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U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE

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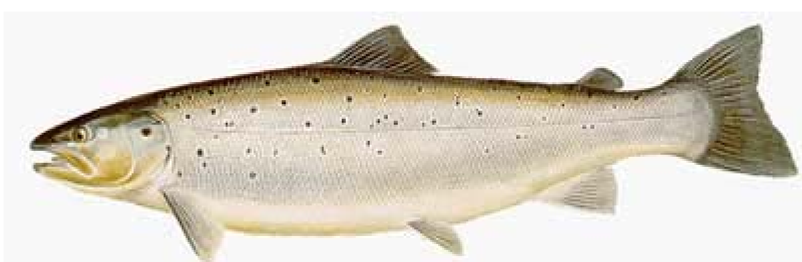

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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 1,650; 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 1,568 in 2010, 29% fewer than observed in 2009 and 37% fewer than returned in 2008. Estimated to return to Gulf of Maine coastal rivers was 164 (90% CI = 136 - 199) adult salmon, the 7th highest for the 1991-2010 time-series. Most returns occurred to the Gulf of Maine Distinct Population Segment, which includes the Penobscot River and these eastern coastal rivers, accounting for 91% of the total return. Overall, 33% of the adult returns to the USA were 1SW salmon and 67% were MSW salmon. Most (85%) returns were of hatchery smolt origin and the balance (15%) originated from either natural reproduction or hatchery fry. A total of 13,098,400 juvenile salmon (fry, parr, and smolts), 4,082 adults, and 500,000 eggs were stocked, with 794,956 juveniles carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 346 sea-run females, 2,859 captive/domestic and domestic females, and 112 female kelts. The number of females (3,317) contributing was less than 2009 (3,944); and the total egg take (18,340,000) was lower than 2009 (20,623,000). Production of farmed salmon in Maine was reported to be 11,127 metric tonnes in 2010, approximately 1.85 times greater than the 6,028 metric tonnes of production reported in 2009.

1.2 Description of Fisheries

Commercial and recreational fisheries for sea-run Atlantic salmon are closed in USA waters (including coastal waters). Estimated catch and unreported catch are zero (metric tonne). A fishery in the main stem of the Merrimack River and small reach of the Pemigewasset River was supported by the release of 1,180 broodstock in 2010.

1.3 Adult Returns

Total return to USA rivers was 1,650 (Table 1.3.1), a 29% decrease from 2009 returns (Table 1.3.2). Returns are reported for three meta-population areas (Figure 1.3.1); Long Island Sound (LIS), Central New England (CNE), and Gulf of Maine (GOM). Changes from 2009 within areas were: LIS (- 30%), CNE (+13%), GOM (- 31%). For the larger rivers changes from 2009 were: Connecticut (- 30%), Saco (+20%), Merrimack (+8%), Penobscot (-33%). In addition to catches at traps and weirs (1,568), the return of 164 (90% CI = 136 - 199) salmon was estimated for coastal populations within the Gulf of Maine area based on a linear regression [ln (returns) = 0.559 ln(redd count) + 1.289]. The ratio of sea ages from trap and weir catches within other coastal GOM rivers was used to estimate the number of 2SW spawners for the estimated returns.

Most returns occurred in the Gulf of Maine area, with the Penobscot River accounting for 80% of the total return. Overall, 33% of the adult returns to the USA were 1SW salmon and 67% were MSW salmon. Most (85%) returns were of hatchery smolt origin and the balance (15%) originated from either natural reproduction or hatchery fry (Figure 1.3.2). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2008 was 0.20%, with the 2SW fish return rate 0.16% (Figure 1.3.3). 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 2008 cohort of wild smolts on the Narraguagus was 0.63% (Figure 1.3.3).

In the USA, returns are well below conservation spawner requirements. Returns of 2SW fish from traps, weirs, and estimated returns were only 3.7 % of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.5 to 6.2 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2010 about 13,099,000 juvenile salmon (91% fry) were released into 16 River systems (Table 1.4.1.). The number of juveniles released was more than that in 2009 (11,665,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six coastal rivers within the GOM area Maine. The 387,000 parr released in 2010 were primarily the by-products of smolt production programs. The majority of smolts were stocked in one river in each of the areas: LIS Connecticut (43,000), CNE Merrimack (73,000), and GOM Penobscot (258,800). In addition to juveniles, 4,080 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 into four coastal rivers in the GOM area 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 four watersheds in the GOM area in the fall were added to USA 2SW returns to calculate spawners. Thus, spawners exceeded returns in 2010 with USA spawners totaling 2,054. Escapement to natural spawning areas was 1,639 (returns released to rivers + stocked pre-spawn adults).

1.5 Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 799,174 salmon released into USA waters in 2010 was marked or tagged. Tags and marks for parr, smolts and adults included: Floy, Carlin, PIT, radio, acoustical, fin clips, and visual implant elastomer. About 20% of the marked fish were released into the CNE area and 71% into rivers in the GOM area (Table 1.5.1).

1.6 Farm Production

Production of farmed salmon in Maine was reported to be 11,127 metric tonnes in 2010, approximately 1.85 times greater than the 6,028 metric tonnes of production reported in 2009 (Table 1.6.1).

1.7 Stocking Eyed Eggs

Eyed eggs for the project were Penobscot origin F2 generation from two hatcheries; 51,000 from the Department of Agriculture facility in Franklin Maine (USDA) and 549,000 from the Green Lake National Fish Hatchery (GLNFH) in Ellsworth Maine. Eggs were planted in the Sandy River drainage, a tributary to the Kennebec River. A total of 12 sites on the mainstem Sandy River and eight tributary streams were selected that were similar to know redd areas in Maine based on substrate and hydraulic conditions. At nine randomly chosen locations a known number of eggs (between 3,484 and 7,659) were buried in a single artificial redd, allowing estimates of emergence rates based on fry captures in emergence traps. Fry traps were installed between 7 May and 10 May 2010 and operated until few or no fry were captured for several consecutive days. In addition to fry trapping assessments, CPUE electrofishing surveys for 0+ parr were also conducted in most planting sites.

All the eggs for this project were buried in nine days between 15 December 2009 and 4 February 2010. Emergence rates from the nine artificial redds with known number of eggs (number of fry captured in the trap divided by the number eggs buried in that redd) ranged from 43.5% to 3.5% and averaged 23.1%. Based on the electrofishing, the nine plantings produced at most 72,000 0+ parr distributed over approximately 3,660 $100m^2$ units of habitat in a total of 36 km up and downstream from the planting sites.

Table 1.3.1 Documented Atlantic salmon returns to USA by geographic area, 2010. "Natural" includes fish originating from natural spawning and hatchery fry.

	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
Area	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
LIS	0	1	3	48	0	0	0	0	52
CNE	37	10	45	11	0	1	0	0	104
[1] GOM	443	61	860	111	1	1	12	5	1494

[1] Includes numbers based on redds, ages and origins are pro-rated based upon distributions for GOM coastal rivers with traps

Table 1.3.2 Documented Atlantic salmon returns to the USA, 1967-2010. "Natural" includes fishoriginating from natural spawning and hatchery fry

	Sea age					Origin	
Year	1SW	2SW	3SW	Repeat	Total	Hatchery	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1078	3	17	1,650	1401	249

Table 1.3.3 Two sea winter (2SW) returns for 2010 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2010	Percentage of Requirement
Long Island Sound	LIS	10,094	51	0.5%
Central New England	CNE	3,435	56	1.6%
Gulf of Maine	GOM	15,670	971	6.2%
Total		29,199	1,078	3.7%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2010. Numbers are rounded to 1,000.

Area		N: Rivers	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Long Island Sound	LIS	2: Connecticut, Pawcatuck	6,299,000	0	6,000	19,000	4,000	43,000	6,371,000
Central New England	CNE	2: Merrimack, Saco	1,783,000	80,000	9,000	0	99,000	0	1,971,000
Gulf of Maine	GOM	10: Androscoggin to Dennys	3,327,000	273,000	0	0	630,000	0	4,230,000
Outer Bay of Fundy	OBF	2: Aroostook, St Croix	527,000	0	0	0	0	0	527,000
Totals for USA		16	11,936,000	353,000	15,000	19,000	733,000	43,000	13,099,000

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2010 by geographic area.

			Captive Reared Domestic		Sea Run		Eggs
River		Purpose	Pre-spawn	Post-spawn	Post-spawn	Total	Eyed
Long Island Sound	LIS	Restoration			2	2	
Central New England	CNE	Restoration/Recreation	780	400		1,180	
Gulf of Maine	GOM	Restoration	404	1,935	561	2,900	500,000

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2010. Includes hatchery and wild origin fish.

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Parr	89,271	14,500	25,291	129,062
AD	Smolt	72,853	3,912	42,692	119,457
CWT	Parr		258,800		258,800
FLOY	Adult	1,180			1,180
OTOL	Fry		40,200		40,200
PING	Adult		40		40
PING	Smolt		599		599
PIT	Adult		2,692		2,692
PIT	Kelt			2	2
RAD	Adult		44	10	54
RAD	Smolt		59	135	194
VIE	Smolt		246,137	757	246,894
Grand Total		163,304	566,983	68,887	799,174

RAD = radio tag
PIT = passive integrated transponder
PING = ultrasonic acoustic tag
OTOL=thermal marked otolith

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2009.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014
2009	6,028
2010	11,127

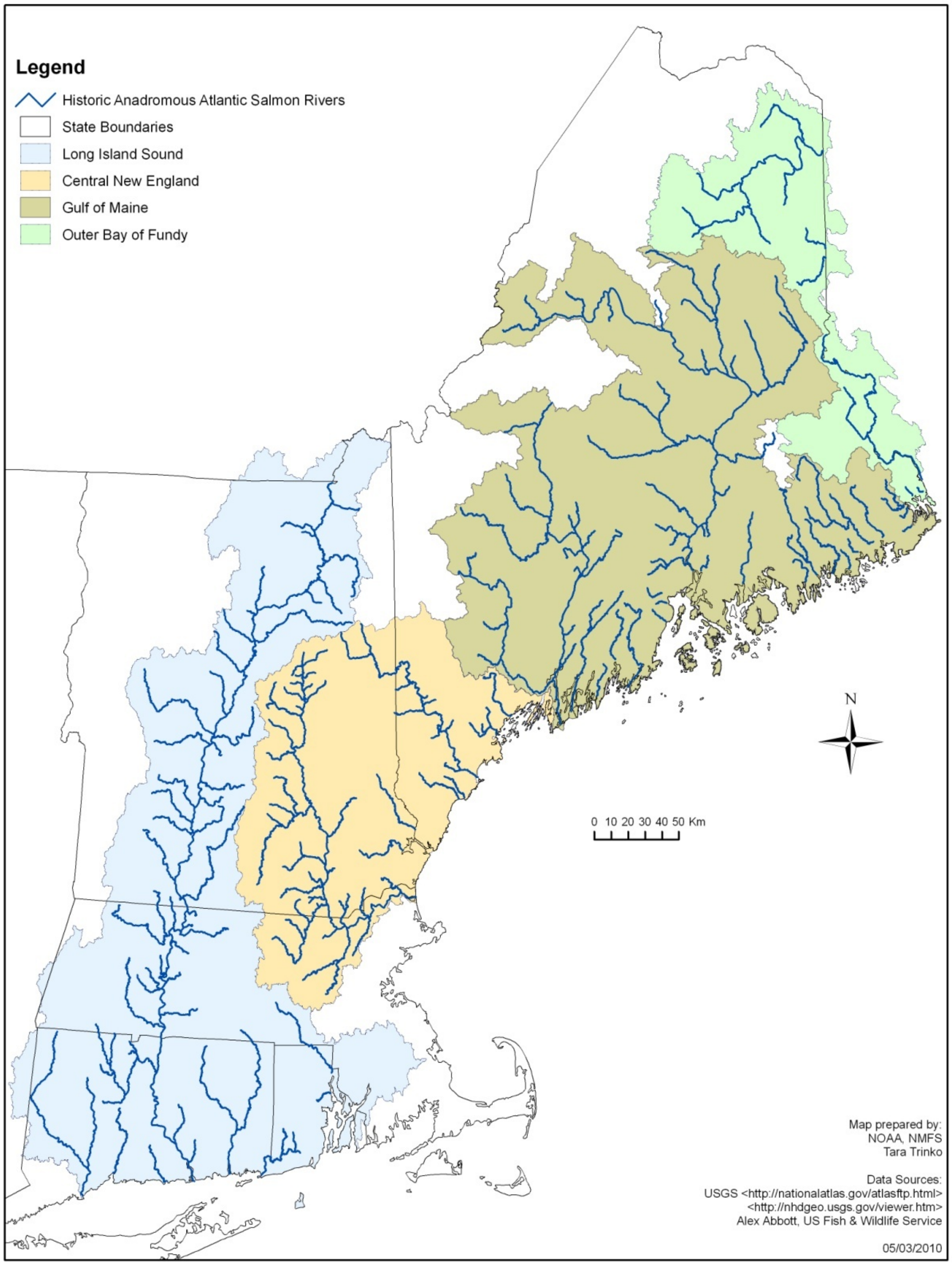

Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2010.

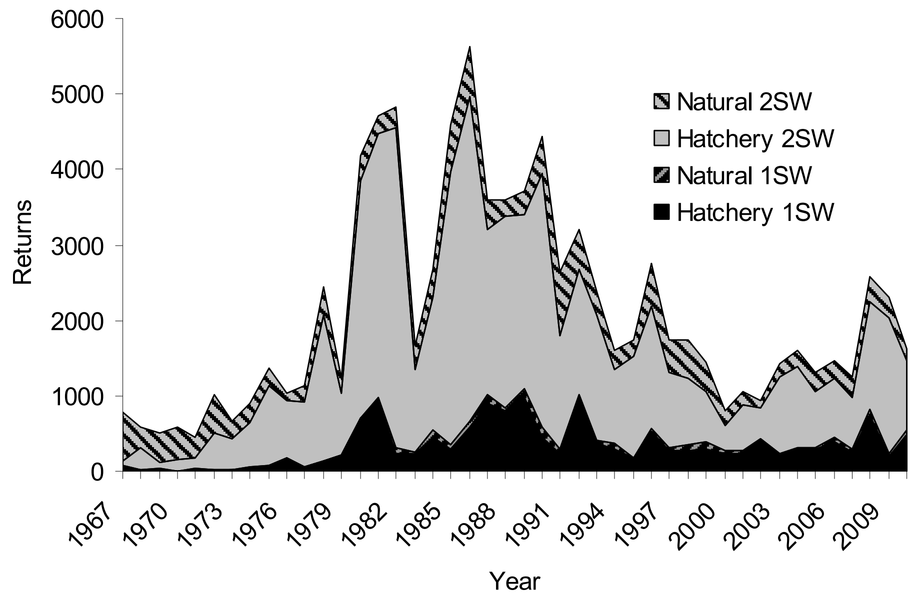

Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2010.

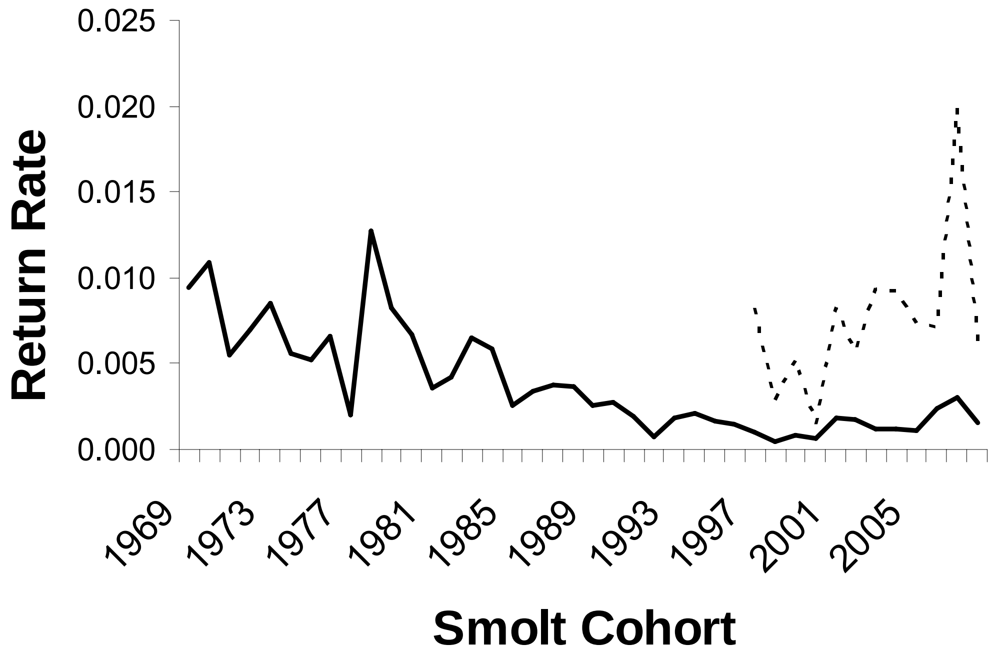

Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2 Status of Stocks

2.1 Distribution, Biology and Management

Atlantic salmon, Salmo salar, is a highly prized game and food fish with a circumpolar distribution. In North America, the species originally ranged from the Ungava Bay southward to Long Island Sound, encompassing most coastal New England river basins (Figure 2.1.1). As a consequence of human development, many native New England populations were extirpated (Fay et al. 2006). Salmon life history is complex because of its use of both headwater streams and distant marine habitats (Figure 2.1.2). The life cycle for US Atlantic salmon begins with spawning in rivers during autumn, and eggs remain in the gravel and hatch during winter. Fry emerge from the gravel in spring. Juvenile salmon (parr) remain in rivers 1–3 years. When parr exceed 13 cm (5 in) in the autumn, they develop into smolts, overwinter, and then migrate to the ocean in spring. Tagging data indicates that US salmon commonly migrate as far north as West Greenland. After their first winter at sea, a small portion (~10%) of the cohort, typically males, become sexually mature and return to spawn as 1 sea-winter (1SW) fish (grilse). Non-maturing adults remain at sea, feeding in the coastal waters of West Greenland, Newfoundland, and Labrador. Historically, gillnet fisheries for salmon occurred in coastal waters. After their second winter at sea (2SW), most US salmon return to spawn, with 3 sea-winter and repeat-spawning salmon life history patterns being less common and becoming rarer (<5%) with declining stock size.

Strong homing capabilities of Atlantic salmon foster the formation and maintenance of local breeding groups or stocks (National Research Council 2002; Verspoor et al. 2002; Spidle et. al. 2003). These stocks exhibit heritable adaptations to their home range in rivers and likely at sea. The importance of maintaining local adaptations has demonstrated utility in salmon conservation (National Research Council 2004). Because of significant declines in Atlantic salmon populations in the US, an analyses of population structure was conducted, and some populations are managed under the Endangered Species Act (ESA, 74 Federal Register 29346, June 19, 2009). The Act required that subgroups must be separable from the remainder of, and significant to, the species to which it belongs to warrant ESA protection. Assessing population structure required broad scale consideration of geologic and climatic features that shape population structure through natural selection. For Atlantic salmon, factors such as climate, soil type, and hydrology were particularly important because these factors influence ecosystem structure and function, including transfer of energy in aquatic food chains (Fay et al. 2006). Numerous ecological classification systems were examined, which integrated the many factors necessary to discern historic structure. Biologists then delineated US Atlantic salmon populations into four discrete stock complexes that are managed discretely: (i) Long Island Sound complex; (ii) Central New England complex; (iii) Gulf of Maine distinct population segment (DPS), and (iv) the Outer Bay of Fundy designatable unit (Figure 2.1.1).

Restoration Areas. Native stocks in both the Long Island Sound and Central New England areas were extirpated in the 1800s (Parrish et al. 1998; Fay et. al 2006). Remnant native populations of Atlantic salmon in the US now persist only in Maine. Whereas Atlantic salmon stocks from the Penobscot River in Maine were used to initiate restoration programs in the Connecticut and Pawcatuck rivers (Long Island Sound DPS) and in the Merrimack and Saco rivers (Central New England DPS), Southern New England programs are now independent. Atlantic salmon populations in both of these areas are fully dependent upon hatchery supplementation programs. The Connecticut River program has been independent from external broodstock sources for several generations, and hatchery abundance has sustained genetic diversity while still allowing some genetic changes to occur, which could be a result of emerging local adaptation (Spidle et. al. 2004). The Central New England area has been more closely linked with the Penobscot River because of annual stocking of 50,000 smolts from Penobscot stock-origin through 2009. However, for several generations, captive broodstock was being developed exclusively from sea-run returns to the Merrimack, facilitating some adaptation. The domination of fry stocking as a restoration tool should be allowing natural selection and adaptation to occur in most freshwater and marine stages (reproduction and alevin incubation occurs in hatcheries). These populations are managed under coordinated federal and interstate restoration efforts, in the form of stocking and fish-passage construction and protected from harvest by state laws, and under the NEFMC Fishery Management Plan.

