juvenile habitat. In self-sustaining populations, the number of returns would frequently exceed this amount by 50 to 100 percent allowing for sustainable harvests and buffers against losses between return and spawning. As such, the status of US Atlantic salmon populations is critically low for all stocks, with the remnant populations of the Gulf of Maine stock complex listed as endangered.

Over the past 5 years, the contributions of each stock complex to total US returns averaged: Central New England (9%), Fundy (1%), Gulf of Maine (81%), and Long Island Sound (10%). Returns in 2007 were typical in that the Penobscot River population accounted for 74% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were multi sea winter (MSW) salmon – mostly 2SW fish. From 1967–1985, the ratio of 3SW salmon to 2SW fish averaged 2% and was as high as 7%. However, from 1986 to 2007 this average declined to 0.6% and the highest ratio was only 1.2%. Only three 3SW fish and one repeat spawner were documented in 2007 returns. Most (74%) returns have been hatchery smolt origin and the balance (26%) originated from fry or parr stocking and natural reproduction.

Return rates also provide an indicator of marine survival. Previous studies have shown that most of the US stock complexes track each other over longer time series for return rates (our best index of marine survival). The time series for the Penobscot population is the longest and has the least variability in release method and location. The 2007 adult return rate for 2SW hatchery smolts released in the Penobscot River in 2005 was 0.108% and the overall return rate (excluding 3SW fish still at sea) was 0.16%. This total return rank was ranked 31 out of 36 cohort reviewed (1969-present) and 10th out of 15 return rates calculated since 1990. Hatchery return rates for the Connecticut population are almost exclusively 2SW fish. Three years of recent data are available that represent returns of healthy smolts – the average for this time series is 0.02%. Return rates for wild and naturally-reared smolts on the Narraguagus River in recent years have mirrored those trends in the Penobscot River and for 2SW fish with a time series dating back to the 1997 smolt cohort return rates average 0.65%..

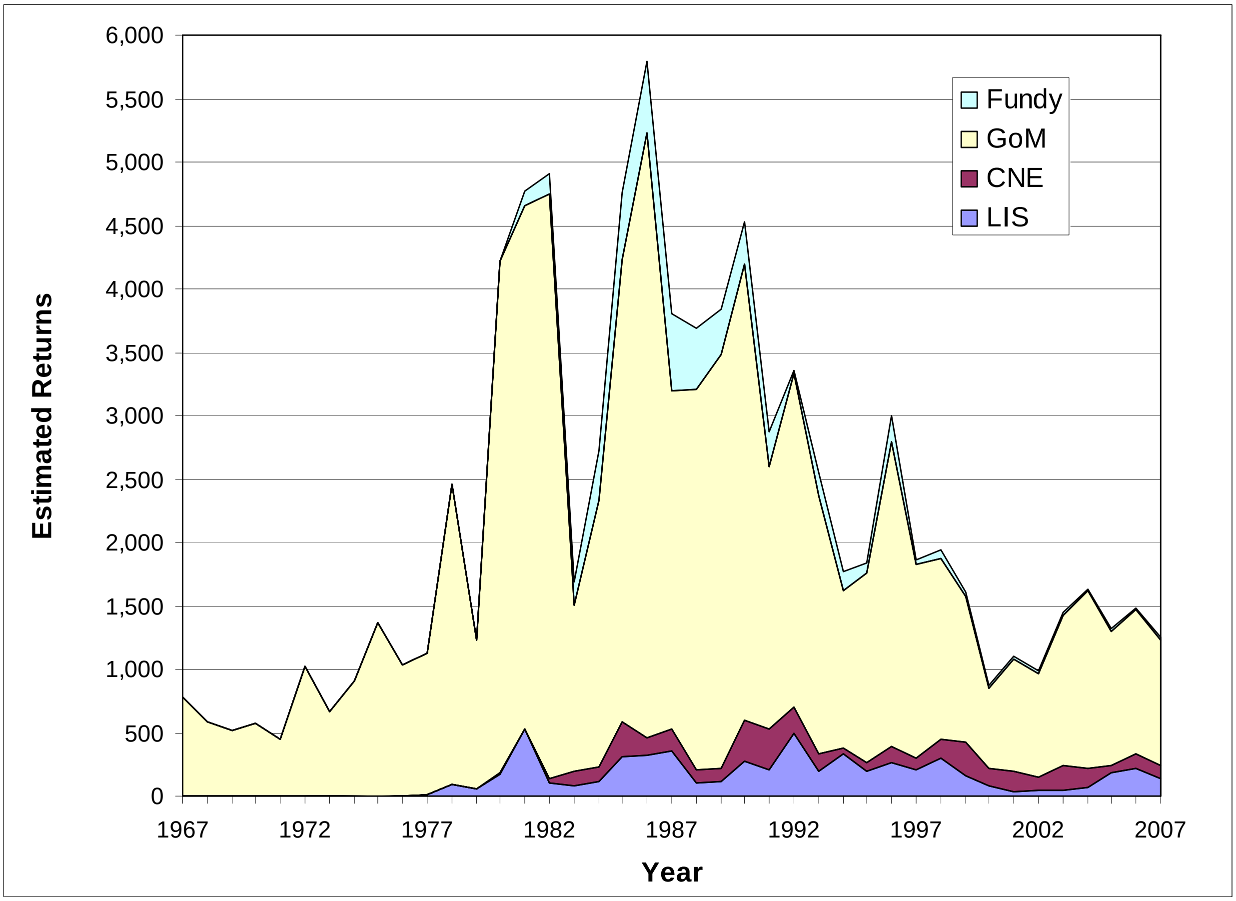


Figure 2.1 Estimated total returns to New England since 1967 from USASAC databases.

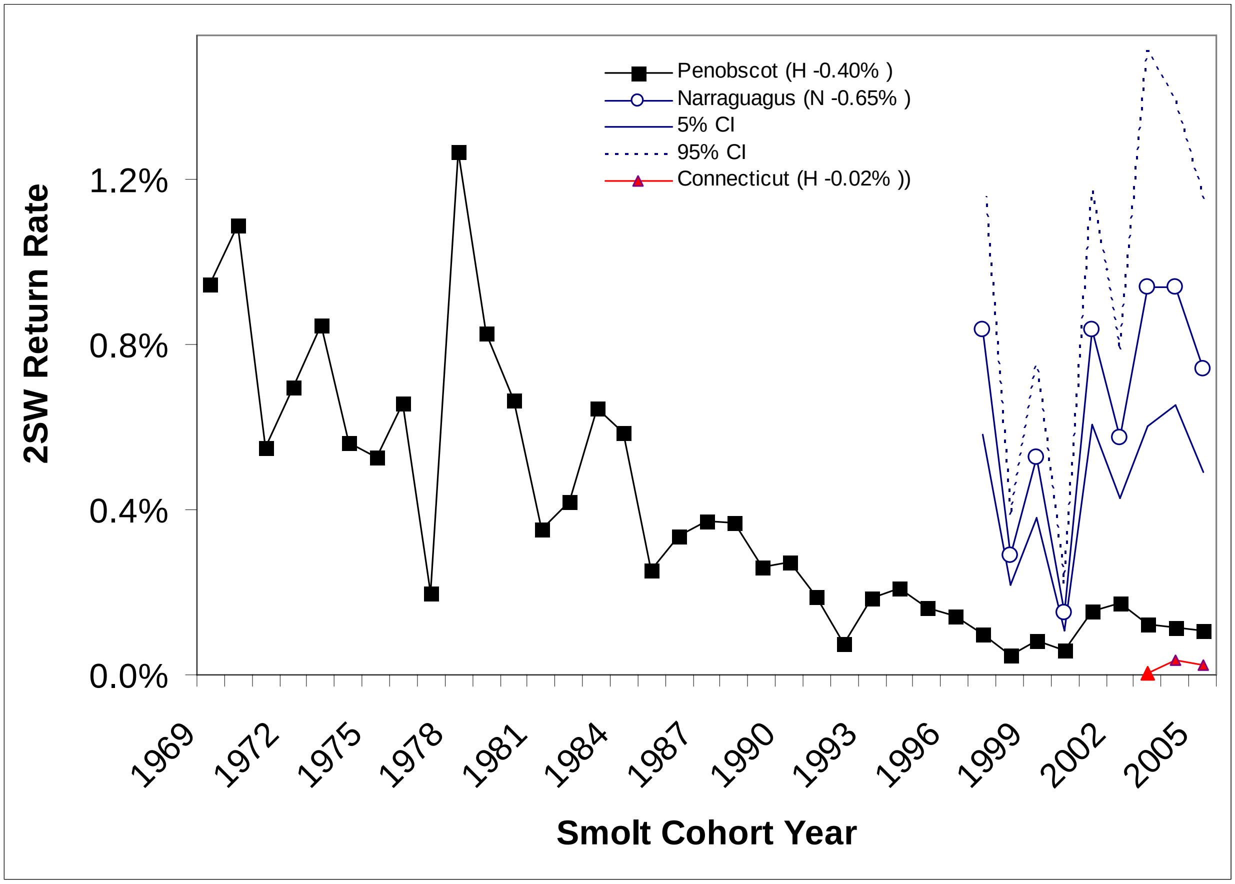


Figure 2.2 Return rates of 2SW Atlantic salmon from the Connecticut, Narraguagus, and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and Connecticut populations and from estimated smolt emigration from the Narraguagus River population.

3.0 Program Summaries

3.1. Connecticut River

3.1.1. Adult Returns

A total of 141 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 107 on the Connecticut River mainstem, 7 in the Farmington River, 6 in the Salmon River, and 21 in the Westfield River. The spring run lasted from May 8 to July 6. Five of the salmon were captured in October. A total of 129 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS). One of the Salmon River returns was observed by snorkeling and never captured.

Ten salmon were radio-tagged and released above Holyoke and an additional salmon was known to have escaped Holyoke. Of the ten radio-tagged fish, five passed the Turners Falls and Vernon fishways. Two of these salmon were trapped at the USACE salmon trap and transport facility at Townshend Dam on the West River and transported above the dam. Three of the tagged salmon passed the Bellows Falls fishway, two of these entered the Williams River and one entered the White River. Five radio-tagged salmon migrated to the Deerfield River.

Nineteen of the returns observed were of hatchery (smolt-stocked) origin, all of which were 2SW. The remaining 122 salmon were of wild (fry-stocked) origin. Sea-age distribution of the wild salmon was one grilse, 120 2SW, and one 3SW. Freshwater age distribution of wild salmon was 1+ (12%), 2^+ (84%) and 3^+ (4%).

3.1.2. Hatchery Operations

The program achieved 75% of egg production goals, 64% of fry stocking goals, and 99% of smolt stocking goals in 2007.

During routine disease screening of ovarian fluid from sea-run broodstock spawned at RCNSS, infectious pancreatic necrosis (IPN) was discovered. Eggs from RCNSS had already been moved to the White River National Fish Hatchery (WRNFH), where they were incubating in isolation from other eggs on station. IPN was detected in only two of the broodstock, but the conservative decision was made to destroy all eggs from Cronin to minimize risk. The genotype of the IPN virus is not a typical North American isolate, leading pathologists to hypothesize that the salmon were exposed during ocean migration..

A fin condition survey was conducted in February at Pittsford National Fish Hatchery (PNFH) to evaluate smolts prior to stocking in 2007. Based on this evaluation and length measurements, PNFH produced 2,348 parr (2% of total), 6,275 smolts with fatal fin condition (6%), and 98,889 viable smolts (92%). Parr are those salmon less than 150 mm in total length. Fatal fin condition is defined as severely eroded pectoral or caudal fins. Smolts with fatal fin condition were not included in the stocking database.

A total of 86,000 1+ presmolts is in production at PNFH for stocking in 2008. In October, they were marked with an adipose fin clip and vaccinated with a multivalent vaccine for *Vibrio* and furunculous. The presmolts will be evaluated for size and fin condition prior to stocking. An outbreak of coldwater disease caused mortality and impacted fin condition at PNFH during summer hot weather.

The USFWS has initiated salmon production at the Berkshire National Fish Hatchery (BNFH). The facility is operated by volunteers supervised by PNFH staff. The first year class of approximately 8,000 two-year smolts will be stocked in spring 2008. They were also adipose fin clipped and vaccinated and their fins will be evaluated before release.

Both the PNFH and BNFH presmolts were marked experimentally with calcein by the USFWS Northeast Fishery Center (NEFC). The objective is to test whether the different banding patterns used on different smolt lots are still visible after two years of marine growth.

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.

In March 2007 some egg incubation stacks at RRSFH started to experience high mortality due to coldwater disease. MADFW treated the eggs with chloramine T, which was successful. Fry produced from eggs that were treated had normal summer survival in streams, but fry stocked prior to treatment had very low survival.

The nuisance diatom *Didymosphenia geminata* (Didymo) was discovered in the extreme upper Connecticut River mainstem and the White River in 2007. Extensive public education efforts were undertaken in the hope of limiting its spread. The presence of Didymo in the White River at and upstream of the river water intake for WRNFH led to concern that use of river water for egg incubation could lead to the spread of Didymo during fry stocking. Despite sand filters, ultraviolet disinfection and other existing and proposed biosecurity measures, the decision was made to discontinue use of river water at WRNFH. Instead, additional chillers will be used to attempt to produce fry at the appropriate time for stocking in the absence of cold river water for incubation.

Egg Collection
A total of 11.3 million green eggs was produced at five state and federal hatcheries within the program. Sea-run broodstock produced 723,000 eggs from 95 females held at the RCNSS. A sample of the fertilized eggs from all sea-run crosses was egg-banked at WRNFH for disease screening and subsequent production of future domestic brood stock. These eggs, along with domestic and kelt eggs produced at RCNSS, were destroyed due to the detection of IPN in sea-run broodstock. Domestic broodstock produced 9.4 million eggs from 1,598 females held at RCNSS, WRNFH, Kensington State Salmon Hatchery (KSSH), and Roger Reed State Fish Hatchery (RRSFH). Kelt broodstock produced 1.2 million eggs from 113 females held at RCNSS and North Attleboro National Fish Hatchery (NANFH). Excluding the eggs from RCNSS that were destroyed, 10.2 million eggs were produced.

3.1.3. Stocking

Juvenile Atlantic Salmon Releases
A total of 6.5 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2007. Totals of 855,000 fed fry and 5.5 million unfed fry were stocked into 36 tributary systems with the assistance of hundreds of volunteers. Totals of 98,889 smolts and 2,348 parr were released into the lower Connecticut River mainstem and the Farmington River. Numbers of fry stocked increased over last year but remain far short of totals stocked in prior years and program goals.

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

3.1.4. Juvenile Population Status

Smolt Monitoring
FirstLight Power Resource Services (FLPRS) and the USFWS contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2007. This was the fifteenth 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. FLPRS purchased the Turners Falls hydro project from the previous owner, Northeast Generation Services. The population estimate was 58,000 (+/- 31,000 95% confidence limits). High flows reduced the number of smolts marked and recaptured resulting in wide confidence limits.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 263,000 smolts were produced in tributaries basin wide. Of these, 205,000 (78%) were produced above Holyoke in 2007. 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 247 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 basin by summer heat and drought. The basin wide mean stocking density was 40.6 /100m^2 unit and the mean 0+ parr density was 10.3/unit with a mean first summer survival of 25%. The mean density of 1+ parr was 3.1/unit with a mean survival from stocked fry of 8%. Mean total lengths at capture of 0+ and 1+ parr were 79 and 142 mm, respectively.

Most smolts produced are again expected to be two year olds, with some yearlings and three year olds. The basin wide smolt production estimate for 2008 calculated from expanding electrofishing data from index stations and assumed overwinter survival is 185,000.

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.

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

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

Fifteen Mile Falls Project –TransCanada 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 1,000 wild smolts were captured and trucked below McIndoes Dam for release, fewer than in the two previous years. Smolt movement and behavior near the entrance to the bypass was evaluated using acoustic tags. Additional facility modifications are likely needed to reduce delay and improve efficiency.

Gilman Dam- Planning for downstream fish passage facilities at this upper mainstem Connecticut River dam is underway.

Zemko Dam- This dam on an Eightmile River tributary upstream of two fishways, was removed by The Nature Conservancy and partners.

Raymond Brook Dam- This dam on a Salmon River tributary, was removed by the Connecticut River Watershed Council and partners.

Woronoco Dam- Smolt passage is scheduled for evaluation at this Westfield River dam in 2008 if turbine installation and fishway changes are completed.

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 in 2006. The Agencies and TransCanada are discussing how to proceed.

Fiske Mill Dam- A fish lift, instead of the initially planned Denil ladder, is being constructed at this Ashuelot River dam and is planned for operation sometime in 2008.

Homestead Dam (West Swanzey Dam)- Removal of this Ashuelot River dam was delayed again due to further design discussions and coordination with work to protect and upstream historic bridge. Removal will be in 2008 or 2009.

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

Brockways Mills- Improved temporary downstream passage was in place in 2007, but construction of a permanent facility was again delayed at this Williams River dam.

Slack Dam- A permanent downstream passage facility was constructed at this Black River dam in 2007 and will be operational for the spring 2008 smolt run.

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

3.1.6. Genetics

The USGS Biological Resources Division, through the Conte Anadromous Fish Research Center (CAFRC), again sampled tissue from all sea-run broodstock for genetic monitoring (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. This genetic monitoring will be transitioned from CAFRC to USFWS NEFC beginning in 2008. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

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

The sea run eggs taken were ultimately destroyed due to IPN being discovered in two adult sea-runs. This is a substantial genetic loss to the program both because of the loss of sea-run eggs for fry stocking and the impact on future domestic broodstock.

Marked sea-run families from last year's egg take were stocked in the Williams (274,000) and Sawmill Rivers (60,000) in spring of 2007 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 450 smolts sampled in downstream bypasses at Rainbow, Cabot Station (Turners Falls Dam) and Holyoke Dam in 2007.

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. Completion of the 2004 smolt/2006 adult analysis is anticipated in early 2008 but additional funding is needed to analyze the 2005-2007 smolt samples already collected as well as future samples.

A production scale milt cryopreservation study was conducted at WRNFH by a Norwegian company contracted by USFWS NEFC. The eye up rate was 71% for eggs fertilized with cryopreserved sperm vs. 85% for controls. This is a substantial improvement over past efforts that showed less than 1% eye up using production scale units. Issues remain to be worked out, including cost; however this offers the potential of freezing sea run sperm for gene banking and crossing year classes.

3.1.7. General Program Information

Ongoing budget difficulties faced by program cooperators, particularly the USFWS, have hampered restoration efforts. In 2007, the USFWS Director authorized use of 2006 earmarks, which were carried over into the new budget year, for salmon recovery. This enabled the Fisheries Program to meet minimum funding requirements. Adequate funding of the USFWS Hatchery program is expected in 2008, but Fishery Management Assistance is again under funded. Additional funding is still needed to meet salmon production goals, conduct needed evaluation and research, and to provide fish passage program wide.

The use of salmon egg incubators in school as a tool to teach about salmon, watersheds and conservation continued to expand throughout the basin. The Connecticut River Salmon Association (CRSA) conducted their Fish Friends program at schools in Connecticut. Trout Unlimited carried a similar message to schools in Massachusetts. Several 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 2007-2008 school years 164 schools participated in this type of salmon education in the four states.

3.1.8. Salmon Habitat Enhancement and Conservation

Program cooperators continued their habitat protection efforts in 2007. Dam removal on Raymond Brook restored habitat for juvenile salmon production. The USFS completed five habitat restoration projects on 1.5 miles of stream in the Green Mountain National Forest. NHFG, in cooperation with several partners, completed 2,100 feet of channel restoration work on Warren Brook, a Cold River tributary, which was heavily impacted by flooding in 2005. Additional restoration efforts are planned for 2009. Program cooperators provided additional 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 with the exception of a one-month catch and release season on a portion of the Penobscot River, angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Aroostook, Narraguagus, Penobscot, Saco, St. Croix, Kennebec, and Union rivers, and at a semi-permanent weir on the Dennys River. Fall conditions were suitable for adult dispersal throughout the rivers, and unlike the previous few years, conditions allowed 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 2007, 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 31 May, 2007 to 7 November, 2007. We captured two adults from smolt stocking, identified by scale reading. Neither fish had any marks or tags visible. These included a male two sea-winter fish and a grilse. The one wild fish captured was a two sea-winter female. We did not capture any suspected aquaculture escapees.

No redds were observed on the Dennys River, despite good conditions and surveys covering approximately 80 % of spawning habitat.

East Machias River. Four redds attributed to wild returns were counted during redd surveys in 2007 in Northern Stream and the East Machias River that included approximately 75 % of known spawning habitat. An additional 34 redds were located in Chase Mill Stream where 44 pre-spawn captive reared adults from CBNFH were stocked.

Machias River. We counted a total of 56 redds, covering approximately 75 % of the spawning habitat in the Machias drainage. Thirty-eight of these redds were likely created by the 59 pre-spawn adult captive broodstock stocked in Mopang Stream, at the outlet of Second Mopang Lake. The remaining 18 redds were in different tributaries and likely from wild returns.

Pleasant River. The Pleasant River weir was not operated in 2007. Five redds were found in the Pleasant River in 2007 during surveys of about 80% of spawning habitat. No redds were seen above Saco Falls in the upper watershed. This is the second consecutive year for redds found in the Pleasant River, and in part are likely 2SW returns from the small number of smolts stocked in 2005.

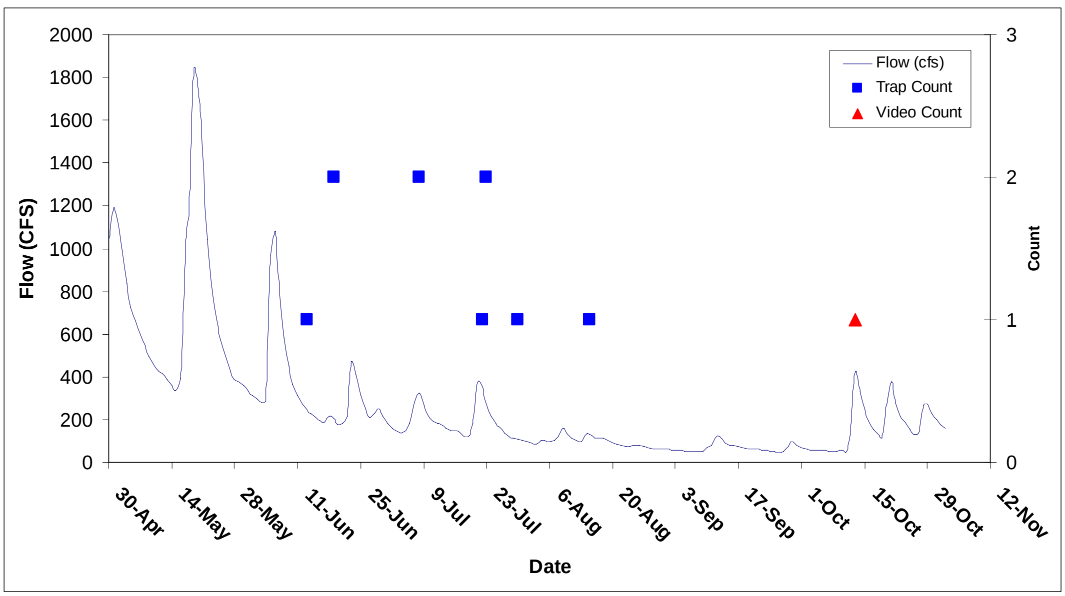
Narraguagus River. BSRFH operated the Cherryfield trap on the Narraguagus from 30 April, 2007 to 1 November, 2007. BSRFH captured two female and five male two sea-winter fish, two grilse, and one unknown of sex (fish was minimally handled under warm water conditions). We did not capture any PIT-tagged fish in 2007. Moderate to low flows reduced opportunity for salmon to jump the dam compared to 2006, and only one fish was detected successfully ascending the spillway dam (Figure 3.2.1). We are unable to determine sex of the fish observed on video.

In 2007, a total of 22 redds were counted during surveys by canoe and foot covering approximately 80% of spawning habitat. Counts were conducted late in the spawning season under ideal flows.

Ducktrap River. No redds were observed during surveys in late November that encompassed 90% of the spawning habitat in the Ducktrap River watershed.

Sheepscot River. The river was surveyed on five dates, focusing on spawning habitat in the upper portion of the mainstem and West Branch. Four redds were attributed to the 61 adults stocked pre-spawn adults from CBNFH.

Cove Brook. No spawning activity was found in Cove Brook during redd surveys in mid and late November 2007 that included all identified Atlantic salmon spawning habitat in the system. This year was the seventh consecutive year where no Atlantic salmon spawning activity was 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 2007 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). Total estimated return for the DPS was 53 (90% CI = 39 - 72) (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 12 generations of Atlantic salmon starting with returns in 1996 from the 1991 spawning cohort averaged 0.7 and the mean replacement rate has not exceeded 1 during this time period. However, in 6 of the 12 years the upper bound of the 90% confidence limits did exceed 1. The replacement rate for 2007 was 1.47 (0.95 - 2.16) 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 adult and juvenile hatchery products to this return rate are not accounted for in this calculation.

Other Maine Atlantic Salmon Rivers

Penobscot River.

A total of 916 sea-run salmon were captured at the Veazie fishway trap during 2007, returning 339 salmon back to the river, marked with an adipose fin punch (AP), or a caudal fin punch (tail punch, UCP). Of these, 30 were recaptured after dropping downstream over the dam and ascending the fishway for a second time and one was recaptured twice. This year's total catch represents a decrease of 129 fish from the 2006 total catch of 1045 sea-run salmon and 69 less than 2005 captures. Of the 916 sea-run salmon returning to the trap in 2007, 260 were 1 sea winter (1SW) fish, or 28% of the total run. The percent of 1SW fish of the total run fluctuates yearly, and while this year's rate is above the mean of approximately 25% for the previous 17 years, it does fall within the range observed over this time period (11% - 48%). The median capture date (all sea ages) for 2007 was June 23, five days later than 2006 and similar to the 1995-2000 time period.

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 2007.

Year	LCI	Mean	UCI
1991	235	294	366
1992	200	247	307
1993	222	264	315
1994	154	192	239
1995	131	162	200
1996	229	284	348
1997	131	165	207
1998	154	200	259
1999	138	175	222
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
2007	39	53	72

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. 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.

During the 2007 trapping season BSRFH, in cooperation with a NOAA-Fisheries study implemented in 2006, continued to document 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 fish with suspected seal bites for further analysis by NOAA staff. Twenty-three fish with suspected seal bites were documented in 2007 at the Veazie trap, representing 2.5% of the seasons run.

Brookfield Power operates the fishway trap at the Weldon Dam on the Penobscot River in Mattawamkeag. The trap is used to enumerate the number of salmon migrating into the East Branch of the Penobscot River. This year, from June 10 through the end of October

60 salmon were captured and released upriver, 10 multi-sea winter fish and 50 grilse; 14 multi-sea winter salmon less than in 2006 and 29 more grilse.

St. Croix River. The research trap at Milltown on the St. Croix operated from 14 May to 27 June 2007. The objective was to enumerate the alewife run and to record other species present during the alewife run. The fishway trap counting ceased operation on 27 June due to funding constraints, but the fishway continued to operate and pass fish, unrecorded, for the remainder of the season. No Atlantic salmon returned to the St. Croix as of 27 June, 2007. One aquaculture origin salmon carcass was removed from trash racks at the dam.

Androscoggin River. BSRFH operated a fishway trap on the Androscoggin River in Brunswick from early May to late October, 2007. A total of 19 Atlantic salmon were trapped and passed upstream. Two additional salmon were captured in the lower portion of the fishway after the lift was closed for the season. These two were released back into the river. Scales were removed from all 21 fish to determine age and origin. However, age and origin had to be estimated for three salmon based on the proportions of hatchery and wild one and two sea-winter salmon among the 18 fish with readable scales. Using these determinations, returns to the Androscoggin River included two wild two sea-winter, six hatchery origin one sea-winter, and 13 hatchery origin two sea-winter salmon.

Aroostook River. The Tinker fish lift and trap was opened on July 6th following the first releases of salmon trapped downriver at Mactaquac and operated until July 29th , when scheduled maintenance of turbine number five eliminated attraction water necessary to operate the fish lift. The Tinker Dam trap catch in 2007 was six Atlantic salmon, compared to 15 in 2006 and eight in 2005.