The Gulf of Maine DPS represents the last naturally spawning stocks of Atlantic salmon in the US and is managed under an ESA recovery program (Anon 2005). There are several extant stocks in the DPS that are divided into three geographic Salmon Habitat Recovery Units (SHRUs): (i) Downeast Coastal (Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers); (ii) Penobscot Bay (Penobscot, Cove Brook, and Ducktrap rivers); and (iii) Merrymeeting Bay (Sheepscot River). Most stocks have a hatchery-supplementation program that is managed on a river-specific basis (Cove Brook and Ducktrap stocks have no hatchery component). Like the restoration programs, fry stocking makes up the majority of the hatchery inputs to the system, but in the Penobscot and selected river systems, smolt stocking is a major contributor that results in significant returns for broodstock collection and natural spawning. In addition, these extant stocks represent potential donor populations for other watersheds. While at low levels, natural reproduction still represents an important element of the management system, and redd surveys both document this contribution and facilitate management of stocked fish to protect naturally spawned offspring.

US watersheds in the Outer Bay of Fundy region are supplemented by St. John River Atlantic salmon broodstock, and the core populations of this management unit have freshwater nursery areas, primarily in Canadian watersheds. The St. John River population is the largest in this region, and fish in the Aroostook River are part of this unit. In addition, the St. Croix River is in this management unit. Within Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses population structure and status and designates which wildlife species are in peril. COSEWIC completed a species-level assessment of Atlantic salmon in eastern Canada in November 2010. The COSEWIC assessment identified 16 designatable units (DUs—equivalent to a DPS/ESU) and the two closest to the US- the outer Bay of Fundy DU and inner Bay of Fundy DU, were listed as endangered and recovery planning is ongoing.

2.2 The Fishery

Atlantic salmon were documented as being utilized by Native Americans in Maine approximately 7,000–6,500 calendar years BP (Robinson et al. 2009). US commercial fisheries started in Maine during the 1600s, with records of catch by various methods. Around the time of the American Revolution, weirs became the gear of choice and were modified when more effective materials and designs became available (Baum 1997). Weirs remained the primary commercial gear, with catches in Maine exceeding 90 mt in the late 1800s and 45 mt in some years during the early 1900s (Baum 1997). Penobscot River and Bay were the primary landing areas, but when the homewater fishery was finally closed in 1948, only 40 fish were harvested in this region.

Recreational angling for Atlantic salmon had historically been important. The first Atlantic salmon reportedly caught on rod and reel was captured in the Dennys River, Maine in 1832 by an unknown angler (Baum 1997). The dynamics of Atlantic salmon fishing are very ritualistic, with fly fishing being the most generally acceptable method of angling, and the advent of salmon clubs among many US rivers creating an important and unique cultural and historical record (Beland and Bielak 2002). Recreational angling has been closed in the US for decades, with the exception of Maine, where regulations became more restrictive and eventually resulted in a catch-and-release fishery only (Table 2.2.1). However, in 1999, when low salmon returns threatened sustainability of even hatchery populations, the remaining catch-and-release fishery was closed. In Maine, an experimental Penobscot River autumn (2006 and 2007) and spring (2008) catch-and-release fishery was authorized, but then closed again until populations rebuild. There remains a unique fishery for Atlantic salmon in New Hampshire, where fish retired from hatchery broodstock are reconditioned and released for angling in tributaries to the Merrimack River, which historically contained sea-run populations. License sales for this fishery are stable at about 1,300 per year.

According to the Atlantic salmon fishery management plan of the New England Fishery Management Council, The management unit for the Atlantic salmon FMP is intended to encompass the entire range of the species of U.S. origin while recognizing the jurisdictional authority of the signatory nations to NASCO. Accordingly, the management unit for this FMP is: "All anadromous Atlantic salmon of U.S. origin in the North Atlantic area through their migratory ranges except while they are found within any foreign nation's territorial sea or fishery conservation zone (or the equivalent), to the extent that such sea or zone is recognized by the United States." Presently, there is a prohibition on the possession of salmon in the EEZ. This effectively protects the entire US population complex in these marine waters and is complementary to management practiced by the states in riverine and coastal waters. However, distant-water fisheries must be managed as well to conserve and restore US salmon populations. Commercial fisheries for Atlantic salmon in Canada and Greenland are managed under the auspices of the North Atlantic Salmon Conservation Organization (NASCO), of which the US is a member. The mixed-stock fisheries in Canada were historically managed by time-area closures and quotas. However, all commercial fisheries for Atlantic salmon in Canada thought to intercept US salmon have been closed since 2000. The Greenland fishery has been managed by a quota system since 1972. In 1993, a modified quota system was agreed to, which provided a framework for quotas based on a forecast model of salmon abundance. From 1993 to 1994, quotas were bought out through a private initiative, but the fishery resumed in 1995 under forecast-modeling-based quotas. In 2002, salmon conservationists and the Organization of Fishermen and Hunters in Greenland signed a five-year, annually renewable agreement, which suspended all commercial salmon fishing within Greenland territorial waters, while allowing for an annual internal use only fishery. In 2007, a similar agreement was signed and will be in effect through 2013.

The scientific advice from ICES has recommended no commercial harvest because of continued low spawner abundance since 2002. Starting in 2003, the annual regulatory measures agreed at NASCO have restricted the annual harvest to the amount used for internal consumption in Greenland, which in the past has been estimated at 20 mt annually, with no commercial export of salmon allowed. In 2006, these same measures were agreed upon and would continue through the 2007 and 2008 fishing seasons, assuming that the Framework of Indicators used in the interim years indicated that there was no significant change in the previously provided multiannual catch advice. The

Framework of Indicators allows for an interim check on the stock status of the West Greenland salmon complex, based on a variety of production measures, such as adult abundance and marine survival rates measured at monitoring facilities in rivers across the range of the species. A similar multiannual regulatory measure was adopted to cover the 2009–2011 fishing seasons.

2.2.1 Aquaculture

Despite declining natural populations, the Atlantic salmon mariculture industry continues to develop worldwide. In eastern Maine and Maritime Canada, companies typically rear fish to smolt stage in private freshwater facilities, transfer them into anchored net pens or sea cages, feed them, and harvest the fish when they reach market size. In the Northwest Atlantic, 66% of production is based in Canada, with 99.4% of Canadian production in the Maritimes and 0.6% in Newfoundland. The balance (44%) of Northwest Atlantic production is in eastern Maine. US production trends for Maine facilities and areas occupied by marine cages have grown exponentially for two decades. By 1998, there were at least 35 freshwater smolt-rearing facilities and 124 marine production facilities in eastern North America. Since the first experimental harvest of Atlantic salmon in 1979 of 6 mt, the mariculture industry in eastern North America has grown to produce greater than 32,000 mt annually since 1997. In Maine, production increased rapidly and peaked at about 16,500 mt in 2000, but abruptly declined to below 6,000 mt in 2005 because of a disease outbreak (infectious salmon anemia) that forced the destruction of large numbers of fish. Production practices also had to change due to federal judge fining producers for violating the federal Clean Water Act through fouling the sea floor with excess feed, medications, feces, and other pollutants. With improved regulations targeting sustainable best management practices with innovative bay-area management creating fallowing areas, farmers have increased sustainability and production, and production has rebuilt (Figure 2.2.1.1). Current management efforts focus on the recovery of natural populations and support of sustainable aquaculture to ensure both resource components are managed in a sustainable fashion. Production for 2010 in Maine was over 11,000 mt the 6th highest in the 26 year time series.

2.2.2 Research Vessel Survey Indices

Atlantic salmon in the ocean are pelagic, highly surface–oriented, and of relatively limited abundance within a large expansive area; therefore, they are not typically caught in standard NEFSC bottom trawl surveys or midwater trawls used to calibrate hydroacoustic surveys. However, researchers in Canada and Norway have successfully sampled Atlantic salmon postsmolts using surface trawls. The NEFSC has been experimenting with these techniques to test them in US waters, while learning more of the distribution and ecology of Atlantic salmon in the marine environment. Between 2001 and 2005, NEFSC surface trawls sampled over 4,000 postsmolts; all postsmolts were counted, weighed, and measured. The presence of any marks and clips were also recorded, as well as fish's external appearance, degree of smoltification and fin condition and deformities, which aided in origin determination. These assessments are providing novel information on US salmon postsmolt ecology and status at sea and will be used to develop future marine surveys.

2.2.3 Hatchery Inputs

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: (i) conservation hatcheries that produce fish from remnant local stocks within a DPS and stock them into that DPS, or (ii) restoration hatcheries that produce salmon from broodstock established from donor populations outside their native DPS. 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 than 25 years, the majority of fish reared for the Long Island Sound and Central New England DPS units are progeny of fish that completed their life cycle in these waters for 3 or more generations. For Central New England, their complete isolation from the Penobscot River population is more recent (2009 year class).

A total of 13.1 million juvenile salmon were stocked in 2010 across 16 river systems, a number typical of the decade. Fry stocking dominates numerically, with 11.9 million stocked; fry were planted in all 16 systems. Four river systems were stocked with parr and six with smolts. Managers stocked around 780,000 smolts in US waters, with 560,000 stocked in the Penobscot River. This total and the percentage stocked in the Penobscot River are typical for the last decade. Penobscot River smolts consistently produce over 75% of the adult salmon returns to the US. Cost and hatchery capacity issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits at the juvenile stage, and naturally reared smolts typically have a higher marine survival rate than hatchery smolts. From a hatchery perspective, rebuilding Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems that successfully reach the ocean and using hatchery production to optimally maintain population diversity, distribution, and abundance. However, survival at sea is a dominant factor constraining stock rebuilding. Building sustainable 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 and effective population sizes.

2.3 Stock Abundance Metrics

US Atlantic salmon populations are assessed by the US Atlantic Salmon Assessment Committee (USASAC), a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Currently, population status of salmon is determined by counting returning adults either directly (traps and weirs) or indirectly (redd surveys). Total returns also include retained fish from angling in other regions, and historical US time-series also include these data. Some mortality can and does occur between trap counts and actual spawning—the actual number of spawners is termed “spawning escapement” and is not estimated for many US populations. However, redd counts provide a reasonable proxy for rivers with populations surveyed with that method. Fisheries could impact escapement as well, but since the mid-1990s, most open fisheries were limited to catch and release because this mortality is lower than retention-fisheries impacts on returns or escapement would be lower. The USASAC is continuing its efforts to develop metrics to examine juvenile production of large parr (pre-smolts) and emigrating smolts..

The modern time-series of salmon returns to US rivers began in 1967 (Figure 2.3.1). Average annual Atlantic salmon returns to US rivers from 1967 to the present was 2,160, and the median is 1,711. 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 (Figures 2.2.1.1 and 2.3.1). 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 and then in 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. The average annual Atlantic salmon returns to US rivers from 1991 to the present is 1,878 fish, only 87% of the time-series average. There has been a downward trend in the production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish), that has affected US populations. In addition, recovery from historical impacts was never sufficient, so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2010 were 1,650 fish, which ranks 23rd in the 44-year time-series and as such is near the median of the time series. Relative to the average during the current marine phase (1991–present), returns were the 11th highest in the 20 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 29,199 spawners (Table 2.3.1). The average percent of the CSE target for the time-series was 7.4%, and in 2010 was only 3.7% of the CSE. In the last decade, total returns have accounted for less than 2% of this target for the Long Island Sound and Central New England stock complexes. However, salmon returns to the Gulf of Maine DPS have been as high as 20% of the CSE during this period, largely because of hatchery smolt returns to the Penobscot River. In smaller rivers of the Gulf of Maine stock complex, the CSE ranged from 3 to 15%. The Outer Bay of Fundy DU is assessed by the Department of Fisheries and Oceans Canada. CSE levels are minimal recovery targets because 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 50–100%, 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, and the remnant populations of the Gulf of Maine stock complex remain endangered.

Over the past 5 years, the contributions of each stock complex to the total US returns averaged <0.5% for the Outer Bay of Fundy, 87% for the Gulf of Maine, 6% for Central New England, and 7% for Long Island Sound. Returns in 2010 were typical, in that the Penobscot River population accounted for the largest percentage (76%) of the total return. In the Penobscot this year, 33% of the adult returns were 1SW salmon and 67% were 2SW fish. From 1967 to 1985, the ratio of 3SW salmon to 2SW fish averaged 1.2%, and was as high as 6%. However, from 1986 to 2010, this average declined to 0.5%, and the highest ratio was only 1.3%. Most (94%) returns in 2010 were hatchery-smolt origin, and the balance (6%) 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 (strongest index of marine survival). For a comprehensive look at return rates throughout New England, a cursory examination of returns from smolt stocked cohorts provides the most informative comprehensive assessment of all regions (Figure 2.3.2). While some subtleties, such as age structure of hatchery smolts, and subsidies from other larger juvenile stocking, such as parr, need further analysis, this is an informative metric. Median return rates for the past 5 years per 10,000 hatchery smolts stocked for the four areas are highest in the Gulf of Maine (16.0) and decrease southward for the Central New England (10.4) and Long Island Sound (1.9) areas.

Maine return-rate assessments provide both a return rate for naturally produced fish (fry stocked or wild spawned) in the Narraguagus River and for Penobscot River hatchery smolts—the longest and least variable in release methods and location (Figure 41.6). Penobscot median return rates per 10,000 smolts from 1969 to 2010 smolt cohorts averaged 5.0 for 1SW salmon and 26.7 for 2SW fish. These return rates have been lower since 1991, when a phase shift in North Atlantic ecosystem production occurred (Chaput et al. 2005); smolt cohorts from 1991 to 2007 median values were 4.4 for 1SW salmon and 15.0 for 2SW fish. Starting in 1997, NOAA began a program to estimate production of naturally-reared smolts in the Narraguagus River, Maine. The median return rate for naturally reared Narraguagus River smolt 1997–2008 cohorts was 72.5 per 10,000. That rate was 6.0 times higher than the Penobscot 2SW hatchery median of 12.0 for the same time-period.

In 2010, the adult return rate for 2SW hatchery smolts released in the Penobscot River was 16.0, ranking 23rd in the 40-year record, while the 2010 return rate for 1SW hatchery grilse was 7.3, ranking 11th in the 40-year record. The 2SW return rate in the Narraguagus River in 2010 was 63.1, more than 4 times that observed in the Penobscot River. This analysis points out a challenge to modern salmon recovery: naturally reared smolts typically have better marine survival than hatchery fish, but the capacity of rivers to produce adequate numbers of smolts is generally well below replacement rates, under current marine survival rates.

2.4 Juvenile Abundance Metrics

The USASAC again made progress in their annual meeting in utilizing databases beyond the traditional role of generating summary tables for the annual report. These databases are rich in information, which is starting to be used to develop large-scale stock assessment products that cross life history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary has been used to summarize return rates across New England for hatchery smolts (e.g. Figure 2.3.2 and 2.4.1). Examination of these data in further detail for such a long time-series is providing insights into program-specific challenges and more general regional trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, is facilitating the development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation, given the broad geographic area (186,500 km2), with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people, with salmon habitat in cities and remote wilderness. However, taken over a long time–series, this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

With the addition of Maine juvenile production data going back 50 years, investigations of the production trends over time and more detailed assessments have been initiated. A first step towards investigating juvenile data is graphical comparison of large parr densities throughout the region (Figure 2.4.2). These density estimates are a product of electrofishing surveys throughout New England. An examination of median densities (# per 100 m2 habitat units) across the 1985 to present time-series shows higher densities in Gulf of Maine DPS (3.5) estimates, relative to the Central New England (1.9) and Long Island Sound (2.7). In the past decade, these medians seem to reach a general equilibrium around densities of 1.7 in Central New England and 2.3 in Long Island Sound. However, densities in the Gulf of Maine have increased in the past five years with the 2000's decade median at 3.3 but the last 5 years rising to 3.7. While insightful, a more thorough examination of these data relative to other factors, such as elevation, temperature, and stocking practices, may provide additional insights into best management practices and environmental factors. Another juvenile metric that provides a composite view of freshwater rearing is indices of smolt production. These estimates are relatively limited in New England, but two longer time-series of data are available and provide a good contrast: the Connecticut River basinwide estimate and the Narraguagus River smolt assessment (Figure 2.4.3). The Narraguagus metric is a mark–recapture estimate using rotary-screw traps that monitor production of fry-stocked fish and naturally spawned fish. The Connecticut estimate is a composite estimate of late–summer, electrofishing-density data weighted geographically with an assumed overwinter survival rate. Further analysis of smolt population dynamics is done periodically to examine other abundance indices, age distribution, and run timing. Because both these indices track natural production of smolts, the general coherency in trends indicated that similar factors may be controlling smolt recruitment on a regional basis in many years. Identification of these factors and when smaller scale differences occur would enhance ability to predict smolt production.

2.5 Biological Reference Points

Biological reference points for Atlantic salmon vary from most other managed species assessed because they are managed in numbers, not biomass, and also because they are a protected species with limited fisheries targets. Fisheries targets (MSY, BMSY, FMSY, FTarget) have not been developed because current populations are so low relative even to sustainable conservation levels. A proxy for minimum biomass threshold for US Atlantic salmon would be conservation spawning escapement (CSE), because this provides the minimum population number needed to fully utilize available freshwater nursery habitat. This number is based on a single spawning cohort (2SW adults), not the standing stock of all age groups. As defined above, the CSE for New England is set at 29,199. The strongest populations in the Gulf of Maine are at less than 8% of their target of 15,670 and almost all these fish are hatchery origin while recovery goals target wild spawners. Natural survival of Atlantic salmon in the marine environment is estimated to be 0.03 per month, resulting in an annual natural mortality rate (M) of 0.36.

2.6 Summary

Historic Atlantic salmon abundance in New England probably exceeded 100,000 returns annually (National Research Council 2004). Habitat destruction and overfishing resulted in a severely depressed US population that, by 1950, was restricted to Maine, with adult returns of just a few hundred fish in a handful of rivers. Hatchery-based stock rebuilding occurred from 1970 to 1990, reaching a peak of nearly 6,000 fish in 1986. A North American collapse of Atlantic salmon abundance started around 1990. In the past decade, US salmon returns have averaged 1,600 fish, and returns in 2010 were 1,650 fish. All stocks are at very low levels; only the Penobscot River population has been near 10% of its conservation spawning escapement and only because of an intensive smolt stocking program. Naturally-reared returns in the Penobscot are proportionally low. Most populations are still dependent on hatchery production, and current marine survival regimes are compromising the long-term prospects of even these hatchery-supplemented populations. Conversely, mariculture is increasing worldwide, and New England production in 2010 was over 11,000 mt.

Table 2.2.1 Recreational (reported in numbers), aquaculture production (thousand metric tons), and commercial (no fishery) landings of Atlantic salmon from Maine. (* Recreational catch is 0 from 1995 forward).

Category	1991-2000 Average	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U.S. Recreational (#)	148	-	-	-	-	-	-	-	-	-	-
US Aquaculture	8.4	13.2	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0	11.1
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	8.4	13.2	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0	11.1

Table 2.3.1 Most current two-sea winter (2SW) conservation spawning escapement requirements for US river populations and 2SW returns (with % of CSE).