Kennebec River. In early May 2007 Florida Power and Light (FPL) started operating a newly constructed fish lift at the Lockwood Project in Waterville. The facility was closed at the end of October. This facility was constructed in part to capture adult Atlantic salmon attempting to migrate upstream to spawn. In cooperation with FPL, BSRFH 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. In this second season of operation 15 salmon were captured and successfully moved to the Sandy River. One additional salmon was captured during the replacement of the flash board in the bypass reach when the headpond was drawn down. This fish was also transported to the Sandy River.

Saco River. Florida Power and Light currently operate three fish passage-monitoring facilities on the Saco River. The Cataract fish lift, located on the East Channel in Saco and the Denil fishway-sorting facility located on the West Channel in Saco and Biddeford were operational from early May to late October. Twenty four salmon were observed moving upriver through these facilities. Only visual observations are recorded at Cataract. Thus, the salmon captured at a third passage facility upriver at Skelton Dam in Dayton and Buxton include those observed passing through the Cataract sites as well as those that may have passed without being observed. Fish length is measured, marks noted, and scales taken for fish handled at the Skelton facility. One multi-seawinter adult had an adipose clip and no other visible marks. Eleven salmon were captured at the Skelton Dam and transported by FPL to the Ossipee River and released. The total returns for the Saco are considered to be 24 salmon; however, due to the possibility of adults ascending Cataract without passing through one of the counting facilities the count could exceed 24. Of the 24 salmon counted at Cataract three were wild two sea-winter, 16 were hatchery origin two sea-winter and five were hatchery origin one sea-winter.

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

3.2.2 Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 7.4 million eggs (as compared to 7.0 million in 2006) for the Maine program in 2007: 2.7 million eggs from Penobscot sea-run broodstock; 3.1 million eggs from six captive broodstock populations; and 1.6 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. Spawning protocols for Penobscot sea run broodstock also continue to utilize 1:1 paired matings. The Pleasant River pedigree broodstock line, composed of pedigree-domestic (genetically selected broodstock reared entirely at hatchery) and captive reared components, was spawned for the third time at CBNFH in 2007.

Mean daily water temperatures at CBNFH during spawning ranged from 13.3 to 3.4 C and averaged 7.8 C from Oct. 24 to Nov. 27 2007. This is not significantly warmer than last years daily mean water temperature of 8.7 C (range 11.9-6.7) over the same time period (t-test P=0.08). However, the variance between the two years showed that water temperatures varied significantly, 7.7 vs. 1.8 in 2007 vs. 2006, respectively (F-test p<0.01). Mean water temperature and variance during the 2007-08 incubation period (Nov 28 – Mar 1st) are not significantly different from the previous year (2.7 C, var. 1.5 in 2007-08 and 2.5 C, var. 1.4 in 2006-07) (t-test p=0.36, F-test 0.41). However, incubation temperatures were lower in 2007-08 from Nov. 28 to Jan. 11, and higher thereafter (up to Mar 1st), as compared to 2006-07.

Egg Transfers

All three egg sources (sea-run, captive, and domestic) from the 2007 spawning cohort were used for the Salmon-in- Schools (FWS) and Atlantic Salmon Federation Fish Friends programs. Domestic Penobscot eggs from GLNFH 2007 spawners were transferred to: Saco River Hatchery (604,000); 301,000 to CBNFH for fry supplementation in the Penobscot sub-basin; 224,000 to the BSRFH for egg planting studies. In December 2007, Penobscot sea-run eyed eggs (2,250) from the 2006 spawning cohort were transferred to the USDA National Cold Water Marine Aquaculture Center located in Franklin, ME.

The Wild Salmon Resource Center, located in Columbia Falls, received approximately 50,000 Pleasant River eyed eggs from CBNFH in 2007. In 2007, the Dug Brook Hatchery, operated by Atlantic Salmon for Northern Maine, received eyed 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.

CBNFH Broodstock Collection
Collection of juvenile Atlantic salmon from six DPS rivers for the captive broodstock program at CBNFH continued in 2007. Juvenile Atlantic salmon are collected annually from their native rivers and brought to CBNFH for rearing. In 2007, 1,084 parr were collected from the following rivers: 155 from the Dennys; 150 East Machias; 249 Machias; 102 Pleasant; 256 Narraguagus; and 172 Sheepscot. Domestic parr were retained at CBNFH from two rivers for pedigree-domestic lineages, 1,250 Dennys, and 650 Pleasant. In 2007, GLNFH retained 1,000 fish from the 2006 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 590 sea-run adult salmon were collected from the Penobscot River (Veazie Dam). Of these 590 fish, 315 females and 222 males (15% grilse) were utilized for spawning at CBNFH in 2007. 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
Twenty seven fry stocking trips departed CBNFH from May 1st to May 31st 2007, as compared to Apr. 21st to Jun. 1st in 2006 (Table 3.2.3.1). All GOM DPS fry were released by May 15th, as compared to May 9th in 2006. River discharge during fry stocking was significantly higher and less variable than last year. Overall, the daily discharge to mean daily discharge ratio was 91% (variance 0.12%) in 2007, compared to 60% (variance 0.34%) in 2006 (t-test P=0.02, F-test P=0.01). Water temperature was not significantly warmer at CBNFH (11.9 C, 4.2 var.) compared to the actual river temperature (10.8 C, 7.3 var.) as measured at the start of the daily stocking trip (paired t-test P=0.08). Water temperatures at CBNFH ranged from 8.5 to 15.0 C while river temperatures were 6.0 to 15.5 C over the duration of fry stocking.

Hydrogen ion concentration (pH) was measured at many of the fry stocking locations in 2007. Additional opportunistic samples are also included. The lowest pH recorded at the time of stocking was on the Dennys River (6.1), and the highest was 7.4 in the Penobscot's E.B. Mattawamkeag River (Table 3.2.3.1).

Fry development as calculated by the Developmental Index (DI) (Kane 1987) ranged from 81-135 during CBNFH stocking efforts (82-173 in 2006). Because Penobscot progeny spawn earlier and are stocked later, these fry have consistently higher DI's (112-135) over the captive reared DPS fish (81-108). Overall, mean DI's in 2007 (105) were similar to last years fry releases (104)(t-test P=0.83).

Eggs, Fry, Parr, and Smolt Stocking
During 2007, approximately 6.2 million Atlantic salmon were stocked into rivers of Maine as fertilized eggs, fry, parr and smolts (Table 5). Of this total, fry accounted for 4.8 million of the life stages stocked. The six rivers in the geographic range of the GOM DPS and the Penobscot River received 1.7 and 1.6 million fry, respectively. Fry numbers for the other Maine rivers are as follows: Kennebec (19,800), Aroostook (853,600), Androscoggin (600), St. Croix (400), Union (22,500), and Saco (700). Age-1 smolts were stocked into the Penobscot River (560,000), Dennys (56,500) and Kennebec (80). No age-2 smolts were stocked in 2007. Age 0-parr were stocked in the Penobscot (507,800) and Narraguagus rivers (15,700). Age-1 parr (2,200) from the CBNFH visitor display pool were stocked into the Machias River. Both eyed (45,600) and green (209,000) eggs were placed into the Kennebec River by BSRFH biologists from eggs taken in year 2007.

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

Area	River	Primary Areas Stocked	Release Date (2007)	D.I.'s for groups	CBNFH Water Temp (C)	River Temp (C)	Actual Discharge (CFS)	Mean Discharge (CFS)	Percent of Mean Flow	USGS Discharge Location	USGS Years record
DPS	Dennys-1	Gilman, Curry, Weir	2-May	93	8.9	6.0	321	373	86%	1021200	48
DPS	Dennys-2	Lower Cathance	3-May	89+95	8.9	8.0	261	357	73%	1021200	48
DPS	Dennys-3	Upper Cathance	7-May	86-95	10.3	11.0	186	310	60%	1021200	48
DPS	East Machias-1	Mainstem	10-May	94-108	13.9	11-19	N/A	N/A	N/A	N/A	N/A
DPS	East Machias-2	Crawforn & Round Lake	11-May	96	13.0	12.5	N/A	N/A	N/A	N/A	N/A
DPS	Machias-1	3rd Lake, Old Stream	4-May	91+98	9.2	8.1-9.7	1,980	2,430	81%	1021500	70
DPS	Machias-2	Lower Mainstem	8-May	96	10.5	9.5	1,390	1,940	72%	1021500	70
DPS	Machias-3	Crooked, WB	9-May	91+97	11.8	14.5	1,280	1,880	68%	1021500	70
DPS	Machias-4	Mopang, Crooked, New	15-May	95+103	13.7	8-13	852	1,690	50%	1021500	70
DPS	Narraguagus-1	Gould, Baker, Upper Mainstem	7-May	100	10.3	9-12	598	712	84%	1022500	59
DPS	Narraguagus-2	Mainstem	8-May	85	10.5		539	715	75%	1022500	59
DPS	Narraguagus-3	Deblois, Bog Brook	9-May	95+102	11.8	14.0	493	699	71%	1022500	59
DPS	Narraguagus-4	Crane Camp, Honeymoon, Powerline	10-May	99	13.9		455	670	68%	1022500	59
DPS	Narraguagus-5	WB NG, Sprague, Spring River	11-May	101+107	13.0	15.5	426	655	65%	1022500	59
DPS	Pleasant-1	Saco Falls to Weir	14-May		13.1	14-15	N/A	233	N/A	1022260	17

Table 3.2.3.2. River pH conditions for stocking events from CBNFH in 2007.

Date	pH	HUC 12 Name	Long	Lat
3-May-07	6.4	Cathance Stream	67.3395	44.9058
3-May-07	6.4	Cathance Stream	67.2671	44.8870
3-May-07	6.4	Cathance Stream	67.3171	44.8851
1-May-07	6.5	Dennys River	67.2328	44.8932
2-May-07	6.1	Dennys River	67.2969	44.9345
2-May-07	6.4	Dennys River	67.2664	44.9004
7-May-07	6.4	Dennys River	67.3149	44.9666
1-May-07	6.2	East Machias River	67.3885	44.7391
11-May-07	6.4	East Machias River	67.3990	44.7652
1-May-07	6.5	Gardner Lake	67.3610	44.7565
11-May-07	6.8	Round Lake	67.5872	45.0103
9-May-07	6.6	Crooked River	67.8693	44.9260
4-May-07	6.3	First Machias Lake	67.8636	45.0893
1-May-07	6.2	Machias River	67.5241	44.7246
9-May-07	6.5	Machias River	67.8729	44.9572
4-May-07	6.5	Old Stream	67.7495	44.9475
2-May-07	7.0	Medomak Pond	69.3695	44.2730
7-May-07	6.4	Beddington Lake	68.1063	44.9061
7-May-07	6.4	Beddington Lake	68.1160	44.9610
1-May-07	6.3	Narraguagus River	67.9381	44.6085
9-May-07	6.4	Narraguagus River	68.0126	44.7860
9-May-07	6.7	Narraguagus River	68.0140	44.7387
1-May-07	6.6	Sheepscot River (2) at Gauging Station	69.5542	44.2560
1-May-07	6.5	Sheepscot River (3)	69.6162	44.1040
2-May-07	6.9	Sheepscot River (3)	69.6228	44.1694
1-May-07	6.9	West Branch Sheepscot River	69.5761	44.2419
2-May-07	7.3	West Branch Sheepscot River	69.4948	44.3930
2-May-07	7.1	West Branch Sheepscot River	69.4948	44.3930
2-May-07	7.1	West Branch Sheepscot River	69.5172	44.3761
2-May-07	6.3	West Branch Sheepscot River	69.5419	44.3169
2-May-07	7.1	West Branch Sheepscot River	69.5647	44.2964
1-May-07	5.8	Spring River Lake	68.0577	44.6095
17-May-07	7.4	EB Mattawamkeag River (3)	68.0275	45.8835
17-May-07	7.1	Mattawamkeag River (1)	67.9861	45.8301
18-May-07	6.9	Kingsbury Stream	69.5064	45.1553
14-May-07	6.4	West Branch Piscataquis River	69.6013	45.2832
15-May-07	7.2	Seboeis River (2)	68.6241	46.0615

Adults
River-specific broodstock reared at CBNFH are routinely released into their natal rivers based on water constraints at the hatchery, individual contribution of each broodfish to stocked progeny, and the need to maintain adequate numbers of broodstock to meet production and other genetic goals. In 2007, excess broodstock were released pre-spawn to the Sheepscot (61), East Machias (44), and Machias (59). For the second year BSRFH conducted experimental pre-spawn release of gravid adults into Hobart Stream, near Dennysville, ME. The origin of these pre-spawn releases into Hobart were Dennys (31), Narraguagus (49).

Post spawn releases included sea run and captive reared broodstock from both CBNFH and GLNFH (Table 6). Following spawning, 567 Penobscot sea-run broodstock were released in the Penobscot River in 2007. 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 905 excess adults, comprised of four and three year old domestic broodstock, into the Penobscot River. GLNFH released 26 of these same Penobscot broodstock into the Kennebec River. The remaining 5 and 6 year old DPS broodstock at CBNFH were released into their natal rivers: Dennys, 31; East Machias, 100; Machias, 178; Narraguagus, 179; and Sheepscot, 87.

3.2.4 Juvenile Population Status

BSRFH conducts electrofishing surveys to monitor abundance of Atlantic salmon juveniles using three sampling approaches. The first is to continue estimating density at index sites on each river to maintain a spatial and temporal record of juvenile abundance. The second method provides a basin-wide population estimate of juvenile salmon (BGEST). The third is a catch per unit effort (CPUE) method based on standardized wand sweeping protocols for a specified time period, typically 300 seconds of wand time. 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 2007 were added to the USASAC Juvenile Salmon database.

MASC estimated parr and/or YOY density 159 sites (Table 3.2.4.1). BSRFH also determined relative abundance at 211 sites (19 not reported because efficiencies were low) using the CPUE method (Table 3.2.4.2). An additional 37 sites were visited to determine presence and absence of juvenile salmon. 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 and 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).

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 (1991-2007), 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 3.2.4.1. Minimum (min), median, and maximum (max) large parr Atlantic salmon population densities (fish/100m^2) based on multiple pass electrofishing estimates in selected Maine Rivers, 2007.

Drainage	Min	Median	Max	n
Penobscot	0.00	0.00	0.00	11
East Branch Penobscot	0.00	0.00	0.00	2
Mattawamkeag	0.00	0.00	0.67	11
Piscataquis	0.00	0.75	33.73	21
Kennebec	0.00	0.00	1.26	17
Dennys	0.69	3.27	7.65	8
Ducktrap	6.18	6.19	8.56	3
East Machias	0.00	1.50	21.64	11
Machias	0.00	4.18	22.32	11
Narraguagus	0.00	2.33	17.94	20
Passagassawakeag	0.00	0.00	0.00	1
Pleasant	0.34	5.87	16.44	5
Sheepscot	0.00	1.99	50.27	16
Saco	0.00	1.03	2.07	2
Aroostook	0.00	0.00	1.64	18

Table 3.2.4.2. Minimum (min), median, and maximum (max) relative abundance of large parr Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2007.

Drainage	Min	Median	Max	N
Lower Kennebec	0.00	0.00	2.60	27
Dennys	0.00	0.20	0.40	4
East Machias	0.00	0.70	2.80	44
Grand Manan Channel	0.00	0.00	0.00	14
Machias	0.00	0.58	2.29	41
Narraguagus	0.00	0.94	5.05	19
Pleasant	0.19	1.10	2.12	4
Penobscot	0.00	0.29	0.59	2
Piscataquis	0.00	0.38	2.51	37

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. Today, RST operations in the Penobscot basin are conducted by DMR on the Pleasant River, which is a tributary of the Piscataquis in the Penobscot River basin. Three RSTs were deployed in 2007 which fished 1 May to 1 June. A total of 1,271 smolts were captured during RST operations in 2007, 1,103 (86.8%) of which were marked with a ventral clip, indicating that the fish were stocked as age 0+ parr. Of the 1,103 marked hatchery fish captured, 9% were stocked as fall parr in 2005 and 91% were stocked as fall parr in 2006. The age distribution of naturally reared smolts was as follows: 1% were age 1+, 90.3% were age 2+, and 8.7%were age 3+, based on reading 103 scales. Naturally reared smolts averaged 161.5 ± 8.9 mm fork length (n = 93) and 40.7 ± 7.5 g wet weight (n = 93) (Tables 3.2.4.3 and 3.2.4.4 and Figures 3.2.4.1 and 3.2.4.2). Genetic samples (n = 273), and gill biopsies (n = 46) were also collected from fish trapped during field operations. Gill samples are being analyzed by USGS.

Sheepscot River. Two RSTs were deployed on the Sheepscot River in 2001, 2002, and 2004-2007. The two RSTs below Head of Tide Dam in 2007 captured 527 smolts, 174 of which were marked with an adipose clip, indicating that they were released in 2005 or 2006 as age 0+ fall parr. At this point, scale analysis is unable to differentiate between the two groups. Fall parr released in 2004 were unmarked, but it is assumed that all of these parr had left the system already. A subsample of smolt scales was used to determine the proportion of ages of naturally reared smolts collected at the traps. These data were also used to determine mean fork length and weight by smolt origin (Tables 3.2.4.3 and 3.2.4.4 and 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+ naturally reared smolts (Table 3.2.4.5). Genetic samples (n =515), gill biopsies (n = 137), and scale samples (n = 504) were collected from fish trapped during field operations.

A dual-frequency identification SONAR (DIDSON) was deployed in the Sheepscot River from April 25 to May 20 as part of a feasibility study to identify migratory fish. The unit was deployed downstream of the rotary screw traps from the eastern river bank with its beam perpendicular to the river flow. Reviews of data concentrated on the period from May 8 to May 20, the peak of the smolt run as indicated by trap catch. Due to the large schools of alewife in the river during the day, it was impossible to identify or enumerate fish. Therefore, data review was limited to the hours between 9:00 PM and 5:00 AM. Atlantic salmon smolts, eels (American eels and Sea lamprey) and alewife were identified using size, swimming direction, and swimming behavior. All other fish were categorized as fish smaller than 45 cm or fish equal or larger than 45 cm (which would include adult salmon, American shad and striped bass). Smolts were enumerated, while eels, small fish, and large fish were indicated by presence/absence.

During the period of May 10 to May 20, investigators documented 212 smolt-like images. All of these smolts bypassed the rotary screw traps and swam through the acoustic beam during the night. During this period a total of 264 smolts were collected in the traps. Eels were present throughout each night from May 8 to May 13, and this coincides with the dates of the largest RST catches of eels. Small fish and large fish were present throughout each night during this period as well. The presence of small fish, large fish, and eels was intermittent during the other nights during the study period.

Narraguagus River. Atlantic salmon smolts have been monitored on the Narraguagus River since 1996, with NOAA staff generating population estimates since 1997. In 2007, assessments continued using four RSTs by NOAA field staff and two RSTs by DMR field staff at three different sites. The DMR sites were located above Beddington Lake (river km 47.69). The NOAA sites were below the lake (river km 11.16 and 7.65). Of the 237 smolts captured upstream of Beddington, 198 were marked and released 2 km upriver. Sixty-five of these smolts were recaptured at the Beddington traps, and using several different methods of population estimation, we estimated upstream production to be less than 1,000 smolts. A population estimate for the entire river was made using a Darroch MLE. The 2007 Narraguagus River smolt estimate of 1,239 ± 133 is the lowest estimate since the inception of rotary screw trapping in 1997 (Figure 3.2.4.3).

A total of 559 smolts were handled, measured and sampled by NOAA staff. Of the 132 scale samples collected from naturally reared smolts, 129 (97.7%) were readable which revealed the following age distribution: 86.6% were age 2+ and 13.4% were age 3+ (Table 3.2.4.5). Age 2+ smolts averaged 167.6 ±14.5 mm fork length and 48.6 ± 12.1g wet weight (Tables 3.2.4.3 and 3.2.4.4 and Figures 3.2.4.1 and 3.2.4.2). The majority of Narraguagus River smolts are found to be naturally reared, with only 17 smolts found to be from parr stocking in fall 2006. The naturally reared smolts varied little in size to smolts of previous years. Genetic (n = 483) and gill biopsy samples (n = 81) were also collected from a sub-sample of the fish trapped during field operations.

Smolt Run Timing In 2007, smolts on the Sheepscot River began their migration approximately a week and a half later than in past years, while run timing on the Narraguagus River was similar to Narraguagus run timing of 2004 and 2005 (Figure 2.3.4.3). The smolt run on the Narraguagus in 2006 began around a week and a half earlier. The median of the Sheepscot migration, according to rotary screw trap catch data, was on ordinal day 130, which was similar to 3 of the 5 previously sampled smolt runs. The median of the smolt run in 2002 and 2006 was approximately 10 days earlier (Table 3.2.4.6). On the Narraguagus River, the median of the 2007 smolt run occurred on ordinal day 130. The median of the run ranged from day 124 to day 143 over the 11 years of rotary screw trapping on the Narraguagus (Table 3.2.4.6).

The cumulative catches of naturally reared smolts in the Sheepscot River and the Narraguagus River show that in previous years naturally reared smolts had a tendency to migrate earlier in the southern end of their range. The smolt run occurred earlier on the Sheepscot River than on the Narraguagus in years or rotary screw trapping which supports the hypothesis presented at the United States Atlantic Salmon Assessment Committee in 2004, that latitude affects smolt run timing. In 2006, the Sheepscot exhibited approximately the same start date as in the past. However, the Narraguagus River smolt run began almost two weeks earlier. In 2007, the Narraguagus smolt run appeared to be more typical of years previous to 2006, but the Sheepscot run began later than usual. For years 2006 and 2007, the run timing of the two rivers was more similar than in other years. In addition, the difference in median run date on the Narraguagus and Sheepscot Rivers was smaller in 2006 and 2007 than in any of the previous years.

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+ naturally reared	
River	2007	3 year average (2004-2006)	2007	5 year average (2002-2006)
Narraguagus	137.9±9.5 n=17	N/A	167.6±14.5 n=111	168.5±14.7 n= 2430
Penobscot*	135.9±12.2 n=101	142.0±17.9 n=72	161.5±8.9 n=93	169.1±15.3 n=134
Sheepscot**	Information not available	160.1±29.5 n=84	184.5±19.0 n=97	181.7±21.3 n=390

* Years 2004-2006
**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	2007	3 year average (2004-2006)	2007	5 year average (2002-2006)
Narraguagus	25.3±5.5 n=17	N/A	46.8± 12.1 n=111	48.3± 13.7 n=1811
Penobscot*	22.9±6.5 n=101	26.0±9.6 n=71	40.7±7.5 n=93	43.1±10.1 n=133
Sheepscot**	Information not available	46.8±26.6 n=83	65.8±19.7 n=97	62.1±19.9 n=390

* Years 2004-2007
**Not sampled in 2003

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

	2007			5 year average (2002-2006)		
River	1+	2+	3+	1+	2+	3+
Narraguagus	0%	86.6%	13.4%	0.1%	89.7%	9.3%
Penobscot*	1.0%	90.3%	8.7%	0.5%	91.6%	7.9%
Sheepscot**	0.9%	89.0%	10.1%	0.6%	96.9%	2.5%

* Years 2004-2006
** Not sampled in 2003

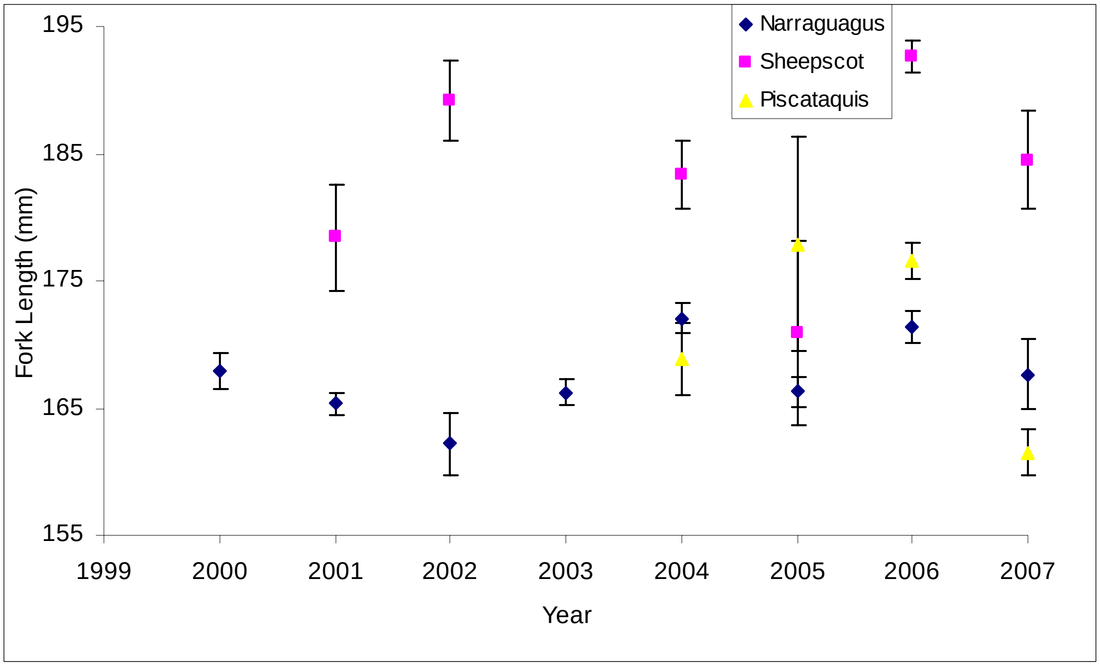


Figure 3.2.4.1. Mean fork length (mm) of age 2+ smolts collected in selected Maine Rivers, 2000-2007.

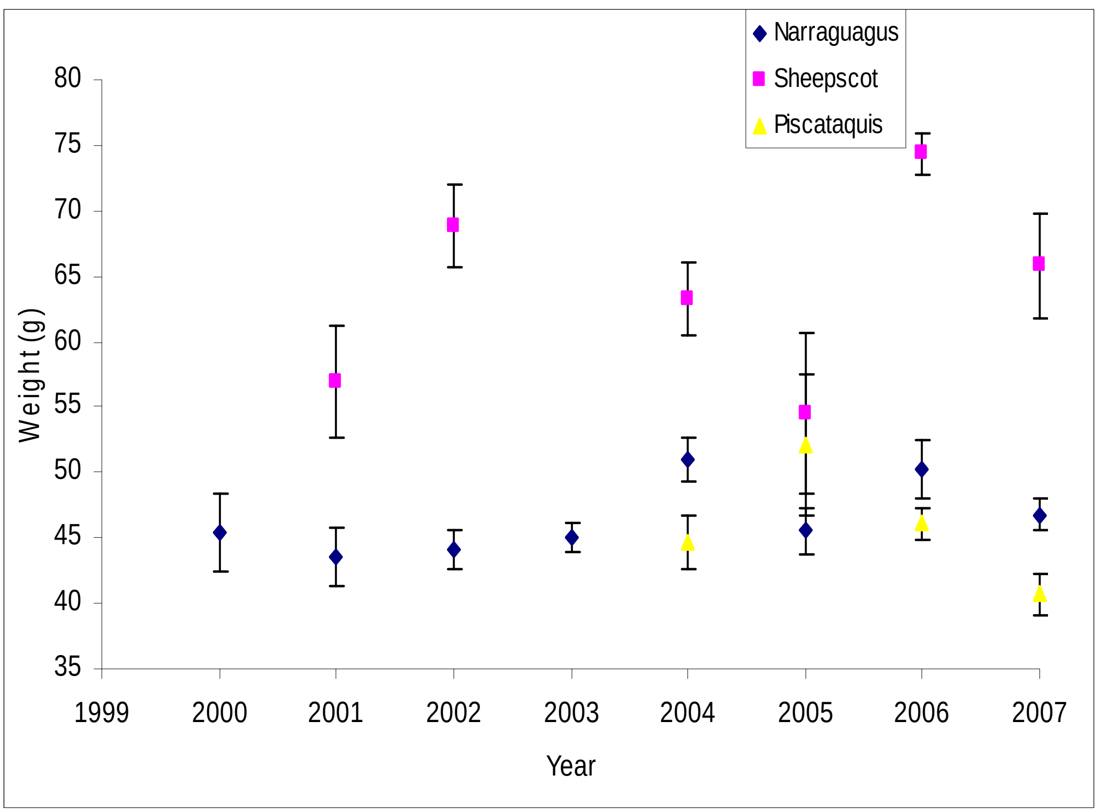


Figure 3.2.4.2. Mean wet weight (g) of age 2+ smolts, collected in selected Maine Rivers, 2000-2007.