Stock Complex	CSE	2010	%CSE
Long Island Sound Complex	10,094	51	0.5%
Central New England Complex	3,435	56	1.6%
Gulf of Maine DPS	15,670	971	6.2%
Subtotals	**29,199**	**1,078**	**3.7%**

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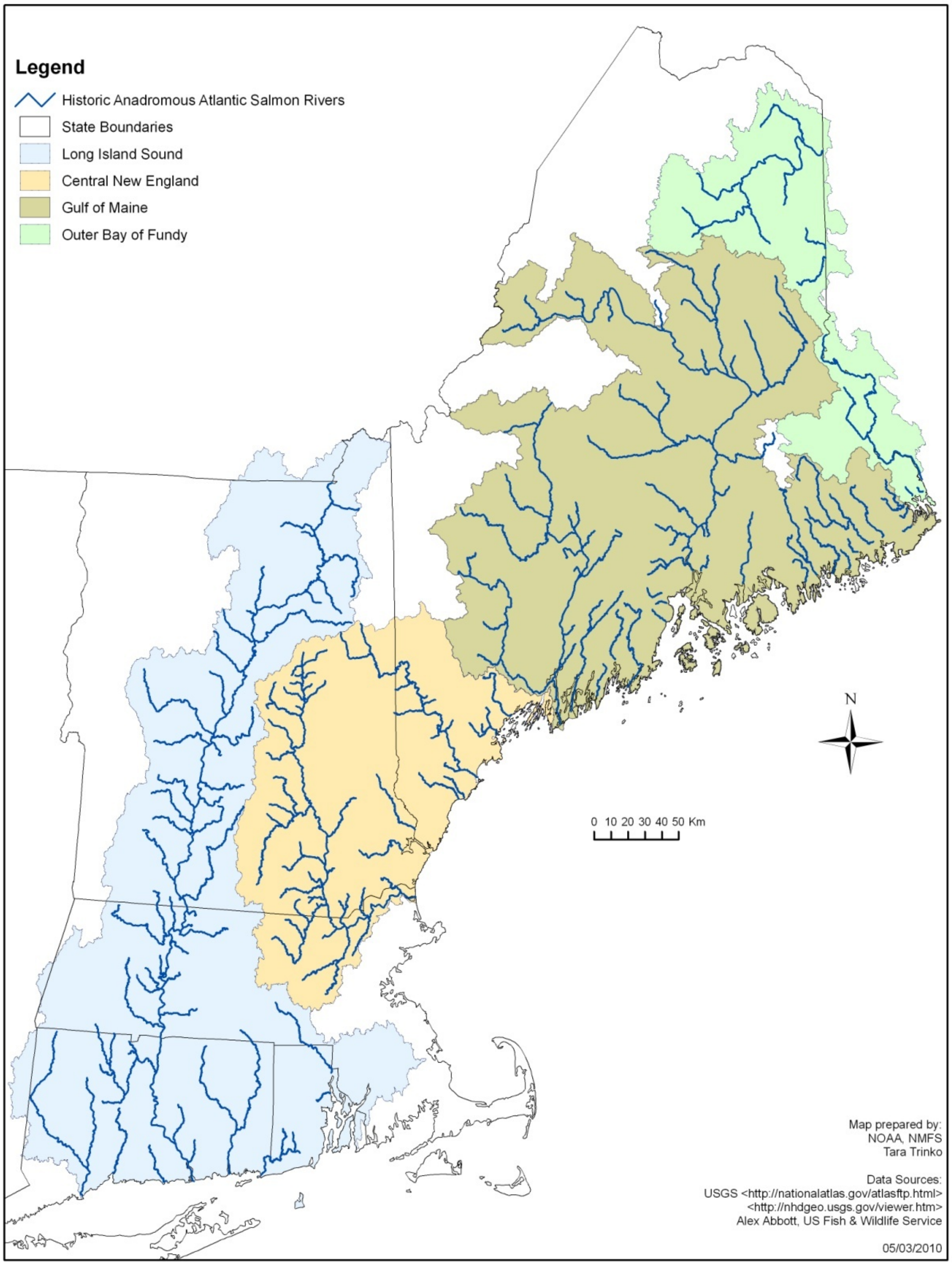


Figure 2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

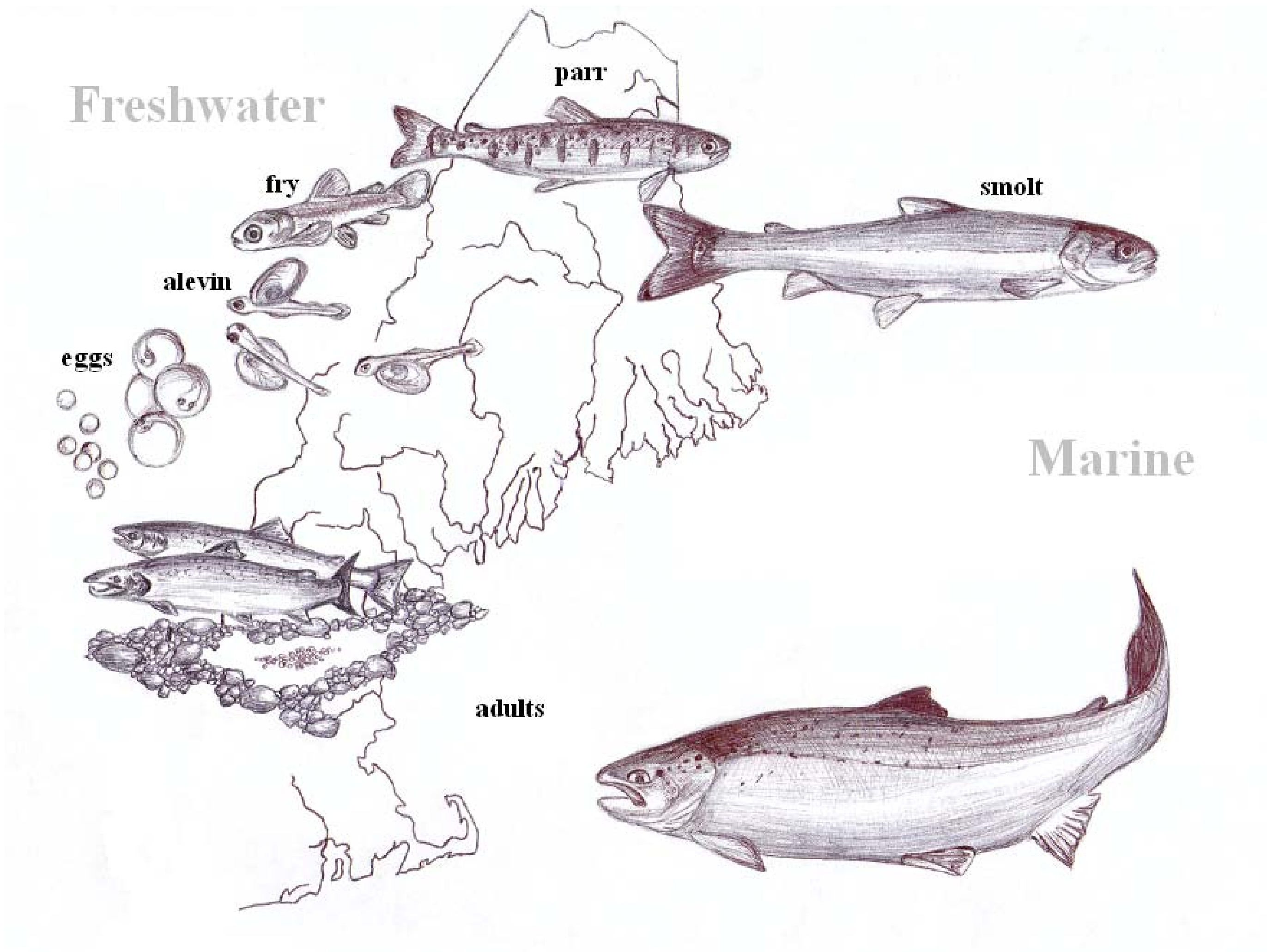


Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

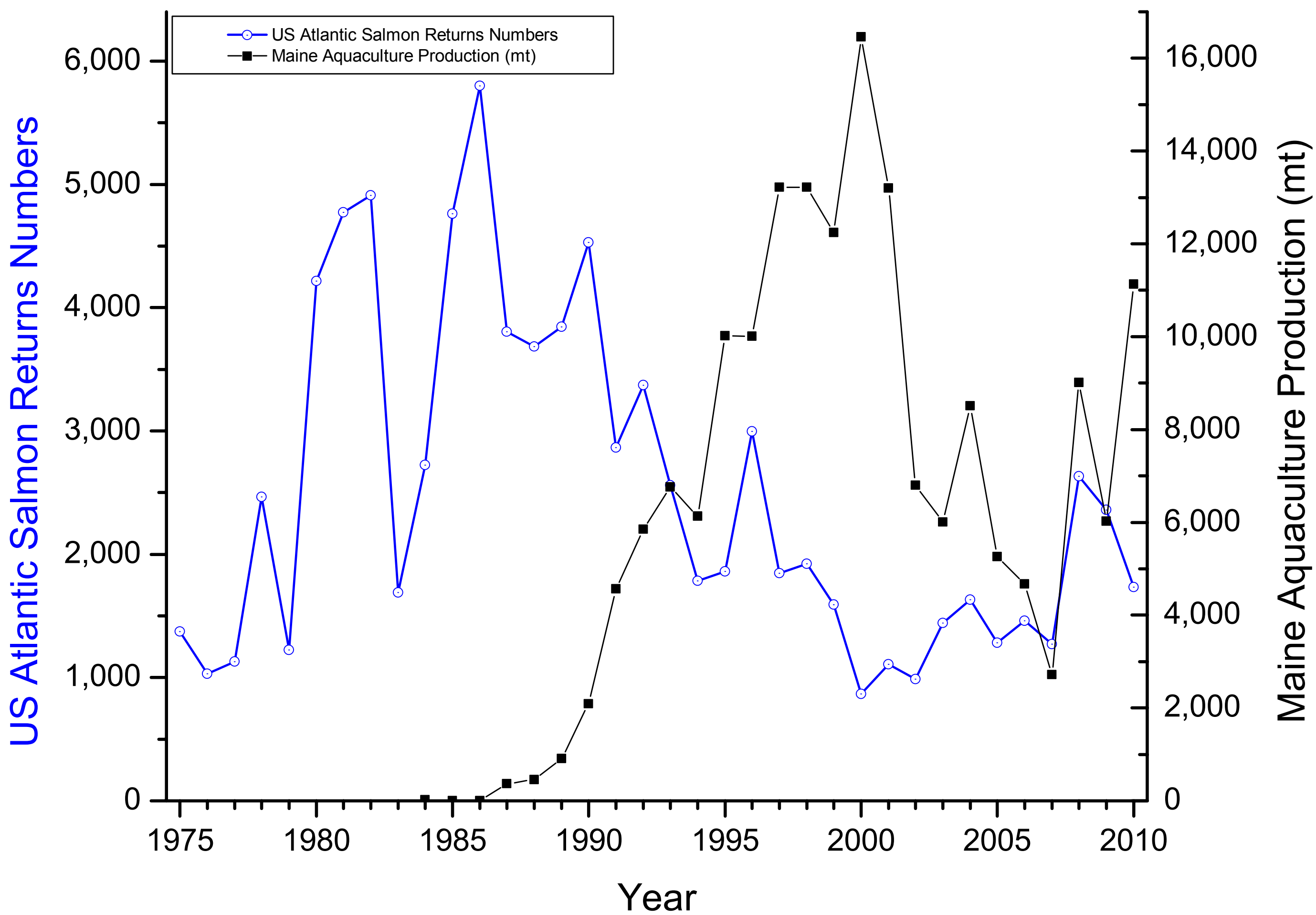


Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons).

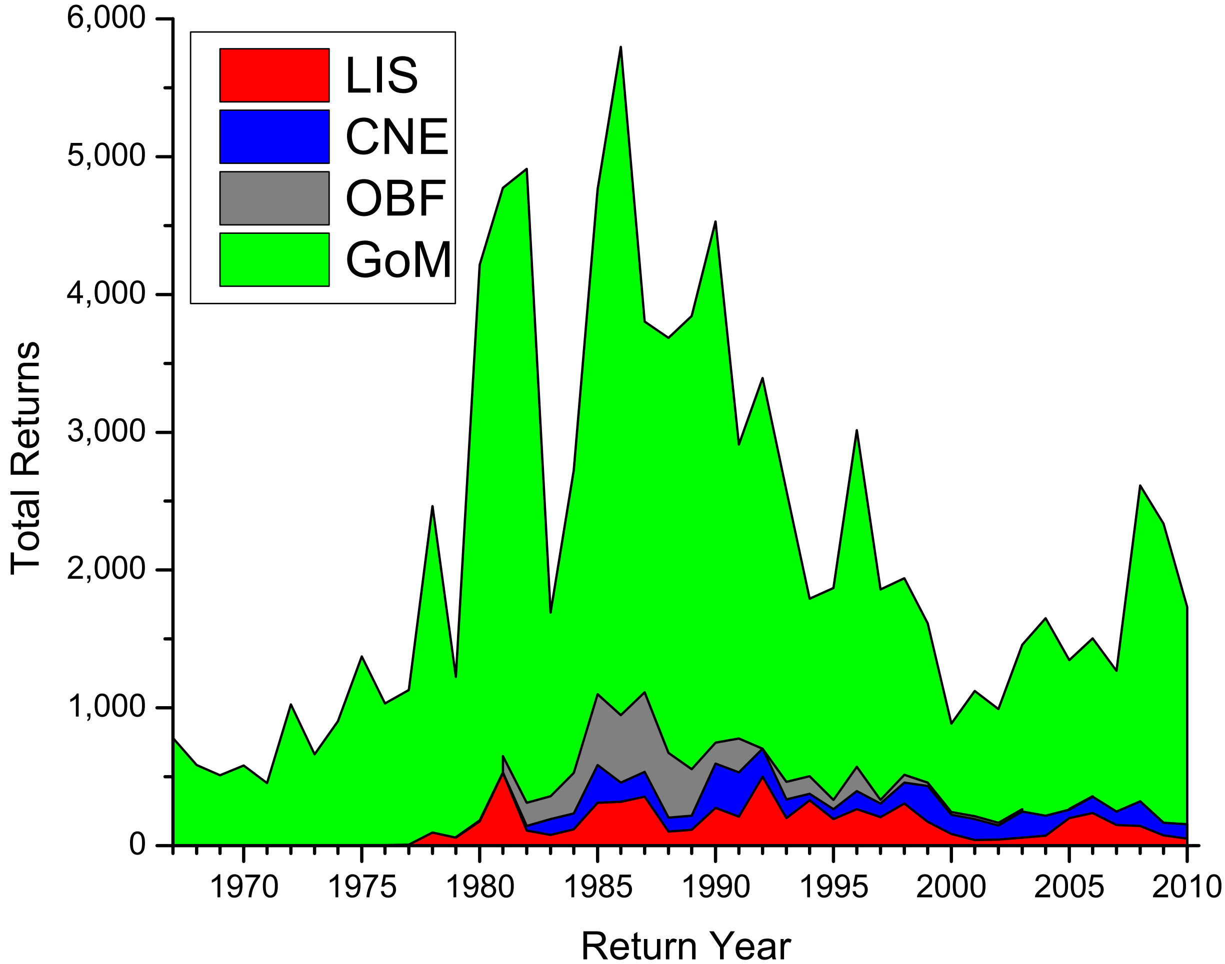


Figure 2.3.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex.