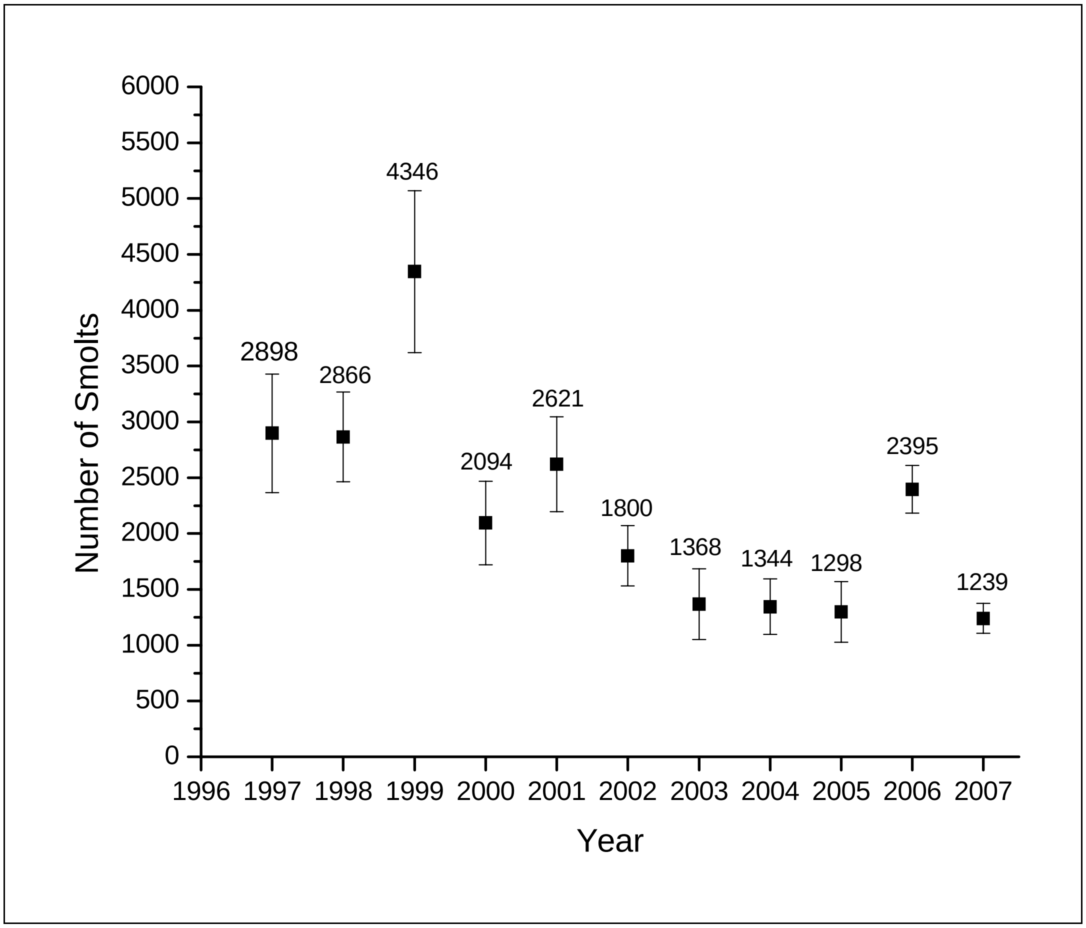


Figure 3.2.4.3. Population estimates (± Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to2007.

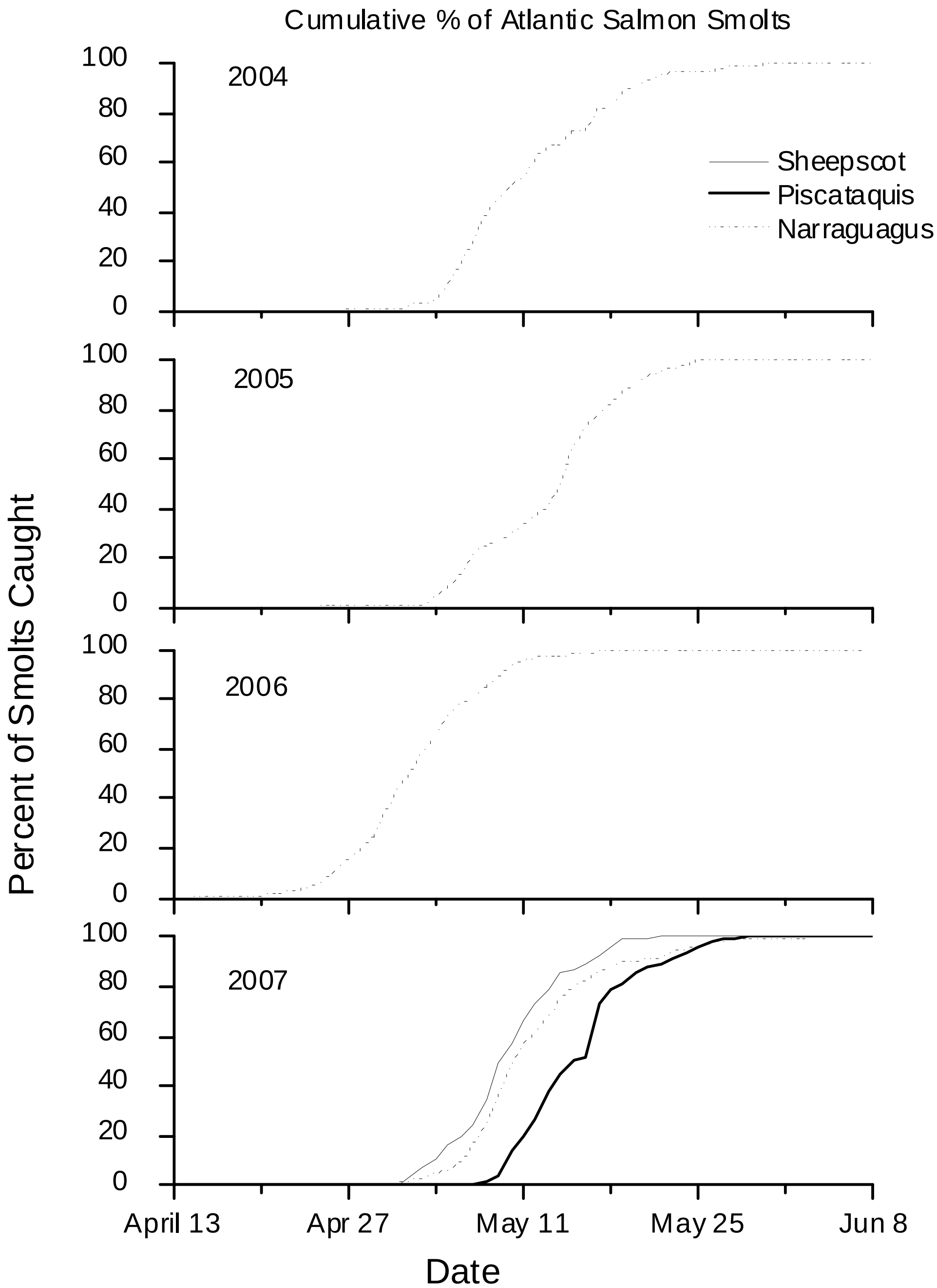


Figure 3.2.4.4. Cumulative percentage smolt catch in Rotary Screw Traps by date (run timing) on the Narraguagus and Sheepscot Rivers, Maine, for years 2004 to 2007. The Piscataquis traps did not fish in 2004**.**

Table 3.2.4.6**.** Ordinal day (days from January) of median smolt catch in rotary screw traps on the Narraguagus and Sheepscot Rivers, 1997-2007.

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

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 traditional tidal power projects in the GOM DPS. One project includes constructing a tidal dam across Little Machias Bay (Cutler Tidal Power Project) and the second, a tidal dam across Half Moon Cove in Cobscook Bay (Half-Moon Cove Tidal Energy Project). The Half Moon Cove project has received a preliminary FERC permit and the Cutler project is application is currently pending before FERC. Four applicants are proposing to use proprietary underwater tidal power generating units not yet commercially available at seven sites. The general locations of the projects are 1) near Verona Island in the Penobscot where 100 Tidal In Stream Energy Conversion (TISEC) devices would be located; 2) near The Chops on the Kennebec (50 TISEC units); 3) Western Passage in Passamaquoddy Bay (55 Underwater Electric Kite (UEK) units); 4) Western Passage (different location - 80 to 120 Ocean Current Generation (OCGen) modules); 5) Cobscook Bay (100 to 150 OCGen modules); 6) Castine Harbor (3 to 50 Tidal Energy 1 (TidE1) devices); and 7) Bagaduce River at the Narrows (1 to 21 TidE1 devices). FERC has issued preliminary permits for all projects except the project on the Kennebec.

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 facilities on the Kennebec at Lockwood (Florida Power and Light (FPL)), Hydro Kennebec (Brookfield Power), Shawmut (FPL), Weston (FPL), and Anson and Abenaki (Madison Paper Industries); on the Sebasticook River at Benton Falls (Benton Falls Hydro Associates), Burnham (Ridgewood Maine Hydro Partners), and Fort Halifax (Florida Power and Light) projects, and replacing culverts on highways and logging roads. On the Presumpscot River, a Settlement Framework Agreement has been negotiated as a prelude to an agreement which would provide for passage at one FERC non-jurisdictional dam and at five additional hydro power dams. On the Narraguagus River, DMR-BSRFH and partners have 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 2007, DPS broodstock (collected in 2006) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

3.2.7 General Program Information

Maine Atlantic Salmon Commission

The Maine Atlantic Salmon Commission (MASC) is a three person group (the Commissioners of Department of Marine Resources (DMR) and Inland fisheries and Wildlife, and a public member) that has management authority for Atlantic salmon in Maine waters. This Commission meets quarterly. However, as of July 1 2007, the MASC staff responsible for providing the Atlantic the Commission fisheries assessment data on which to base management and policy decisions was merged with staff of the DMR Stock Enhancement Division. Pat Keliher is the director of the Bureau of Sea Run Fisheries and Habitat formed in the consolidation.

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. A team of six scientists (Ian Fleming, Kerry Naish, David Secor, Scott McKinley, Lee Blankenship, Deborah Brosnan) was convened to review the Maine program during a three-day visit to Maine in February 2007. The visit 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 were 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 was distributed in May 2007, but has yet to be posted on the SEI website. Recommendations addressed approach and governance, adaptive management, river specific stocking, hatchery operations (including broodstock genetics management, and release strategies), assessment, and research.

Changes in Governance

In response to the hatchery review recently conducted by Sustainable Ecosystems Institute (SEI), the state and Federal agencies responsible for managing Atlantic salmon in Maine are developing a new governance structure for the Maine Atlantic salmon program. The new governance structure addresses needs highlighted by SEI such as (1) the hatchery program should be more fully integrated with the recovery program; (2) the agencies should develop a conceptual framework for recovery; and (3) this framework should guide all recovery efforts. The new governance structure is replacing the Maine Atlantic Salmon Technical Advisory Committee and the Recovery Team. It is based on an agreed upon recovery framework with the intent that: 1) recovery and restoration are done in accordance with the framework; 2) the framework and the program are based on best available science; 3) resources are made available to implement those actions or measures agreed to in any given cycle; 4) there is dispute resolution and continuity throughout the year; and 5) horizontal and vertical communication among and within agencies will improve. Action Teams related to estuarine, marine, and freshwater survival and production, conservation hatcheries, managing genetic diversity, population assessment, and outreach are the key component of the new Atlantic salmon program. Action Teams have just started the process of identifying the highest priority research and management actions to recover the Gulf of Maine Distinct Population Segment of Atlantic salmon.

Penobscot Fishery
An experimental one-month fishery occurred on the Penobscot River, Maine from 15 September to 15 October 2007. The BSRFH staff had the authority to close the fishery during the open season as necessary to protect the resource. The primary criterion for temporary closures was river temperature and the fishery was closed for one day early in the season, when river temperatures exceeded 68 F (20 C). The 2007 experimental had the same regulations as the 2006 season:

- 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 90 licenses were sold, with about one third of the anglers complying with reporting requirements. A total of 83 angler trips were reported. Anglers had the opportunity to fish over at least 31 Atlantic salmon based on the catch of salmon at the Veazie trap. Three Atlantic salmon were captured and released and an additional 10 Atlantic salmon raised/observed.

3.2.8 Salmon Habitat Enhancement and Conservation

Riparian Restoration

Hand labor and large logs were used to stabilize a large eroding bank at a historic log landing on the banks of the Machias River (67.8635 44.9806). This Project SHARE sponsored project was in cooperation with a restoration course at the Eagle Hill Foundation Humboldt Research Institute located in Steuben, ME. A second site, located just downstream, is planned for restoration in 2008.

Habitat Connectivity

In 2007 USFWS and Project SHARE completed 392 stream-road crossing surveys using Vermont assessment protocol (n=19 prior to June) and the new 2007 Maine Road-Stream Crossing Survey protocol (n=373 after June 2007). Surveys included: 380 culverts, 3 open bottom arches, 3 bridges, and 6 abandoned road crossings.

The primary focus area for the culvert surveys was the West Branch Machias River where 188 stream-road crossings were identified. Of these 188 locations, it was determined that 55 crossings had adequate water flow for maintaining fish communities. The remainders were cross-drains. Of these 55 sites, 24 (44%) were classified as barriers to fish, 29 (52%) were potential AOP barriers and 2 (4%) were determined not to impede aquatic organism passage. One of the “potential” barriers was retrofitted with an Open Arch Culvert in 2007. USFWS and Project SHARE staff has plans to conduct fisheries assessments in the remaining 54 West Branch Machias sites in 2008.

In 2007, 13 stream habitat connectivity projects were completed in four Downeast Rivers using funds from USDA-WHIP, USFWS, MASC-SCEP, Project SHARE, Washington County Soil and Water Conservation District, and private landowners. One stream-road crossings (culvert) was completely removed in the Machias River watershed. The remaining 12 projects replaced undersized or failing structures with open bottom arches that spanned 1.2 times bankfull stream width (Table 3.2.8.1). Although the majority of these restoration projects were located above mapped juvenile Atlantic salmon habitat, the Harmon Brook site, in the East Machias watershed, was within mapped habitat. This location is routinely stocked with fry, although stocking was not conducted in 2007 in anticipation of culvert replacement. Pre-construction electrofishing collected 40 salmon parr just above and below the road in Harmon Brook. One restoration site, located 50 meters above the West Branch Machias River, contained both YOY and parr Atlantic salmon during the pre-construction fish removal efforts.

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. Monitoring is done to determine if the projects withstand natural flood and beaver activity threats. Ongoing monitoring of the 27 open arch culverts constructed in Downeast salmon rivers since 2005, have found no failures from high flow events. One open arch location, installed in 2005, was dammed by beavers in 2007. The dam height was about ¾ of the inlet opening and din not affect the structure or road. The beavers were moved by an animal control trapper removed the animals and the dam removed.

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

Watershed	**Stream**	**Previous Culvert (#) @ Diameter (m)**	**Arch Width (m)**	**Arch Height (m)**	**Est. km Opened**	**Long. DD**	**Lat. DD**
Dennys	Venture Brook	1@5.5	6.1	2.5	5.31	67.288	44.904
East Machias	Dead Brook	3@0.9	4.3	1.8	3.06	67.534	45.018
East Machias	Harmon Brook	3@1.1 + 1@1.2	4.9	2.0	7.08	67.616	45.009
Machias	Dunning Brook	1@0.9	3.7	1.5	1.45	67.896	45.067
Machias	Dunning Brook	1@1.2	3.7	1.5	1.93	67.891	45.064
Machias	2nd Machias Lake Trib	1@0.8	4.3	1.8	1.45	67.885	45.052
Machias	Dunning Brook	1@0.6	Removed		2.09	67.890	45.063
Machias	RB Trib.	1@1.2	3.7	1.9	0.48	67.873	44.945
Machias	RB Trib.	1@0.6	3.0	1.6	0.32	67.872	44.940
Machias	Lanpher Brook	1@1.1	3.7	1.5	0.64	67.832	45.048
Machias	RB Trib.	2@0.8	3.0	1.4	0.80	67.880	44.963
Narraguagus	Lawrence Brook	2@0.8 + 1@0.9	4.3	1.8	6.44	67.920	44.645
Narraguagus	Great Falls Branch	6@0.9	4.0	2.0	11.58	67.974	44.728
		TOTAL			42.64		

Habitat Complexity

Maine streams have large wood loads far below predicted levels, and notably low compared to other parts of the United States. Although extensive research has been done on the relationship between Pacific salmonids and wood, relatively little is known about the role wood plays in influencing juvenile Atlantic salmon populations. Two hypotheses were tested in Old Stream, Maine, via snorkel survey in sites with naturally occurring high and low wood densities: 1) the density of juvenile Atlantic salmon was higher in sites that contained high as opposed to low loading of wood, and 2) where wood was available, juvenile salmon tended to be associated with it within a site. LWD was added to two sites, each with a paired control site, in Creamer Brook, East Machias Drainage in October, 2006. Results showed that age 1+ or older juveniles were at significantly higher densities in sites with high wood loading, but substrate coarseness was a more important factor. In addition, a significant proportion of both age 0+ and older juveniles associated with wood in sites where it was available. However, this association also interacted with substrate coarseness and weed cover. These findings suggest that wood is an important habitat feature for juvenile Atlantic salmon, but cannot be viewed in isolation of other habitat factors. In 2007, LWD was added to two sites, each with a paired control site.

Meadow Brook Salmon Rescue

In August 2007, nine adult Atlantic salmon died stranded on a bar in the Penobscot River off Meadow Brook, Bangor, during low tide. In addition, several salmon were rescued. Within one week BSRFH, with the assistance of NOAA Fisheries, had state, city, and federal permits in hand and hired a contractor. The Meadow Brook channel was relocated to prevent stranding in two daytime low tides. During the tide cycle following the initial day's work, over 20 adults used the stream as a thermal refuge and successfully exited as the tide receded. The channel longitudinal profile and three cross sections were surveyed the week following construction.

3.3 Merrimack River

3.3.1 Adult Returns

Seventy-four sea-run Atlantic salmon returned to the Essex Dam, Lawrence, MA and were captured in the fish lift. Captured salmon were transported to the Nashua National Fish Hatchery, NH (NNFH). Sex determination was made for 74 of the salmon, with 32 (43.3.0%) being male and 42 (56.7%) female. Ten salmon died at the hatchery prior to spawning. Fifty-nine salmon were spawned, including 24 (40.7%) males and 35 (59.3%) females. Following the results of tests to ensure the absence of pathogens, 60 salmon were transported to the North Attleboro National Fish Hatchery, MA (NANFH) in fall for reconditioning.

Scales from 74 sea-run Atlantic salmon were analyzed to determine age and origin. Of the 74 sea-run salmon, 60 (81.1%) were of hatchery smolt origin and 14 (18.9%) were of fry origin. Of the 60 hatchery smolt origin salmon, 8 (13.3%) were grilse (1SW) and 52 (86.7%) were two sea-winter fish (2SW). Of the 14 fry origin salmon, one (7.1%) was a grilse, 12 (85.7%) were two sea-winter fish, and one (7.1%) was a three sea-winter fish.

In 2007, adult salmon that returned represented three cohorts: 2002 - 2004. The rate of return, per 10,000 fry stocked, increased in the past three years (2001-2003). In these years the return rates were: 0.027, 0.050, and 0.127, respectively (Table 3.3.1.1). Return rates have improved to levels last seen in the mid to late 1990s. However, current return rates are far below the rates of the late 1970's to the mid 1980's, when returns exceeded one fish per 10,000 fry stocked. Beginning in 1999, fry stocking densities were decreased to approximately one half of what had previously been stocked. Concerns had been raised that density dependent factors were contributing to low parr survival and sea-run returns.

Also in 2007, adult salmon of hatchery smolt origin represented two cohorts: 2005 - 2006. The rate of return per 1,000 smolts stocked in years 2003-2005 was: 0.87, 1.48, and 1.24, respectively (Table 3.3.1.2). Return rates do not differ markedly from rates of return in previous years.

Anglers reported observations of salmon downstream of Essex Dam in the summer months after the fish lift had closed, but origin (sea-run and/or released domestic broodstock) was not known. High water levels in spring and much of the summer and fall may have made it difficult for migrating fish to find the entrance of the fish lift. In addition, the fish lift did not operate for extended periods during spring due to flood flows and resultant debris loading.

Table 3.3.1.1 Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2004.

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/ 2.3	Total Returns		
1994	8	45	0	0	1	54	2,816,000	0.192
1995	19	63	0	5	0	87	2,827,000	0.308
1996	4	23	0	0	0	27	1,795,000	0.150
1997	1	3	0	0	0	4	2,000,000	0.020
1998	2	6	0	0	0	8	2,589,000	0.031
1999	1	4	0	0	3	8	1,756,000	0.046
2000	0	11	0	0	0	11	2,217,000	0.050
2001	2	1	0	0	2	5	1,708,000	0.029
2002	0	6	1	0	-	7	1,414,000	0.050
2003	5	12	-	-	-	17	1,335,000	0.127
2004	1	-	-	-	-	1	1,541,500	-
2005	-	-	-	-	-	-	962,500	-
2006	-	-	-	-	-	-	1,009,325	-
2007	-	-	-	-	-	-	1,140,000	-

Table 3.3.1.2 Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 - 2006.

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	0	74	50,000	1.48
2005	10	52	-	62	50,000	1.24
2006	8	-	-	-	50,000	-
2007	-				50,000	

3.3.2. Hatchery Operations

NANFH shipped a total of 505,087 domestic eyed eggs to Warren State Fish Hatchery, NH (WSFH) on 14 March. Resulting fry were released in the upper Merrimack River watershed during the month of May. High river flows postponed one trip to the Mad River until mid-May, later than the typical stocking date. The hatchery released 658,129 unfed fry in the lower watershed during the period 24 April - 16 May. Fry released in the lower watershed were genetically marked and were composed of 40% sea-run and 60% kelt progeny.

On 26 January and 28 February eyed eggs (115, 445) were shipped to the Green Lake National Fish Hatchery, ME (GLNFH) for smolt production and released downstream of Essex Dam. Eggs were selected at random from most sea-run (10%) kelt (12%), and domestic (78%) females to obtain the greatest genetic diversity.

Egg Collection

Sea-Run Broodstock

Seventy-four sea-run Atlantic salmon were trapped at the Essex Dam in 2007, and 35 females and 24 males were spawned in the Fall. Fish were spawned during the period 25 October - 13 November, and produced 299,264 eggs. The 35 females produced an average of 8,550 eggs each. Approximately 264,933 (88.5% of total) green eggs were shipped to NANFH for incubation/fry production and subsequent release in the lower watershed. Approximately 34,331 (11.5% of total) sea-run eggs were retained at NNFH for broodstock and smolt production, and initial estimates indicate 89% eye-up.

Captive/Domestic Broodstock

A total of 687 female domestic broodstock spawned at NNFH provided an estimated 2,587,181 eggs in 2007. Of the 687 females, 134 were four-year-old and 553 were three-year-old broodstock, respectively. The domestic broodstock spawning season began on 1 November, ended 4 December, and included eight spawning events. Approximately 1.8 million eggs from broodstock were shipped to NANFH during the period 1 November to 15 November. Domestic broodstock eggs were also retained at NNFH 117,214 (4.5%) for smolt production and educational outreach programs.

NANFH spawned 45 female kelts during the period 7 November to 3 December. In total, 511,245 eggs were collected from three year classes, including 2003, 2005 and 2006. Eggs were fertilized with milt collected from reconditioned kelts and broodstock. Kelt reconditioning is on-going with 60 kelts received at NANFH on 7 January.

Sea-run eggs (264,933) transferred from NNFH to NANFH during the period 25 October to 13 November were incubated in isolation while results from ovarian fluid samples were determined to be negative for pathogens. Genetically marked unfed fry will be released in Spring 2008. Domestic eggs (2,469,967) were also received from NNFH on 30 October through 15 November. Approximately 75% of the resulting fry will be released without genetic marks in the Merrimack River watershed, and the remaining fry will be stocked in the Pawcatuck/Wood River watershed in the State of Rhode Island.

3.3.3. Stocking

Approximately 1.2 million juvenile Atlantic salmon were released in the Merrimack River watershed during the period April - June. The release included approximately 1,140,000 unfed fry (NANFH) 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, the Pemigewasset River, also were stocked.

3.3.4 Juvenile Population Status

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.

Yearling Fry / Parr Assessment

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

The seven index sites, established as early as 1982, provide an extensive time series of yearling parr catch-per-unit effort, relative abundance, and density. The sites include a total of 165.4 units (one unit = 100 m^2) of habitat. Sites are located on the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers.

During the period 1994 - 2003 stocking density of fry had been altered at index sites to evaluate population level responses to different stocking rates. Stocking densities had generally ranged from 36 to 96 fry/unit among sites, but in recent years, 1999 – 2007, the densities have ranged from 18 to 48 fry/unit among sites. The results of evaluations of yearling parr at sites suggest that past high fry stocking densities had resulted in density dependent factors that may have adversely affected the growth of parr. Given the shift in 1999 to lower stocking densities, parr abundance presented for index sites in (Table 3.3.4.1) are not representative of a standardized stocking effort in years 1994 - 2007.

Table 3.3.4.1 Estimated statistics for yearling parr per habitat unit at Index Sites (IS) and sample sites in the Merrimack River watershed, 1994 – 2007.

Sample Site	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean	SD	CV
Hubbard		14.1	0.8	3.6	12.8	11.8	2.8	4.9	12.3						7.9	5.4	68
Needleshop			6.1	13.6	5.2	6.4	1.2	1.5	7.6						5.9	4.2	70
Blood								4.8	4.8						4.8	0.0	0
Mid Mad	3.3	2.5					6.7	1.9	7.1						4.3	2.4	57
Smith*	3.3	6.5	7.1	0.9	9.2	4.7	0.9	0.7	2.8	1.0	1.8	2.1	0.9	0.3	3.0	2.8	93
S.B. Piscat.*	3.5	2.8	8.7	3.7	5.5	3.4	1.6	2.1	4.1	0.1	1.2	1.2	1.2	2.1	2.9	2.2	75
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*	3.1	1.8	4.5	0.1	11.7	0.3	0.5	0.1	1.8	0.9	1.5	0.3	1.7	0.6	2.1	3.0	148
Pemi Wood.		4.3	1.4	1.6	2.1	2.6	3.0	0.5	5.3						2.6	1.6	61
Pemi Hist*	0.6	8.8	0.5	1.7	1.2	1.4	4.1	1.1	3.5	2.8	4.7	5.5	2.3	2.6	2.9	2.3	78
Eastman		2.0	1.3	0.8	4.4	1.8	4.6	2.8	2.8						2.5	1.4	54
Lower Mad*	0.6	4.3	1.4	1.8	2.9	3.2	2.5	1.3	3.2						2.4	1.2	50
Beebe*	1.3	1.8	1.8	2.7	3.9	3.0	2.7	1.7	2.1						2.3	0.8	35
U. Baker*	1.9	5.5	2.1	0.8	2.4	1.1	1.4	2.5	2.3						2.2	1.4	62
Baker*	1.0	3.2	2.0	1.4	4.3	1.4	0.7	0.8	4.2	1.5	1.3	4.2	2.8	1.7	2.2	1.3	60
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*	1.8	2.9	0.8	1.2	2.4	0.7	3.0	0.9	2.0	2.2	2.1	1.9	1.7	1.7	1.8	0.7	40
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*	1.6	3.4	0.1	0.0	0.1	0.5	0.5	0.0	1.0	1.4	0.3	0.7	0.1	0.4	0.7	0.9	128
Academy		0.3	0.0												0.1	0.2	141
Select Mean*	2.2	3.9	2.9	1.3	4.2	2.4	1.4	1.1	2.8	1.4	1.8	2.3	1.5	1.3	2.2	1.9	###
SD*	1.4	1.9	2.7	1.0	3.3	1.9	1.2	0.8	1.1	0.9	1.4	1.9	0.9	0.9	0.8	0.9	###
CV*	63	48	92	75	79	82	90	72	38	63	76	84	60	68	37	48	43
Mean															**2.4**	**1.7**	**80**

Impacts of River Obstructions

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

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

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

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

3.3.5 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 and 2007 decreased fish passage efficiency at the dam. Floods in years 2006 and 2007 halted fish lift operations in spring with near record flows approaching 100,000 cfs at the dam. Continued high water in May and June again precluded efforts to clear the fish lift of debris and limited operation of the lift until the mid and later part of the upstream migration period in 2007. As a result of the flood and problems with the fish lift Enel, owner and operator of facilities at Essex Dam, chose to make improvements to the dam.