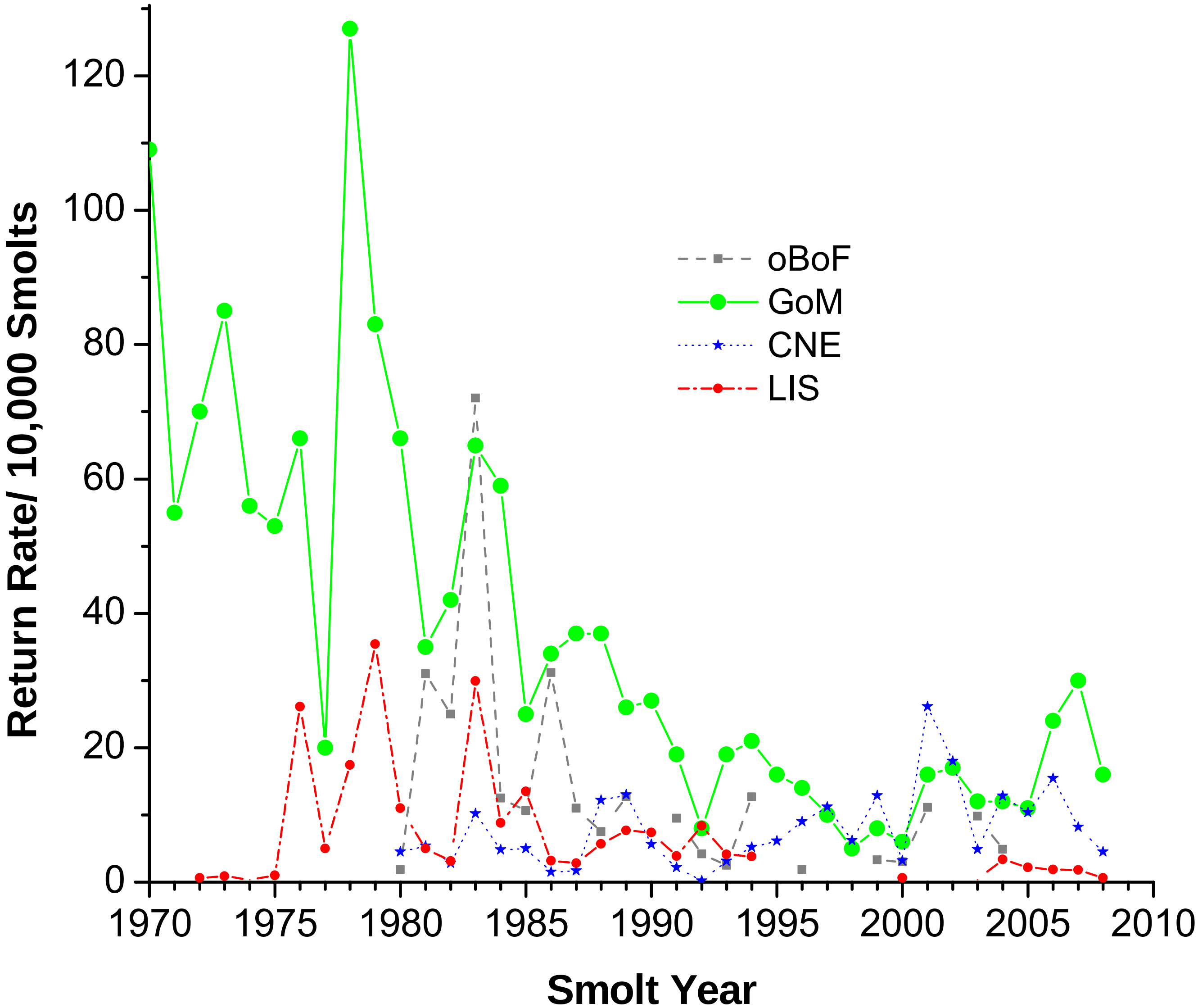


Figure 2.3.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

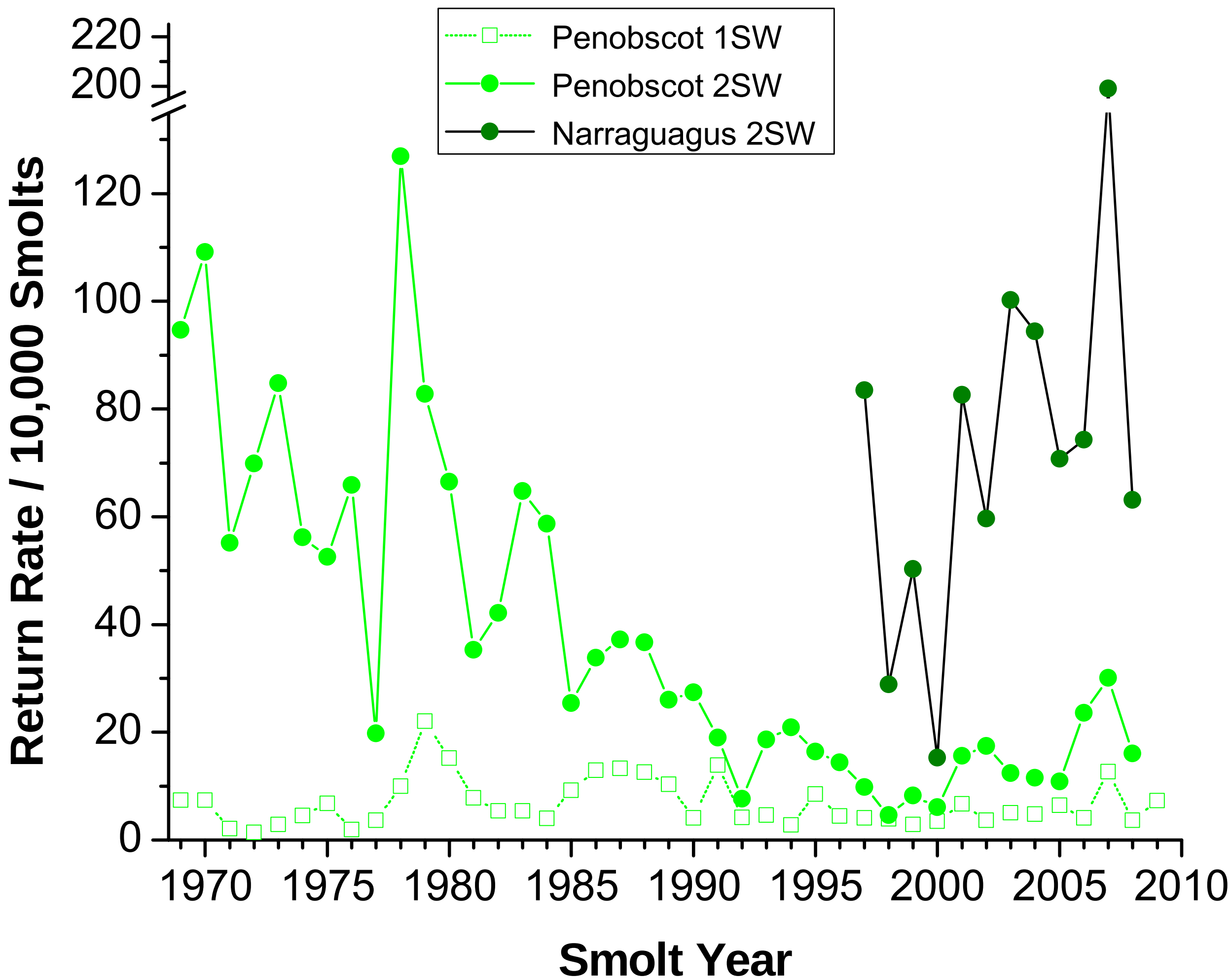


Figure 2.4.1 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

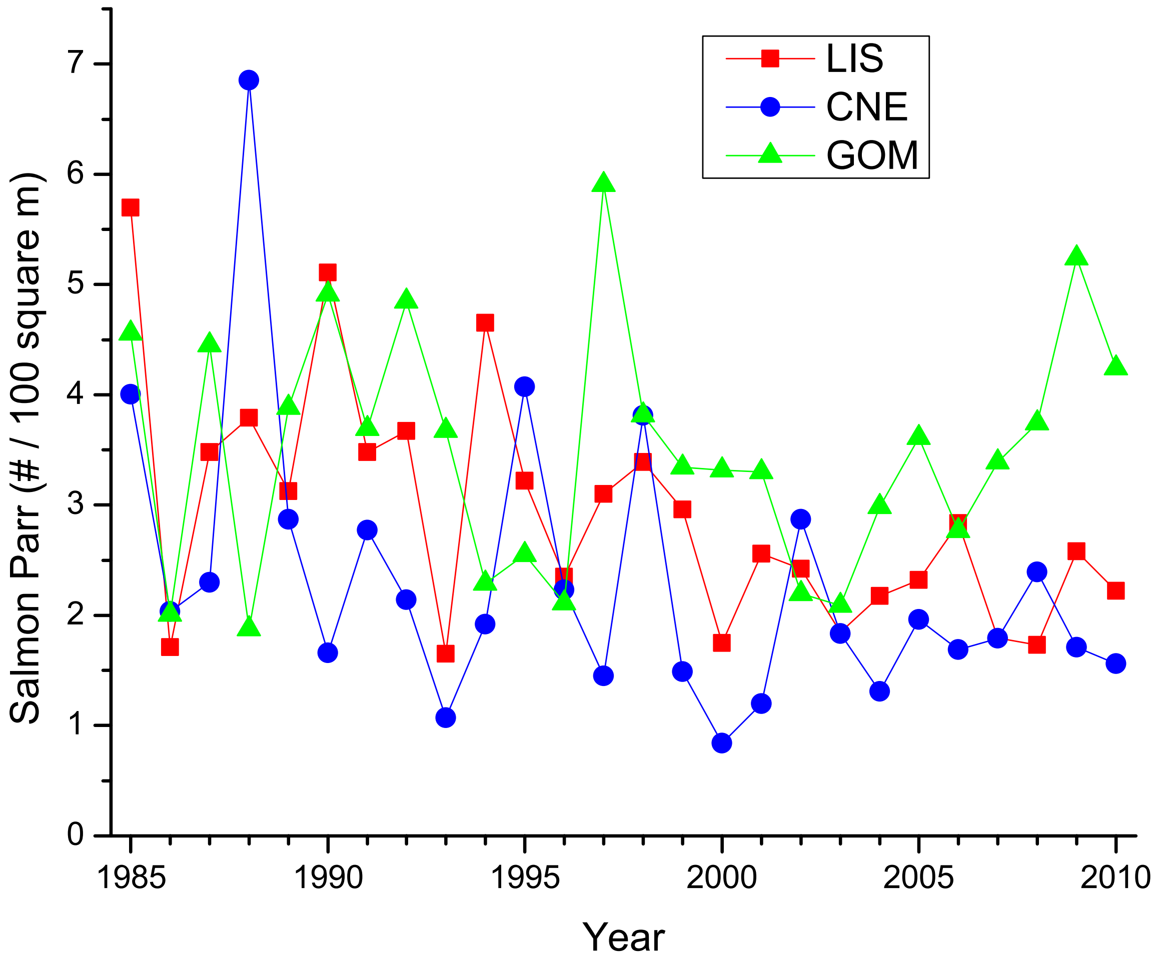


Figure 2.4.2 Median large parr densities from electrofishing sites with multiple sample years from 1984 through present from USASAC databases for three stock complexes: Long Island Sound, Central New England, and in the Gulf of Maine DPS.

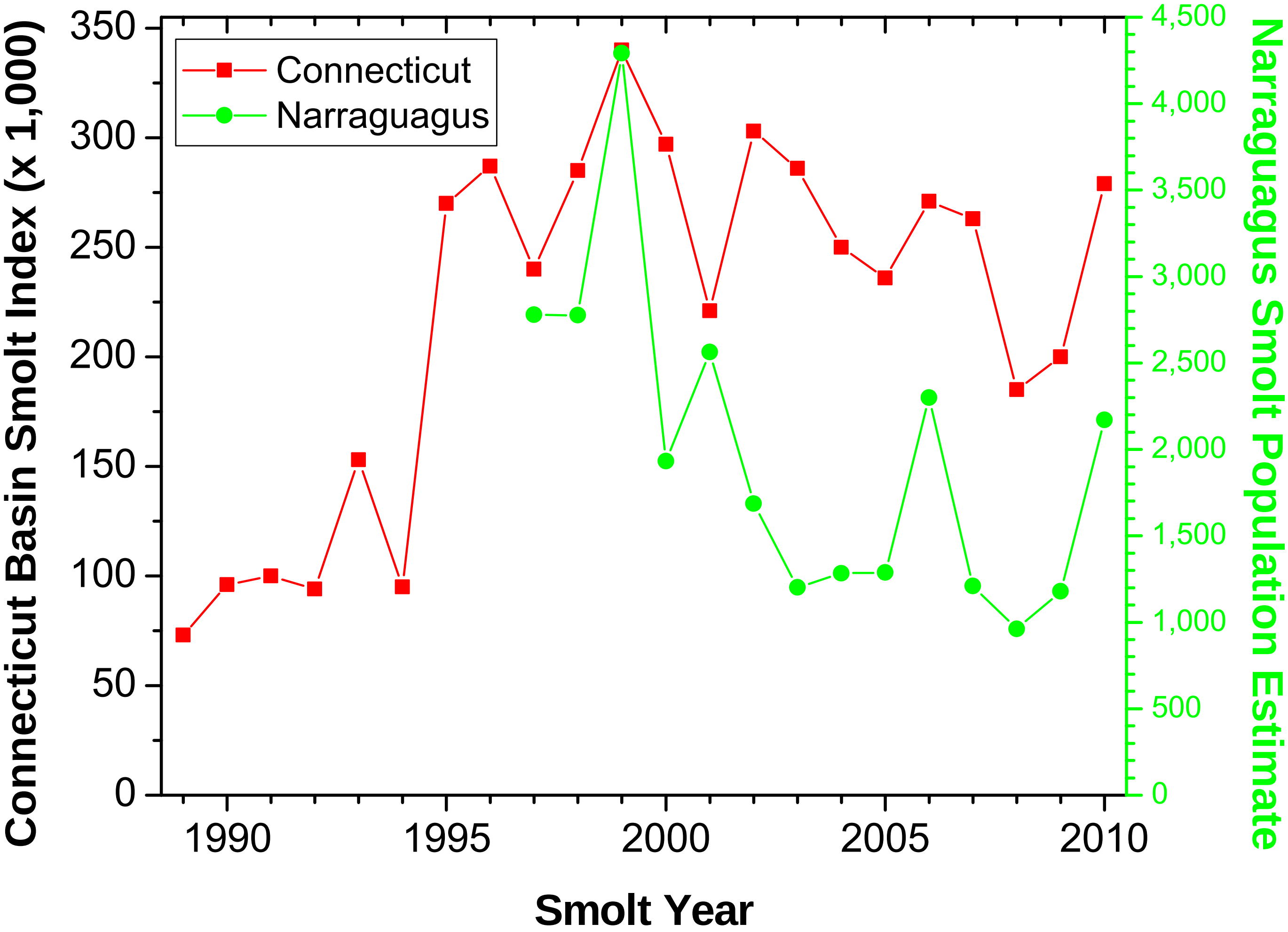


Figure 2.4.3 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basis in total. See text for details of estimation methods.

3 Long Island Sound

3.1 Long Island Sound: Connecticut River

Connecticut River Atlantic Salmon Commission (CRASC) partner agencies continued their varied work on diadromous fish restoration in 2010. Below is a summary of work on Atlantic salmon.

3.1.1 Adult Returns

A total of 51 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 41 on the Connecticut River mainstem, four in the Farmington River, two in the Salmon River and four in the Westfield River. The spring run lasted from April 29 to June 29. A total of 40 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS).

One of the Salmon River fish was observed below a fishway but not captured. Ten salmon were radio-tagged and released above Holyoke. Two entered the Deerfield River and the remaining eight passed the fishways at Turners Falls and Vernon. Three of these entered the West River, one entered the Cold River and four passed the Bellows Falls fishway. One of these entered the Black River, one entered the Williams River and two passed the Wilder fishway. One of these entered the Ammonoosuc River passing up and down over the first dam, which has no fishway, at least twice under relatively high flow conditions.

Three of the salmon observed were of hatchery (smolt-stocked) origin. The remaining 48 were of wild (fry-stocked) origin. All of the returns were 2SW except one wild grilse. Freshwater age distribution of wild salmon was 1^+ (4%), 2^+ (94%) and 3^+ (2%).

3.1.2 Hatchery Operations

The program achieved 72% of egg production goals (10.8 million eggs produced, 15 million goal), 60% of fry stocking goals (6.0 million fry stocked, 10 million goal), and 43% of smolt stocking goals (43,000 viable smolts stocked, 100,000 goal) in 2010.

Biosecurity measures undertaken in response to detection of infectious pancreatic necrosis (IPNv) at RCNSS in 2007 continued. Spawning required a crew of about 25 staff supplied by CRASC cooperators to meet biosecurity requirements. Fish health testing was done on all females by ovarian fluid sampling and on all males, including mature parr, by lethal sampling. All 2010 sea-run returns tested negative for IPNv and eggs for future broodstock were transferred from RCNSS to Kensington State Salmon Hatchery (KSSH) and White River National Fish Hatchery (WRNFH) after disease testing. Production sea-run eggs for fry stocking were transferred to WRNFH to allow incubation at suitable water temperatures.

A fin condition survey was conducted in February at Dwight D. Eisenhower National Fish Hatchery (DDENFH) to evaluate smolts prior to stocking in 2010. Based on this evaluation and length measurements, DDENFH produced 18,285 parr (29% of total), 2,833 smolts with fatal fin condition (4%), and 42,013 viable smolts (67%). 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. Fin condition surveys of smolts have been conducted annually since 2006.

A total of 95,000 1+ presmolts is in production at DDENFH for stocking in 2011. In October, they were marked with an adipose fin clip and vaccinated with a multivalent vaccine for *Vibrio* and *Aeromonas salmonicida* (furunculosis). For the first time this year, parr were graded out and stocked in suitable habitat at the time of vaccination. This reduces densities in the hatchery pools for the remaining smolt size fish while allowing the parr to potentially grow for another year and then smoltify. The presmolts will be evaluated for size and fin condition prior to stocking.

A fin condition survey was conducted in February at Berkshire National Fish Hatchery (BNFH) to evaluate smolts prior to stocking in 2010. Based on this evaluation and length measurements, BNFH produced 751 parr (39% of total), 478 smolts with fatal fin condition (25%), and 679 viable smolts (36%). BNFH has 4,000 1+ presmolts in production for stocking in 2011. They were adipose fin clipped and vaccinated in December and their size and fin condition will be evaluated before release.

The nuisance diatom *Didymosphenia geminata* (Didymo) was discovered in the extreme upper Connecticut River mainstem and the White River in 2007. Public education and agency disinfection efforts continue in the hope of limiting its spread. Starting in April 2011, the use of felt soled waders will be been banned in Vermont to reduce the spread of invasive organisms and disease. Because of the threat of Didymo, WRNFH continued to utilize chillers, rather than river water, to provide suitable temperatures for fry incubation. Since the initial discovery, Didymo has also been found in the Mohawk and Passumpsic rivers.

Egg Collection

A total of 10.8 million green eggs was produced at five state and federal hatcheries within the program. Sea-run broodstock produced 180,000 eggs from 26 females held at RCNSS. Domestic broodstock produced 10.0 million eggs from 1,935 females held at WRNFH, KSSH, and RRSFH. Kelt broodstock produced 593,000 eggs from 55 females held at NANFH. Egg production remained below the prior ten year average of 11.6 million and the program goal of 15 million. Domestic egg production could be increased at WRNFH, but necessary funding and staff are not available at this time.

3.1.3 Stocking

Juvenile Atlantic Salmon Releases

A total of 6.1 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2010. Totals of 811,000 fed fry and 5.2 million unfed fry were stocked into 39 tributary systems with the assistance of hundreds of volunteers. Totals of 49,100 2smolts, 19,000 2parr and 6,300 1+parr were released into the lower Connecticut River mainstem, the Westfield River, and the Farmington River. Numbers of fry stocked declined from last year and 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 Resources and the USFWS contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2010. This was the eighteenth consecutive year that a study has been conducted on the Connecticut River mainstem by marking smolts at the Cabot Station bypass facility at Turners Falls and recapturing them at the bypass facility in the Holyoke Canal. The population estimate was 245,000 (+/- 130,000 95% confidence limits). The confidence limits were wide due to relatively low recapture rate. This is by far the highest estimate in the time series. Even the lower 95% confidence limit is as high as the previous highest estimate.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 279,000 smolts were produced in tributaries basin wide. Of these, 216,000 (77%) were produced above Holyoke in 2010. 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. Some recent research in Connecticut River tributaries and Maine suggests that overwinter survival is lower than assumed in the electrofishing smolt estimate.

This is the first time the mark-recapture estimate at Holyoke has been greater than the above-Holyoke portion of the index station estimate. It appears that 2010 was a good year for smolt production in the Connecticut River basin, but perhaps not as good as the mark-recapture estimate appears.

Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at 216 index stations throughout the watershed. Sampling was conducted by CTDEP, MAFW, NHFG, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production. Densities and growth of parr varied widely throughout the watershed. The basin wide mean stocking density was 39.2 /100m^2 unit and the mean 0+ parr density was 8.4/unit with a mean first summer survival of 19%. The mean density of 1+ parr was 2.9/unit with a mean survival from stocked fry of 7%. Mean total lengths at capture of 0+ and 1+ parr were 78 and 142 mm, respectively. Density of 0+ parr is similar to last year despite lower stocking densities, but 1+ density declined from last year. Size at capture of both 0+ and 1+ parr was also less than last year.

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 2011 calculated from expanding electrofishing data from index stations and assumed overwinter survival is 208,000. The estimate is down 25% from last year, presumably largely due to the hot dry summer.

3.1.5 Fish Passage

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

Holyoke Dam- Plans for development of a new downstream passage screen and bypass system for the main Holyoke generating station (Hadley Falls) were put on hold as the City of Holyoke reconsidered project design due to cost concerns. A new proposal is being developed. Construction is still scheduled to begin in 2012.

Vermont Yankee Nuclear Power Plant- Entergy continues to seek a 20 year extension to their operating license scheduled to expire in 2012. Studies to evaluate the impact of the plant's thermal discharge on smolt migration were delayed again.

Fifteen Mile Falls Project –TransCanada operated the smolt sampler at Moore Dam to continue to collect data on seasonal and diurnal timing and smolt abundance as a precursor to passage facility development at Moore and Comerford. A total of 3,214 wild smolts was captured in 2010 and trucked below McIndoes Dam for release, the largest number captured to date. Flow inducers were installed in 2010 to improve guidance, but installation was delayed until mid June when the smolt run was nearly over. Flow inducers will be operated and evaluated throughout the smolt run in 2011.

Gilman Dam- Development of designs for downstream fish passage facilities at this upper mainstem Connecticut River dam was delayed and construction is now planned for 2011, with operation in 2012. The existing bypass with a revised plunge pool will be operated in 2011.

Woronoco Dam- A new full depth trash rack with ¾ inch spacing was installed in 2010 and evaluated by releasing radio tagged smolts. Results were improved over past designs but successful passage was lower than expected and high generation flows were not evaluated. Modifications were made to the rack and plunge pool to address potential problems and downstream passage will be reevaluated in 2011.

Manhan River Dam- Denil ladder construction was delayed due to construction problems and the completion date is now uncertain.

Deerfield River- Construction of downstream passage modifications at Deerfield 3 and Deerfield 4 were agreed to and modifications at Deerfield 4 were completed. A new fish screen and bypass at Deerfield 3 is under construction.

Crescent Street Dam- This Millers River dam had been considered non-jurisdictional by FERC, but FERC recently reversed its position and downstream passage is now being pursued.

Fiske Mill Dam- Fish lift construction at the first dam on the Ashuelot River was delayed again but completion of construction and operation is now planned for Spring, 2011.

Homestead Dam (West Swanzey Dam)- Removal of this Ashuelot River dam was completed in 2010, after much delay.

Brockways Mills- Improved temporary downstream passage was in place in 2010, but construction of a permanent facility was again delayed at this Williams River dam.

Bethel Mills- Interim spill was in place for the 2010 smolt run but construction of a permanent downstream facility was delayed at this dam on the Third Branch of the White River. Construction is now anticipated to occur in 2011.

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

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

3.1.6 Genetics

Tissue samples were taken from all 2010 sea-run broodstock for genetic monitoring. Microsatellite analysis for broodstock management was completed by the NEFC. The sea-run broodstock were PIT tagged to ensure individual identification at spawning. This information is necessary to develop the mating scheme linking individual broodstock to their genetic information, in a deliberate effort to mate salmon that are not closely related. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

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

Sea-run origin fry were stocked in Bronson Brook (24,000) and the Williams (118,000) and Sawmill rivers (59,000) in spring of 2010 for mature parr production.

Beginning in 1998, genetically identifiable domestic broodstock have been maintained at the WRNFH. By tracking the individual matings, individual families and therefore stocked fry can be genetically “marked” for post stocking evaluation. Starting 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 (regions) for later identification. The resultant fry were stocked starting in 2002 to expand the marking and program evaluation efforts. This effort has continued since then. Partial fin clips were taken from smolts sampled in downstream bypasses at Cabot Station at Turners Falls Dam (2,872), Holyoke Dam (395), and Rainbow Dam (150) in 2010 for genetic analysis.

Data analysis has only been completed for six of the ten regions of fry stocked in 2002 and sampled in 2004 smolts and 2006 adults. The four regions not yet analyzed were created by a different brood year of sea-runs, which has not been genotyped yet. A plan has been developed for funding and genotyping is currently underway for the remaining four regions from the 2004 smolts and 2006 adults as well as the 2005-2010 smolt samples and 2007-2010 adult samples already collected and all future samples. Ten marked year classes have been created and will continue to provide opportunities for sampling through the 2013 smolt and 2015 adult runs. Fry stocked in 2011 will be the last group of genetically marked fry.

A CRASC Broodstock Management Plan is being developed to assist genetic management and to document practices. A final draft has been completed and will be presented to the Technical Committee for approval at its next meeting.

3.1.7 General Program Information

Ongoing budget difficulties faced by program cooperators have hampered restoration efforts. Additional specific funding to the USFWS for the Connecticut River Program has not been received since a one-time congressional appropriation in 2004. Production goals at USFWS facilities have been maintained at 2004 levels without additional funding increases. A sustained funding increase is required to increase production at USFWS hatcheries. Additional funding is also needed to conduct needed evaluation and research, and to provide necessary fish passage.

The use of salmon egg incubators in school as a tool to teach about salmon, watersheds and conservation continued to expand throughout the basin. The Connecticut River Salmon Association (CRSA), in cooperation with CTDEP conducted their Fish Friends program at schools in Connecticut. Trout Unlimited in cooperation with MADFW carried a similar message to schools in Massachusetts. Several cooperators including CRSA, NHFG, USFS, USFWS, VTFW and the Southern Vermont Natural History Museum cooperatively conducted the program in Vermont and New Hampshire. For the 2010-2011 school year 182 schools participated in this type of salmon education in the four states.

3.1.8 Migratory Fish Habitat Enhancement and Conservation

Program cooperators continued their habitat protection efforts in 2010. The USFS completed four habitat restoration projects in headwater tributaries of the West and White rivers. Large woody debris was placed in two miles of stream to restore ecological functions and processes in the Green Mountain National Forest. In addition, two culverts were removed and three were replaced with bottomless arches to restore habitat connectivity and open up 3.5 miles of habitat. NHFG, in cooperation with several partners, conducted habitat restoration work on Warren Brook, a Cold River tributary, in 2010. A holistic plan is being developed for habitat restoration in the Cold River watershed. Grants were awarded to partners to remove a dam on two tributaries stocked with salmon in Connecticut (Pequabuck and East Branch Eightmile rivers). It is hoped these dams can be removed as early as 2011.

3.2 Long Island Sound: Pawcatuck River

3.2.1 Adult Returns

One Atlantic salmon adult was captured at the Potter Hill Fishway in 2010. The fish is a male of wild (fry stocked) origin. It is estimated as a 3 year old smolt and a 2 sea winter adult.

3.2.2 Hatchery Operations

Egg Collection

Sea-Run Broodstock

The sea-run fish was not spawned this year.

Captive/Domestic Broodstock

We currently have two captive fish of sea-run origin at the Perryville Hatchery. They were not spawned in 2010 because of lack of personnel.

3.2.3 Stocking

Juvenile Atlantic Salmon Releases

Approximately 290,000 Atlantic salmon fry from the North Attleboro National Fish Hatchery were stocked into the Pawcatuck River and its tributaries on May 5, 2010. The *Salmon in the Classroom* program was responsible for stocking approximately 6,000 fry into the Pawcatuck River and its tributaries.

One year old smolts of domestic origin, totaling approximately 3,912, were raised and adipose fin-clipped at the Arcadia Hatchery. The majority of the smolts were released in April. All smolts were stocked at the RIDEM boat ramp in Westerly, Rhode Island.

Adult Salmon Releases

Rhode Island did not release any adult broodstock for recreational fishing in 2010.

3.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were conducted in the fall of 2010 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). Ten stations were sampled from September into November. Parr, 0 years old, ranged in length from 46 mm to 85 mm, with an average of 60.5 mm. Parr, 1 year old, ranged in length from 90 mm to 203 mm, averaging 141.9 mm.

Smolt Monitoring

No work was conducted on this topic during 2010.

Tagging

All smolts were released with adipose fin clips.

3.2.5 Fish Passage

Massive flooding occurred at the Potter Hill fishway in the spring of 2010. Flood waters did not recede at this location until mid April.

Left, Potter Hill Dam taken from fishway, May 1, 2006. Right Potter Hill Dam, view from above of fishway and dam, April 2, 2010 (note slide gate and submerged structure of fishway exit. At one point water was flowing over the roadway.).

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 permit to develop hydropower at this location and reapplied in 2009 to continue the process.

3.2.6 Genetics

No genetics samples were collected in 2010.

3.2.7 General Program Information

Plans for fishways at dams located upstream of Potter Hill Dan, where our fish trap is located, are ongoing. A dam removal at Shannock Falls has been completed and plans for a fishway at Horseshoe Falls, located just upstream of Shannock are progressing.

3.2.8 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2010.

4 Central New England

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

Eighty-four sea-run Atlantic salmon returned to the Essex Dam, Lawrence, MA and were captured in the fish lift. Eighty-three captured salmon were transported to the Nashua National Fish Hatchery (NFH), NH. One salmon was found with other species in samples collected for MA Division of Marine Fisheries. Sex determination was made for 84 of the salmon, with 54 (64%) being male and 30 (36%) female. Six of the salmon died prior to spawning, and one was a non-spawner. Seventy-seven salmon were spawned, including 49 (64%) males and 28 (36%) females. All remaining fish were dispatched after spawning for fish health tests to ensure the absence of pathogens that potentially could be passed to offspring.

Scales from 84 sea-run Atlantic salmon (one broodstock) were analyzed to determine age and origin. Of the 84 sea-run salmon, 69 (82.1%) were of hatchery smolt origin and 15 (17.9%) were of fry origin. Of the 69 hatchery smolt origin salmon, 29 (42.0%) were grilse (1SW) and 40 (60.0%) were two sea-winter fish (2SW). Of the 15 fry origin salmon, seven (46.7%) were grilse, seven (46.9%) were two sea-winter fish, and one (6.7%) was a three sea-winter fish.

In 2010, adult salmon that returned represented three fry cohorts: 2005 - 2007. The rate of return, per 10,000 fry stocked, for the 2006 cohort decreased substantially from the upward trend of the preceding five years (2001-2005). The serve flooding that occurred throughout the watershed in the spring of 2006 may have contributed to the low 2006 return rate of 0.05 for smolts.

Smolt origin adult returns in 2010 represented two cohorts: 2008 – 2009. The rate of return per 1,000 smolts stocked in 2008 was among the lowest on record. In 2008 approximately 90,000 1+ smolts were stocked; smolts (50,000) were reared at the Green Lake National Fish Hatchery (GLNFH) and at the Nashua National Fish Hatchery (40,000; NNFH).

4.1.2 Hatchery Operations

NANFH shipped a total of 572,144 domestic eyed eggs to Warren State Fish Hatchery, NH (WSFH) in one shipment on 4 February 2009; resulting fry were released in the upper Merrimack River watershed. NANFH also released 329,124 unfed fry in the lower watershed in late April. No sea-run eggs were received at NANFH from NNFH due to implementation of bio-security measures.

NANFH spawned 57 female kelts from 4 November - 30 November with a total of 669,177 green eggs collected from two year classes. Of the total eggs taken, 91% were from 51 females of the 2008 year class and 9% were from 6 females of the 2009 year class. Eggs were fertilized with milt collected from kelts and domestics. Due to low numbers, it was necessary to use males multiple times during the spawning season (11 males from 2007 kelt year class, 3 precocious parr, and 5 domestic males).

Retired kelts used as display fish were spawned for the State of Rhode Island programs because domestic eggs were not available from NNFH. A total of 49,580 green eggs were collected from six kelts to support fry production, and outreach and education for the Pawcatuck River Restoration Program.

Forty-one new female kelts (2009 sea-run returns) were received at NANFH from NNFH in late January for reconditioning.

Egg Collection

Sea-Run Broodstock

Eighty-four sea-run Atlantic salmon were trapped at the Essex Dam in 2010; seven died, and the remaining 28 females and 50 males were held at Nashua NFH. Fish were spawned during the period 20 October - 12 November, and produced 201,098 green eggs that resulted in 182,794 eyed eggs. All sea-run eggs were held and incubated at NNFH to avoid exposing other hatcheries to eggs that could hold infectious pathogens. NNFH achieved 91% eye-up in its third year of significant sea-run egg incubation. The 28 females produced an average of 7,182 eggs each. The hatchery retained 6,249 sea-run eggs for F1 captive broodstock production.

Domestic Broodstock

A total of 135 female and 313 male captive (F1 from sea-runs) broodstock spawned at NNFH, and there were 803 non-spawners. The spawners provided an estimated 720,770 eggs, all of which were retained at NNFH for incubation/fry production and subsequent release to the upper Merrimack River watershed, the Saco River watershed, or the Adopt-A-Salmon educational programs. Of the 135 females, 62 were four years old and 73 were three years old, respectively. The domestic broodstock spawning season began on 28 October, ended 2 December, and included 7 spawning events. From the initial lot of 720,770 eggs, 501,532 reached the eyed egg stage for a disappointing 70% eye up rate.

4.1.3 Stocking

In 2010, 1,481,000 Atlantic salmon fry were released into the Merrimack River watershed in April and May. Salmon fry were propagated at NNFH, NANFH, and WSFH. NNFH reared 300,150 fed fry, NANFH reared 329,124 unfed fry, and WSFH reared 851,726 unfed fry. All major tributaries upstream from the Nashua River, excluding the Winnipesauke and Contoocook rivers, were stocked with fry. Numerous small tributaries to the Merrimack River and its principal tributary, the Pemigewasset River, were also stocked with fry.

An estimated 72,853 smolts were released into the watershed with approximately 50,000 one-year-old smolts reared by the GLNFH released into the lower Merrimack River downstream of Essex Dam (Lawrence, MA) in early April. An additional 22,853 one-year-old smolts were released into the Souhegan River. All smolts were F1 or F2 progeny of Merrimack River lineage salmon. This was the third year that all smolts were derived from adults of Merrimack River origin. Smolt produced at GLNFH were not marked or tagged, whereas smolts reared at NNFH received an adipose clip prior to release. Scale signatures and fin clips will be used to differentiate returning sea-run fish from fry or smolt stocking origin.

Smolt stocking has been timed to reduce the potential impacts of predation by striped bass. Bass typically arrive in the estuary and near shore coastal environment proximal to the Merrimack River in mid to late April.

4.1.4 Juvenile Population Status

Yearling Fry / Parr Assessment

Since 2003, the number of fall parr sample sites has been reduced from a high of 28 to seven traditional (historic) index sites. In 2010 the number of sampling sites was reduced to six. 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, members of Trout Unlimited (TU), school groups, the Student Conservation Association (SCA), and numerous volunteers.

The six 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 133.0 units (one unit = 100 m^2) of habitat. Sites are located on the Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers. The index sites on the Baker and South Branch Piscataquog rivers were repositioned in 2009. A repositioning of sites was required due to stream alterations resulting from high flows. During the period 1994 -1998 the number of fry stocked had been altered at index sites to evaluate population level responses to stocking density. In particular, stocking densities were generally doubled and ranged from 36 to 96 fry/unit among sites, but in recent years, 1999 - 2010, the densities were returned to levels used prior to 1994 (range from 18 to 48 fry/unit among sites). The change in stocking densities was based on the results of evaluations of yearling parr at sites. These results suggest that past high fry stocking densities resulted in density-dependent factors that may have adversely affected the growth of parr.

4.1.5 Fish Passage

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

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

Studies and evaluations of salmon 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 that include river herring, American shad, and American eel.

All returning adult salmon are 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; however, the results of ongoing studies, as well as the stipulations of recent relicensing agreements for dams in the watershed, could result in modification to existing facilities, and the construction of new facilities.

The numbers of adult salmon that return annually has remained low. While target fish levels have been identified that require construction of additional fish passage facilities throughout the watershed, they have not been reached so as to trigger the need for construction of upstream fish passage facilities. Fishery resource agencies will continue to consult and coordinate with hydroelectric facility owner/operators and water resource users to construct and improve upstream and downstream fish passage facilities and to improve and ensure the survival of migrating salmon and other fish species.

Upstream and Downstream Fish Passage – Mainstem Dams

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 precluded efforts to clear the fish lift of debris and limited operation of the lift until the mid and later part of the upstream migration period in 2007. As a result of floods and problems with the fish lift, Enel chose to make improvements to the dam and fish lift.

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

Enel has agreed to effect suitable eel passage at Essex Dam with the installation of a passage facility at the south end of the dam. Monitoring has determined the presence of eels in the dam toe pool between the powerhouse and the dam and it is proposed that a passage facility will be installed in that location in Summer/Fall 2011. Observations at the dam toe pool and at the fish lift indicated an increase in the abundance of elvers during the migration season. The lack of leakage associated with the new inflatable crest gate system likely diminished “false eel attraction” to the dam, thus concentrating migrating eels in the actual fish lift and also to the area where eel passage facilities are proposed for installation.

A similar inflatable crest gate system as that installed at Essex Dam was installed in the fall of 2009 at the Amoskeag Dam. PSNH determined that this modification would provide operational and environmental benefits including: elimination of impoundment drawdown for flashboard replacement; improved control of upstream water levels in both high and low-flow situations; minimize the extent and duration of “false fish attraction” to the dam due to leakage; and enhanced aesthetics associated with advanced water-control technology and decreased trash loading at the dam.

PSNH continues to work cooperatively with the USFWS, NHFGD, and USGS with the operation of smolt capture facilities at Ayers Island Dam (Pemigewasset River). The company will continue meeting regularly with the state and federal fishery resource agencies to develop new and improved fish passage strategies/facilities and to monitor the progress of fish passage agreements.

4.1.6 Genetics

Funding was secured in 2002 for genetic analyses of sea-run salmon, domestic broodstock, and kelts used in Merrimack River hatchery production programs. Fin-clip 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 2010 were tracked by tissue samples with eggs/fry segregated in hatcheries to enable the identification of parent origin and point of initial stocking in defined geographic regions. These regions are primarily partitioned into lower (sea-run parentage fry), middle (kelt parentage fry), and upper watershed (F1/domestic parentage fry).

All fish stocked downstream from Ayers Island Dam (Bristol, NH) located on the Pemigewasset River 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).

A primary point of interest has been whether fry-origin adult returns are occurring from areas in proportion to number of fry stocked, 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. Importantly, time of adult maturity and subsequent out stocking of fry is based groups (sea-run, kelt and domestic). Sea-run adults historically spawn and mature earlier than their domestic equivalents coinciding with more favorable stocking conditions in these southern tributaries. Later maturing domestic origin fry are stocked into the upper tributaries of the Pemigewasset. Kelts are stocked into the middle section of the watershed. The results of genetic analyses could provide opportunities to better understand genetic relatedness among fish and to subsequently develop improved and refined mating protocols.

Return rates of fry origin adults remain well below replacement levels and have not met program expectations. The first genetically marked year-class, 2004, resulted in adult returns beginning in 2007. The most recent draft report (February, 2011) provides parentage analysis of the 2010 adult returns produced from 2005, 2006 and 2007 year classes. Low number of adult returns limits the use of parentage analysis to evaluate the contributions of various stocking locations.

In 2008, the Merrimack River program began releasing smolts from Merrimack River sea-run return parentage at the traditional site upriver from tidewater. Based on work conducted by the Northeast Fishery Technology Center and Conte Anadromous Fish Lab and as reported by the Center and Lab, genetic relationships among populations of Merrimack, Connecticut, Penobscot, and Maine Distinct Population Segment (DPS) salmon populations were determined using microsatellite loci to quantify estimates of genetic diversity within and between populations. Results indicate a lower amount of genetic differentiation among the Penobscot, Connecticut, and Merrimack river populations compared to the differences observed among the DPS populations. Slight, but significant genetic differences were observed between the Connecticut and Penobscot River populations, however significant differences were generally not observed between the Merrimack and Penobscot populations. Accordingly, following the establishment of a river-specific broodstock and discontinuation of stocking Penobscot River juveniles, the Connecticut River population has become slightly genetically divergent from the Penobscot stock, although there is a clear indication of recent shared lineage.

Management and restoration goals for the Merrimack River program have included 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 NANFH for smolt production and subsequent release in the Merrimack River in Spring 2010. In past years eggs were shipped to GLNFH for parr/smolt grow-out, however with the expanded ESA listing of salmon in Maine, GLNFH is no longer accepting eggs outside of the Maine DPS. The Merrimack River is now reliant on both the NNFH and NANFH for smolt production. Whereas a minimum of 50,000 smolts were produced in previous years at GLNFH, anticipated production level of approximately 25,000 smolts is expected for the Merrimack River in year 2011 due to limited space at the hatcheries. Eggs for smolt production were selected at random from nearly all parentage categories including sea-run, kelt, and domestic fish to obtain the greatest genetic diversity.

4.1.7 General Program

Atlantic Salmon Broodstock Sport Fishery

The NHFG via a permit system manages an Atlantic salmon broodstock fishery in the mainstem Merrimack River (NH) and lower portion of the Pemigewasset River. Whereas angled Atlantic salmon required the presence of a floy tag on captured fish as well as 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, a minimum fish length of 15 inches, and the presence of a floy tag. The season is open all year for taking salmon with a catch and release season from 1 October to 31 March. In Spring 2010, 400 (age 3 and 4) domestic broodstock were released for the fishery.

In Fall 2010, an additional 780 (age 2) broodstock were released for a combined total release of 1,180 fish to support the fishery.

For many years anglers had submitted catch and harvest reporting diaries on a voluntary basis. However, in 2006 and 2007, participation in the volunteer reporting program fell below 10% of the total number of anglers that purchased an Atlantic salmon broodstock permit. A minimum participation level of 10% was determined to be necessary for a meaningful statistical assessment of the fishery, and therefore, diaries are no longer used to monitor the fishery.

The decline in volunteer angler reporting does not appear to indicate a decline in the popularity of the broodstock fishery. Permit sales have remained steady in recent years, with approximately 1,400 permits sold each year since 2006. In 2009, 1,439 anglers purchased a permit to fish for broodstock salmon. Data for the 2010 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.

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

Adopt-A-Salmon Family

The 2010 school year marked the eighteenth 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 diadromous fish restoration efforts. The program is administered by the CNEFRO with support from the NNFH, the Amoskeag Fishways, and a corps of very dedicated volunteers and SCA interns. Most participating schools implement the program throughout the school year with highlights including a visit to NNFH for a ninety minute educational program in November, and incubating salmon eggs in the classroom beginning in January/February for release as fry into the watershed in the late Spring. In January 2010, 35 schools received 10,180 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 2010, 819 students and 100 teachers and parents from 14 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 develop 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 2010 was 15,590, including 9,771 students and 5,819 adults. Since its inception Fishways has documented greater than one-half-million visitors, and about 7,600 school programs have been delivered to date. The total number of outreach and partly at Center programs offered in 2010 was 137 with 4,812 students and 3,538 adults participating; the total program participants, as well as visitors, and meeting/outreach participants was 21,295. 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.

Central New England - Integrated ME/NH Hatchery Production

The FWS, Eastern New England Fishery Resources Complex has developed an agreement with MDMR to engage in planning and implementing an Atlantic salmon restoration and enhancement project in the Saco River watershed (see section 4.2.3). In 2009, NANFH produced and released one-year-old smolts and yearling parr. The agreement has now been revised, and NNFH and NANFH will produce and stock in aggregate, 10,000 one-year-old smolt annually in the Saco River in Spring; produce and provide at a minimum 5,000 parr for continued Saco River Salmon Club (Club) “grow-out" or release to the Saco River; and produce and provide to the Club, Atlantic salmon eyed eggs from Merrimack River domestic strain. A minimum of 250,000 eyed eggs will be provided in Year 2011 and 400,000 eyed eggs will be provided thereafter in Years 2012 -2015, the period of the agreement. An estimated 473,958 eyed eggs were shipped from NNFH to the Club hatchery in February/March 2010. NANFH produced 24, 529 one-year-old smolts for release to the river in April, and produced 15,524 parr for shipment to the hatchery in December 2010.

Based on shifts in availability of smolts from GLNFH, results from genetic analysis and changes to freshwater habitat availability, there will be changes to salmon management in the Merrimack River watershed. Proposed changes include reduction in smolt production to approximately 25,000 due to limitations of NNFH and NANFH and reduced fry production, due to reduction in the use of kelts, and the lack of notable differential success of lower river tributaries. Fry production would decrease from a target of 1.4 million to 1.0 million, focusing stocking of fry only on areas above Ayers Island Dam and within the Souhegan river watershed. In addition, a pilot program would be initiated to test the efficacy of allowing sea-run fish run the river instead of becoming part of the broodstock at NNFH. These sea run fish would be a small subsection of all returning fish, identified via adipose fin clips, that were stocked as smolts in the Souhegan. These fish would be the first salmon in the Merrimack River allowed the opportunity to naturally return and spawn. Potential and likely effects of these changes would be lower sea-run returns, increase need for F1 hatchery broodstock and the resulting need to closely monitor increase potential for genetic bottle necks. In addition, benchmarks based on new management initiatives, will be developed and included in a revised framework document expected to be developed with partners in 2011.

4.1.8 Migratory Fish Habitat Enhancement and Conservation

Habitat Restoration

A feasibility study is underway to determine a scope of work for ecosystem restoration on the Shawsheen River, Lawrence/North Andover, MA. The river enters the Merrimack River approximately 1.0 rkm downstream of Essex Dam and river herring and salmon have been observed in the lower reaches of the river. While habitat in the upper reaches of the Shawsheen River is better suited to river herring, aquatic habitat in the lower reaches of the river may improve for salmon with proposed restoration measures. The Shawsheen River Restoration Project is led by the non-profit Center for Ecological Restoration in collaboration with the Town of Andover. Partners include Atria Senior Living, Inc. (owner of Marland Place Dam); NOAA Fisheries; US Fish and Wildlife

Service; American Rivers; Mass. Environmental Trust; Shawsheen River Watershed Association; and others. In 2008, Mass. Division of Ecological Restoration (formerly Riverways Program) awarded Priority Project status to the project. The goals of the project are to restore fish passage and riverine ecological functions to the lower Shawsheen River. The Shawsheen River is a tributary of the Merrimack River which flows roughly northeast along a 40.2 rkm course, entering the Merrimack River in Lawrence, MA. Three dams, Balmoral, Marland Place, and Ballardvale, block upstream passage of migratory and resident aquatic species. The first two dams are proposed for removal, and the third dam will either be removed or fish passage facilities would be constructed.