Enel is replacing 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 will provide a number of operational and environmental benefits including: elimination of impoundment drawdown for flashboard replacement; improved control of upstream water levels in both high and low-flow situations; more effective fish passage as flashboard damage and leakage periods, which provide "false 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.

Throughout the early winter months, and during cold conditions**,** the flashboard cofferdam required for crest gate installation was moved to the last 300-foot section of the dam. Ongoing work consisted of chipping and drilling to prepare for the installation of the structural steel reinforcement in the last section of the concrete foundation. The exterior of the compressor building, and power and communication conduits, have been installed from the existing powerhouse to the compressor building. One-hundred feet of crest air bladders and steel panels in the first of three zones has been installed. Planned activities in the 2007/2008 winter consist of completing the installation of components in the interior of the compressor building, the continuation of the foundation work on the last 300 feet along the crest of the dam, and the installation of additional crest gate sections, providing weather and river flows permit.

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

PSNH will work cooperatively with the USFWS, NHFGD, and USGS to operate the Ayers Island Dam (Pemigewasset River) fish sampler during the 2008 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 2007 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 and have not met program expectations. The first genetically marked year class returned in Spring 2007, and at this time results from the genetic marking program are not yet available.

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

In addition to using river specific broodstock, the Merrimack River program continued to stock Penobscot River smolts (50,000) in 2007 at a site upriver from tidewater. Based on work conducted by the Northeast Fishery Technology Center and Conte Anadromous Fish Lab and as reported by the Center and Lab, genetic relationships among populations of Merrimack, 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 River 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 River population has become slightly genetically divergent from the Penobscot stock, although there is a clear indication of recent shared lineage. Continued directed gene flow, through stocking, of juveniles from the Penobscot River stock into the Merrimack River 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. Accordingly, eyed eggs from the Merrimack River program were shipped to GLNFH for smolt production and subsequent release in the Merrimack River in Spring 2008. Eggs were selected at random from nearly all sea-run (10%), kelt (12%), and domestic (78%) females to obtain the greatest genetic diversity.

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 2007, 479 (age 3 and 4) domestic broodstock were released for the fishery. In Fall 2007, an additional 1,081 (age 2) broodstock were released for a combined total release of 1,560 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. In 2006 and 2007, participation in the volunteer reporting program fell below 10% of the total number of anglers that purchased an Atlantic salmon broodstock permit. A minimum participation level of 10% was determined to be necessary for a meaningful statistical assessment of the fishery. The decline in volunteer angler reporting does not appear to indicate a decline in the popularity of the broodstock program. Permit sales have remained steady in recent years, with a slight increase from 1,395 sold in 2006 to 1,446 in 2006. Data from the 2007 season is not yet available. Permit sales suggest that anglers continue to value this unique opportunity to fish for Atlantic salmon in northern New England. Alternative methods of monitoring the broodstock fishery, such as an online angler reporting system, will be investigated in the future.

Broodstock are known to be captured and killed in the fishery for consumption. 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.

Adopt-A-Salmon Family

The 2007 school year marked the fifteenth year in which the Adopt-A-Salmon Family Program has been providing outreach and education to school groups in ME, NH, and MA in support of Atlantic salmon recovery and restoration efforts. The program is administered by the CNEFRO with support from the NNFH, the Amoskeag Fishways, and a corps of very dedicated volunteers and SCA interns. Most participating schools implement the program throughout the school year with highlights including a visit to the hatchery (NNFH) for a ninety minute educational program in November, and incubating salmon eggs in the classroom beginning in January/February for release as fry into the watershed in the late Spring. In February 2007, 42 schools received 15,910 eggs to be reared in classroom incubators. Throughout the winter and spring, eggs were monitored by students until they hatched. In late Spring, fry were released into the Merrimack River watershed. In November 2007, 1,532 students and 150 teachers and parents from 24 schools throughout central New England participated in the educational program at NNFH. During the visit, participants learned about the effects of human impacts on migratory fish and other aquatic species and observed Atlantic salmon spawning demonstrations.

The Amoskeag Fishways Partnership

The Merrimack River Anadromous Fish Restoration Program continued to be represented in The Amoskeag Fishways Partnership [Partnership (www.amoskeagfishways.org)]. Partners that include PSNH, Audubon Society of New Hampshire, NHFG, and the USFWS continue to create and implement award winning environmental education programs based at the Amoskeag Fishways Learning and Visitors Center (Fishways) in Manchester, NH. With the Merrimack River watershed as a general focus, the partnership is offering educational outreach programming to school groups, teachers, the general public, and other targeted audiences.

Fishways is open throughout the year, offers environmental education programs from pre-school to adult, museum quality exhibits, seasonal underwater viewing windows, family centered special events, live animal programs, and a vacation series for children. Fishways visitation in 2007 was 22,850, including 13,551 students and 9,299 adults. Since its inception Fishways has documented greater than one half-million visitors, and about 6,500 school programs have been delivered to date. School programs taught in 2007 totaled 247 with 94 programs taught offsite. Fishways continues to be an exciting, educational place to attend programs, to see wildlife and fish up-close, and to carry out environmental education and conservation programs. All agencies continue to participate as active members of the Management and Program committees that provide oversight for the Partnership.

The Partnership was formed to create, manage, and oversee educational activities at the Fishways. The four-way collaboration among partners was formed in 1995 to increase visitation to the Fishways by creating new and improved educational programs, expanded year-round hours of operation, and an innovative, hands-on exhibit hall; by strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire; and by broadening the educational focus of the visitor center to encompass more than just the fish passage facility. Grants awarded to the Fishways were funded by Twin City Public Television with National Science Foundation funds, the USEPA, and the Conservation Plate Fund through NHFG, totaling $50,000.

3.3.8. Salmon Habitat Enhancement and Conservation

Habitat Restoration

In 2007, the multi-agency New Hampshire River Restoration Task Force (NHRRTF) continued to work on identifying dams for removal in the state and pursuing strategic alterations and/or modifications of dams. There are two dams in the Merrimack River watershed scheduled for removal, the Merrimack Village Dam, Souhegan River, Merrimack, NH and the Black Brook Dam, Black Brook, Manchester, NH.

Merrimack Village Dam, Souhegan River, NH

During 2007 project partners continued to work on the design, engineering and permitting for the project. Many meetings, both public and informal, occurred during the year to address tasks. Final engineering plans are at 90% and have been reviewed by numerous project partners whom also represent state and federal agencies. Comments have been received and are being addressed. The wetland application is in draft form and is anticipated to be submitted to the NH Department of Environmental Services in February 2008. Historical and archaeological surveys have been completed and reports have been forwarded to the NH Division of Historical Resources. The Merrimack Village Dam was deemed individually eligible for the National Register of Historic Places. The restoration project proposes to remove this historic structure, and as a result, a Memorandum of Agreement (MOA) was developed by project partners, including NOAA which is the lead federal agency. The MOA has been reviewed by the NH Division of Historic Resources, comments have been incorporated and it is currently being circulated for signatures. Based on the proposed estimated cost for the project, all funds have been secured. Funding is being provided by Pennichuck Water Works, a variety of federal and state agencies, and private organizations. The proposed project will go out to bid in early 2008 and it is anticipated that on site work will begin in Summer 2008.

Black Brook Dam, Black Brook, NH

During 2007, project partners continued to work on the design, engineering and permitting for the project. During 2007, the proposed project was presented to the NHRRTF members and additional informal meetings occurred with project partners to address the final design and wetland application. In January 2008, the project consultant and several project proponents met with the City of Manchester, Conservation Commission to present the project and to address concerns and comments. The final engineering plans are at 90% and comments have been received from project partners, NHRRTF, and the City of Manchester, Conservation Commission. Sediment sampling and analysis was completed and further analysis is warranted to determine the impacts (if any) on the benthic community. A large amount of funding has been secured through an EPA grant and from the City of Manchester. The need for additional funding was identified, and federal and non-federal grants pursued are awaiting approval. The project is currently proposed for completion in winter of 2008/2009, and it is scheduled to be removed by NH Department of Environmental Services, Dam Bureau.

Pemigewasset River and Headwater Streams, NH

In the headwaters of the watershed (Pemigewasset River), review continues regarding the removal of a small dam in North Woodstock, NH that would affect juvenile salmon rearing habit. In addition, habitat restoration and protection projects are being coordinated with the staff of the WMNF. One 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. One forty-foot bridge has been purchased and is in use. Plans are in place to purchase two more bridges as funds become available. The second project involves replacing six permanent stream crossings that are currently preventing upstream access to valuable salmon and brook trout habitat. Replacing these crossings will protect downstream habitat and provide access to upstream habitat for salmonids and other aquatic species. Funding has been obtained to replace one of the crossings and funding is currently being sought to replace the remaining crossings.

3.4. Pawcatuck River

3.4.1. Adult Returns

Two Atlantic salmon were captured at the Potter Hill Fishway in 2007. Both female salmon were marked with adipose fin clips.

3.4.2. Hatchery Operations

Egg Collection

Sea-Run Broodstock
Currently, the Rhode Island Division of Fish and Wildlife (RIDFW) have two sea-run Atlantic salmon that were caught in 2007. These fish were spawned in November yielding approximately 9,000 eggs. Milt was provided by the North Attleboro National Fish Hatchery.

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 five, four year old fish and two three year old fish at the Perryville Hatchery.

3.4.3. Stocking

Approximately 120,500 Atlantic salmon fry were stocked in the Pawcatuck River watershed in 2007. Of those, 5000 were fed fry raised at the Arcadia Hatchery. The Salmon in the Classroom program had 30 participating schools and each stocked approximately 200 fry, which were hatched in their classrooms. All of the fry were acquired from the North Attleboro National Fish Hatchery. Also in 2007, 11,260 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 9, 2007. A total of 120,500 fry were released in the tributaries and mainstem of the Pawcatuck River watershed excluding the Wood River and its tributaries. The 5000 feeding fry were released in May, 2007 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.

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

Approximately 11,260, 1 year old smolts were raised at the Arcadia Warmwater Research Hatchery. These smolts were adipose fin-clipped and released in March, April, May, August and September 2007 at various locations in the Pawcatuck River (Table 3.4.3.2). Primarily, the smolts were released in the lower reaches of the river near the salt water interface in Westerly, RI. The average smolt length was 191 mm and average weight was 64 g. The smolts released in the summer months were raised in one of the ponds at the Arcadia Hatchery. They were indicating that they wanted to head downstream at that time so they were released.

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
3/20/2007	Merrimack domestic - Arcadia	Westerly boat ramp	500
3/28/2007	Merrimack domestic - Arcadia	Westerly boat ramp	1172
4/19/2007	Merrimack domestic - Arcadia	Westerly Yacht Club	1767
5/2/2007	Merrimack domestic - Arcadia	Westerly boat ramp	1690
5/29/2007	Merrimack domestic - Arcadia	Westerly boat ramp	600
5/29/2007	Merrimack domestic - Arcadia	Ashaway River	600
8/29/2007	Merrimack domestic - Arcadia	Shannock Falls	508
9/21/2007	Merrimack domestic - Arcadia pond	Roaring Brook	4400
Total			11237

Adult Salmon Releases
No adult broodstock were released into Rhode Island waters in 2007. It was agreed, in 2007, that Rhode Island would receive adult broodstock from the Nashua National Fish Hatchery and from White River National Fish Hatchery for recreational fishing. These fish were acquired in 2008 and their stocking will be reported in next year's report.

3.4.4. Juvenile Population Status

Index Station Electrofishing Surveys
Parr assessments were conducted in the late summer and fall of 2007 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, 2007. All fish were measured to fork length.

Parr, 0 years old, ranged in length from 42 mm to 98 mm, with an average of 60.2 mm. Parr, 1 year old, ranged in length from 105 mm to 200 mm, averaging 143.8 mm. Mean lengths in 2007 were lower than those found in 2006 for 0 year old parr and 1 year old parr. Mean densities of 0 year old parr and age 1 year old parr were 3.8 and 1.8 per 100 m^2, respectively (Tables 2 and 3), an increase over last year. These densities represent an increase in both age classes of parr from 2006. The increase in densities of both year classes is most likely due to an increase in stocking. In 2005 no fry were stocked at all. There are still two stations that are sampled where no fry are stocked. These are both located in the Wood River.

Smolt Monitoring
No work was conducted on this topic during 2007.

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 2007.

3.4.7. General Program Information

No dam removal or fishway construction work was conducted during 2007. Fishway reconstruction is underway at the Bradford Dam. Initial improvements in the area creating a canoe portage have been conducted. The next phase of the project is in progress which will entail a redesign of the leaky fishway to make it fully functioning.

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 2007.

4.0 Terms of Reference and Emerging Issues in New England Salmon

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

The focus topics for this meeting were 1) regional assessment products; ICES terms of reference -2) biological characteristics and 3) marine survival; 4) NASCO Rivers Databases, 5) coastal fish communities, and 6) juvenile production indices, and 7) disease issues.

4.1 Regional Assessment Products

The group discussed the concept of the report as a more integrated regional assessment product in addition to a consolidated assessment report. The committee felt that the core data in the report is coming together quicker, usually prior to the meeting, since the committee established a consolidated Access database. These gains have been made possible by the expertise and stewardship of this database by Dr. John Sweka. His approach of including the group in development and focusing design around relevant questions has made a useful data resource. In addition, having a database leader has made all groups more responsive to populating this database in a timely manner. While the database has been used by USASAC primarily to generate tables for this report, it is rich in information that could be used to develop stock assessment products beyond adult return counts and percentage of conservation spawning escapement. In particular, the incorporation of more juvenile data across the regions, especially in impending incorporation of additional data from the Maine juvenile database may allow opportunities for regional assessment of juvenile indices and development of new metrics. Some examples of regional assessment products were presented and discussed. One example that is particularly salient is a visualization of juvenile density data (Figure 4.1.1). This figure was developed as a stock assessment team was trying to assess the spatial coverage of density data towards developing a sub-regional metric. The figure illustrates several concepts important to the development of regional assessment products: 1) Geographic Information Systems provide perspectives that may not be apparent in examining data tables or graphs and should be useful at a regional level; 2) broad spatial coverage is needed but not always available; 3) data resolution relative to time series is often variable and spatially disparate; and 4) the amount of data already in the databases is of sufficient spatial and temporal scales that more metaanalyses could be undertaken. An additional point, not highlighted in the figure is that combining historically separate databases could provide essential context for analyses. For example, in Figure 4.1.1 an overlay of stocking time series could highlight areas that are not sampled or lightly sampled may have been areas with little or no stocking and no natural reproduction.

In discussions at the meeting, it became apparent that some progress could be made by creating tables or graphs that combine date from different programs when available. For example, the Connecticut and Merrimack programs both report average juvenile survival rates from stocking. However, you have to look in separate sections to find these data. Consolidation of such vital rate information would be of use to both scientists and managers. The USASC believes that the time saved by pre-meeting assembly and the opportunity of having the region's salmon scientists together to graph and visualize data as well as to analyze and discuss provides additional opportunities to use the integrated dataset annually. The USASC felt that this is a large undertaking and should be accomplished over the course of several meetings. Some considerations that the USASAC believed were essential were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New England and NASCO managers for US data, and 3) making sure that as more data is developed and analyzed it was utilized as a tool to rebuild. To this last point, the USASAC recognizes they need to provide core stock assessment information (provide a yardstick of progress) but understands the need to better communicate information to managers as opportunities and threats are recognized (provide rebuilding tools).

The incorporation of new benchmarks and indices should be a thoughtful intellectual pursuit and the committee felt that time to reflect upon proposed indices and metrics would make the final products stronger. As such, the group decided to start an outline of possible metrics that are currently used, could be refined, and ideas for new metrics. Table 4.1.1 is the start of a living document that will be reviewed both intersession and during our annual summer teleconference. It is anticipated that member of Maine's Evaluation and Assessment Action team will utilize this table during development of their work plan and share these results with USASAC and possibly consult with analysts from other programs as well. This table together with better communication of broader regional metrics and comparative analyses should improve the utility and rigor of the annual assessment products.

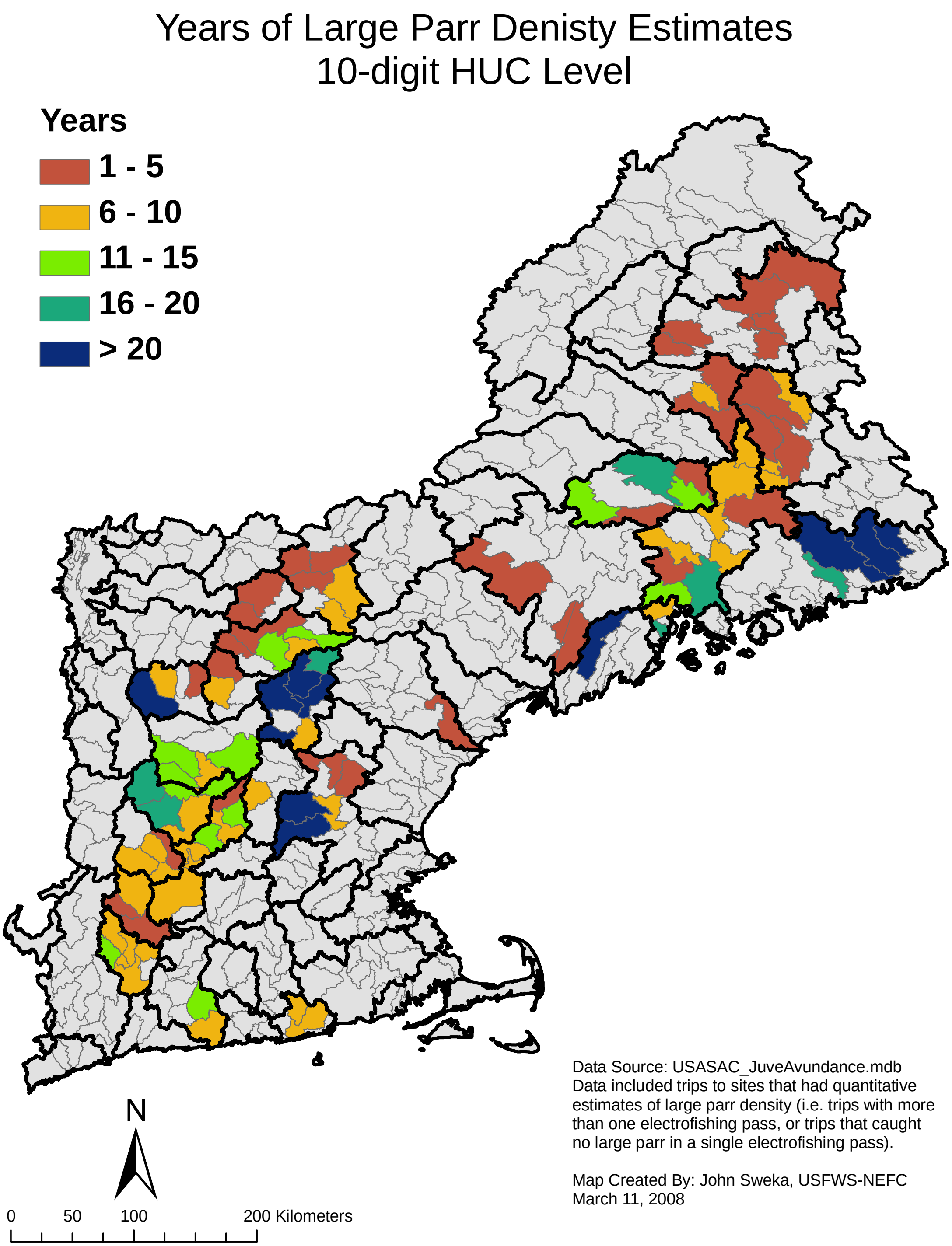


Figure 4.1.1. Map of USASAC juvenile database for New England illustrating the intensity of juvenile sampling data for the last quarter century.

Table 4.1.1 Example of spreadsheet to track and develop regional metrics to better provide a composite of US Atlantic salmon status of stocks and better facilitate comparisons between stock complexes.

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

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

4.2 Biological Characteristics of Smolts and Fecundity of Adults: Presentations and Discussion Topic

4.2.1 2008 WGNAS biological characteristics (WP07-05): Tim Sheehan.

NASCO has requested ICES to address changes in biological characteristics of Atlantic salmon: What biological characteristics have changed over time and how might these be related to declines in marine survival? Towards this goal, a database template was created and distributed to the ICES working group for population. This database will allow analyses to address the above question, and will also allow scientists to formulate additional analyses that should be pursued. Variables that will be examined among stock complexes include size at age, proportion of sexes, and proportion of maiden spawners. Each member will include data from a population or populations with robust time series of the required data, creating a meaningful dataset to address these questions. The United States will need to decide which populations to include, with consideration given to predominant origin of the fish (hatchery or wild), and how representative the populations are of the entire country.

4.2.2 Merrimack River Fry Evaluation and Update (WP07-06): Joe McKeon

We analyzed Merrimack River smolt sizes over time, estimated by back-calculated lengths from scales, and found that smolt size of returning adults has not varied over time and that returning hatchery smolts were larger than wilds smolts. Fry stocking studies indicated that stocking density and stocking location (river) affected size of parr, and is assumed to affect smolt size. Resulting densities of parr were also sometimes related to stocking density, and fish at higher density sites may have experience density dependent growth. We addressed substantial striped bass predation on smolts near dams on the Merrimack by altering management strategies where smolts were stocked lower in the river and earlier in the year in an effort to allow the smolts to emigrate before striped bass arrived in the spring. This strategy appeared to increase survival.

4.2.3 Changes in Penobscot River Atlantic Salmon Fecundity (Presentation): Joan Trial

We examined fecundity of Penobscot River salmon in a preliminary analysis, with fecundity data (total number of eggs per fish length) compared from an 1872 Craig Brook Hatchery report and 2003/2004 data from Craig Brook. Although some variables cannot be accounted for, such as spawn method, the slopes of these two data sets differed statistically. This could be due to genetic changes via domestication or changes in rearing environment. In addition, Machias and Narraguagus River salmon were introduced to the Penobscot population to bolster restoration efforts in the 1970's, and fecundity data from these populations are similar to that observed by Atkins. This suggests that changes in fecundity have occurred in the current Penobscot population since the 1970's.

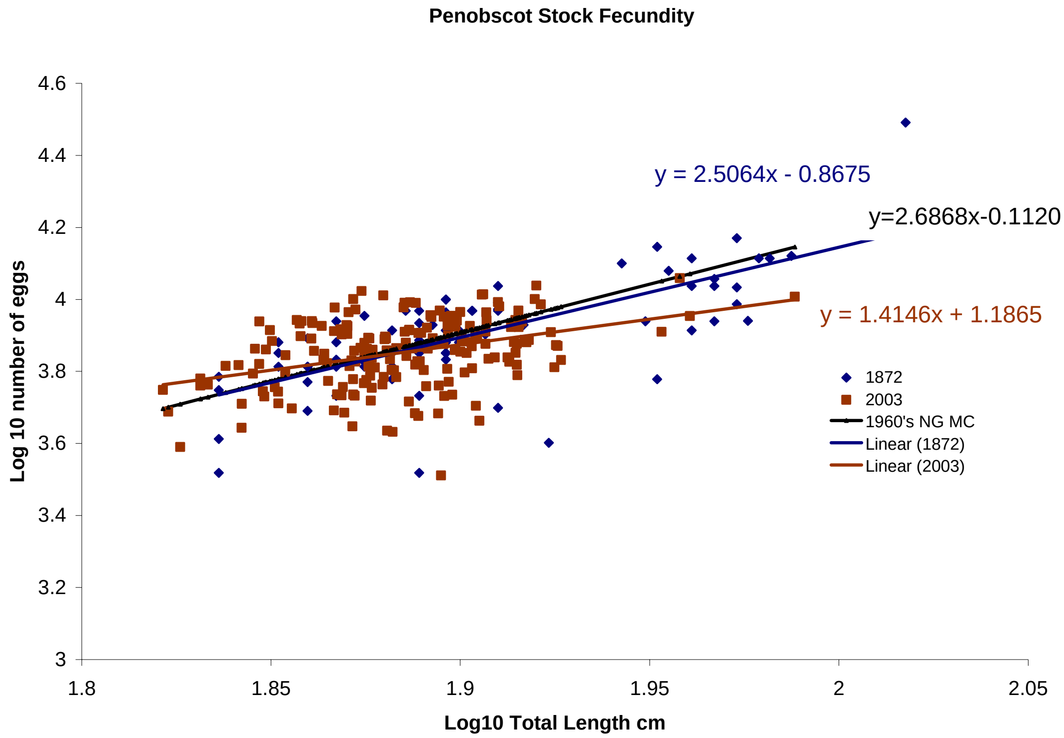


Table 4.2.3.1 Fecundity of individual females measured by Wilkie (2003 & 2004),C.F. Atkins (1872), and output of regression from Baum and Meister (1971) for broodstock from the Narraguagus and Machias rivers used to begin restoration of the Penobscot River.

4.3 ICES Marine Survival

4.3.1 Penobscot River Atlantic Salmon Studies, 2000-2006 – Using VIE Tag Data to Influence Stocking Decisions (Christine Lipsky, NOAA & Richard Dill MEDIFW)
This study was initiated to assess the impact of time and location of release on adult salmon returns in the Penobscot River System. Each year, 550,000 Atlantic salmon 1-year smolts and 200,000 fall (0+) parr were stocked at each of three river sites (Mattawamkeag, Milo, and Howland) on two dates that were at least two weeks apart (early and late releases). The West Enfield Smolt Pond was an additional release site, located near the Howland site. About 200,000 of the released smolts were marked with visual implant elastomer tags (VIE) and adipose fin clips. The marking quality was assessed and corrections for tag color and other factors were made to improve mark recognition. All returning adults were collected downstream at the Veazie trap. Results at all of the sites were variable over time and show an overall decline in returns from 2001-2005. Release date did not impact returns. Release site had an impact on returns. The best results came from smolts stocked at the Milo and West Enfield Smolt Release Pond. The worst results came from smolts stocked at the Mattawamkeag site and these results informed the management recommendation to discontinue releases at this site.

4.3.2 Estuarine and Coastal Migration and Survival of Wild Atlantic Salmon Smolts in Maine Using Ultrasonic Telemetry (John Kocik, James Hawkes, Timothy Sheehan, Paul Music, NOAA, and Ken Beland, Maine Atlantic Salmon Commission)
NOAA used telemetry to assess smolt survival and migratory behavior with the objective of determining survival, speed of passage, behavior and choice of migratory pathway through river, estuary and bay. About 100 wild smolts were collected annually from rotary screw traps in the Narraguagus River and then surgically implanted with Pinger tags from 1997-1999 and 2002-2004. The smolts were collected near the peak of the emigration and were slightly larger than the average outmigrating smolt. The second period of releases coincided with a change of equipment that increased receiver resolution in the estuary and bay. Results indicate a mean transit speed of 0.87 kilometers per hour. The slowest transit speeds were documented in the river (0.38 kilometers per hour) and speed generally increased from the river through the estuary, middle and outer bay. Speed of passage was influenced (decreased) by the number of times the smelts reversed direction while moving downriver. Multiple reversals were possible and did not appear to impact survival. It is interesting that the smolts were observed to move into the bay through a pathway that is narrower than the available options. From 62-74% of the smolts survived to reach the estuary. About 41-54% of the smolts reached the middle bay and 36-47% reached the outer bay alive. Overall about half the salmon were lost as they moved from the river to the outer bay. The tags are generally not recovered so it can only be assumed that the tags may have stopped working (unlikely) or that the smolts have died and been removed from the system. The application for these study results could be to inform management decisions about the timing and location of approved dredging permits, for example, since the speed and migratory behavior is seen to be fairly predictable.