Merrimack Village Dam, Souhegan River, NH

In 2010, the multi-agency New Hampshire River Restoration Task Force (NHRRTF) continued to work on identifying dams and fish passage impediments for removal in state waters, as well as pursuing strategic alterations and/or modifications of dams.

Among others, two dams on the Souhegan River a major tributary in the Merrimack River watershed are being considered for removal.

With the removal of Merrimack Village Dam on the Souhegan River, migratory and resident fish were provided access to 23.2 rkm of main stem river habitat and 8.0 rkm of tributary habitat. Funding for the project was provided by Pennichuck Water Works, federal and state agencies, and non-government organizations. The National Oceanic and Atmospheric Administration, NOAA (Restoration Center), the lead federal agency for the project, continues to fund ongoing physical parameter studies of the dam site.

In cooperation with NHFGD, NNFH has released in aggregate an estimated 100,000 one-year-old adipose clipped smolts in the river in Spring from 2008 - 2010, with expectation that adult returns would migrate to the river and use available spawning habitat.

Salmon fry have been stocked in the recovering reach above the old dam site and cursory electrofishing surveys have been conducted that documented the presence of young-of-year parr at two sites within the fry stocked area.

A feasibility study is now being conducted to evaluate the potential ecosystem benefits of removing both McClane and Goldman Dams, Milford, NH. Removal of these structures would allow migratory fish access to upriver habitat, could reduce flooding in the watershed, and reduce a safety hazard.

4.2 Central New England: Saco River

4.2.1 Adult Returns

Florida Power & Light Energy (FPLE) operated three fish passage-monitoring facilities on the Saco River. The total return to the Saco River for 2010 was 20 adult Atlantic salmon. However, the count could exceed 20 due to the possibility of adults ascending Cataract without passing through one of the counting facilities and not being captured at the Skelton trap. Twenty salmon were observed moving upriver through the Cataract fish lift (East Channel, Saco) and Denil fishway-sorting facility (West Channel in Biddeford), which were operated from 1 May to 31 October, 2010. Six adult sea-run Atlantic salmon were captured at Skelton Dam in Dayton and Buxton and transported by FPLE to the Ossipee River and released. Thirteen of the returns were of hatchery origin (8-2SW, 5-1SW) and 7 were naturally reared (4-2SW, 3-1SW).

4.2.2 Hatchery Operations

Egg Collection

In 2010, 474,000 eyed eggs from Merrimack River origin broodstock were transferred from the Nashua National Fish Hatchery to the Saco River Salmon Hatchery. A portion of these were distributed to school programs (Fish Friends) and the remaining reared at the hatchery for stocking as fry.

4.2.3 Stocking

Juvenile Atlantic Salmon Releases

In April 2010, a total of 21,013 smolts were transported from North Attleboro National Fish Hatchery and released to the river. An additional 12,000 1-year old parr were transferred to the Saco River Salmon Club Hatchery in the autumn of 2009, held overwinter, and stocked in the mainstem in May. Approximately 315,000 fry, reared at the Saco River Salmon Club Hatchery, were released into one mainstem reach and 28 tributaries of the Saco River.

Adult Salmon Releases

No adult Atlantic salmon were stocked into the Saco River.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

No electrofishing surveys directed at assessing juvenile Atlantic salmon populations were conducted in the Saco River watershed in 2010.

Smolt Monitoring

Tagging

All smolts (21,013) transported from NANFH to the Saco River for release received an adipose fin clip.

4.2.5 Fish Passage

The license issued to Florida Power and Light Energy (FPLE) for the Bar Mill hydro project located on the Saco River on 26 August, 2008 by Federal Energy Regulatory Commission established a fund to enhance Atlantic salmon adult returns to the Saco River. This fund financed the 2009 and 2010 smolt stockings.

4.2.6 Genetics

Six genetic samples were collected in 2010. The samples were taken from sea-run adult returns captured at the Skelton Dam passage facility. All tissue samples were preserved in 95% ethanol and have been archived.

4.2.7 General Program Information

The US Fish and Wildlife Service and Department of Marine Resources continue to work with Saco River Salmon Club Hatchery to adaptively manage Atlantic salmon in the Saco River.

4.2.8 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2010.

5 Gulf of Maine

5.1 Adult Returns

Documented adult Atlantic salmon returns to rivers in the geographic area of the Gulf of Maine DPS (73 FR 51415-51436) in 2010 were 1,494. Returns are the sum of counts at fishways and weirs (1,411) and estimates from redd surveys. No fish returned “to the rod”, because angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Narraguagus, Penobscot, Kennebec, and Union rivers, and at a semi-permanent weir on the Dennys River. Fall conditions were suitable for adult dispersal throughout the rivers, and conditions allowed redd counting.

Escapement to these same rivers in 2010 was 1,224. Because there was no rod catch, the escapement to the DPS area was assumed to equal returns (estimated or released after capture) plus released pre-spawn captive broodstock (adults used as hatchery broodstock are not included). In 2010, 404 pre-spawn captive broodstock were stocked in the Sheepscot, East Machias and in Hobart Stream.

Small Coastal Rivers

Dennys River. The Dennys River weir trap was operated from 13 May to 25 October, 2010. A total of six salmon (4 naturally reared; 2 hatchery origin) were captured and released upstream. All of the wild and one of the hatchery returns were 2SW salmon. Returns were 3.7 % of CSE on the Dennys River. We did not capture any suspected aquaculture escapees in 2010. No redds were observed during surveys covering approximately 53 % of spawning area identified in the habitat database (spawning area surveyed/total spawning area).

East Machias River. Five (5) redds attributed to wild returns were counted during redd surveys in 2010 in the East Machias River that included approximately 74 % of known spawning habitat area. An additional 32 redds were located in Northern Stream where 40 pre-spawn captive reared adults from CBNFH were stocked.

Machias River. We counted a total of 31 redds, covering approximately 65 % of the spawning habitat area in the Machias drainage. No pre-spawn adult captive broodstock were stocked in the watershed, thus all redds were produced by wild returns.

Pleasant River. Four redds were found in the Pleasant River in 2010 during surveys of about 81% of spawning habitat area.

Narraguagus River. BSRFH staff operated the Narraguagus fishway trap from 30 April, to 4 November, 2010, recording a total of 76 returns. Only 12 for these were naturally reared as juveniles, the remainder was stocked as parr or smolt. Thirty three of the returns were 1 SW (44 %) and 39 were 2 SW (51 %). One multi sea-winter salmon observed ascending the spillway on video, was assigned an age and origin based on captures. In 2010, 64 redds were counted during surveys by canoe and foot covering approximately 67% of spawning habitat area.

Ducktrap River. Nineteen redds were observed during surveys in late November that encompassed 73% of the spawning habitat area in the Ducktrap River watershed.

Sheepscot River. The river was surveyed, focusing on spawning habitat in the upper portion of the mainstem and West Branch. Twenty five redds were attributed to sea-run returns and seventeen redds were attributed to the 86 stocked pre-spawn adults from CBNFH. Surveys encompassed 82% of spawning habitat by area.

Cove Brook. No spawning activity was found in Cove Brook during redd surveys conducted in November 2010 that included 100% of identified Atlantic salmon spawning habitat in the system. No Atlantic salmon spawning activity has been detected for 12 years (1999 to 2010), despite repeated and extensive searches annually.

Union River. No Atlantic salmon were captured at the fishway trap operated by Black Bear Hydro Partners, LLC on the Union River in Ellsworth below Graham Lake. This year the fishway was operated daily from mid-May to mid-June after which it was checked three or more days per week until the end of October.

Redd Based Returns to Small Coastal Rivers

Scientists estimate the total number of returning salmon to small coastal rivers using capture data on rivers with trapping facilities (Dennys, Pleasant, Narraguagus and Union rivers) combined with redd count data from five additional rivers. Estimated returns are extrapolated from redd count data using a return-redd regression [ln (returns) = 0.559 ln (redd count) + 1.289] based on redd and adult counts from 1991-2009 on the Narraguagus River, Dennys River and Pleasant River (USASAC 2010). Total estimated return based on redd counts for the small coastal rivers was 164 (90% CI = 136 - 199) (Table 5.1.1). Estimates after 2004 include the Union River.

Table 5.1.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2010. Estimates after 2004 include the Union River.

Year	LCI	Mean	UCI
1991	211	272	349
1992	179	229	295
1993	201	244	296
1994	138	178	229
1995	119	151	192
1996	204	261	333
1997	115	151	197
1998	132	182	245
1999	120	161	210
2000	71	94	123
2001	88	103	125
2002	25	35	48
2003	57	72	94
2004	54	77	109
2005	44	71	111
2006	49	79	122
2007	38	55	77
2008	94	127	171
2009	114	160	217
2010	136	164	199

Large Rivers

Penobscot River. The Veazie Dam fishway trap was operated daily from 3 May through 29 October, 2010. We captured 1,316 sea-run Atlantic salmon during 2010, releasing 619 salmon back to the Penobscot River upstream of the Veazie Trap. Two salmon escaped through the trap entrance cone and were not handled. An additional 119 salmon (79 females, 40 males) were transported to Craig Brook National Fish Hatchery (CBNFH) and subsequently released prior to spawning. Total escapement to the Penobscot River above the Veazie Dam in 2010 was 738, or 11 % of the CSE for the watershed. Only 41 of these entered the East Branch.

Brookfield Power operated the Weldon fishway on the East Branch of the Penobscot River from 2 June through 31 October, 2010. Salmon were classified as multi-sea winter (MSW) or one-sea winter (1SW) based on a visual observation of total length. This year, 41 salmon were captured and released upriver into the East Branch of the Penobscot River (8 MSW and 33 1SW); a decrease of 304 salmon from 2009.

Since 2006 marked smolts have been stocked below Great Works Dam, Penobscot River, Maine. Each year three groups received an identifying visible implant elastomer (VIE) and an adipose fin clip (AC). The primary purpose of these marked groups was to have an index of marine survival, with three pseudo-replicates to estimate the variance associated with the return rate (Table 5.1.2). For the three cohorts with 2SW returns, the percent coefficient of variation (CV) for return rate ranged from 8.15% to 27.24% (Table 5.1.3). The increased variability after 2006 may be related to a change in stocking timing. In 2006 the marked smolts were stocked on four consecutive days in standard week 17. For 2007, stocking was distributed between week 16 (3 consecutive days) and 17 (1 day), with the first and last dates 11 days apart. Stocking occurred over 12 days in 2008, with one day in week 15, one in week 16, and two consecutive days in week 17.

Table 5.1.2 Return rates for marked smolts (by auxiliary and individual VIE mark) released below Great Works Dam, Penobscot River, Maine in 2006, 2007, and 2008.

Smolt Cohort Year	Number Stocked	Mark Obs	1SW Returns	2SW Returns	3SW Returns	Total Returns	Return Rate per 10,000	% Return
2006	--	AC/NV	8	90	0	98	--	--
2006	56,156	LEG	19	82	0	101	17.99	0.180
2006	56,870	REG	25	89	0	114	20.05	0.200
2006	56,040	RER	21	74	1	96	17.13	0.171
2006	169,066	Total	73	335	1	409	24.19	0.242
2007	--	AC/NV	56	118	--	174	--	--
2007	49,219	LEG	56	95	--	151	30.68	0.307
2007	49,122	REG	36	53	--	89	18.12	0.181
2007	49,278	RER	50	65	--	115	23.34	0.233
2007	147,619	Total	198	331	0	529	35.84	0.358
2008	--	AC/NV	4	31	--	35	--	--
2008	49,262	LEG	14	65	--	79	16.04	0.160
2008	49,195	REG	16	31	--	47	9.55	0.096
2008	49,332	RER	16	64	--	80	16.22	0.162
2008	147,789	Total	50	191	0	241	16.31	0.163

Table 5.1.3 Average return rates (per 10,000) for VIE marked smolts stocked below Great Works Dam, Penobscot River, Maine in 2006, 2007, and 2008.

Smolt Cohort Year	Mark Observed	Average Return Rate per 10,000	Standard Deviation	Coefficient of Variation (%)
2006	LEG, REG, RER	18.39	1.50	8.15
2007	LEG, REG, RER	24.04	6.31	26.24
2008	LEG, REG, RER	13.94	3.80	27.24

In 2010, 29 Atlantic salmon observed at the Veazie Dam fishway had a fin clip(s) identifying them as returns from stocked parr. Returns were from three stockings years (2006-2008) because fall parr can spend 8, 20, or possible 32 months in freshwater before migrating to sea. The marked parr returns included: seven 1SW fish with a AC+LV fin clip (2008 stocking cohort), one 1SW fish with a LV fin clip (2007 stocking cohort), eight 2SW Atlantic salmon with a AC+LV fin clip (2006 stocking cohort), twelve 2SW fish with LV fin clips (2007 stocking cohort), and one 1SW fish with a AC+LV fin clip (2006 stocking cohort).

Androscoggin River. The Brunswick fishway trap was operated from 3 May to 22 October, 2010. The fishway was closed July 21 through September 2 for maintenance and high water temperatures. The total trap catch was 9 sea-run adult Atlantic salmon (2 naturally reared 2SW; 5 hatchery 2SW; 2 hatchery 1SW).

Kennebec River. The Lockwood fish lift was operated by FPLE staff from 1 May to 31 October, 2010. The trap was shut down from 9 August to 20 August for scheduled maintenance. The total trap catch for 2010 was 5 adult sea-run Atlantic salmon (2 hatchery origin 2SW, 2 naturally reared 2SW, and one naturally reared 1SW).

Sebasticook River. The Fort Halifax dam was removed in the summer of 2008 opening up 7.33 river kilometers of habitat and allowing all species of diadromous fishes to reach the Benton Falls fish lift. The Benton Falls fish lift was operated from 24 April to 7 July, 2010. No adult Atlantic salmon were captured or observed at the facility during that period.

5.2 Hatchery Operations

Egg Production

Sea-run, captive, and domestic broodstock reared at CBNFH and GLNFH produced 5.95 million eggs for the Maine program in 2010: 2.09 million eggs from Penobscot sea-run broodstock; 1.91 million eggs from three domestic broodstock populations; 1.96 million eggs from six captive broodstock populations.

Spawning protocols for domestic and captive broodstock at CBNFH give priority to first time spawners and use 1:1 paired matings. Spawning protocols for Penobscot sea run broodstock also use 1:1 paired matings. A total of 292 Penobscot origin females, 117 domestic females, and 358 captive females were spawned at CBNFH

At GLNFH, 314 age four domestic females were spawned to provide eggs for in-stream egg planting in the Sandy River, a tributary to the Kennebec River. Spawning protocols at GLNFH also call for 1:1 paired matings.

Egg Transfers

CBNFH transferred sea-run, captive and domestic eyed eggs to GLNFH for parr and age 1 smolt production (Penobscot, Narraguagus, and Pleasant stocks), to two facilities operated by the Downeast Salmon Federation for private rearing (Pleasant and East Machias stocks), and to DMR for implantation in artificial redds (Sheepscot stocks).

GLNFH transferred eyed, Penobscot domestic origin eggs to DMR for planting in artificial redds in the Sandy River, a tributary to the Kennebec River.

In addition, all three egg sources (sea-run, captive, and domestic) from the two federal hatcheries were used to support the Salmon-in-Schools (FWS) and Atlantic Salmon Federation Fish Friends programs in 2010.

Wild Broodstock Collection and Domestic Broodstock Production

In 2010, 1,119 wild parr (162, Dennys; 160, East Machias; 261, Machias; 105, Pleasant; 261, Narraguagus; 170, Sheepscot) were collected by DMR and transported to CBNFH for captive rearing. No new domestic lines of pedigreed broodstock were started at CBNFH in 2010.

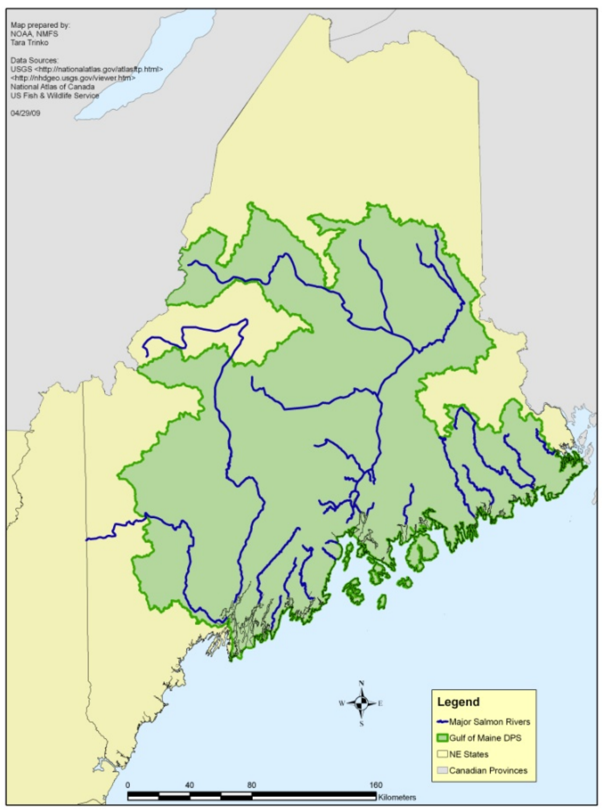
GLNFH retained approximately 1,200 fish from the 2009 year class of sea run Penobscot-strain Atlantic salmon. These fish will be used for F2 domestic egg production at GLNFH for 2-3 years.

The total adult sea-run broodstock collection from the Penobscot River (Veazie dam) was 700 fish in 2010. These fish were transported to CBNFH. All Penobscot River adults captured were marked with PIT tags and sampled for genetic characterization.

Disease Monitoring and Control

Disease monitoring and control was conducted at both hatcheries in accordance with hatchery broodstock management protocols and biosecurity plans. All incidental mortalities of future or adult broodstock were necropsied for disease monitoring. Analysis, conducted at the Lamar Fish Health Unit (LFHU), indicated that incidental mortalities were not caused by infectious pathogens. All lots of fish to be released were sampled in accordance with fish health protocols at least 30 days prior to release. At CBNFH, samples of reproductive fluids are collected from each female and male spawned; at GLNFH ovarian fluid is collected from 150 females. All reproductive fluids are analyzed at LFHU.

All Penobscot sea run broodstock retained at CBNFH were tested for Infectious Salmonid Anemia (ISA) as they were brought to the station in 2010. Incoming adults were isolated in a newly constructed screening facility to undergo sampling procedures and await the results of PCR testing. Q-PCR tests identified 10 adults as being ‘suspect’ for ISA. All suspects were released back to the Penobscot River. Fish held in the same tank(s) as suspect fish were isolated in a single Swedish pool while additional analysis was completed; results from the cell culture assays did not show pathogenic activity. Analysis of test results revealed the suspect fish were exposed to the HPRO strain of ISA, a non-pathogenic genotype also observed in 2009. The HPRO strain is not associated with morbidity or mortality. Because the ten fish were not positively diagnosed with a strain that is associated with fish mortality by two separate tests, pathologists deemed the fish held in tanks with the suspect fish could be spawned.



5.3 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.

Juvenile Stocking

Age-1 smolts reared at GLNFH were stocked into the Penobscot Basin (567K), and Narraguagus (62K). 2010 was the second year of a three year direct estuary release study in the Penobscot Basin. Approximately 33K smolts, marked with unique VIE tags, were moved from GLNFH into the West Enfield smolt ponds, following a ten day imprint period, the smolts were transported to the Verona Island boat launch for a night release into the estuary. The aim of the study is to double adult returns from smolt releases. Future assessments will include acoustic tagging for estuary tracking, examination of paired releases using VIE tag information and Na^+/K^+-ATPase analysis.

Temperature advanced age 0 parr reared at GLNFH released into the Penobscot Basin totaled 259K; all GLNFH origin parr were marked with coded wire tags in 2010. Ambient age 0 parr reared at CBNFH released into the Sheepscot River totaled 14.5K; all CBNFH origin parr were marked with adipose fin clips.

CBNFH produced approximately 3.2 million fry, primarily unfed, for release throughout the GOM DPS. With the goal of stocking fry at the appropriate developmental stage, as measured by the developmental index (DI), release dates differed amoun rivers. Downeast fry were released at DIs ranging from 91% to 105%; while fry released in the Penobscot Basin had DIs ranging from 111% to 126%.

GLNFH produced 18.9K unfed fry for an outreach effort in cooperation with the Union River Salmon Association; all fry were released into the Union River.

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 brood fish to stocked progeny, and the need to maintain adequate numbers of broodstock to meet production and other genetic goals. In 2010, gravid excess broodstock were released in October to the Sheepscot (86) and East Machias (40). Adults released into the East Machias River were tagged by BSRFH personnel with gender coordinated Carlin tags in order to facilitate observation of adults in spawning habitat. Additional releases of gravid excess broodstock, of mixed origins, occurred in Hobart Stream: Dennys (98), East Machias (74), Machias (69), Narraguagus (23), and Pleasant (14).

2010 was the second year of a three year adult translocation study using Penobscot sea-run adults. The goal of the study is to increase the likelihood of successful natural reproduction by translocating adults captured and brought to CBNFH into high quality spawning habitat in the upper Piscataquis River. A total of 119 adults (40 males and 79 females) were released in early October; 44 of the females were tagged with radio tags for tracking movements during the spawning season. As part of the experiment, the fry request for the Penobscot River basin was reduced to 1 million, to account for the increase in natural reproduction.

Following spawning, 561 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2010. 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.

Post-spawn age 4 and 5 captive broodstock from CBNFH were released into their natal rivers: Dennys (78); East Machias (104); Machias (228), Narraguagus (238); Pleasant (96); Sheepscot (97).

GLNFH released 1,091 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River.

5.4 Juvenile Population Status

BSRFH conducts electrofishing surveys to monitor abundance of Atlantic salmon juveniles, assess management actions, and test hypotheses. In 2010, we conducted 395 electrofishing trips to assess juvenile salmon populations and community ecology. We used two sampling methods: depletion estimates at measured area sites (n=38) and standardized catch-per-unit-effort (CPUE). Fish abundance is presented as fish per unit, where one unit equals 100 m^2 and relative abundance (CPUE) in fish/minute. All data for 2010 were added to the USASAC Juvenile Salmon database. Juvenile densities and CPUE varied considerably among sites in Maine rivers in 2010 (Table 5.4.1 and 5.4.2).

The increased use of CPUE method allowed sampling to cover a broader geographic area, and to include more sites. To assess the relationship between CPUE and density both methods were used at randomly chosen sites in the Kennebec watershed (7) and selected coastal rivers (11). The CPUE was either within or adjacent to the site in the same meso-habitat (i.e. riffle upstream of blocking nets). Regressions for the two areas were similar, and provide a way to translate relative abundance to density (Figure

5.4.1). Further, because method changes that might affect CPUE, would not affect depletion estimates, we intend to use randomly chosen “double method” sites annually to maintain a record of catchability for gear and methods and to calibrate CPUE data among years.

Table 5.4.1 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, 2010. Rivers are grouped by Salmon Habitat Recovery Unit (SHRU).

	DENSITY		PARR / unit		
SHRU	Drainage	N	Median	Maximum	Minimum
DE Coast	Dennys	4	2.26	2.73	0.98
	East Machias	8	4.57	21.69	0.91
	Machias	7	7.03	13.80	0.54
	Narraguagus	7	5.68	8.84	3.52
	Pleasant	3	6.77	28.00	4.15
PN Bay	Penobscot	7	17.03	22.07	0.00
ME Bay	Kennebec	8	1.01	15.09	0.00
	Sheepscot	14	3.01	16.57	0.63

Table 5.4.2 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, 2010. Rivers are grouped by Salmon Habitat Recovery Unit (SHRU).

	CPUE		PARR / min		
SHRU	Drainage	N	Median	Maximum	Minimum
DE Coast	Dennys	13	0.40	2.80	0.20
	East Machias	32	0.79	6.31	0.00
	Hobart	5	0.60	1.60	0.40
	Machias	27	1.78	8.84	0.00
	Narraguagus	10	1.29	2.57	0.00
	Pleasant	13	1.40	3.74	0.00
PN Bay	Cove	3	0.00	0.00	0.00
	Ducktrap	1	0.76	0.76	0.76
	Penobscot	109	0.00	3.91	0.00
ME Bay	Kennebec	106	0.00	2.94	0.00
	Sheepscot	4	0.80	2.40	0.00
	Androscoggin	2	0.10	0.20	0.00

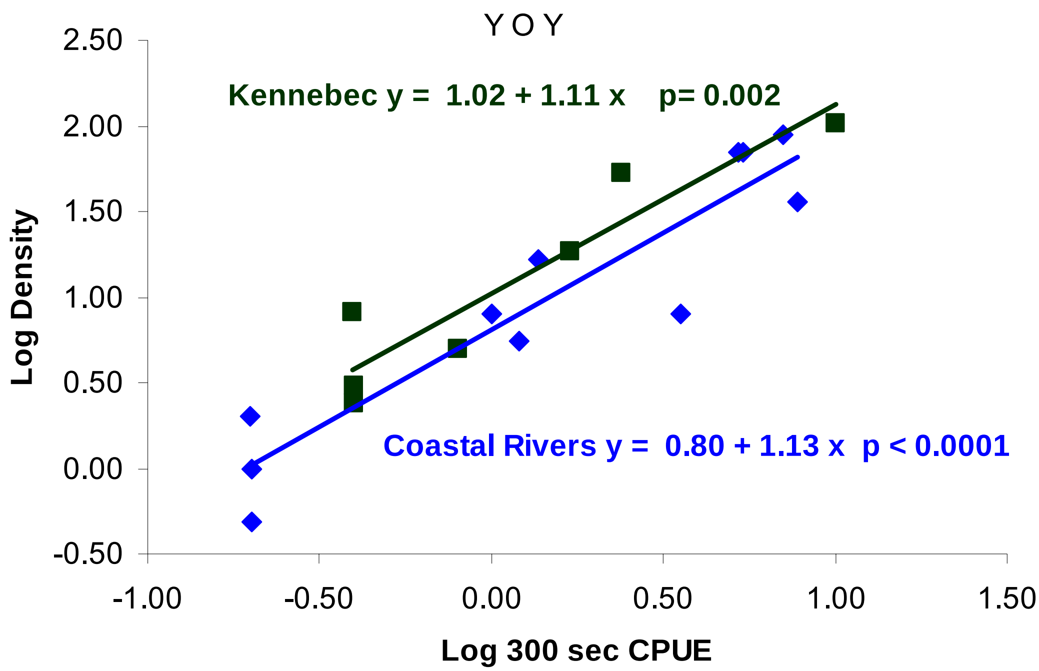


Figure 5.4.1 Relationship between log YOY salmon CPUE (YOY / min) and log density (YOY/unit) at sites in the Kennebec (green) and in Coastal Rivers (blue). Both linear Regressions were significant and had adjusted R^2 > 85%.

Smolt Abundance

NOAA-National Marine Fisheries Service (NOAA) and the Maine Bureau of Sea Run Fisheries and Habitat (BSRFH), conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in several of Maine's coastal rivers. Scientists generated population estimates using program DARR 2.0.2 for R (Bjorkstedt 2005; Bjorkstedt 2010). Beginning in 2009, estimates for all years in the time series were recalculated using DARR 2.0, which differs from the program used in the past (SPAS; Arnason et al. 1996) in that DARR pools strata based on several predetermined factors and is data driven. In SPAS, the user is required to pool strata, which may result in inconsistent pooling from assumptions made by each user and/or across time. This change made minimal changes to estimates and only minor changes to the error structure but ensures a more rigorous and repeatable analysis. Summaries for each river follow.

Narraguagus River

Of the 588 new smolts captured in the traps upstream of Beddington Lake (river km 47.62), 587 were marked, PIT tagged, and released 5.41 km upstream. The estimate of smolt production above Beddington Lake was 1,709 ± 108 smolts. This estimate includes both naturally-reared smolts and smolts that were stocked as parr. The PIT tagged smolts spent an average of 2.18 days at large (range 1 to 10) from time of release to recapture at the upstream RSTs. Travel time of smolts from the upstream release site to NOAA's RST sites was calculated at 9.19 days (range: 5 to 15; n = 28), which is an average distance per day of 5.21rkm (range: 1.53 to 11.32; n = 65).

We collected 6,791 smolts, 375 of which were recaptures (5.5%) at the NOAA RST sites (river km 11.16 and 7.65). A subset of smolts was scale sampled (n= 401 and tissue sampled for genetics (n=662). Of the scale samples collected, the age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) is as follows: 78.4 % age 2+, and 21.6 % age 3+ (Table 5.4.3). Age 2+ smolts averaged 179 ±16 mm fork length (n=160) and 57.9 ± 17.2 g wet weight (n = 160) (Tables 5.4.4 and 5.4.5 and Figures 5.4.2 and 5.4.3). During the first week of May, ~ 62,000 age 1+ salmon smolts were stocked, and therefore most of the smolts collected were of hatchery origin (88%). The population estimate for naturally-reared smolts at the NOAA sites was 2,170 ± 228 smolts (Figure 5.4.4). The total estimate of smolts (naturally reared, fall parr and hatchery stocked smolts) exiting the Narraguagus system was 33,234 ± 1,895.

The population estimate on the Narraguagus River for naturally-reared smolts in 2010 of 2,170 ± 228 was almost double that of the previous year (1,180 ± 91) and is slightly higher than the average of estimates from years 1997-2009. The population had been trending lower recently (2007-2009), coinciding with the annual release of hatchery 0+ parr and 54,000 age 1+ smolts. The population estimate of naturally reared smolts derived at the site above Beddington Lake (992 ± 74) is approximately 46% of the entire river estimate. This percentage is much lower than that of both 2009 and 2008, which were 61% and 75%, respectively.

Sheepscot River

We captured 688 smolts at the Sheepscot River site, 224 of which were marked with an adipose clip, indicating they were stocked as 0+ parr in 2008 or 2009. A subsample of scales (n=494) and tissue samples (n=472) were collected from smolts. We use scale samples collected to determine the proportion of naturally-reared smolt ages and to generate mean fork length and weight by smolt origin summaries (Tables 5.4.4 and 5.4.5 and Figures 5.4.2 and 5.4.3). This year, the Sheepscot River smolt run's naturally reared component was composed of 97.6% age 2+ and 2.4% age 3+ (Table 5.4.3).

Age 2+ naturally-reared smolts averaged 192 ± 26 mm fork length (n = 239) and 72.0 ± 23.8 g wet weight (n = 239) (Tables 5.4.4 and 5.4.5, Figures 5.4.2 and 5.4.3). The population estimate of naturally-reared smolts was 2,372 ± 266. The estimate of smolts of hatchery origin (stocked as fall parr in 2008 and 2009) was 1618 ± 391.

The population estimate of all emigrating smolts for the Sheepscot River of 3,936 ± 370 (1.38 smolts/habitat unit) was more than double the 2009 estimate of 1,809 ± 151. The increase in the population estimate mirrors increases in densities seen in parr during fall electrofishing (Paul Christman, pers. comm). Densities were higher at many sites in 2009 than in 2008, which may be attributed to favorable growing conditions in 2009.

Pleasant/Piscataquis River

We collected 1,088 smolts in the Pleasant River RSTs, 1063 (97.7%) of which were marked with a ventral clip or a ventral clip and an adipose clip, indicating that the fish were stocked as age 0+ parr. Of the 1063 marked smolts captured, 15.5% were stocked as fall parr in 2008 and 84.5% were stocked as fall parr in 2008. The distribution of unmarked smolts (n = 25) is as follows, based on scale reading: 24.0% stocked as fall parr in 2009, 8.0% stocked as fall parr in 2008, 12.0% age 1+, 40.0% age 2+, and 16.0% age 3+(Table 5.4.3). Age 2+ naturally-reared smolts averaged 170 ± 13 mm fork length (n = 10) and 48.5 ± 9.7 g wet weight (n = 10) (Tables 5.4.4 and 5.4.5, Figures 5.4.2 and 5.4.3).

We collected 2002 smolts in the Piscataquis River RSTs, 968 of which were marked and released 3.2 km upstream. Of these marked smolts, 349 were recaptured (36.1%). The age composition of naturally-reared smolts is: 77.8% age 2+, 22.1% age 3+, and 0.1% age 4+, based on scale reading (n=1034) (Table 5.4.3). Age 2+ naturally-reared smolts averaged 143 ± 10 mm fork length (n = 803) and 28.4 ± 6.4 g wet weight (n = 762) (Tables 5.4.4 and 5.4.5, Figures 5.4.2 and 5.4.3). The population estimate of emigrating smolts was 9,304 ± 1,213.

Hobart Stream

We captured 12 naturally reared smolts in the alternative smolt trap. Age 2+ naturally-reared smolts averaged 161 ± 17 mm fork length (n = 12) and 39.5 ± 10.6 g wet weight (n = 12) (Tables 5.4.4 and 5.4.5, Figures 5.4.2 and 5.4.3).

Smolt Run Timing

In 2010, the median run date of smolts on the Narraguagus and the upper Piscataquis was similar to that of 2009 (within three days), while the smolt run on the Sheepscot was almost a week earlier than in 2009 (Figure 5.4.5.). Median run dates on the

Sheepscot River and the Narraguagus River were the earliest seen since trapping began on each of the rivers. (Figure 5.4.5.).

Median run date of smolts in 2010 were the earliest seen since trapping began in 1996 on the Narraguagus River. The first smolt caught on the Sheepscot River in 2010 was caught on ordinal day 101, which is seven days earlier than in any other year (In 2006, the first smolt was caught on day 108). Reasons for the early smolt run include the fact that the winter of 2009-2010 was the third warmest winter in Maine on record and one of the least snowy snow seasons on record (National Weather Service Forecast Office, 2010). The reduced snowpack coupled with extremely warm temperatures provided water temperatures that were optimal (>10 degrees C) for smolt migration in early April.

Table 5.4.3 Freshwater age of naturally-reared smolts collected in smolt traps on selected Maine rivers.

	2010				5 year average (2005-2009)			
River	1+	2+	3+	4+	1+	2+	3+	4+
Hobart	0%	100%	0%	0%	N/A	N/A	N/A	N/A
Narraguagus	0%	79.2%	20.8%	0%	0.6%	89.1%	10.1%	0.1%
Piscataquis-Pleasant River	17.6%	58.8%	23.5%	0%	0%	89.1%	10.9%	0%
Piscataquis	0%	77.8%	22.1%	0.1%	0.7%	50.5%	48.2%	0.7%
Sheepscot	0%	97.6%	2.4%	0%	4.7%	90.4%	4.9%	0%

Table 5.4.4 Mean fork length (mm) by origin of smolts captured in smolt traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2010	n	5 year average ('05-'09)	n	2010	n	5 year average ('05-'09)
Hobart	N/A	N/A	N/A	N/A	12	161±17	N/A	N/A
Narraguagus	291	167±16	459	165±18	160	178±16	619	166±14
Pisq-Pleasant	903	128±8	1,649	134±12	10	170±13	279	166±14
Piscataquis	0	N/A	0	N/A	803	143±10	594	141±12
Sheepscot	91	162±11	270	145±13	239	192±26	459	184±18

Table 5.4.5 Mean smolt wet weight (g) by origin of smolts captured in smolt traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2010	n	5 year average ('05-'09)	n	2010	n	5 year average ('05-'09)
Hobart	N/A	N/A	N/A	N/A	12	39.5 ± 10.6	N/A	N/A
Narraguagus	290	46.6±14.9	459	46.1±16.6	160	57.9± 17.2	619	46.0± 12.4
Pisq-Pleasant	902	20.0±4.2	1,626	21.7±6.1	10	48.5±9.7	250	42.1±9.2
Piscataquis	0	N/A	0	N/A	762	28.4±6.4	611	27.4±7.5
Sheepscot	91	44.3±9.6	270	33.6±9.4	239	72.0±23.8	459	65.8±20.2

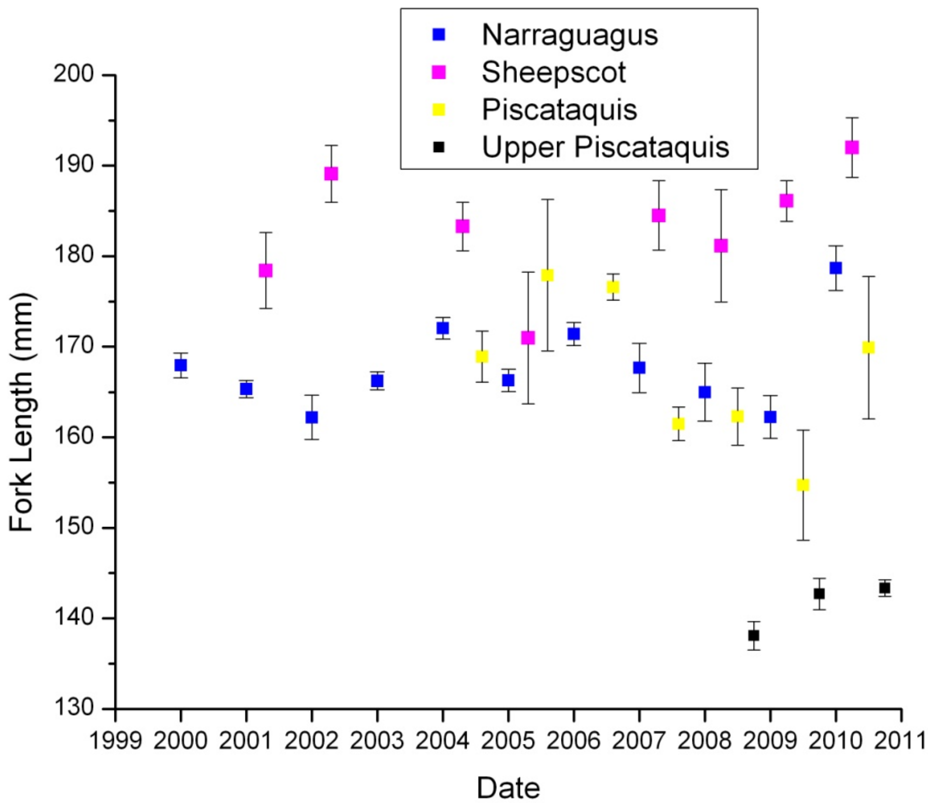


Figure 5.4.2 Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2000-2010.

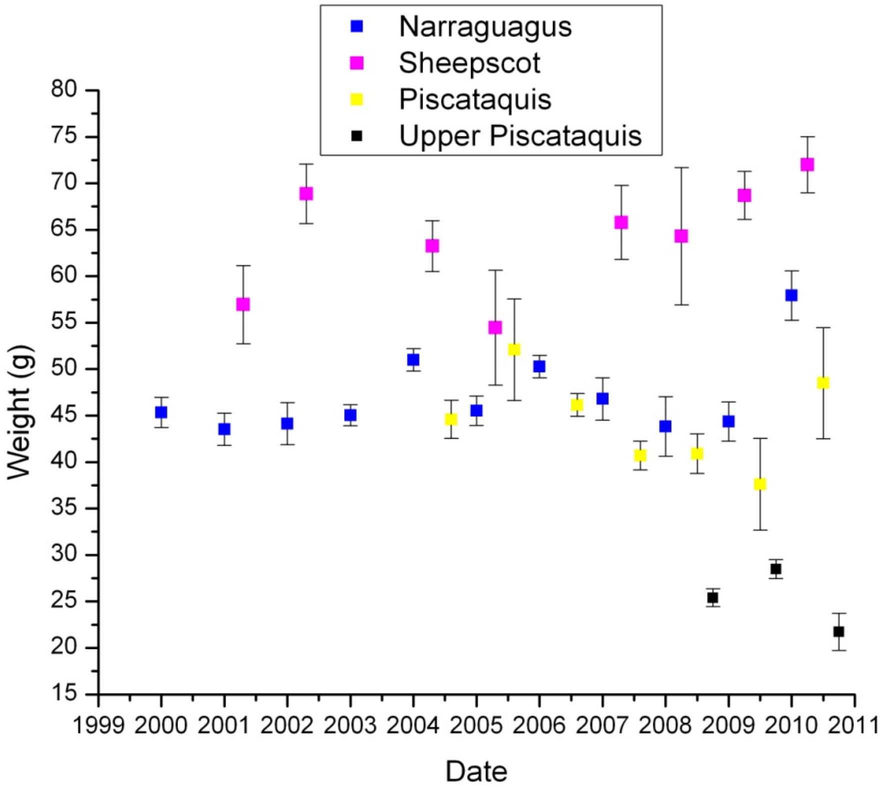


Figure 5.4.3 Mean wet weight (g) ± 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2000-2010.