4.3.3 Feeding Ecology of Atlantic Salmon Postsmolts in Penobscot Bay, Maine – Does Origin Matter? (Timothy Sheehan & Mark Renkawitz, NOAA)

NOAA conducted this diet study in concert with a post-smolt trawling survey from 2001-2005 in Penobscot Bay. The trawling survey involved live capture and release of Atlantic salmon smolts in the upper, middle and outer bay and offshore in the Gulf of Maine. A total of 242 out of the 3,843 smolts collected were lethally sampled for stomach content analysis. The origin of these lethally sampled smolts varied. There were seven naturally reared (or wild) salmon (in river 24 months), nine parr (in river 20 months), 32 parr (in river 8 months), and 194 recently released smolts (in river less than one month). Results indicate the overall stomach content or diet composition as follows: 24% Atlantic herring, 24% fish remains, 6% miscellaneous fish, 30% eupausiids, 7% miscellaneous crustaceans, 6% polychaete worms, and 3% other. The diet composition shifts as the fish move from upper bay to the offshore sites. More herring were found in smolts in the upper bay while less herring and more miscellaneous fish were observed in the guts of fish offshore.

The most striking difference in the diet composition depended on smolt origin or how long the salmon had been living and feeding in the wild. Stomach composition for the naturally reared salmon and 20 month parr was about 75% fish whereas less herring and more eupausiids were found in the 8 month parr and hatchery stocked smolts. The diet composition is important because the energy available from different prey items is significant: Atlantic herring 10.6 Kj/g, miscellaneous fish 6.1 Kj/g, euphausiids 3.4 Kj/g, miscellaneous crustaceans 3.2 Kj/g, and polychaete worms 3.7 Kj/g. Generally the stomach weight to smolt weight ratio was higher for smaller fish and lower for larger fish (the hatchery smolts). So, the trend in available energy is greater for the smolts that spent the greatest amount of time in river and the least for the recently released hatchery smolts. In other words, smolt origin matters. It's not clear how much this matters – it is possible that recently released smolts haven't learned to eat live prey fish or that they are less motivated at first because of higher body fat content which might lead to a lag in feeding behavior. Still, these results may hold implications for stocking management and more work is needed.

4.4 NASCO Rivers Database

The Rivers Database on the NASCO website has several sections for each river: rivers (general information), habitat, juvenile production, adult production, and impacts. Previously, the Committee had entered data for all U.S. salmon rivers into the rivers table. NASCO is now requesting countries to enter data into the impacts table. This is a big job that needed simplification and coordination by the Committee if member agencies were to be expected to accomplish it. Prior to the 2008 meeting, an Excel spreadsheet was created in which all U.S. salmon rivers were listed along the top (columns; see example below). The listed impacts from the NASCO database were edited to reduce the number of possible impacts, eliminate overlap, and make the exercise quicker. The editing was mindful of impacts common to U.S. salmon streams. These impacts were listed as rows. This spreadsheet was distributed to each appropriate agency with just the rivers in their jurisdiction. Each agency was asked to enter the number 1 into each cell that represented an existing impact for a particular river. An example of a completed spreadsheet (abridged) is shown on the following page. All completed spreadsheets were merged into one master spreadsheet. These data were brought to the meeting and entry into the NASCO web based database was begun.

The process was slower than anticipated due to the design of the database. For example, the system requires the user to start fresh, repeating lots of common information, for each impact entered for a single river. There is no way to import lots of similar data into the database without a tedious line-by-line entry. This means that it is unlikely that all available impacts data for U.S. rivers will be entered prior to the 2008 NASCO meeting, although data entry will continue after the Committee meeting. Furthermore, it appears that some data previously entered into the Rivers Table for U.S. rivers is no longer in the database. Both of these issues will be raised with the NASCO Secretariat during the 2008 NASCO meeting.

RI IMPACTS SUMMARY

Name: __Veronica Masson____________

Date: __10/25/2007__________________

IMPACTS:		RI RIVERS:	Beaver	Pawcatuck	Pawtuxet	Wood
Acid Deposition:	*acid deposition*					
Added Chemicals:	*irrigation*		1	1		
	aquaculture activities					
	agriculture acitivities					
	discharges from business or industry				1	
Added Nutrients:	*forestry/timber harvesting operations*					
	agricultural operations		1	1		
	discharges from business or industry				1	
	dams, natural debris					

4.5 Emerging Issues – Coastal Fish Communities

Two presentations focusing on Alosid restoration programs in the Gulf of Maine were given at the 2008 USASAC meeting: *Status of Central Gulf of Maine – Alosid Management Initiatives* by Joe McKeon, and *Kennebec River Diadromous Fish Restoration* by Nate Gray. McKeon's program mainly focuses on American shad restoration through culture activities, although they do conduct some adult river herring trapping, transport, and release for restoration in rivers with diminished runs. Most shad and river herring releases occur in the Merrimack River and drainage, but the program also has activities from the Kennebec River down to the Pawcatuck River. The program is seeing limited success, and major issues are shad egg production and survival at Nashua National Fish Hatchery (partially due to State regulations prohibiting formalin use), shad and river herring brood collection during large floods, lack of river herring brood sources because of the region wide population collapse that began in 1992, and the political resistance to stock river herring brood into some premium historical but extirpated habitat. At this point, McKeon is questioning whether we should be culturing shad at all in systems where shad exist, but instead working harder to open up fish passage. Gray's program focuses on trapping, trucking, and releasing alewife brood; pumping alewife brood around dams; and shad culture activities in the Kennebec River and drainage. His program is seeing more success with both culture activities and alewife transport, and the upper Kennebec River is experiencing a rapid shad population increase. Issues mostly revolve around increasing fish passage and political resistance to stock alewife brood into some premium historical but extirpated habitat.

A debate ensued over the role of the USASAC in Alosid restoration. Major points included: restoration of all diadromous fish needs to be a priority for Atlantic salmon restoration; diadromous fish restoration and Atlantic salmon restoration need to be integrated into a broader program in support of each other; strategic planning including all diadromous fish biologist / manager partners is needed; the sequence of stock and species rebuilding could effect results; expectations about Alosid restoration success needs to be managed; restoration activities and dam removals could complicate salmon assessment, requiring a shift in assessment and a need for different data collection; and a study of large waters is needed to examine restoration effects on lower river ecology. Specific comments about Maine's future plans with Penobscot River restoration included: the importance of Milford dam for passage, trapping and counting, and public awareness after dam removal; the current mismatch of restoration priorities between the Penobscot River salmon program and the Kennebec River Alosid program; a general consensus that diadromous fish restoration activities in the Penobscot should focus on the lower drainages in an effort to establish growing populations in advance of dam removal; and thoughts on current and future harvest management of river herring population with a preferred switch from maximum sustained yield management to a greater consideration for ecosystem function goals.

4.6 Juvenile Production Estimates or Indices

This topic focused on issues surrounding methods of estimating juvenile ATS abundances. Speakers presented results from work across several drainages that showcased the spatial extent juvenile salmon move at varying life stages. This work also described the real problem of trying to estimate abundance based on current assumptions about juvenile salmon behavior. These discussions led mostly toward how best to apply different sampling schemes.

Sweka described the results of work done within the Sheepscot River. This work examined the spatial origin of smolts trapped in rotary screw traps. First, the majority of smolts were from the upper drainage. There was a large difference between streamside incubation and hatchery fry favoring stream side incubators. Where there were more cyprinids there were also more parr. Finally, the greatest constraint on survival seemed to be from 0+ to 1+ parr. This led to his recommendation to place fry higher into the drainage or maximize 1+ parr stocking in the lower drainage.

This led to discussion on how watershed area influences parr density. Contributors raised the point that all we know about stream production dynamics suggests it is variable (River Continuum Concept) and in some situation the drainage is managed as all is equal (i.e. Riffle A = Riffle B). Some methods discussed to account for this were to apply quantile regression analysis to determine upper limits, combine prediction with physical habitat, and selectively apply depletion estimates for 0+ parr.

Ernie Atkinson presented work examining movement of fry point stocked into several streams. The results showed fry moving up to 2 kilometers downstream and up to 500 meters upstream throughout one season of growth.

Throughout the session discussions kept returning to the metrics used in estimating juvenile abundance and what is useful. Hayes led the discussion by listing steps and criteria for analysis. First step is to determine goal(s):

1. Determine overall status (i.e. abundance)
2. Determine trend in status
3. Determine overall spatial distribution
4. Determine if trends differ spatially

Hayes then stated that each of these goals may be best served with different sampling designs and could be examined using fixed or random sites.

1. If looking at trends then fixed sites are applicable because they offer better trend detection but have a higher potential for investigator bias. This is somewhat reduced with larger sample sizes.
2. For fish that are less mobile fixed sites allow tracking and survival rates.
3. Fixed sites allow connection to long term data sets.

4. Fixed sites can be logistically easier to access and crews become familiar with them.

There are disadvantages to using fixed sites:

1. They reduce sample size available for status selection across region.
2. If not random it raises issues on how to incorporate them in overall status determination.
3. Analysis of data requires mode-based inference. Issues arise with statistical models

The session wrapped up by discussing several considerations for estimating abundances. These included site selection and analysis (consider the goals and objectives), use a combination of fixed and random sites to address the needs of researchers, and stratify sites to create larger pieces. This approach would provide some trend data as well as spatial data allow for more contrasts to be applied.

4.7 Emerging Issues: Disease and Management of Diseases

4.7.1 IPN at Cronin in Connecticut – the Pathology – Presented by John Sweka for John Coll

Working Paper: 2007 IPN Virus Risk Mitigation Practices for 2008. Infectious pancreatic necrosis (IPN) is a viral disease that is transmitted both horizontally (fish to fish) and vertically (parent to offspring). IPN is widely distributed, but has not been a problem to Atlantic salmon in the United States. Norway and Scotland have both experienced outbreaks. It was noted that in both cases the outbreaks occurred approximately 10 years after the first detections.

IPN was identified from two, pooled sea-run Atlantic salmon ovarian samples from Richard Cronin National Salmon Station (RCNSS) on October 15, 2007. The samples were a composite of ovarian fluid from 5 female Atlantic salmon. Samples were confirmed positive for IPN using cell culture and polymerase chain reaction assays. As a result, the entire year class of Atlantic salmon at RCNSS and eggs shipped to White River National Fish Hatchery were destroyed. Subsequent PCR assays and histology of kidney, spleen, blood and pancreatic tissue produce negative results. The US Geologic Survey Western Fisheries Research Center identified the isolate to be most similar in base pair structure to the Canada 3 genotype, which is significantly different from most other North American IPNV genotypes studied. Historically, this isolate was originally from arctic char and it is different from and "pre-dates" the aquaculture industry. Because this is not a typical North American isolate, pathologists speculate that the salmon were exposed during ocean migration. RCNSS has and continues take measures to isolate pools by using glass panels to reduce the possibility of transfer via splashing and vapors as well as measures to eliminate cross contamination.

Group discussion:
There were several concerns regarding the outbreak at RCNSS (possible cross-contamination of test tubes, poor labeling of tubes and the lack of ability to identify individual fish or pools were infected fish were held). A lot of discussion centered on Craig Brook National Fish Hatchery (CBNFH) regarding river specific isolation. Currently at CBNFH, fish are held in an isolations facility and are screened for ISA. All parr are held in isolation for one year and any deaths result in necropsies. The risk of carrier fish that don't die and infect other fish is very real. Given the current levels of isolation, any outbreak of IPN would result in the loss of an entire year classes of Penobscot stock or three year classes of DPS river stocks. The loss of a year class represents the loss of genetic diversity. Each DPS River is isolated in its own bay and is in essence its own individual hatchery; however, the pool within a bay is not isolated. It is possible to isolate each pool and that would require pool specific gear. Egg banks are only as isolated as the parent stock. Currently, Green Lakes National Fish Hatchery (GLNFH) maintains a domestic strain of Penobscot Atlantic salmon. That stock is a random mix of eggs from individual year classes. There is concern regarding the introduction of IPN at GLNFH; however, eggs transferred from CBNFH do remain isolated from other stocks.

The USASAC is very concerned with ways to isolate hatchery populations to minimize the impact of an outbreak, early detection and testing procedures, adult carriers passing upstream, and best management practices at aquaculture facilities. There was a question regarding our reporting responsibilities to OIE, an international reporting agency and whether the US could now be considered a positive zone. Sebastian Belle did make an offer to provide for some gene banking as a backup to the loss of a year class, but noted he would need to investigate further.

USASAC statement about pre-planning for IPN:
IPN represent a critical threat to Atlantic salmon recovery. The introduction and discovery of IPN at any hatchery facility will result in loss of genetic diversity and the loss of one to three year classes. Current procedures for screening and isolating fish are inadequate to protect against an IPN outbreak. Options for IPN mitigation, prevention and screening need to be investigated immediately and this should be a fish health priority.

4.7.2 Didymo Effects of Fry Production – briefing in CT River – Jay McMenamy

One concern of *Didymosphenia geminate,* aka didymo or rock snot, introduction in the Connecticut River is that the White River National Fish Hatchery uses White River water for fry production. The options to mitigate for didymo are to enhance the existing water source system with fine filters or use well water and a chiller. Currently, the hatchery is not using any river water. All production is on well water and that has increased the cost of production.

Vermont's Agency on Natural Resources disinfection protocol was presented. It requires crews to work downstream, disinfect when moving upstream in the same river or when moving to a new body of water. Quat, germicidal detergent, is used to disinfect equipment. There is a soak time of 30 minutes for felt-soled boots.

Group Discussion:
Prior to the USASAC meeting each agency shared existing disinfection protocols so that each document could serve to inform other agencies. These documents are filed as background documents for this meeting on the USASAC website. The group discussed sampling protocols and the logistics of disinfecting gear. Everyone agreed that sampling protocols should minimize the possibility of transferring or introducing didymo. Crews are going to try and work downstream in a drainage and group work within drainage to minimize upstream and between drainage introductions. The group also discussed disinfection of gear. Many agreed that felt-soled boots are difficult to properly disinfect. One suggestion was using soles such as Aqua Stealth (LL Bean) and Korker's Stream Wading Boots (come with interchangeable felt and lug sole) to eliminate the use of felt or allow for a through overnight disinfection. The interaction of staff and discussion provided field-practical steps for all to consider to minimize biologists acting as vectors of exotic species or diseases.

5.0 Appendices

5.1. List of Attendees

First Name	Last Name	Primary Email	Agency	Location
Ernie	Atkinson	Ernie.Atkinson@maine.gov	ME	Jonesboro, ME
Sebastian	Bell	maineaqua@aol.com	NGO	Hallowell, ME
Merrie	Cartwright	Merrie.Cartwright@noaa.gov	NOAA	Portland, ME
Kevin	Cheung	Kevin_Cheung@fws.gov	FWS	N. Attleboro, MA
Paul	Christman	Paul.Christman@maine.gov	ME	Hallowell, ME
Mary A	Colligan	Mary.A.Colligan@noaa.gov	NOAA	Gloucester, MA
Oliver	Cox	Oliver.N.Cox@maine.gov	ME	Bangor, ME
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT	Old Lyme, CT
Nate	Gray	Nate.Gray@maine.gov	ME	Hallowell, ME
Dan	Hayes	hayesdan@msu.edu	NGO	East Lansing, MI
Tom	King	Thomas_King@fws.gov	FWS	Orland, ME
John	Kocik	John.Kocik@noaa.gov	NOAA	Orono, ME
Melissa	Laser	Melissa.Laser@maine.gov	ME	Hallowell, ME
Christine	Lipsky	Christine.Lipsky@noaa.gov	NOAA	Orono, ME
Larry	Loftin	Larry_Lofton@fws.gov	FWS	N. Attleboro, MA
Greg	Mackey	Greg.Mackey@maine.gov	ME	Jonesboro, ME
Doris	Mason	Doris_Mason@fws.gov	FWS	Lamar, PA
Joe	McKeon	Joe_McKeon@fws.gov	FWS	Nashua, NH
Jay	McMenemy	Jay.McMenemy@state.vt.us	VT	Springfield, VT
Steve	Mierzykowski	Steve_Mierzykowski@fws.gov	FWS	Old Town, ME
Lori	Nordstrom	Lori_Nordstrom@fws.gov	FWS	Old Town, ME
Jessica	Pruden	Jessica.Pruden@noaa.gov	NOAA	Gloucester, MA
Jan	Rowan	Jan_Rowan@fws.gov	FWS	Sunderland, MA
Peter	Ruksznis	Peter.Ruksznis@maine.gov	ME	Bangor, ME
Paul	Santavy	Paul_Santavy@fws.gov	FWS	Ellsworth, ME
Rory	Saunders	Rory.Saunders@noaa.gov	NOAA	Orono, ME
Tim	Sheehan	Tim.Sheehan@noaa.gov	NOAA	Woods Hole, MA
Doug	Smithwood	Doug_Smithwood@fws.gov	FWS	Nashua, NH
John	Sweka	John_Sweka@fws.gov	FWS	Lamar, PA
Joan	Trial	Joan.Trial@maine.gov	ME	Bangor, ME
Theo	Willis	TheoWillis06@aim.com	NGO	Portland, ME
Jed	Wright	Jed_Wright@fws.gov	FWS	Falmouth, ME

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

Number	Authors	E-mail Address	Title
BK08-01	Tim Sheehan	Tim.Sheehan@noaa.gov	WGNAS TOR 2008
BK08-02	Tim Sheehan	Tim.Sheehan@noaa.gov	DFC Resolutions 2007
BK08-03	Joan Trial	Joan.Trial@maine.gov	USA National Report
BK08-04	Maine ASC	Joan.Trial@maine.gov	Maine Disinfection Protocol (WP)
BK08-05	NEANS	info@northeastans.org	USFWS-Didymo Recommendations for Decon. Of Outdoor Equipment
BK08-06	VT-ANR Didymo Task Force		VT-ANR Disinfection Protocol, CT River
PS08-01	Jay McMenemy	Jay.McMenemy@state.vt.us	Connecticut River Atlantic salmon restoration, 2007 (PPT)
PS08-02	Joseph McKeon	Joe_McKeon@fws.gov	Merrimack River Atlantic salmon restoration, 2007 (PPT)
PS08-03	Joan Trial	Joan.Trial@maine.gov	Maine Atlantic salmon restoration, 2007 (PPT)
WP08-01	Christine Lipsky James Hawkes Peter Ruksznis Mitch Simpson Ruth Haas-Castro	Christine.Lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smolt Studies: 2007 (WP)
WP08-02	Tim Sheehan	Tim.Sheehan@noaa.gov	WGNAS TOR Overview (PPT)
WP08-03	Mary Colligan	Mary.A.Colligan@noaa.gov	NASCO 2008 (PPT)
WP08-04	Tim Sheehan	Tim.Sheehan@noaa.gov	2007 WGNAS Summary (PPT)
WP08-05	Tim Sheehan	Tim.Sheehan@noaa.gov	2008 WGNAS biological characteristics (PPT)
WP08-06	Joe McKeon	Joe_McKeon@fws.gov	Merrimack River Fry Evaluation and Update (PPT)
WP08-07	Tim Sheehan	Tim.Sheehan@noaa.gov	WGNAS Nearshore Marine Survival (PPT)

Number	Authors	E-mail Address	Title
WP08-08	Christine Lipsky Richard Dill	Christine.Lipsky@noaa.gov	Penobscot River Atlantic salmon studies, 2000-2006 (PPT)
WP08-09	John Kocik Jim Hawkes Tim Sheehan Paul Music Kenneth Beland	John.Kocik@noaa.gov	Estuarine and Coastal Migration and Survival of wild Atlantic salmon smolts in Maine using ultrasonic telemetry (PPT)
WP08-10	Tim Sheehan Mark Renkawitz	Tim.Sheehan@noaa.gov	Feeding ecology of Atlantic salmon postsmolts in Penobscot Bay, Maine: Does origin matter? (PPT)
WP08-11	Steve Gephard	Steve.Gephard@po.state.ct.us	Impacts Summary for US Rivers- New England Summary (PPT)
WP08-12	Joe McKeon	Joe_McKeon@fws.gov	Alosid Management Initiatives (PPT)
WP08-13	Nate Gray	Nate.Gray@maine.gov	Kennebec River Diadromous Fish Restoration (PPT)
WP08-14	John Sweka	John_Sweka@fws.gov	HUC 10 Large Parr Estimates (PPT)
WP08-15	Dan Hayes	hayesdan@msu.edu	Utility of Fixed Sites in Stream Monitoring (PPT)
WP08-16	John Sweka	John_Sweka@fws.gov	2007 IPN Virus Isolation from Connecticut Sea-Run Atlantic Salmon and Virus Risk Mitigation Practices for 2008 (WP and PPT)
WP08-17	Sharon MacLean	Sharon.MacLean@noaa.gov	Update on IPNV in the Northeastern US (WP)
WP08-18	Jay McMenemy	Jay.McMenemy@state.vt.us	Didymo Effect on Fry Production- Briefing in CT River (PPT)
WP08-19	John Sweka Meredith Bartron Joan Trial Paul Christman	John_Sweka@fws.gov	Sheepscot River Habitat Genetics (WP and PPT)
WP08-20	John Sweka Greg Mackey	John_Sweka@fws.gov	Functional Relationship Between Watershed Size and Atlantic salmon parr density (WP and PPT)

Number	Authors	E-mail Address	Title
WP08-21	Joan Trial	Joan.Trial@maine.gov	Site Size (PPT)
WP08-22	Mitch Simpson Joan Trial	Mitch.Simpson@maine.gov	Electrofishing site habitat area at different stream flows on the Narraguagus River, ME (WP)
WP08-23	Ernie Atkinson Greg Mackey	Ernie.Atkinson@maine.gov	A Summary of Fry Movements (PPT)
WP08-24	Mike Loughlin	Mike.Loughlin@maine.gov	Upstream Fry Migration (PPT)
WP08-25	Dave Bean Samantha Horn-Olsen	David.Bean@noaa.gov	Maine and neighboring Canadian Commercial Aquaculture Activities and Production (WP)
WP08-26	Jed Wright John Sweka Alex Abbot Tara Trinko	Jed_Wright@fws.gov	GIS-Based Atlantic Salmon Habitat Model (WP)

5.3 Glossary of Abbreviations

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

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

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.
Parr 8	Parr stocked at age 0 that migrate as 1 Smolts (8 months spent in freshwater).
Parr 20	Parr stocked at age 0 that migrate as 2 Smolts (20 months spent in freshwater).

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

5.5 Abstracts from Regional Atlantic Salmon Assessment Committee Meeting

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

5.5.1 Maine Atlantic Salmon and their Ecosystems (2008 Meeting)

Bailey, M. and M. Kinnison; University of Maine, School of Biology and Ecology, Orono, ME; Result of selective pressures measured by otolith characteristics of newly released hatchery-raised Atlantic salmon fry. Atlantic salmon (Salmo salar) restoration efforts in Maine employ fry stocking as one of the primary population enhancement strategies. Some characters, such as large size or fast growth, are often thought to correlate with high survival in the wild. However, there are few data on the survival of newly stocked Atlantic salmon fry based on these characters. Hatchery rearing may reduce mortality in newly hatched fry, but natural selection may act strongly on stocked fry after they are released into the wild. These resulting survival patterns can be examined by reconstructing attributes of fry biology at stocking using characteristics of growth rings in otoliths. For this study, otoliths (sagittae) were compared from newly released fry with otoliths from stocked fry residing in the wild for 30 to 60 days. Developing a relationship between fry biology and otolith characteristics for newly hatched Atlantic salmon may well be an important tool for describing selective mortality at early life stages. Contact: michael.bailey@umit.maine.edu

Bailey, M. and M. Kinnison; University of Maine, School of Biology and Ecology, Orono, ME; Survival and life history variation of Atlantic salmon in Shorey Brook, Maine. From 2000 to 2006, individually marked juvenile Atlantic salmon (Salmo salar) were regularly monitored in Shorey Brook, a tributary of Narraguagus River. Sampling included over 25 electrofishing samples from 37 sections (each 20m long) of Shorey Brook, and from smolt weirs and in-stream passive integrated transmitter (PIT) arrays. The use of these PIT arrays allowed us to account for fish leaving the system as smolts and non-smolt migrants, decreasing biases in mortality estimates. These arrays have also recorded three likely adult salmon returning to the stream (two confirmed adults, one unconfirmed). Software program MARK was used to estimate survival of four year classes during this study, relative to seasonality and life history attributes of the fish. Results indicate that parr in Shorey Brook have higher over winter survival, higher percentage precocious parr, and higher numbers of fall migrants than has been noted in other salmon streams in New England. These characteristics of parr life history can be missed by traditional survey approaches that occur only once per year, with substantial demographic consequences. Contact: michael.bailey@umit.maine.edu

Bean, D. 1 and Y. Gao2; 1NOAA's National Marine Fisheries Service, Northeast Regional Office, Gloucester, MA; 2Makah Fisheries Management, Neah Bay, WA; Stable isotopic composition of otoliths in identification of hatchery origin of Atlantic salmon (Salmo salar) in Maine. Stable isotope analyses of otoliths of Atlantic salmon (Salmo salar) were conducted in an attempt to develop a reference database on isotopic variability among various production hatcheries that support the Maine aquaculture industry and recovery of endangered Atlantic salmon populations. If successful, a diagnostic tool that can provide definitive information on identification of the hatchery origin could serve as a novel marking technique, and the chemical method may provide a low cost and more effective alternative to DNA analysis for mixed stocks. During the first phase of the study, 40-50 sagittal otoliths of juvenile Atlantic salmon were collected from each of the five Atlantic salmon production hatcheries in Maine and analyzed for stable isotope ratios (18O/16O or 18O, and 13C/12C or 13C). By identifying stable isotopic variations of otoliths of Atlantic salmon from different hatchery settings, we were able to establish some isotopic criteria or standards to assign a likelihood that the origin of the cultured salmon was from a specific study hatchery. Combination of 18O and 13C values in otoliths showed that the five hatcheries can be clearly separated and chemically identified. The statistical results indicate that otolith samples can be correctly identified to a hatchery with higher than 88% correct classification for four hatcheries; one hatchery was slightly lower at 73 % correctly classified. The data support the hypothesis that detectable differences between hatchery water sources can be detected within the otoliths of Atlantic salmon, and that isotopic separations among the five hatcheries appear to be well correlated with the different river systems or watersheds in which the hatcheries are located. Contact: David.Bean@noaa.gov

Beland, K. and S. Koenig; Project SHARE (Salmon Habitat and River Enhancement), Eastport, ME ; Coordinating local habitat restoration initiatives with Atlantic salmon habitat databases: how to make sure we're fixing the right stuff; Project SHARE (SHARE) has been conducting an active program to assess and correct habitat degradation on private lands occurring in the five so-called 'Downeast Salmon Rivers" (Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers). These five watersheds are included within the Gulf of Maine Distinct Population Segment designated by Federal resource agencies. SHARE maintains a database containing more than 800 locations where potential habitat degradation has been documented, and documents measures to address issues identified during field surveys. Among many ongoing activities, SHARE is implementing a program to assess and correct habitat connectivity and fish passage deficiencies at stream crossings associated with the extensive logging road networks that occur in these watersheds. Improving the capacity to use these location data in conjunction with resource agency habitat and resource assessment datasets has become a priority for SHARE, in order to direct limited habitat restoration funds to areas most likely to improve habitat conditions for Atlantic salmon. Despite increasingly widespread use of an electronic database and GIS for information management, much progress remains to be made to realize seamless coordination of datasets originating from various sources. Frequently encountered barriers to data communication include: data confidentiality issues, incompatible data formats, inconsistent stream and town naming conventions, lack of unique record identifiers, and others. Ultimately, SHARE wishes to participate in coordinated habitat enhancement efforts that transcend single issue projects and address aquatic habitat quality and connectivity within focused areas having the greatest potential to benefit Atlantic salmon in Maine. Contact: belandkf@roadrunner.com

Christman, P.M., D. McCaw and J. Overlock; Maine Department of Marine Resources, Hallowell, ME; Planting Atlantic salmon eggs with a new hydraulic planter. In the past several years, Maine Department of Marine Resources has made several advances in utilizing green and eyed eggs for population enhancement of Atlantic salmon (Salmo salar). Green eggs have been found to be difficult to move due to handling shock. However, both green and eyed eggs have been successfully transported and buried in artificial redds in the Sandy and Sheepscot rivers. In the most recent study, efforts have been made to overcome the logistics of burying eggs in the gravel while minimizing mortality. In the 2006/2007 project eggs were buried using a newly developed hydraulic egg planter that utilizes a water stream to drill into the substrate and deposit eggs. Green and eyed eggs were buried using the new planter on the Sandy River and eyed eggs on the Sheepscot River. Fry trapping results indicate that the new planter successfully deposited eyed eggs and produced juveniles. Emergence rates were 43.6, 33.8 and 10% for three artificial redds on the Sandy River and 10.4, 1.3 and 0.53% for three artificial redds on the Sheepscot River. Green eggs did not develop on the Sandy River, most likely due to handling. Also fry were trapped from three natural redds produced by released pre-spawn adults; emergence rates estimated from a range of fecundity were 8.9-10.1, 8.4-9.9 and 0%. Overall, the new planter very worked well given that juveniles were produced. Observations indicate that large enough numbers of eggs can be planted in a reasonable time frame to make it possible to use for watershed scale supplementation. Contact: paul.christman@maine.gov

Elskus, A.A 1,2 and C. Straub1; 1University of Maine, School of Biology and Ecology, Orono, ME; 2US Geological Survey, Maine Field Office, University of Maine, Orono, ME; Initial findings on multiple stressor effects in early life stage Atlantic salmon (Salmo salar): blueberry pesticides, acid, aluminum. Rivers in Maine experience a broad range of stressors, including acidity, aluminum (Al), endocrine-disrupting chemicals, organochlorines and pesticides, some of which may be present simultaneously. Exposure to multiple stressors can have effects on organisms that cannot be predicted from exposure to individual stressors alone (Relyea et al. 2001). Blueberry pesticides, acidic water and Al combinations are present in some downeast rivers, but their potential effects on resident Atlantic salmon (Salmo salar) are unknown. Additionally, alternative pesticides are being proposed to replace those currently used in Maine, and their effects on salmonids also are unknown. We hypothesized that combinations of acid/Al (AA) + pesticides would have stronger sub-lethal effects on early life stage salmon than either stressor alone. The study objectives were to determine whether pesticide-contaminated, acid/Al rivers pose a greater threat to salmon than pesticide-contaminated rivers alone, and to provide data on the potential effects of candidate pesticides on sensitive early-life stages before these pesticides come into use. We exposed F2 Penobscot River Atlantic salmon swim up fry to the current use herbicide formulation, VelparTM (active ingredient hexazinone), or its proposed alternative, CallistoTM (active ingredient mesotrione), at environmentally realistic concentrations (0.75 ppb a.i.) and at concentrations ten fold higher (7.5 ppb a.i.), in the presence and absence of high acidity (pH = 3.9 - 5.2) and elevated inorganic (toxic) aluminum (254-724 ppb). To better mimic real world conditions in which dissolved organic carbon significantly affects the availability of toxic aluminum, dosing solutions were made up in Machias River water (DOC = 7.2 mg/L). Fish were exposed for 5 days in a flow-through system at 14°C. Survival, prey capture and immune function were evaluated. Pesticide treatment alone had no effect on survival relative to untreated controls, but AA treatments significantly reduced survival. Of the four multiple-stressor (pesticide +AA) groups, three sustained mortalities significantly higher than those of the AA control. However, it is likely that the dramatic drop in pH on day 2 (pH 3.8-4.3 across all acid/Al treatments), rather than a multiple-stressor effect, drove this difference in mortality. High variability masked potential treatment effects on prey-capture. Immune function assays were inconclusive. The results indicate that blueberry pesticide effects on prey capture and survival may increase in the presence of acid/Al, but high variability among replicates, and the dramatic drop in pH on day 2, confounds interpretation of the data. Studies with additional endpoints and replicates are planned. Relyea, R.A., Mills, N., 2001. Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (Hyla versicolor). Proc. Nat. Acad. Sci. USA 98: 2491-2496. Contact: aelskus@usgs.gov

Fernandes, S.1, G.B. Zydlewski2 and M.T. Kinnison1; 1University of Maine, Department of Ecology & Environmental Science, Orono, ME; 2University of Maine, School of Marine Sciences, Orono, ME; Annual movement and migration patterns of Atlantic and shortnose sturgeons in the Penobscot River, ME. The status of Atlantic and shortnose sturgeon populations in the Penobscot River of Maine are currently unknown yet vital to protection of these at risk species. In this study we have begun to assess abundance, distribution, and movements of adult and sub-adult Atlantic and shortnose sturgeons in this River system. In 2006 and 2007 we sampled for sturgeon using multifilament nylon gillnets set on the bottom of the river and estuary in likely habitat. We recorded the length, weight and morphometric measurements from all individuals and assessed their sex and reproductive status. All individuals were implanted them with an external numeric tag and internal 124 kHz PIT-tag, and a subset of individuals were tagged with ultrasonic transmitters to allow us to track the movement via active tracking and a large acoustic receiver array in the river and bay. In this presentation we consider Atlantic and shortnose sturgeon movement patterns through the summer, fall, and winter of 2006 and the spring and summer of 2007. In particular we discuss patterns of seasonal movements associated with foraging, overwintering, and spawning habitat use. Our results not only provide management agencies with a better idea of the status and ecology of Atlantic and shortnose sturgeon in a portion of their range that is under-studied, but also highlight critical habitat and associated risks to sturgeon in this system. Contact: stephen.fernandes@umit.maine.edu

Giray. C. 1, V. Bowie1, W. Young-Lai2 and B. Glebe2; 1Micro Technologies Inc., Richmond, ME; 2St. Andrews Biological Station, St. Andrews, NB, Canada; Blue mussels (Mytilus edulis): a natural ISA vaccine factory? Bivalve shellfish are routinely used as indicator species for human viral and bacterial pathogens due to their ability to concentrate these agents from the surrounding waters. While they have also been implicated as potential reservoirs of aquatic animal pathogens, previous work investigating infectious salmon anemia virus (ISAV) bioaccumulation by blue mussels (Mytilus edulis), a common fouling organism at marine Atlantic salmon (Salmo salar) grow-out sites, indicated that contrary to expected outcomes, not only was ISAV not concentrated by M. edulis, but its viability was reduced below that expected from mere degradation in seawater. Since the ability of ISAV to cause cytopathic effect in cell culture was significantly reduced following filtration by M. edulis, we examined whether its ability to cause disease in S. salar was also negatively affected. Naïve salmon were exposed by immersion to a virulent strain of ISAV processed through M. edulis and the survivors were subsequently challenged by injection with ISAV. Results showed that positive control treatments exposed to virus not filtered by M. edulis suffered heavy mortalities. Conversely, fish initially exposed to ISAV filtered through M. edulis showed significantly lower mortalities during both the immersion exposure and the challenge. ISAV processed through M. edulis appears to lose virulence, but retain sufficient structural properties to produce immune protection in S. salar from subsequent exposure to the virus. Contact: cxgiray@microtechnologies.biz

Hart, D.1, K. Wilson2, P. Vaux1, and A.A. Elskus3; 1University of Maine, Mitchell Center for Environmental and Watershed Research, Orono, ME; 2University of Southern Maine, Aquatic Systems Group, Portland, ME; 3US Geological Survey, Maine Field Office, University of Maine, Orono, ME; Diadromous Species Restoration Research Network (DSRRN): A New Five-year Collaborative Effort. Diadromous fish populations are undergoing steady declines in the US leading to threatened and endangered listings. The central goal of the Diadromous Species Restoration Research Network (DSRRN) is to leverage, expand, and integrate the diverse array of research and management activities focused on the restoration of diadromous fish species in ways that improve ecological understanding and enhance restoration outcomes. The strength of the DSRRN is its connection to and integration with the Penobscot River Restoration Project (Maine), the most ambitious restoration effort ever proposed for a watershed of this size. Within this context unparalleled opportunities exist to study questions fundamental to diadromous fish ecology and restoration, including: the role of diadromous fish in marine-freshwater linkages, the interdependency of co-evolved diadromous species, multi-species interactions in a restoration context, and the effects of multiple stressors on restoration results. DSRRN will work to coordinate the overlapping/ interconnected research efforts of academic, government, tribe and watershed stakeholders, provide administrative structure, and support data management. This grant will support two scientific meetings to identify critical research areas in multi-species restoration (Year 1) and synthesize outcomes (Year 5), and three interactive workshops targeting critical research topics (Years 2, 3 and 4). We anticipate at least one synthesis paper per workshop and several master's theses focused around workshop topics and diadromous species. Evaluations, member feedback, reports, quarterly meetings with core members, and other mechanisms will be used to assess progress and success. The issue of diadromous fish restoration is complex and it is only through a broad collaborative approach drawing on data and knowledge from other systems, worldwide, that progress may be achieved and mis-steps minimized. Through RCN-facilitated research partnerships that place mission-driven restoration efforts in an integrated science context, key basic and applied research needs can be identified that might otherwise be overlooked. By actively engaging stakeholders, the RCN will facilitate public understanding of the critical role that science plays in guiding ecological restoration. Please help us begin this process by bringing your questions, your ideas and your vision to the network! Contact: aelskus@usgs.gov

Hawkes, J.P.1, R. Saunders2 and A. Vashon3; 1NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; 2NOAA's National Marine Fisheries Service, Protected Resources Division, Orono, ME; 3US Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Augusta, MEManaging the impacts of double-crested cormorant predation on endangered Atlantic salmon smolts. Atlantic salmon smolts (Salmo salar) are exposed to intense predation pressure as they migrate from freshwater into estuarine and near-shore marine environments. During this period, double-crested cormorants (Phalacrocorax auritus) are a significant predator of Atlantic salmon smolts. To assess whether cormorant predation rates could be reduced, cormorant harassment activities were undertaken in 2004 and 2005 using various pyrotechnics, lasers, and human/boat activities. These endeavors effectively displaced cormorants from feeding locations and effectively lowered predation on emigrating smolts in the Narraguagus River, Maine. Contact: james.hawkes@noaa.gov

Holbrook, C.1, J. Zydlewski2 and M. Kinnison; 1University of Maine, Department of Biological Sciences, Orono, ME; 2US Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME; Effects of hydroelectric dams on survival and behavior of migrating Atlantic salmon smolts in the Penobscot River, Maine. Survival and behavior of migrating hatchery (n=493) and naturally-reared (n=133) Atlantic salmon (Salmo salar) smolts were evaluated in 2005 and 2006 through the Penobscot River and estuary in Maine using acoustic telemetry. Mortality, movement rates, and use of a secondary migration path (the Stillwater Branch) were quantified. River sections containing three mainstem dams (Howland, Milford and West Enfield dams) accounted for 43% and 60% of total losses for 2005 and 2006, respectively, though these sections accounted for only 16% and 6% of monitored reaches. Survivorships through sections with dams ranged from 95-100% and 71-100% in 2005 and 2006, respectively. Movement rates were significantly slower at dams compared to free-flowing reaches, and smolts arriving at dams during the day experienced longer delays than smolts arriving at night. Use of the Stillwater Branch by individual release groups ranged from 0-26% and 0-19% in 2005 and 2006, respectively; was significantly lower for groups released in a tributary compared to the mainstem; and was positively associated with river discharge. As part of the Penobscot River Restoration Project, the planned removal of two dams is expected to enhance passage through the mainstem corridor for salmon and other migratory fish. However, this study demonstrates that the two dams scheduled for removal (Great Works and Veazie dams) had little affect on smolt survival and highlights the need to improve passage at the Milford, Howland and West Enfield dams, as well as at facilities in the Stillwater Branch, which likely will be passed by more smolts after hydro-system changes are implemented. Contact: jzydlewski@usgs.gov

Kasprak, A.1, N.P. Snyder1, I.V. Buynevich2 and E.A. Johnson1; 1Boston College, Department of Geology and Geophysics, Chestnut Hill, MA; 2Woods Hole Oceanographic Institution, Coastal Systems Group, Woods Hole, MA; Measuring sedimentation rates and land-use change in a dam-influenced lake delta: Narraguagus River, Maine. Deposits of the Narraguagus River in coastal Maine were investigated to determine river sediment transport rates during the past ~150 years, a period of extensive timber harvest in the watershed. Such transport rates will provide a baseline for process-based studies of interactions between substrate mobility and habitat characteristics. The study area was the inlet of Beddington Lake, which has undergone changes in its surface level due to the construction (circa 1850) and subsequent failure in 1951 of a dam installed at the lake outlet to facilitate log drives on the Narraguagus River. Based on historic (1946-1996) aerial photograph analysis, exposed river deposits from the period of elevated lake level were identified. In August 2007, these subaerial deposits were sampled using soil pits, hand auger cores, bailer-borings, and ground penetrating radar (GPR). In-channel pebble counts were performed at several locations at and upstream of the study area. Overall, sediment samples collected from the subaerial deposit show a fining trend downstream from the Narraguagus River mouth into Beddington Lake. Upstream sediment pits and cores in the deposit show a gravel layer at ~1 m depth. We hypothesize that this layer corresponds to river deposition prior to dam construction. Above this gravel layer was found a coarsening upward trend in individual soil pits and cores, from mud to coarse sand, which is representative of a prograding lake delta. This sediment package is, on average, 0.98 m thick, and we believe that its deposition occurred during the ~101 years that the dam was present on Beddington Lake. The calculated average vertical sedimentation rate, therefore, was 1.0 cm/year at this proximal position in the lake delta during the time the dam was operational. Above this coarsening upward sequence, soil pits and cores have a topmost layer of fine sand and mud, with 0.22 m average thickness. Given that Beddington Lake has not been dammed since 1951, a current average vertical floodplain sedimentation rate of 0.4 cm/year was calculated. Organic materials, dominated by wood chips and fragments of cut logs, can be found in the subaerial deposit. The concentration of these organics increases with depth, suggesting that logging activities in the Narraguagus River were most vigorous in the time soon after dam construction. Our ongoing research includes interpretation of GPR transects, textural sediment analyses, Wolman pebble count analyses, and mapping and correlation of the sediment pits and cores. Contact: kasprak@bc.edu

Laser, M.1, R. Saunders2, T. Sheehan3 and T. Trinko2, 1Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME; 2NOAA's National Marine Fisheries Service, Protected Resources Division, Orono, ME; 3NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA; Penobscot River Multi-Species Management Plan: does multi-species mean ecosystem-based? The Penobscot River Restoration Project (PRRP) offers some unique opportunities to reconnect the native diadromous species with historic habitats and restore the concomitant ecological functions of the native diadromous suite. In particular, alewives are presently absent from the drainage with the exception of two tributaries of the Penobscot Estuary (Souadabscook Stream and the Orland River). While the PRRP will substantially improve passage conditions in the Penobscot Basin, it is in no way a "silver bullet." There are roughly 100 small dams and other fish passage barriers in the Penobscot Basin that will prevent some species from accessing historic habitats after the implementation of the PRRP. Thus, many other passage impediments will need to be addressed in order to realize the full potential of the PRRP. In order to begin to prioritize restoration efforts following implementation of the PRRP, the Maine Department of Marine Resources, Maine Department of Inland Fisheries and Wildlife, and NOAA's National Marine Fisheries Service have begun evaluating ways to prioritize restoration efforts. This effort, the Penobscot River Multi-Species Management Plan, includes four strategic goals: (1) coordinating management activities, (2) providing safe and effective upstream and downstream passage for diadromous and native freshwater fishes, (3) maintaining or improving abiotic (physical) and biotic habitat for diadromous and selected resident fishes, and (4) using adaptive ecosystem-based management. An interagency Penobscot Fisheries Committee will develop an operational plan that details how these goals will be achieved as passage to habitat becomes available. Contact: melissa.laser@maine.gov

Letcher, B.1, K. Nislow2, J. Coombs1,2, M.O'Donnell1 and T. Dubreuil1; 1 US Geological Survey/Leetown Science Center, S.O. Conte Anadromous Fish Research Center, Turners Falls, MA; 2US Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; 3University of Massachusetts, Program in Organismic and Evolutionary Biology, Amherst, MA; Habitat effects on resident brook trout persistence. To determine habitat effects on persistence of brook trout populations, the effects of habitat fragmentation among stream reaches and of habitat structure within a stream reach were estimated. Direct estimations were made of size-specific dispersal, growth, and survival of stream-dwelling brook trout in a stream network with connected as well as naturally-isolated tributaries. Growth and survival differences were estimated between fish living in pools as compared to fish living in riffles. Multiple-generation, individual-based data were used to develop and set parameters for a size-class and location (or habitat)-based population projection model, allowing for testing effects of habitat structure on population dynamics at local (i.e., subpopulation) and of habitat fragmentation on local and system-wide (i.e., meta-population) scales. Demographic rates which influence the persistence of isolated and fragmented populations were identified. In the naturally-isolated tributary, persistence was associated with higher early juvenile survival (~45% greater), shorter generation time (one-half) and strong selection against large body size as compared to the open system, resulting in a stage-distribution skewed towards younger, smaller fish. Simulating barriers to upstream migration into two currently-connected tributary populations caused rapid (2 - 6 generations) local extinction. These local extinctions in turn increased the likelihood of system-wide extinction, as tributaries could no longer function as population sources. Within stream reaches, average yearly survival was 5% higher for fish in pools as compared to riffles, but was up to two-fold higher for large fish (>135 mm). In contrast, there was no difference in body growth for fish in pools compared to fish in riffles. Thus, variation in habitat structure will influence population persistence by influencing survival, but not body growth. For both analyses, large fish had disproportionately large effects on population persistence, suggesting that it will be particularly important to protect large fish from harvest in stressed systems (fragmented or low pool density). Contact: ben_letcher@usgs.gov

Loughlin, M.; Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME; Upstream migration by Salmo salar hatchery fry in four Downeast streams. Point stocking Atlantic salmon fry is a routine fisheries practice. Numbers of fry stocked at points are calculated based on desired stocking densities. When point stocking fry on tributary streams from access roads and trails, frequently there are substantial lengths of inaccessible suitable habitat upriver of the access points. Information on upstream movement of fry is valuable to predict if habitat upriver of the crossing can be expected to be used by fry or parr. If upstream habitat is used by fry, then that habitat area should be used to calculate the estimated number of fry to be stocked. Upstream migration of fry is noted in Masu salmon fry (Nagata and Irvine 1997) and in Atlantic salmon parr (Erekinaro and Gibson 1997). Observations of DMR-BSRF researchers suggest upstream migration of Atlantic salmon fry (Atkinson 2006, comm.) but are confounded by fry stockings 5.5 and 6.5 kilometers upriver as well as potential unobserved “wild” redds in the vicinity. Fry movement of Salmo salar downstream to 2000 meters is documented (Atkinson 2006, comm.) and was used as an anticipated downstream movement distance. Two tributaries of the Machias and East Machias rivers were examined with a CPUE electrofishing technique. Transects equidistant above and below the stocking point were chosen and sampled up to a distance of 500 meters approximately 4 months post stocking. This preliminary study found evidence of upstream migration of fry to 100 meters at all locations and up to 500 meters above the stocking point at one location. Atkinson, E.A. (comm.) 2006. Observations on fry drift studies at Northern Stream to an A.S.C. staff training on CPUE fishing techniques at Little Lyford Pond Camps. Erekinaro, J. and R.J. Gibson. 1997. Interhabitat migration of juvenile Atlantic salmon in a Newfoundland river system, Canada. Journal of Fish Biology 51(2):373-388. Nagata, M. and J.R. Irvine. 1997. Differential dispersal patterns of male and female masu salmon fry. Journal of Fish Biology 51(3): 601. Contact: mike.loughlin@maine.gov

Loughlin, M.; Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME; Water temperature changes in canopy-limited riparian habitat at four DPS utility crossings. During 1999 a natural gas pipeline was installed across eastern Maine roughly following logging road 01-00-0 (the Stud Mill Road), widening the open corridor created by the road. This increased the corridor width from approximately 18 meters for the logging road alone to approximately 45 meters. Three of the four streams crossed the original road corridor in culverts or a bridge. The forth crossing was wooded prior to the installation of the pipeline corridor. The corridor was widened from 45 meters to approximately 95 meters for an electric transmission line during the winter of 2005/2006. During summer 2005 automated, synchronized, temperature loggers were installed above and below four stream crossings, and temperatures recorded hourly were analyzed by regression analysis and "t" test. At three locations water temperatures were significantly higher downstream of the clearings. One exception was noted on the West Branch Machias River, where downstream temperature was significantly cooler than upstream. During summer 2006 automated, synchronized, temperature loggers were installed above, within and below the same four crossings, and temperatures recorded hourly were analyzed by regression analysis and the Student's t-test. At three locations water temperatures were again significantly higher downstream of the clearings. Again an exception was noted on the West Branch Machias River, where downstream temperatures were significantly cooler than upstream. Contact: mike.loughlin@maine.gov

Mackey, G.1, F. Magilligan2, K.H. Nislow3, B. Fisher2, J. Wright4, M. Laser5, and E. Atkinson2; 1Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME; 2Dartmouth College, Department of Geography, Hanover, NH; 3US Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; 4US Fish and Wildlife Service, Falmouth, ME; 5Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME; Large wood in Maine rivers and juvenile Atlantic salmon population densities and habitat use. Maine streams have large wood loads far below predicted levels, and notably low compared to other parts of the United States. Although extensive research has been done on the relationship between Pacific salmonids and wood, relatively little is known about the role wood plays in influencing juvenile Atlantic salmon populations. Two hypotheses were tested in Old Stream, Maine, via snorkel survey in sites with naturally occurring high and low wood densities: 1) the density of juvenile Atlantic salmon was higher in sites that contained high as opposed to low loading of wood, and 2) where wood was available, juvenile salmon tended to be associated with it within a site. Results showed that age 1+ or older juveniles were at significantly higher densities in sites with high wood loading, but substrate coarseness was a more important factor. In addition, a significant proportion of both age 0+ and older juveniles associated with wood in sites where it was available. However, this association also interacted with substrate coarseness and weed cover. These findings suggest that wood is an important habitat feature for juvenile Atlantic salmon, but cannot be viewed in isolation of other habitat factors. This work supports the need for greater understanding of the relationship between Atlantic salmon and wood in rivers. Contact: greg.mackey@maine.gov

MacLean, S.A.1, C. Giray2 and S.K. Ellis3; 1NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Narragansett, RI; 2Micro Technologies, Inc., Richmond, ME; 3US Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Service, Eastport, ME; Survey of Northwestern Atlantic fishes for salmonid viral pathogens. Tissues from more than 3600 fish of 20 different species were assayed in efforts to identify potential reservoirs of salmonid viral pathogens, with special interest in the infectious salmon anemia virus (ISAV). Fish were taken from rivers, streams, and coastal areas of Maine, from within or near net pens containing ISAV-infected salmon, and from the West Greenland commercial salmon fishery. Assays included viral culture on 3 cell lines (EPC, CHSE-214 and SHK or ASK) and reverse transcription-polymerase chain reaction specific for ISAV (ISAV-RT-PCR) or for salmon swimbladder sarcoma virus (SSSV). ISAV-RT-PCR positive results were obtained from one fish taken from the Narraguagus River, Maine, of 931 (0.1%) alewife (Alosa pseudoharengus) sampled in total, and from one of 549 (0.2%) Atlantic salmon (Salmo salar) collected from the West Greenland commercial fishery. Twelve of 137 (9%) Atlantic salmon smolts used in streamside experiments tested positive for SSSV types 1 or 2 by SSSV-specific RT-PCR. A North American strain (IVa) of viral hemorrhagic septicemia virus (VHSV), most closely related to Pacific coast strains, was isolated from one of 260 (0.4%) herring (Clupea harengus harengus) taken from Maine coastal waters. Viruses were not detected in samples from 12 Atlantic salmon escapees or from fishes taken from within or near salmon net pens. Aside from SSSV, the results indicate that the prevalence of salmonid viruses in wild marine fish populations in Maine is quite low, leaving the source(s) of ISAV in cultured salmon in Maine still to be determined. Contact: sharon.maclean@noaa.gov

McCormick, S.D. 1, J. T. Kelly1, M. Monette1 and T. Liebich1, 2; 1US Geological Survey, S.O. Conte Anadromous Fish Research Center, Turners Falls, MA; 2NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; Evidence for acidification as a causative factor in the decline of Atlantic salmon in eastern Maine. Acid precipitation has caused chronic acidification and extirpations of Atlantic salmon in Norway and Nova Scotia. The moderate buffering capacity of rivers in eastern Maine prevents chronic acidification, but these rivers do experience episodic low pH events. It was previously thought that Atlantic salmon were sensitive only to long-term (several weeks) exposure to low pH. However, our recent laboratory studies demonstrate that even short term (2-6 days) exposure of smolts to pH 5.3 results in loss of seawater tolerance, impaired ion regulatory ability in fresh water and mortality at inorganic Al levels of 11, 42 and 55 µg/l, respectively. Preliminary data on pH and inorganic aluminum levels in an ongoing survey in eastern Maine indicate that these levels occur in many sites in eastern Maine. Compromised ion regulation of smolts reared in streamside tanks occurred in the mainstem of the Narraguagus and Pleasant rivers when pH dropped below 5.5. Further, data from Norway provide direct evidence that compromised ion regulatory ability of smolts results in reduced adult return rates. Together these results provide strong circumstantial evidence that episodic acidification has been a contributing factor to the decline of Atlantic salmon and that this effect continues today. Contact: mccormick@umext.umass.edu

Mierzykowski, S.E.; U.S. Fish and Wildlife Service, Maine Field Office, Old Town, ME; Contaminant assessment of white suckers from eight rivers in the Gulf of Maine Distinct Population Segment for Atlantic salmon. White suckers (Catostomus commersoni) are a common sentinel species used in state, regional, and national biomonitoring programs to illustrate contaminant conditions and trends. White suckers were collected for tissue residue analyses between 2003 and 2006 to assess contamination in eight Gulf of Maine rivers where the endangered Atlantic salmon (Salmo salar) is considered a Distinct Population Segment (DPS) under the Endangered Species Act. Ninety whole-body white suckers collected from 27 locations among the eight rivers having DPS salmon were analyzed individually (n=25) or in multi-fish composites (n=22) for organochlorine compounds and trace elements. Of 22 organochlorine compounds included in the analytical scan, two were detected with regularity - polychlorinated biphenyls (PCBs) and p,p'-DDE. Total PCB was detected in all sucker samples from the Dennys River (mean 0.041 µg/g), two fish from the Pleasant River (0.007 µg/g, 0.018 µg/g), and four composite samples from the East Machias River (mean 0.005 µg/g). Total PCB in suckers from the DPS rivers were similar to levels reported in regional and national biomonitoring programs. Although Total PCB was detected in 25 samples, and suckers from the Dennys River had six-fold higher Total PCB concentrations than fish from two other DPS rivers, Total PCB concentrations in DPS river white suckers did not exceed suggested biological effect levels. DDE, a metabolite of the insecticide DDT, was found in 12 of 28 samples (median 0.003 µg/g) from the DPS rivers at levels 3 to 15 times lower than levels reported in regional and national biomonitoring programs, and two orders of magnitude below a suggested DDT tissue threshold-effect level of 0.60 µg/g. The mean mercury concentration for all white sucker samples (0.22 µg/g) from the DPS rivers was at the suggested tissue effect threshold level (0.20 µg/g). Mercury is frequently found in biota at elevated levels in New England. Relative to higher trophic level fish species such as smallmouth bass (Micropterus salmoides), elevated levels of mercury (> 0.50 to 1.00 µg/g) are not commonly found in white suckers in New England. Among the DPS rivers, the highest mercury levels were found in white suckers from the Machias River (0.69 µg/g) and to a lesser extent in the West Branch of the Sheepscot River (mean 0.35 µg/g). In white suckers from DPS-designated rivers, concentrations of 18 other trace elements appeared lower or similar to median values reported in Maine, regional, or national biomonitoring programs. Contact: steve_mierzykowski@fws.gov

Music, P.M. and J.P. Hawkes; NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; **Assessment of rotary screw trap environmental conditions and sampling effects on emigrating Atlantic salmon smolts.** Rotary Screw Traps (RSTs) are used to collect data on Atlantic salmon smolt production, migration timing, and run composition in several rivers in Maine. To better understand the possible environmental effects of using RSTs to sample smolts, water velocity and temperature conditions in RST live cars and rivers were monitored during the 2004 field season. Water temperatures in the live cars ranged from 4.5 to 20.8 C and were within 0.33 C of river water temperature 95% of the time. Water velocity in the live cars varied from 0 to 2.06 meters per second, and no stagnant water or excessive flows were recorded. Smolt mortalities in the RST live cars were extremely low (only 0.2% of the total catch) and were generally due to debris loading. The data indicated that environmental conditions inherent to RST live cars are unlikely to harm smolts. RSTs provide a low stress and safe environment for capturing Atlantic salmon smolts and other fishes, and most hazards are foreseeable and preventable. As such, RSTs should be considered a safe tool for sampling juvenile Atlantic salmon. Contact: paul.music@noaa.gov

Nislow, K.H.1, B.P. Kennedy2, J.D. Armstrong3 and K.H. Williams3; 1US Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; 2University of Idaho, Moscow, ID; 3FRS, Scottish Fisheries Service, Faskally, Scotland, UK ; Nutrient restoration using Atlantic salmon carcasses in Scottish Highland streams' It has long been known that an excess of nutrients can degrade freshwater ecosystems and fish habitat. However, in some situations human activities can reduce nutrients below expected levels and negatively affect fish production. In this study, nutrients (in the form of adult Atlantic salmon carcasses) were restored to salmon rearing streams in the Conon River basin, northeastern Scotland, in order to determine impacts on aquatic food webs and juvenile salmon production. Carcasses were extensively colonized by aquatic macroinvertebrates, and salmon-derived nutrients were readily incorporated into periphyton, macroinvertebrates, and juvenile salmon, in some cases at considerable distance from carcass addition locations. Juvenile salmon and macroinvertebrate biomass was significantly greater in carcass-addition compared to reference sites. These results suggest that nutrient limitation of production should be considered in habitat management plans, and that migratory salmon may play an important role in the nutrient dynamics of small oligotrophic streams. Contact: knislow@fs.fed.us

O Donnell, L. and E. Cusack ; Shannon Regional Fisheries Board, Limerick, Ireland; Managing Atlantic salmon in Ireland – a case study on the River Shannon; The river Shannon is the largest river in Ireland measuring over 380 km long with a 70-km estuary and yet it doesn't have a sustainable stock of wild Atlantic salmon. Only two sub-catchments are currently reported as capable of sustaining an exploitable salmon population – the rivers Mulkear and Feale. In 2007, the Irish government decided to ban mixed stock fishing for Atlantic salmon. For Ireland as a whole, this meant that there was no drift netting fishing permitted at sea and cessation of any drift net fishing where mixed stocks were intercepted. In addition to the closure of commercial fisheries, also rivers were either closed for salmon fishing or severe restrictions were placed on angling. The Shannon system is a mixed fishery holding large stocks of pike, perch, rudd, roach and bream. Ireland's largest hydro-electric power scheme operates a dam with a boran fish lift on a bypass channel at the upper tidal limit of the fishery. Various low head hydro schemes are also present in the catchment and are now being upgraded due to a switch to "greener" energy supplies. Water quality and habitat degradation continue to be major issues facing the protection of salmon in the juvenile stages. Fish counters have become an invaluable tool to fishery managers in accessing the status of the adult populations and 2007 has seen dramatic increases in the numbers of salmon returning to our rivers.So what lies ahead now for fishery manager with a limited capital budget? The Shannon Regional Fisheries Board are involved in many projects, such as: Development of a partnership model with the state agency, fishery owner and angling clubs creation of a committee and technical group - which includes the country's top scientists - to advise on strategies to restore salmon populations to the upper catchment. Part of the steering group which is implementing the EU Water Framework Directive (2000/60/EC). Rehabilitation of spawning and nursery streams through provision of technical assistance to various bodies including NGO's .One year on, we have made considerable progress, but a lot more is required. This won't happen overnight. Fishery managers need to plan for the long term, i.e. 5-10 years.Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy Contact: lodonnell@shrfb.com

Pert, C.C. 1, K. Urquhart1, P. Cook1, U. McCarthy1, A. McBeath1, J. Simons1, S. McBeath1, R. Kilburn1 and I. R. Bricknell1,2 ; 1Fisheries Research Services, Marine Laboratory, Aberdeen, UK; 2University of Maine, School of Marine Sciences, Orono, ME; Monitoring the infective pressure of Lepeophtheirus salmonis (Krøyer 1837) on wild salmonid populations in Scotland. There is controversy concerning the distribution of salmon lice (Lepeophtheirus salmonis) within sea lochs. Some authors suggest there are low numbers of sea lice in the marine regions of a sea loch and that L. salmonis infection occurs under conditions of full salinity. Low numbers of lice then infect their host and gradually reach peak infection levels with time. A second model proposes that salmon lice gather at river mouths during the spring and early summer, and infect in a large single settlement event low salinity waters. The aim of this research is to establish (i) where within the Loch Torridon system infestation with L. salmonis occurs, (ii) seasonal variation in infectious pressure and whether copepodid, pre-adult or adult stages are responsible for infesting the host. Sentinel cages were located in Loch Shieldaig in a tidal exchange zone between Loch Torridon and the open sea, positioned to correspond to migration patterns of salmonids, tidal currents and to allow easy access. At each station 50 Atlantic salmon were introduced for 7 days, at monthly intervals, and environmental parameters, including plankton, temperature, salinity, current speed and direction, were recorded. After exposure to lice infectious pressure in the loch, the species and number of lice at each developmental stage were recorded. Data from Mar 2006 through Sep 2007 showed the majority of lice were at the copepodid stage. The mean number of lice per fish showed a continual increase throughout the study period even when the numbers of lice on adjacent salmon farms had been very low. There were low numbers of mobile L. salmonis stages within the loch from spring to early summer, which increased throughout the winter and following spring, with no winter decline in lice numbers as previously reported. Infection was initiated by copepodid and pre-adult stages. Adult salmon lice play a minor role in establishing infection. In addition, a survey of the L. salmonis burdens of returning sea trout (S. trutta) was conducted over three years (2005-2007), comparing the Scottish east and west coast populations. Over 350 returning sea trout were caught and sea lice burdens established. This is a direct comparison between the lice burdens of wild salmonids in an area with high farming activity (West Coast) and low farming activity (East Coast). In this part of the study, the highest lice burden was found on East Coast fish (7.8 lice/fish) compared with only 3.3 lice/fish on the West Coast of Scotland. This complex result suggests that the decline in sea trout on the West Coast of Scotland may not be due to increased sea lice burdens. Sea lice instead form part of a complex, multi-factorial problem and the reasons behind the decline in Scottish West Coast sea trout remains poorly understood. Contact: Ian.Bricknell@umit.maine.edu

Renkawitz, M.D. and T.F. Sheehan; NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA; Feeding ecology of Atlantic salmon postsmolts in Penobscot Bay, Maine: rearing origin matters. Maine's Penobscot River Atlantic salmon population remains at critically low abundance despite intensive stocking of multiple life stages. High rates of mortality in the nearshore environment may be contributing to low adult return rates. NOAA Fisheries Service conducted Postsmolt Trawl Surveys from 2001-2005 to investigate this hypothesis. Dietary analyses on postsmolt mortalities collected during this survey have yielded insights into the health and fitness of early marine phase postsmolts. Of the 253 stomach samples obtained, 4% were empty while 85% contained two prey types or less. A negative relationship was observed between stomach content weight and fish length. Fish that lived in the river longer (naturally-reared and parr-stocked fish) tended to be smaller and consumed more fish prey than fish that emigrated immediately post-stocking (smolt-stocked fish). Naturally-reared and parr-stocked fish consumed 81% fish and 18% crustaceans (by weight) whereas stocked smolts consumed 48% fish and 42% crustaceans. Differences in the type and quantity of consumed prey may imply contrasting levels of fitness and be indicative of other behavioral differences that affect survival. These data improve our understanding of early marine phase dynamics among the different stocking groups and may aid in defining causal ecological mechanisms that influence marine survival. Contact: mark.renkawitz@noaa.gov

Renkawitz, M.D.1, T.F. Sheehan1 and G.S. Goulette2; 1NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA; 2NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; Depth, behavior and survival of emigrating Atlantic salmon (Salmo salar) postsmolts in Penobscot Bay, Maine. Maine's Penobscot River Atlantic salmon population remains at low abundance despite intensive stocking. High near-shore mortality is hypothesized to contribute to low adult returns. To gain information on emigrating postsmolt dynamics, NOAA Fisheries Service conducted a postsmolt trawl survey in Penobscot Bay from 2001-2005. The assumption that emigrating postsmolts were available for capture by a surface trawl was evaluated by implanting 26 salmon smolts with acoustic depth tags. Detection arrays monitored fish passage through 40km of estuary and 45km offshore through Penobscot Bay. Greater than 90% of the detections occurred in water depths of 4m or less, but depths up to 18m were recorded, suggesting that postsmolts spend most of the time near the surface but occasionally dive deeper. Emigration rates for successful migrants were rapid (approximately 1 km/h), and only 39% of the postsmolts were successfully detected by the outermost arrays. These results suggest that postsmolts experience high rates of near-shore mortality despite their short residence time. These data improve our understanding of near-shore dynamics and may aid in defining the causal mechanisms influencing early marine survival. Contact: Mark.Renkawitz@noaa.gov

Snyder, N.P. 1, M.R. Castele1 and J.R. Wright2; 1Boston College, Department of Geology and Geophysics, Chestnut Hill, MA; 2US Fish and Wildlife Service, Gulf of Maine Coastal Program, Falmouth, ME; Observations of bedload sediment transport in Maine rivers: implications for Atlantic salmon habitat restoration. Atlantic salmon spawning and rearing success partially depends on substrate habitat quality, which is influenced by grain size (median, D50 = 16-256 mm) and mobility. The ability of a given stream reach to transport coarse bedload controls whether it is embedded or armored. Historical land-use changes in Maine may have altered channel geometry, resulting in changed frequency of substrate-mobilizing events. Future adjustments in channel geometry and habitat quality (via natural stream processes or restoration projects) depend on erosion, transport and deposition of sediment. We present results from monitoring of coarse bedload transport using marked particles at one site on the Narraguagus River (December 2005-June 2007), and three sites in the Sheepscot River watershed (July 2006-June 2007). All four sites are mapped as salmon spawning and/or rearing habitat, and we monitor two cross sections at each. The greatest observed bed reorganization occurred in winter-spring 2006-2007, which included a significant flood event in April (recurrence interval, RI ~9 yr on the Sheepscot River and ~5 yr on the Narraguagus River). During this period, two of the three sites in the Sheepscot watershed exhibited significant particle mobility (40-75% of all marked particles), and the third had modest mobility (~15%). This contrast in mobility is likely due to differences in local channel morphology (slope, flow depth, width), and upstream sediment mobility and supply from eroding glacial deposits. The Narraguagus River reach had significant mobility during the winter-spring 2005-2006 period (~40%; including a RI ~2 yr flood) and the winter-spring 2006-2007 period (50-67%). We cannot separate the effects of ice-rafting processes from those of floods, but the similarity in mobility during the two winters suggests that ice is likely an important influence on bedload transport processes. These results suggest that the frequency of bedload transport is reach specific, depending on factors including local channel geometry, upstream sediment supply and transport, and formation of frazil ice. This underscores the importance of conducting reach-scale studies of present channel conditions as a prerequisite for habitat restoration projects. This analysis holds the potential for refining watershed- and reach-based Atlantic salmon productivity models. Contact: noah.snyder@bc.edu

Spencer, R. 1, J. Zydlewski2 and G. Zydlewski3; 1University of Maine, Department of Biological Sciences, Orono, ME; 2US Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME; 3University of Maine, School of Marine Sciences, Orono, M; Comparison of migratory urge and gill Na+, K+ -ATPase activity of Atlantic salmon (Salmo salar) smolts from Dennys and Penobscot River stocks. Migratory urge and gill Na+, K+ -ATPase activity of Penobscot and Dennys River smolts were investigated simultaneously in a controlled hatchery environment. Smolts were tagged with Passive Integrated Transponders (PIT) and placed in behavioral evaluation tanks for a series of seven two-week long trials (n=30 new smolts*stock-1*trial-1) spanning the smolt migratory window (April-June). Non-lethal gill biopsies were collected from each smolt at the start and end of each trial to measure gill enzyme activity. Dennys smolts had the same or higher mean Na+, K+ -ATPase activity than Penobscot smolts on all sample dates. The seasonal pattern of increase, peak, and decline in enzyme activity of Dennys smolts were temporally and quantitatively similar to Penobscot smolts. The dates of onset, peak, and reduction of downstream (with tank flow) movements were independent of stock but overall Penobscot smolts moved 15.5% more frequently. Smolt activity became increasingly diurnal during peak migration but most downstream movement (>59%) still occurred at night. Dennys smolts were slightly but significantly more nocturnal than Penobscot smolts during peak migration. Correlations between the frequency of downstream movement and gill Na+, K+ -ATPase activity were absent or weak for Penobscot and Dennys smolts. Contact: randy.spencer@maine.gov

Trial, J.G.; Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Bangor, ME; Driving tips from the Hatchery Review; The Hatchery Review team made a point about changing the drivers of recovery for the Maine program. Specific quotes include "Hatchery supplementation should follow, not drive, recovery" and "Hatchery evaluation should not be viewed as research but as a core element of the Recovery Program. Accordingly, it is important to integrate scientific assessment advice into decisions regarding hatchery production and release schedules." Past stocking requests have been for a number of fish of a given life stage. Except that fish meet New England Fish Health standards, managers were not explicit about fish quality, developmental maturity, or about matching development to stocking timing. Hatchery practices, history, and economics drove the product and delivery date. It is necessary to refine requests for hatchery products so that recovery goals drive hatchery production. The Bureau of Sea Run Fisheries and Habitat has started a process to facilitate a change. Teams for each life stage (fry to smolt) have been established to: 1) review the literature on survival of hatchery products related to measurable characteristics of "fish quality" and evaluate past stocking performance of current hatchery products in Maine; 2) determine which requests to the Craig Brook National Fish Hatchery or Green Lake National Fish Hatchery may be appropriate for quality of fish; 3) prepare a request and justification in a written "White Paper" that highlights changes from the current product and develop an evaluation of the product. The measurable quality traits likely will vary by life stage and be linked to rearing regime and hatchery practices. Effective management of hatchery products also involves understanding environmental variability, so target dates are year-specific not calendar-specific. Answers to questions that will help refine stocking timing will also be in the literature and in data from past program practices. Contact: joan.trial@maine.gov

Ward, D.M. 1, K.H. Nislow2 and C.L. Folt1; 1Dartmouth College, Department of Biological Sciences, Hanover, NH; 2US Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; The effect of slimy sculpin on juvenile salmon survival and density dependence. The effects of slimy sculpin (Cottus cognatus) on survival of stocked Atlantic salmon (Salmo salar) in the Connecticut River basin were evaluated. In field sampling across salmon stocking sites, salmon first-summer survival declined with increased sculpin density, but salmon survival was not affected by any other fish species. Stomach sampling showed that sculpin preyed on newly-stocked salmon fry. In 2005 and 2006 we conducted manipulative field experiments to determine how sculpin affect salmon density-dependent survival. Salmon fry were stocked at three population density treatments in three streams with sculpin and three streams without sculpin (density treatments blocked within streams, 18 sites total). Mean salmon survival was three-fold higher in streams without sculpin (18±3%) than streams with sculpin (6±2%). Furthermore, sculpin reversed the direction of density-dependence for juvenile salmon survival. In streams without sculpin salmon survival was highest at low stocking density, while in streams with sculpin salmon survival was highest at the highest stocking density. The results show that spatial variation in fish community characteristics influences salmon population dynamics and has important implications for management strategies such as determining optimal stocking densities. Contact: Darren Ward Email: darren.ward@dartmouth.edu

Whiting, M.C. 1 and S. Koenig2; 1Maine Department of Environmental Protection, Bangor Regional Office, Bangor, ME; 2Project SHARE, Eastport, ME; Evidence of water quality enhancement of Crooked River due to roadbed applications of crushed limestone adjacent to the stream. Episodic acidification of the Downeast salmon rivers during high stormwater flows has been an on-going concern relative to the restoration of Atlantic salmon. Experimental limestone applications to add stream buffering capacity was identified as a high priority project by the Project SHARE Research Committee. To date, we have not added limestone directly to rivers. However, Maine Dept. of Environmental Protection has determined that limestone can be added to terrestrial infrastructure (road surfaces, roadside ditches, bridge abutments, etc.) without water pollution discharge permits. In May of 2007, crushed limestone gravel was added to the 52 00 0 logging road on a 300 foot long slope on the north side of the bridge over the Crooked River. The Crooked River is a second order stream, and a tributary to the Machias River. The stone was added to improve road bed traction and to reduce erosion. During rainstorms, runoff has been observed to flow down the sloped roadway and into the Crooked River. The potential addition of carbonate buffering to the nearby Crooked River was an anticipated benefit of using limestone. A comparison of before/after treatment, and above/below the bridge, show that stream pH has been less extreme below the bridge after the treatment. During Hurricane Noel (beginning on November 3, 2007) the pH above the bridge went as low as 5.0; below the bridge the pH remained above 5.5. The data indicate that terrestrial limestone applications can affect the chemistry of stormwater runoff and can enhance buffering capacity of a second order stream. Contact: mark.c.whiting@maine.gov

Whoriskey, F.; Atlantic Salmon Federation, St. Andrews, NB, Canada; Sonic tracking of smolts from Canadian rivers across the Gulf of St. Lawrence to the Strait of Belle Isle. Sonic telemetry was used to document concurrently the movements and freshwater and estuary survival of smolts from Canadian rivers over a 600 km north to south gradient. Some of the post-smolts were tracked subsequently across the Gulf of St. Lawrence to the Strait of Belle Isle, a distance of up to > 1000 km from the initial release points. Survival patterns in freshwater and the estuary were consistent for individual rivers among years. Also, there were consistent differences in survival rates among rivers, but survival to the sea was not systematically higher in more northern sites. Movement rates across the Gulf of St. Lawrence were about 25 km/d. Fish from multiple rivers were detected in the Strait of Belle Isle on the same day, providing the first documented evidence in the ocean of shoals of salmon post-smolts originating from multiple rivers. The Strait appears to be an important migration pathway for smolts from southern Gulf of St. Lawrence rivers. However, no tagged smolts from the site on the Quebec North Shore were detected there. Water temperatures < 0°C were recorded in the Strait during the smolt migration period. Contact: asfres@nb.aibn.com

Wilkins, B.C. and N.P. Snyder; Boston College, Department of Geology and Geophysics, Chestnut Hill, MA; Comparison of channel morphology in two Atlantic coastal streams: implications for Atlantic salmon habitat - preliminary results and analysis. Bedload sediment mobility is important to Atlantic salmon (Salmo salar) spawning and rearing success. Channel beds that are not mobilized on a frequent enough basis will become armored or embedded over time, impeding the creation of redds and negatively influencing the likelihood of egg survival. Channel shape is an important factor affecting bedload sediment mobility within streams. It is believed that Maine river-channel morphology has been altered by land use practices, ultimately creating wider and shallower channels and lowering the stream competence. If correct, these changes may be partially responsible for the limited number of returning Atlantic salmon currently observed in Maine rivers. To evaluate the magnitude of these changes, we are preparing a statistical comparison of channel morphology between two Atlantic coastal streams: the Narraguagus River in Downeast Maine and the Jacquet River in northern New Brunswick, Canada. Compared to the Narraguagus, the Jacquet River has relatively healthy returns of adult salmon and a differing land-use history. Both watersheds have roughly equal drainage areas (Narraguagus 588 km2, Jacquet 510 km2) and similar mean annual precipitation (1244 and 1200 mm respectively). During the summer of 2007 we surveyed a 13.6 km section of the Narraguagus River with drainage area ranging from 129 to 247 km2, and a 10.4 km reach of the Jacquet River with drainage area ranging from 94 to 265 km2. Measurements were made of active and bankfull width, depth, and channel gradient at 100-meter intervals, and grain size counts were performed at 200-meter intervals. Preliminary results indicate significantly greater bankfull width to depth ratios on the Narraguagus River (29 ± 11) than in the Jacquet River (23 ± 9). This is indicative of lower basal sheer stress and reduced bedload sediment mobility. Contact: benjamin.wilkins@bc.edu

Zydlewski, G. 1, J. Zydlewski2 and S. Lashua1; 1University of Maine, School of Marine Sciences, Orono, ME; 2US Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME; Long-term seawater performance and scale circuli deposition of Atlantic salmon smolts. Penobscot strain Atlantic salmon were held in saltwater for up to four months to examine the relationship between growth and survival to gill Na+, K+-ATPase activity levels and determine scale circuli deposition rates. In May 2006, 940 salmon smolts from Green Lake National Fish Hatchery were analyzed for their freshwater gill Na+, K+-ATPase activity levels. Individuals were classified as having "low", "medium", or "high" levels based on the normal distribution of activities observed on the day of gill collection (10 May). All individuals were transferred isothermally to full strength seawater and maintained on photoperiod and temperature regimes similar to what they would normally experience during their migration from the Penobscot River to the Labrador Sea. Fish scales were taken and size (fork length and weight) was recorded on days 1, 3, 14, 44 and monthly for four months. Fish grew throughout the experiment, but fish size, growth rate, and gill Na+, K+-ATPase activity in saltwater did not differ among freshwater ATPase groups. Scale circuli spacing was greater when the salmon were in saltwater (than when in freshwater in the hatchery). It took approximately two weeks to deposit a single circulus in saltwater, compared to eleven days while in freshwater. Scale circuli deposition rates from this study can be used to approximate ages of adult Atlantic salmon returning to freshwater rivers. Based on this laboratory experiment, it is unlikely that small scale variation in gill Na+, K+-ATPase activity is predictive of long-term performance (measured as survival and growth) in seawater. Contact: gayle.zydlewski@umit.maine.edu

5.6 Historical Tables

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

Table 1. Documented Atlantic salmon returns to USA rivers, 2007. "Natural" includes fish originating from natural spawning and hatchery fry.

RIVER	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
Androscoggin	6	1	11	2	0	0	0	0	20
Connecticut	0	1	19	120	0	1	0	0	141
Kennebec	2	2	6	5	1	0	0	0	16
Merrimack	8	1	52	12	0	1	0	0	74
Dennys (DPS)	1	0	1	1	0	0	0	0	3
Narraguagus (DPS)	0	2	0	9	0	0	0	0	11
Other GOM DPS [1]	0	8	0	31	0	0	0	0	39
Pawcatuck	0	0	2	0	0	0	0	0	2
Penobscot	226	35	575	88	0	0	1	0	925
Saco	4	0	16	4	0	0	0	0	24

[1] Numbers based on redds, ages and origins are pro-rated based

Table .2. Documented Atlantic salmon returns to the USA, 1967-2007. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

	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
2007	297	954	3	1	1,255	931	324

Table 3. Two sea winter (2SW) returns for 2007 in relation to spawner requirements for USA rivers.

River	Spawner Requirement	2SW spawners-2007	Percentage of Requirement
Penobscot	6,838	663	9.70
Connecticut	9,727	139	1.43
Pawcatuck	367	2	0.54
Merrimack	2599	64	2.46
GOM-DPS	1,564	31	1.98
Other Maine rivers	8,104	44	0.54
Total	29199	943	3.23

Table 4a. Number of juvenile Atlantic salmon stocked in USA, 2007.

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,345,000	0	600	2,300	600	99,000	6,447,500
Aroostook	854,000	0	0	0	0	0	854,000
Androscoggin	1,000	0	0	0	0	0	1,000
Dennys	257,000	0	0	0	56,500	0	313,500
East Machias	245,000	0	0	0	0	0	245,000
Kennebec	20,000	0	0	0	0	0	20,000
Machias	470,000	0	2,200	0	0	0	472,200
Narraguagus	346,000	15,700	0	0	0	0	361,700
Pleasant	177,000	0	0	0	0	0	177,000
Penobscot	1,606,000	337,800	0	0	559,900	0	2,503,700
Saco	576,000	0	0	0	0	0	576,000
Sheepscot	198,000	0	0	0	0	0	198,000
Union	22,000	0	0	0	0	0	22,000
Merrimack	1,140,000	0	0	0	50,000	0	1,190,000
Pawcatuck	115,000	0	4,900	0	6,400	0	126,300
Total for United States	12,372,000	353,500	7,700	2,300	673,400	99,000	13,507,900

Table 4b. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon for the USA in 2007 by river.

		Captive Reared Domestic		Sea Run	
River	Purpose	Pre-spawn	Post-spawn	Post-spawn	Total
Connecticut	Restoration	0	0	0	0
Dennys	Restoration	0	31	0	31
East Machias	Restoration	44	100	0	144
Hobart Stream	Restoration	80	0	0	80
Kennebec	Restoration	0	26	0	26
Machias	Restoration	59	178	0	237
Merrimack	Restoration/Recreation	1081	479	0	1,560
Narraguagus	Restoration	0	179	0	179
Penobscot	Restoration	0	905	567	1,472
Sheepscot	Restoration	61	87	0	148
Total United States		1,325	1,985	567	3,877

Table 5. Summary of tagged and marked Atlantic salmon released in USA, 2007.

		Stock Origin									
Mark	Life Stage	Connecticut	Dennys	East Machias	Machias	Merrimack	Narraguagus	Pawcatuck	Penobscot	Sheepscot	Grand Total
AD	Adult								909		909
FLOY	Adult					1510					1,510
PIT	Adult		62	144	237		228		567	148	1,386
RAD	Adult	10							19		29
TEMP	Fry						3916		33397		37,313
AD	Parr	2996						4908			7,904
PIT	Parr	747									747
AD	Parr						15687				15,687
LV	Parr								105577		105,577
AD	Smolt	99600						6352			105,952
PING	Smolt	108									108
RAD	Smolt								64		64
VIE	Smolt								147619		147,619
Grand Total		103,461	62	144	237	1,510	19,831	11,260	288,152	148	424,805

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

TEMP = thermal otolith mark

Table .6. Aquaculture production (metric tones) in New England from 1997 to 2007.

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

Table 7. Juvenile Atlantic salmon stocking summary for New England in2007.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,345,000	0	600	2,300	600	99,000	6,447,500
Total for Connecticut Program							**6,447,500**
Androscoggin	1,000	0	0	0	0	0	1,000
Aroostook	854,000	0	0	0	0	0	854,000
Dennys	257,000	0	0	0	56,500	0	313,500
East Machias	245,000	0	0	0	0	0	245,000
Kennebec	20,000	0	0	0	0	0	20,000
Machias	470,000	0	2,200	0	0	0	472,200
Narraguagus	346,000	15,700	0	0	0	0	361,700
Penobscot	1,606,000	337,800	0	0	559,900	0	2,503,700
Pleasant	177,000	0	0	0	0	0	177,000
Saco	576,000	0	0	0	0	0	576,000
Sheepscot	198,000	0	0	0	0	0	198,000
Union	22,000	0	0	0	0	0	22,000
Total for Maine Program							**5,744,100**
Merrimack	1,140,000	0	0	0	50,000	0	1,190,000
Total for Merrimack Program							**1,190,000**
Pawcatuck	115,000	0	4,900	0	6,400	0	126,300
Total for Pawcatuck Program							**126,300**
Total for United States							**13,507,900**
Grand Total							**13,507,900**

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 2007.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Post-Spawn	Total
Connecticut	Restoration	0	0	0	0
Dennys	Restoration	0	31	0	31
East Machias	Restoration	44	100	0	144
Hobart Stream	Restoration	80	0	0	80
Kennebec	Restoration	0	26	0	26
Machias	Restoration	59	178	0	237
Merrimack	Restoration/Recreation	1,081	479	0	1,560
Narraguagus	Restoration	0	179	0	179
Penobscot	Restoration	0	905	567	1,472
Sheepscot	Restoration	61	87	0	148
Total		1,325	1,985	567	3,877

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 2007 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
NHFG	4&5	Adult	H		FLOY	50		May	Merrimack
UOM	0	Fry	H		TEMP	33,397		May	Penobscot
UOM	0	Fry	H		TEMP	3,916		May	Narraguagus
NAI	3	Adult	W	Connecticut	RAD	1	PIT	May	Connecticut
NAI	4	Adult	W	Connecticut	RAD	9	PIT	May	Connecticut
NAI	2	Smolt	W	Connecticut	PING	108	DYE	May	Connecticut
USFWS	1	Parr	H	Connecticut	AD	648		April	Connecticut
USFWS	2	Parr	H	Connecticut	AD	1,387		April	Connecticut
USFWS	2	Parr	H	Connecticut	AD	961		Mar	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	63		June	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	48,990		Mar	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	49,899		April	Connecticut
USFWS	1	Smolt	H	Connecticut	AD	648		April	Connecticut
USGS	1	Parr	W	Connecticut	PIT	747	DYE	Oct	Connecticut
USFWS	6	Adult	H	Dennys	PIT	31		Dec	Dennys
USFWS	6	Adult	H	Dennys	PIT	31		Oct	Grand Manan
USFWS	5	Adult	H	East Machias	PIT	100		Dec	East Machias
USFWS	5	Adult	H	East Machias	PIT	44		Oct	East Machias
USFWS	5	Adult	H	Machias	PIT	178		Dec	Machias
USFWS	5	Adult	H	Machias	PIT	59		Oct	Machias
NHFG	4&5	Adult	H	Merrimack	FLOY	350		May	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	550		Oct	Merrimack
NHFG	4&5	Adult	H	Merrimack	FLOY	79		June	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	531		Sept	Merrimack
DMR	1		H	Narraguagus	AD	15,687		Sept	Narraguagus

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	5	Adult	H	Narraguagus	PIT	179		Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	49		Oct	Grand Manan
RIF&W	1	Parr	H	Pawcatuck	AD	4,400		Sept	Pawcatuck
RIF&W	1	Parr	H	Pawcatuck	AD	508		Aug	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	2,913		May	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	1,672		Mar	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	1,767		April	Pawcatuck
FPL	4	Adult	H	Penobscot	AD	4		Dec	Kennebec
FPL	4	Adult	H	Penobscot	RAD	19	AD	Dec	Kennebec
FPL	2	Smolt	H	Penobscot	RAD	42		June	Kennebec
FPL	2	Smolt	H	Penobscot	RAD	22		May	Kennebec
NOAA	1		H	Penobscot	LV	105,577		Dec	Piscataquis
NOAA	1	Smolt	H	Penobscot	VIE	147,619	AD	April	Penobscot
USFWS	5	Adult	H	Penobscot	PIT	567		Nov	Penobscot
USFWS	4	Adult	H	Penobscot	AD	438		Dec	Penobscot
USFWS	3	Adult	H	Penobscot	AD	467		Dec	Penobscot
USFWS	5	Adult	H	Sheepscot	PIT	61		Oct	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	87		Dec	Sheepscot

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

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

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,488	928	3,874
Hatchery Juvenile	382,739	277,162	420,116
Wild Adult			10
Wild Juvenile	855		855

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

	1SW		2SW		3SW		Repeat			2003-2007
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	6	1	11	2	0	0	0	0	**20**	10
Connecticut	0	1	19	120	0	1	0	0	**141**	131
Dennys	1	0	1	1	0	0	0	0	**3**	5
Kennebec	2	2	5	6	1	0	0	0	**16**	16
Merrimack	8	1	52	12	0	1	0	0	**74**	94
Narraguagus	0	2	0	9	0	0	0	0	**11**	14
Pawcatuck	0	0	2	0	0	0	0	0	**2**	2
Penobscot	226	35	575	88	0	0	1	0	**925**	1,078
Saco	4	0	16	4	0	0	0	0	**24**	27
Total	**247**	**42**	**681**	**242**	**1**	**2**	**1**	**0**	**1,216**	**1,377**

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

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	1598	9,390,000
Merrimack	Domestic	687	2,587,000
Penobscot	Domestic	394	1,595,000
Dennys	Captive	84	425,000
East Machias	Captive	78	456,000
Machias	Captive	150	714,000
Narraguagus	Captive	186	854,000
Pleasant	Captive	77	275,000
Sheepscot	Captive	81	349,000
Total	**Captive/Domestic**	**3,335**	**16,645,000**
Connecticut	Kelt	113	1,190,000
Merrimack	Kelt	45	511,000
Total	**Kelt**	**158**	**1,701,000**
Connecticut	Sea Run	95	723,000
Merrimack	Sea Run	35	299,000
Pawcatuck	Sea Run	2	9,000
Penobscot	Sea Run	315	2,697,000
Total	**Sea Run**	**447**	**3,728,000**
Grand Total for Year	**2007**	**3,940**	**22,074,000**

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.

	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
Cocheco															
1993-1997	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															
1977-1997	1,042	13,610,000	8,300	8,320	66,197,000	6,200	0	0		1,154	16,626,000	10,500	10,516	96,434,000	6,900
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
2007	95	723,000	7,600	1,598	9,390,000	5,900	0	0		113	1,190,000	10,500	1,806	11,303,000	6,300
Total Connecticut	1,788	19,229,000	7,500	26,511	169,106,000	5,800	0	0		2,147	26,296,000	9,900	30,446	214,634,000	6,100
Dennys															
1939-1997	26	214,000	7,600	0	0		360	1,155,000	3,100	23	167,000	7,000	409	1,536,000	5,200
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
2001	0	0		0	0		82	359,000	4,400	0	0		82	359,000	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
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
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
Total Dennys	26	214,000	7,600	0	0	0	1,133	4,765,000	4,564	40	331,000	8,600	1,199	5,308,000	4,900
East Machias															
1995-1997	0	0		0	0		272	759,000	2,700	0	0		272	759,000	2,700
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
2007	0	0		0	0		78	456,000	5,800	0	0		78	456,000	5,800
Total East Machias	0	0		0	0	0	1,065	4,450,000	4,555	0	0		1,065	4,450,000	4,600
Kennebec															
1979-1997	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															
1992-1997	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															
1941-1997	456	3,263,000	7,300	0	0		576	1,796,000	3,000	8	52,000	6,400	1,040	5,111,000	6,600
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
2007	0	0		0	0		150	714,000	4,800	0	0		150	714,000	4,800
Total Machias	456	3,263,000	7,300	0	0	0	1,903	8,003,000	4,591	8	52,000	6,400	2,367	11,318,000	4,900
Merrimack															
1983-1997	805	5,849,000	7,400	5,504	32,282,000	5,800	0	0		0	0		6,309	38,131,000	6,700
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
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

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
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
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
Total Merrimack	1,256	9,723,000	8,900	10,132	51,736,000	4,300	0	0		381	3,952,000	10,700	11,769	65,411,000	5,200
Narraguagus															
1962-1997	0	1,303,000		0	0		463	1,491,000	3,200	0	0		463	2,794,000	3,200
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
2007	0	0		0	0		186	854,000	4,600	0	0		186	854,000	4,600
Total Narraguagus	0	1,303,000		0	0	0	1,908	7,145,000	3,882	0	0		1,908	8,448,000	3,900
Orland															
1967-1997	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															
1992-1997	8	76,000	9,800	0	0		0	0		0	0		8	76,000	9,800

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
1999	6	61,000	10,200	0	0		0	0		0	0		6	61,000	10,200
2000	0	0		0	0		0	0		5	43,000	8,600	5	43,000	8,600
2001	0	0		2	2,000	1,100	0	0		1	8,000	7,800	3	10,000	3,300
2002	0	0		0	0		0	0		3	10,000	3,300	3	10,000	3,300
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
2006	0	0		4	4,000	1,000	0	0		0	0		4	4,000	1,000
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
Total Pawcatuck	18	152,000	6,900	6	6,000	1,000	0	0		9	61,000	6,600	33	219,000	5,500
Penobscot															
1871-1997	16,193	139,229,000	7,800	2,784	6,846,000	2,400	0	0		0	0		18,977	146,075,000	7,600
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
2007	315	2,697,000	8,600	394	1,595,000	4,000	0	0		0	0		709	4,292,000	6,100
Total Penobscot	19,218	165,074,000	8,500	6,422	17,551,000	3,000	329	1,400,000	4,300	0	0		25,969	184,026,000	5,800
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
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
Total Pleasant	0	0		0	0	0	296	1,220,000	5,014	0	0		296	1,220,000	5,000
Sheepscot															
1995-1997	18	125,000	6,900	0	0		133	368,000	2,400	20	185,000	9,300	171	678,000	3,900
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
2007	0	0		0	0		81	349,000	4,300	0	0		81	349,000	4,300
Total Sheepscot	18	125,000	6,900	0	0	0	900	3,599,000	4,109	45	439,000	10,100	963	4,163,000	4,400
St Croix															
1993-1997	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

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
Union															
1974-1997	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	1,788	19,231,000	7,500	26,511	169,106,000	5,800	0	0		2,147	26,296,000	9,900	30,446	214,632,000	6,100
Dennys	26	214,000	7,600	0	0		1,133	4,763,000	4,600	40	330,000	8,600	1,199	5,307,000	4,800
East Machias	0	0		0	0		1,065	4,450,000	4,500	0	0		1,065	4,450,000	4,500
Kennebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Machias	456	3,263,000	7,300	0	0		1,903	8,001,000	4,600	8	52,000	6,400	2,367	11,316,000	4,900
Merrimack	1,256	9,722,000	8,800	10,132	51,736,000	4,300	0	0		381	3,952,000	10,700	11,769	65,410,000	5,200
Narraguagus	0	1,303,000		0	0		1,908	7,145,000	3,900	0	0		1,908	8,448,000	3,900
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	18	152,000	6,900	6	6,000	1,100	0	0		9	61,000	6,600	33	219,000	5,500
Penobscot	19,218	165,074,000	8,500	6,422	17,551,000	3,000	329	1,400,000	4,300	0	0		25,969	184,026,000	5,800
Pleasant	0	0		0	0		296	1,220,000	5,000	0	0		296	1,220,000	5,000
Sheepscot	18	125,000	6,900	0	0		900	3,598,000	4,100	45	438,000	10,100	963	4,162,000	4,400
St Croix	39	291,000	7,200	0	0		0	0		0	0		39	291,000	7,200
Union	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Grand Total	**23,472**	**204,359,000**	**8,700**	**43,071**	**238,399,000**	**5,500**	**7,534**	**30,577,000**	**4,100**	**2,630**	**31,129,000**	**11,800**	**76,707**	**504,465,000**	**6,600**

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

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

	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
2007	1,000	0	0	0	0	0	1,000
Totals:Androscoggin	**8,000**	**0**	**0**	**0**	**0**	**0**	**8,000**
Aroostook							
1978-1997	1,206,000	317,100	38,600	0	32,600	29,800	1,624,100
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
2007	854,000	0	0	0	0	0	854,000
Totals:Aroostook	**3,433,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**3,851,400**
Cocheco							
1988-1997	1,050,000	50,000	10,500	0	5,300	0	1,115,800
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							
1967-1997	43,935,000	2,820,600	1,802,600	0	3,743,500	963,200	53,264,900
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
2007	6,345,000	0	600	2,300	600	99,000	6,447,500

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Connecticut	**120,400,000**	**2,834,300**	**1,813,400**	**14,900**	**3,771,300**	**1,434,100**	**130,268,000**
Dennys							
1975-1997	623,000	8,300	3,400	0	143,100	29,200	807,000
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
2007	257,000	0	0	0	56,500	0	313,500
Totals:Dennys	**2,386,000**	**225,400**	**7,300**	**0**	**532,700**	**29,200**	**3,180,600**
Ducktrap							
1986-1997	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-1997	368,000	6,500	42,600	0	97,600	30,400	545,100
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
2007	245,000	0	0	0	0	0	245,000
Totals:East Machias	**2,736,000**	**7,500**	**42,600**	**0**	**108,400**	**30,400**	**2,924,900**
Kennebec							
2001	3,000	0	0	0	0	0	3,000
2002	7,000	0	0	0	0	0	7,000
2003	42,000	0	0	0	0	0	42,000
2004	52,000	0	0	0	0	0	52,000
2005	30,000	0	0	0	0	0	30,000
2006	8,000	0	0	0	0	0	8,000
2007	20,000	0	0	0	0	0	20,000
Totals:Kennebec	**162,000**	**0**	**0**	**0**	**0**	**0**	**162,000**
Lamprey							
1978-1997	946,000	427,700	58,500	0	138,100	32,800	1,603,100
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

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2001	111,000	0	300	0	0	0	111,300
2002	103,000	0	0	0	60,000	0	163,000
2003	106,000	0	0	0	0	0	106,000
Totals:Lamprey	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**
Machias							
1970-1997	858,000	86,900	117,800	0	180,500	44,100	1,287,300
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
2007	470,000	0	2,200	0	0	0	472,200
Totals:Machias	**4,434,000**	**98,900**	**122,000**	**0**	**191,300**	**44,100**	**4,890,300**
Merrimack							
1975-1997	19,770,000	227,500	583,700	0	1,109,100	635,900	22,326,200
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
2007	1,140,000	0	0	0	50,000	0	1,190,000
Totals:Merrimack	**35,458,000**	**232,600**	**598,100**	**0**	**1,619,000**	**638,100**	**38,545,800**
Narraguagus							
1970-1997	584,000	30,300	14,600	0	106,800	84,000	819,700
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
2007	346,000	15,700	0	0	0	0	361,700
Totals:Narraguagus	**4,146,000**	**96,100**	**14,600**	**0**	**107,800**	**84,000**	**4,448,500**
Pawcatuck							
1979-1997	1,859,000	1,209,200	248,500	0	47,000	500	3,364,200

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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
2007	115,000	0	4,900	0	6,400	0	126,300
Totals:Pawcatuck	**5,587,000**	**1,209,200**	**268,100**	**0**	**112,200**	**500**	**7,177,000**
Penobscot							
1970-1997	9,143,000	2,094,600	1,372,800	0	8,799,900	2,508,200	23,918,500
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
2007	1,606,000	337,800	0	0	559,900	0	2,503,700
Totals:Penobscot	**20,761,000**	**5,199,500**	**1,394,400**	**0**	**14,346,200**	**2,508,200**	**44,209,300**
Pleasant							
1975-1997	187,000	2,500	1,800	0	54,700	18,100	264,100
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
2007	177,000	0	0	0	0	0	177,000
Totals:Pleasant	**853,000**	**16,000**	**1,800**	**0**	**63,400**	**42,100**	**976,300**
Saco							
1975-1997	1,142,000	273,500	201,200	0	263,400	9,500	1,889,600
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
2003	501,000	20,000	0	0	3,200	0	524,200

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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
2007	576,000	0	0	0	0	0	576,000
Totals:Saco	**5,832,000**	**438,700**	**219,200**	**0**	**342,200**	**9,500**	**6,841,600**
Sheepscot							
1971-1997	325,000	70,800	20,600	0	92,200	7,100	515,700
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
2007	198,000	0	0	0	0	0	198,000
Totals:Sheepscot	**2,608,000**	**132,900**	**20,600**	**0**	**92,200**	**7,100**	**2,860,800**
St Croix							
1981-1997	1,261,000	355,900	158,100	0	747,200	20,100	2,542,300
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
2007	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							
1971-1997	93,000	289,300	0	0	379,700	251,000	1,013,000
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
2007	22,000	0	0	0	0	0	22,000
Totals:Union	**462,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,464,100**
Upper StJohn							
1979-1997	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	**7,300**
Aroostook	3,433,000	317,400	38,600	0	32,600	29,800	**3,851,300**
Cocheco	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	120,399,000	2,834,300	1,813,500	15,000	3,771,300	1,434,200	**130,252,000**
Dennys	2,386,000	225,400	7,300	0	532,800	29,200	**3,181,000**
Ducktrap	68,000	0	0	0	0	0	**68,000**
East Machias	2,736,000	7,500	42,600	0	108,400	30,400	**2,924,500**
Kennebec	162,000	0	0	0	0	0	**162,100**
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	4,433,000	98,900	122,000	0	191,300	44,100	**4,889,500**
Merrimack	35,458,000	232,500	598,100	0	1,619,000	638,100	**38,545,600**
Narraguagus	4,147,000	96,100	14,600	0	107,800	84,000	**4,449,200**
Pawcatuck	5,587,000	1,209,200	268,100	0	112,200	500	**7,177,000**
Penobscot	20,760,000	5,199,400	1,394,400	0	14,346,200	2,508,200	**44,208,300**
Pleasant	853,000	16,000	1,800	0	63,400	42,100	**976,700**
Saco	5,832,000	438,700	219,200	0	342,200	9,500	**6,841,300**
Sheepscot	2,608,000	132,900	20,600	0	92,200	7,100	**2,861,000**
St Croix	1,269,000	470,400	158,300	0	808,000	20,100	**2,725,600**
Union	461,000	371,400	0	0	379,700	251,000	**1,463,500**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**216,316,000**	**13,584,500**	**4,783,000**	**15,000**	**22,718,900**	**5,188,800**	**262,591,100**

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									
1983-1997	26	499	6	2	5	80	0	1	**619**
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**
2007	6	11	0	0	1	2	0	0	**20**
Total for Androscoggin	43	543	6	2	7	86	0	1	**688**
Cocheco									
1992-1997	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									
1974-1997	35	3,500	28	2	19	787	9	0	**4,380**
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**
2007	0	19	0	0	1	120	1	0	**141**
Total for Connecticut	49	3,559	28	2	96	1897	13	1	**5,645**
Dennys									
1967-1997	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**
2007	1	1	0	0	0	1	0	0	**3**
Total for Dennys	38	317	0	1	32	746	3	31	**1,168**
Ducktrap									
1985-1997	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-1997	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-1997	12	189	5	1	0	9	0	0	**216**
2006	4	6	0	0	3	2	0	0	**15**
2007	2	5	1	0	2	6	0	0	**16**
Total for Kennebec	18	200	6	1	5	17	0	0	**247**
Lamprey									
1979-1997	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									
1967-1997	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									
1982-1997	159	758	17	8	87	827	26	0	**1,882**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2002	31	17	0	0	1	6	0	0	**55**
2003	12	129	0	0	0	4	0	0	**145**
2004	17	92	2	0	2	15	0	0	**128**
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**
2007	8	52	0	0	1	12	1	0	**74**
Total for Merrimack	332	1,352	22	8	128	1011	27	0	**2,880**
Narraguagus									
1967-1997	92	645	19	52	59	2,293	68	149	**3,377**
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**
2007	0	0	0	0	2	9	0	0	**11**
Total for Narraguagus	92	650	19	54	95	2431	70	155	**3,566**
Pawcatuck									
1982-1997	1	141	1	0	0	3	0	0	**146**
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**
2007	0	2	0	0	0	0	0	0	**2**
Total for Pawcatuck	2	150	1	0	1	17	1	0	**172**
Penobscot									
1968-1997	8,805	38,272	276	623	528	3,135	28	76	**51,743**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2004	276	952	10	16	5	59	3	2	**1,323**
2005	269	678	0	8	6	22	0	2	**985**
2006	338	653	1	4	15	33	0	0	**1,044**
2007	226	575	0	1	35	88	0	0	**925**
Total for Penobscot	11,296	44,413	288	710	726	3842	35	99	**61,409**
Pleasant									
1967-1997	5	12	0	0	11	215	2	2	**247**
2000	0	0	0	0	1	2	0	0	**3**
2001	0	0	0	0	1	9	1	0	**11**
2003	0	0	0	0	1	1	0	0	**2**
2004	0	0	0	0	0	1	0	0	**1**
Total for Pleasant	5	12	0	0	14	228	3	2	**264**
Saco									
1985-1997	39	420	3	5	0	2	0	0	**469**
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**
2007	4	16	0	0	0	4	0	0	**24**
Total for Saco	129	614	3	7	28	81	3	0	**865**
Sheepscot									
1967-1997	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-1997	296	1,804	9	24	1	12	0	0	**2,146**
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	43	543	6	2	7	86	0	1	**688**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	49	3,559	28	2	96	1,897	13	1	**5,645**
Dennys	38	317	0	1	32	746	3	31	**1,168**
Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec	18	200	6	1	5	17	0	0	**247**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	332	1,352	22	8	128	1,011	27	0	**2,880**
Narraguagus	92	650	19	54	95	2,431	70	155	**3,566**
Pawcatuck	2	150	1	0	1	17	1	0	**172**
Penobscot	11,296	44,413	288	710	726	3,842	35	99	**61,409**
Pleasant	5	12	0	0	14	228	3	2	**264**
Saco	129	614	3	7	28	81	3	0	**865**
Sheepscot	6	38	0	0	30	358	10	0	**442**
Union	303	1,821	9	28	1	16	0	0	**2,178**

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

Year	Total Fry (10,000s)	Total Returns	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 2002 - 2005 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	0	0	3	90	7	0
2002	490	88	0.179	0	10	0	11	69	1	2	6			0	22	72	7	
2003	482	96	0.199	0	7	0	13	80		0				0	20	80		
2004	526	8	0.015	13	88		0							13	88			
2005	542	1	0.002	100										100				
Total	**7,401**	**1,354**																
Mean			**0.536**	**4**	**9**	**0**	**2**	**67**	**4**	**0**	**4**	**0**	**0**	**4**	**11**	**67**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%) 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 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 2002 - 2005 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	0	0	5	89	5	0
2002	725	165	0.228	1	10	0	12	72	1	1	3			1	22	73	4	
2003	700	139	0.198	1	14	0	12	73		0				1	26	73		
2004	765	14	0.018	7	93		0							7	93			
2005	776	1	0.001	100										100				
Total	**10,767**	**2,005**																
Mean			**0.416**	**3**	**14**	**0**	**3**	**65**	**2**	**0**	**5**	**0**	**0**	**3**	**17**	**65**	**7**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1979	3	3	1.034	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	20	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	17	15	0.902	0	0	0	0	87	13	0	0	0	0	0	0	87	13	0
1983	16	1	0.064	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	13	2	0.156	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0
1985	14	12	0.881	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	8	1	0.126	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
1988	33	13	0.391	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	28	19	0.680	0	63	0	11	26	0	0	0	0	0	0	74	26	0	0
1990	27	11	0.407	0	45	0	0	45	0	0	9	0	0	0	45	45	9	0
1991	37	2	0.054	0	50	0	0	0	0	0	50	0	0	0	50	0	50	0
1992	55	15	0.271	0	20	0	0	67	0	0	13	0	0	0	20	67	13	0
1993	77	52	0.673	0	13	0	6	77	0	0	4	0	0	0	19	77	4	0
1994	110	49	0.447	0	31	0	4	63	0	0	2	0	0	0	35	63	2	0
1995	115	42	0.367	2	38	0	5	52	0	0	2	0	0	2	43	52	2	0
1996	91	19	0.208	0	58	0	11	26	0	0	5	0	0	0	68	26	5	0
1997	148	4	0.027	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	119	2	0.017	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	99	2	0.020	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0

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

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

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

2000	125	9	0.072	0	0	0	0	89	0	0	11	0	0	0	0	89	11	0
2001	125	12	0.096	0	8	0	17	75	0	0	0	0	0	0	25	75	0	0
2002	119	22	0.185	5	5	0	14	77	0	0	0			5	18	77	0	
2003	112	8	0.071	0	38	0	25	38		0				0	63	38		
2004	118	2	0.017	0	100		0							0	100			
2005	124	0	0.000	0										0				
Total	**1,760**	**322**																
Mean			**0.293**	**0**	**26**	**0**	**3**	**56**	**1**	**0**	**9**	**0**	**0**	**0**	**29**	**56**	**10**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1975	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	6	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	7	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	11	18	1.698	0	0	0	0	11	33	22	28	6	0	0	0	33	61	6
1979	8	43	5.584	0	0	0	0	84	5	2	9	0	0	0	0	86	14	0
1980	13	42	3.333	0	0	0	0	19	5	19	52	5	0	0	0	38	57	5
1981	6	78	13.684	0	0	0	6	81	0	5	8	0	0	0	6	86	8	0
1982	5	48	9.600	0	0	2	2	77	8	0	10	0	0	0	2	79	19	0
1983	1	23	27.479	0	4	4	17	65	4	0	4	0	0	0	22	70	9	0
1984	53	47	0.894	0	13	0	4	77	2	0	4	0	0	0	17	77	6	0
1985	15	59	3.986	0	2	0	7	69	2	0	20	0	0	0	8	69	22	0
1986	53	111	2.114	0	11	0	0	77	1	0	9	0	2	0	11	77	10	2
1987	108	264	2.449	0	2	0	9	85	0	0	4	0	0	0	11	85	4	0
1988	172	93	0.541	1	5	0	0	90	0	0	3	0	0	1	5	90	3	0
1989	103	45	0.435	2	7	0	31	60	0	0	0	0	0	2	38	60	0	0
1990	98	21	0.215	5	0	0	10	81	0	0	5	0	0	5	10	81	5	0
1991	146	17	0.117	0	6	0	6	76	12	0	0	0	0	0	12	76	12	0
1992	112	15	0.134	0	0	0	0	93	7	0	0	0	0	0	0	93	7	0
1993	116	11	0.095	0	0	0	27	45	0	9	18	0	0	0	27	55	18	0
1994	282	53	0.188	0	0	0	13	85	0	0	2	0	0	0	13	85	2	0
1995	283	87	0.308	0	0	0	22	72	0	6	0	0	0	0	22	78	0	0

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

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

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

1996	180	27	0.150	0	0	0	15	85	0	0	0	0	0	0	15	85	0	0
1997	200	4	0.020	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1998	259	8	0.031	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1999	176	8	0.046	0	0	0	13	50	0	0	38	0	0	0	13	50	38	0
2000	222	12	0.054	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2001	171	5	0.029	0	0	0	40	20	0	0	40	0	0	0	40	20	40	0
2002	141	8	0.057	0	0	0	0	88	13	0	0			0	0	88	13	
2003	133	18	0.135	0	0	0	33	67		0				0	33	67		
2004	156	1	0.006	0	0		100							0	100			
2005	96	0	0.000	0										0				
Total	**3,331**	**1,166**																
Mean			**2.367**	**0**	**2**	**0**	**14**	**62**	**3**	**2**	**9**	**0**	**0**	**0**	**15**	**65**	**12**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1993	38	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	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	0	0	100	0	0
2002	40	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2003	31	0	0.000	0	0	0	0	0		0				0	0	0		
2004	56	0	0.000	0	0		0							0	0			
2005	1	0	0.000	0										0				
Total	**522**	**19**																
Mean			**0.034**	**0**	**4**	**2**	**2**	**46**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**48**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	12	2	0.165	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0			0	33	67	0	
2003	25	13	0.526	8	38	0	8	46		0				8	46	46		
2004	28	0	0.000	0	0		0							0	0			
2005	26	0	0.000	0										0				
Total	**352**	**82**																
Mean			**0.232**	**0**	**21**	**0**	**4**	**56**	**0**	**0**	**0**	**0**	**0**	**0**	**25**	**56**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2002 - 2005 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 (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
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	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0			0	21	79	0	
2003	81	22	0.271	0	18	0	9	73		0				0	27	73		
2004	93	4	0.043	0	100		0							0	100			
2005	84	0	0.000	0										0				
Total	**1,254**	**247**																
Mean			**0.195**	**0**	**10**	**0**	**4**	**79**	**0**	**0**	**6**	**0**	**0**	**0**	**14**	**79**	**6**	**0**

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

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

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

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

Year Stocked	Number of adult returns per 10,000 fry stocked						
	Merrimack	**Pawcatuck**	**CT Basin**	**Connecticut (above Holyoke)**	**Salmon**	**Farmington**	**Westfield**
1998	0.031	0.000	0.048	0.050	0.039	0.017	0.078
1999	0.046	0.085	0.070	0.072	0.454	0.020	0.056
2000	0.054	0.061	0.071	0.062	0.108	0.072	0.131
2001	0.029	0.047	0.158	0.165	0.160	0.096	0.188
2002	0.057	0.000	0.228	0.179	0.799	0.185	0.381
2003	0.135	0.000	0.198	0.199	0.526	0.071	0.271
2004	0.006	0.000	0.018	0.015	0.000	0.017	0.043
2005	0.000	0.000	0.001	0.002	0.000	0.000	0.000
Mean	**2.367**	**0.034**	**0.416**	**0.536**	**0.232**	**0.293**	**0.195**
StndDev	**5.579**	**0.045**	**0.477**	**0.743**	**0.258**	**0.321**	**0.186**

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

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

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

	Mean age class (smolt age.sea age) distribution (%)										Mean age (years) (%)				
	1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.2**	**2**	**3**	**4**	**5**	**6**
Connecticut (basin)	0.00	0.08	0.00	0.04	0.81	0.01	0.00	0.05	0.00	0.00	0.00	0.13	0.82	0.05	0.00
Connecticut (above Holyoke)	0.00	0.04	0.00	0.03	0.86	0.01	0.00	0.05	0.00	0.00	0.00	0.07	0.86	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	0.23	0.00	0.13	0.62	0.00	0.00	0.00	0.00	0.00	0.01	0.37	0.62	0.00	0.00
Westfield	0.00	0.06	0.00	0.05	0.85	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	0.10	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**	**0.17**	**0.78**	**0.04**	**0.00**

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

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