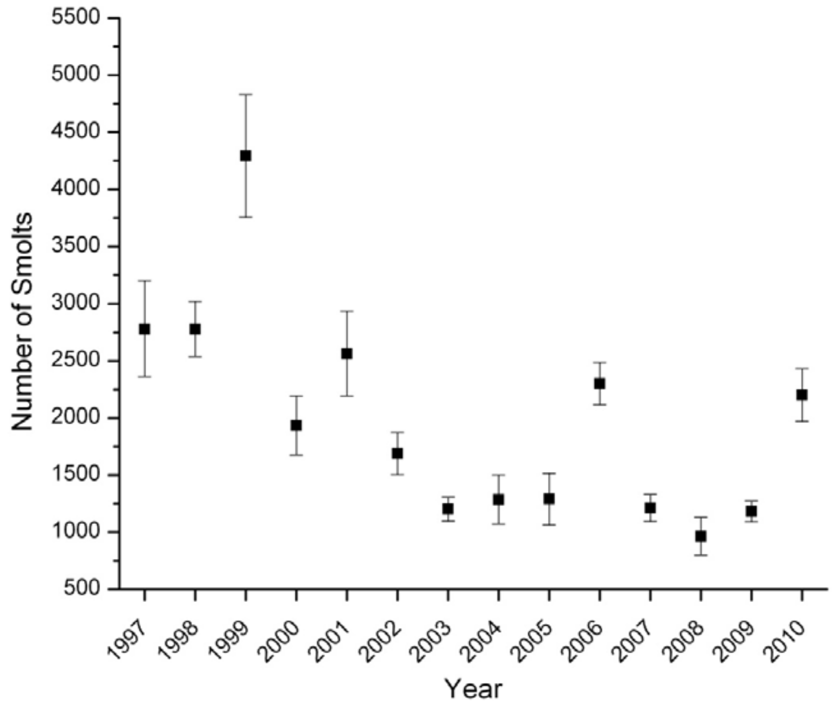


Figure 5.4.4 Population Estimates (± Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to 2010 using DARR 2.0.2.

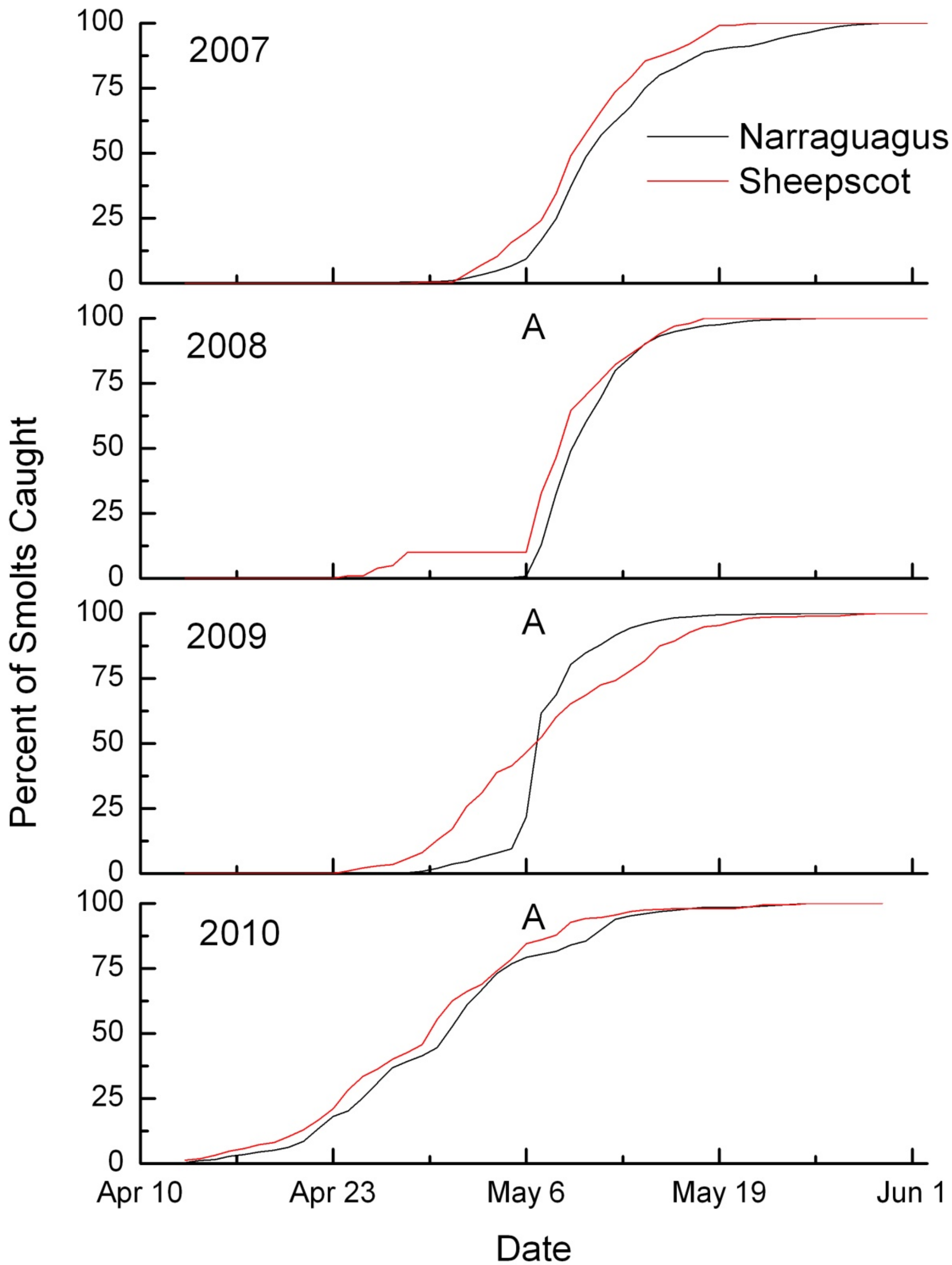


Figure 5.4.5 Cumulative percentage smolt catch for smolts of all origins in Rotary Screw Traps by date (run timing) on the Narraguagus and Sheepscot Rivers, Maine, for years 2007 to 2010.

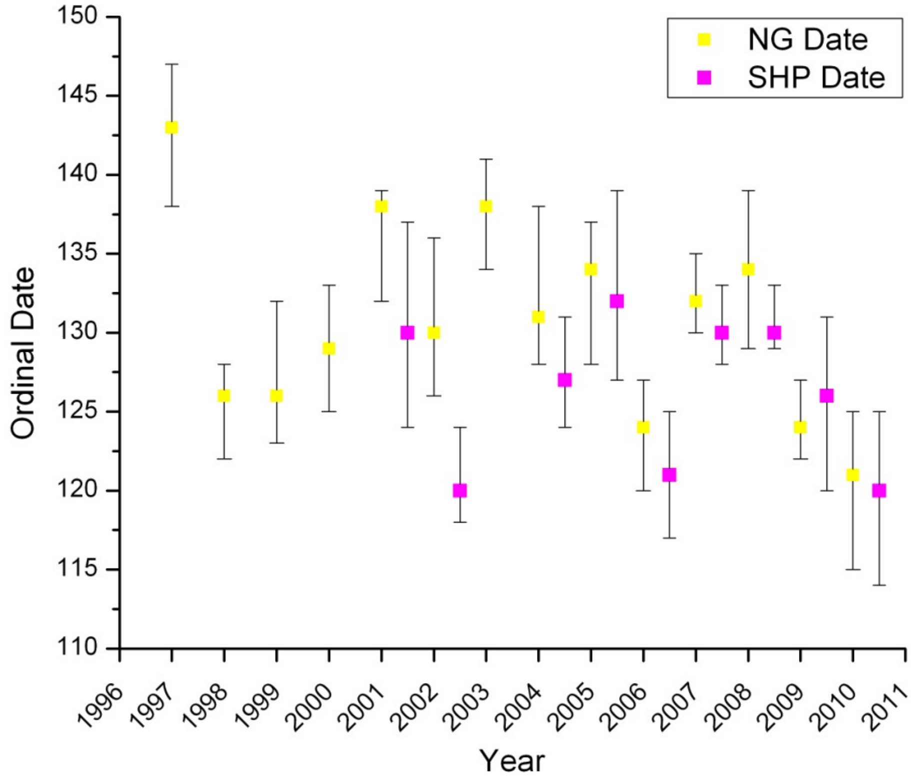


Figure 5.4.6 Ordinal day (days from January) of median smolt catch of naturally-reared smolts in rotary screw traps on the Narraguagus and Sheepscot Rivers, 1997-2010. Error bars represent 25th and 75th percentiles of median run dates.

5.5 Fish Passage

West Winterport Dam Removal

In August 2010, The West Winterport Dam was removed after a longer than expected process. The dam on the North Branch of Marsh Stream at West Winterport, built on a ledge where the stream is eighty-five feet wide, was erected to run a water-powered gristmill in the early 19th century, and later powered a sawmill. Subsidies to small hydroelectric generating facilities in the early 1980's prompted John Jones to buy, refurbished and installing turbines and a powerhouse at the dam. When the subsidy expired toward the end of the 1990s, economic incentive for operating the hydroelectric facility at the West Winterport Dam ended. The climate seemed ripe for dam removal, on the heals of the Edwards Dam removal, the removal of the two dams on nearby Souadabscook Stream, and one on the Pleasant River in Brownville. Maine Council of the Atlantic Salmon Federation undertook permitting and fundraising to remove the West Winterport Dam. The process required approval by both FERC and the Maine Department of Environmental Protection (MDEP). Fishery agencies supported the dam removal for its restoration potential for sea-run fish. When the dam removal application became public, opposition arose in the towns of Winterport and Frankfort, based on variety of claims. MCASF obtained approval from FERC and MDEP to remove the dam in late 2003, however because of local opposition John Jones decided not to go forward with removal. Because the dam wasn't being removed, in 2005 the fisheries agencies required that fish passage had to be provided (i.e. repair the derelict fishway). Facing yet another large expense, Jones worked to change local opinion, and in 2008, the two towns to release him from an agreement not to remove the dam. It was not until 2010 that the Maine Council of the Atlantic Salmon Federation obtained the necessary permits and funding to remove the West Winterport Dam.

Fishway Repaired at Meddybemps Lake, Dennys River Watershed

The downstream entrance of the Denil fishway at Meddybemps Lake Dam was be modified to increase velocities creating better attraction flow conditions and a stream boulder repositioned to remove obstruction at the fishway entrance. The fishway exit was extended 14 ft into Meddybemps Lake. The invert of this extension allowed adding a series of baffles with sequentially higher invert elevations upstream. The baffles are intended to decrease flow and velocities in the fish fishway at high lake levels; and as lake elevations drop, will be removed to maintain flow down the fishway.

Penobscot River Restoration Project Milestones

In mid-December 2010, the Penobscot River Restoration Trust completed the purchase of the Veazie, Great Works and Howland dams for $24 million from PPL Corp. The purchase was funded with approximately $10 million raised from private donors and nearly $15 million secured by Maine's Congressional delegation from National Oceanic and Atmospheric Administration Fisheries and the U.S. Fish and Wildlife Service.

The Great Works, in Old Town, and Veazie dams will be removed and a fish bypass built around the Howland structure, the first three dams salmon encounter on the Penobscot River. The FERC issued orders in June 2010, requiring the Trust to surrender licenses for each of these three projects when dam removal or bypass construction is complete. Another $18 million is needed to complete this work. A fish lift must also be built at the dam in Milford.

PIT Antennae Installed at Fishways on Penobscot River

As part of monitoring the Penobscot River Restoration Project (PRRP) the USGS Co-operative Fish and Wildlife Unit is examining spawning migration of Atlantic salmon (Salmo salar) through nine dams on the Penobscot River. All salmon passed upstream or transported from the Veazie fishway were implanted with a Passive Integrated Transponder (PIT) at the time of capture. PIT readers were installed at nine dams on the Penobscot River with antenna arrays located at the entrance and exit of the dam fishways, replicating prior work (2002-2004). Subsequent years will provide observations of how the removal of Great Works and Veazie Dams (the lowest two) influences salmon migration.

5.6 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick, and at the Lockwood fish lift on the Kennebec River. In total 14 (5 on the Kennebec, and 9 on the Androscoggin) genetic samples were collected in 2010. All were tissue samples were preserved in 95% ethanol. Fin material obtained from adipose or caudal fin punches were collected and archived for DNA analysis from 1,309 (99.5%) of the 1,316 Atlantic salmon captured at the Veazie Dam fishway trapping facility.

Since 1999, all broodstock at CBNFH have been PIT tagged and sampled for genetic characterization via fin clips. This activity allows establishing 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 2010, DPS broodstock (collected in 2008) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.7 General Program Information

U. S. Fish & Wildlife Service Schools Programs

2010 marked the sixteenth year of FWS' outreach and education program, which focuses on endangered Atlantic salmon populations and habitats in Maine rivers. Student participants are provided the opportunity to raise river-specific Atlantic salmon eggs and fry in classrooms and release the fry into their natal river in early May. Classroom instruction involves the life cycle of Atlantic salmon and other diadromous fish, habitat requirements and human impacts which can affect their survival. The Salmon-in-Schools program contributes fry to the Dennys, Machias, East Machias, Pleasant, Narraguagus, Sheepscot, Union and Penobscot rivers. In addition to educational facilities, a business is annually invited to participate in the program to broaden exposure to the general public.

CBNFH and GLNFH provide Atlantic salmon eggs for the Maine Council, Atlantic Salmon Federation to support the Fish Friends program. Like the FWS' Salmon-in-Schools, Fish Friends offers comparable educational opportunities in 77 additional Maine schools, reaching some 2,200 students, cooperating teachers and parents annually. The two programs, working in partnership, reach over 3,600 people each school year.

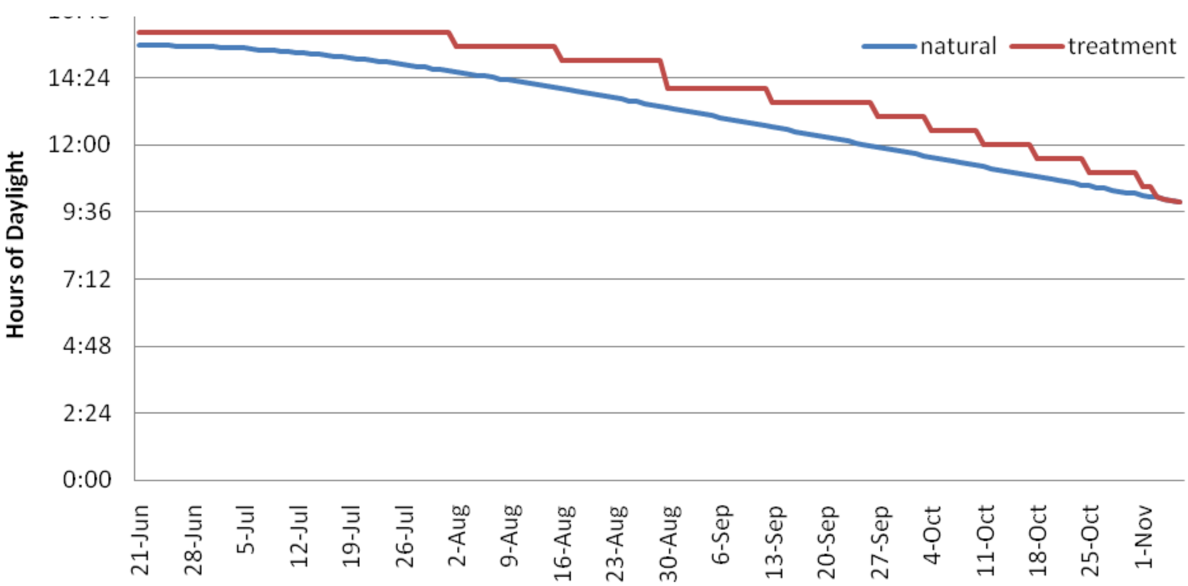
Egg Take at CBNFH

Following two disappointing egg takes in 2008 and 2009, Craig Brook National Fish Hatchery (CBNFH) administered a photoperiod treatment on Penobscot sea run broodstock in an attempt to delay the onset of spawning in 2010. Since 2000 the spawn timing of Penobscot broodstock has steadily advanced from the 2nd of November to as early as October 24th. As CBNFH relies solely on ambient water sources, eggs taken in October are typically exposed to water temperatures above optimal levels for spawning and egg incubation [6 – 10 °C]. Above-optimal water temperatures during early egg development affect egg survival, embryonic deformities and fry survival. In addition, accelerated early egg development results in fry that biologically require feeding, but are unable to do so due to cold ambient process water.

In 2008 hatchery spawning activities did not start until early November to ensure that eggs were collected in favorable temperatures. No attempt was made to delay broodstock maturation and as a result many females had matured much earlier; this resulted in an incomplete egg take. In 2009, Penobscot broodstock were sorted on 29 October and it was discovered that all females were ready to spawn; observations during spawning indicated that some females were over-ripe resulting in another incomplete egg take.

In 2010, a photoperiod treatment was designed with the goal to delay maturation and the onset of spawning in the sea-run broodstock. Day length in the holding pools was maintained at the summer maximum (solstice on 21 June) for an additional two weeks and returned to ambient length on 1 November. Filtered ambient light augmented using overhead lighting on timers to produce the predetermined schedule (Figure 5.7.1). Broodstock were separated by gender in the Swedish pools on 19 October. During this sort and examinations on 28 October, 1 November, and 8 November the broodstock were examined to determine maturation level. Penobscot broodstock were spawned on 9 November; a ten day delay in spawning compared to the ten year average.

Figure 5.7.1 Comparison of day length in the S pools where Penobscot River broodstock were held (top red) and the natural day length (bottom blue) for the period 21 June through 1 November 2010 at CBNFH.



The delay of egg take into mid-November allowed eggs to begin incubation in optimal water temperatures. Using a temperature projection based on a five year average, it is currently estimated that Penobscot eggs taken in 2010 will reach 100% development between 5 May and 17 May, 2011. This projected date range should lead to fry being released at biologically appropriate development and environmental conditions.

Survey of Dams

In late 2010 the National Marine Fisheries Service began a comprehensive survey of all non-FERC licensed dams within the freshwater range of the Gulf of Maine Distinct Population Segment (GOM DPS). The purpose of the survey is to (1) to gather information on the current use of the dam, future ambitions and goals for the dam, and whether or not dam owners would consider opportunities for dam removal or fish passage improvements; and (2) to inform dam owners of funding opportunities that can alleviate concerns related to the Endangered Species Act. There are over 400 dams that are part of this survey.

5.8 Migratory Fish Habitat Enhancement and Conservation

Habitat Connectivity

In 2010, 42 habitat restoration and/or connectivity projects were completed in eh Machias River watershed using funds from USDA-WHIP, USFWS, NOAA Fisheries, the American Recovery and Reinvestment Act, Project SHARE, and private landowners such as the Downeast Lakes Land Trust. Thirty one stream-road crossings were retrofitted with bankfull spanning open arch structures, six sites had complete road decommissions, one crossings was replaced with a bridge, three remnant log driving dams were removed and one lateral boulder wall was breached. The total fish bearing stream habitat opened to access by the 42 projects was estimated at 121.9 kilometers (Table 5.8.1).

The primary goals of these enhancement projects were to restore aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment) through the crossing or remnant log driving structure. Annual monitoring is performed to determine if projects withstand natural flood and beaver activity threats. Structures in Downeast salmon rivers withstood extreme floods in the autumn of 2010 and no failures from beaver activity have been reported.

Habitat Complexity

A large wood (LW) habitat improvement project was initiated by BSRFH staff in 2006 to improve habitat complexity and suitability by placing trees into the river at a rate of one tree per ten meters of river length.   A combination of “cut and drop” trees and trees with root balls were added to 14 treatment sites between 2006 and 2009. Unfortunately no trees were placed in streams in 2010, however a grant award of 37,000 was received from Eastern Brook Trout Joint Venture. This funding was used to locate eleven additional LW treatment sites across four drainages (Sheepscot, Narraguagus, Machias, and East Machias); ten of which will be treated in 2011. Observations indicate the treatments have created habitat complexity; with small shallow pools, riffles, and over head cover associated with the added wood pieces. Trees with attached root balls have not moved, and geomorphologic changes seem to be occurring more quickly than with the dropped trees. Fish community data, collected annually at selected sites and five years after treatment at others, will be analyzed in the near future.

Table 5.8.1 Projects restoring stream connectivity in Maine Atlantic salmon watersheds, indicating stream, km of juvenile salmon habitat access and watershed area, project area dimensions, and a description of the structure.

	Habitat Access		Project / New Structure		
Machias River Site	Stream (Km)	Watershed (ha)	Length (m)	Width (m)	Description
Machias River	0.81	na	0.0	0.0	Breach Lateral Boulder Wall
Grover Lake Tributary	1.61	0.34	na	3.4	Build Single Lane Bridge
Lanpher Brook	1.77	0.61	0.0	0.0	Decommission Crossing
Dead Stream	9.02	1.56	0.0	0.0	Decommission Crossing
Honeymoon Brook Tributary	0.81	0.11	0.0	0.0	Decommission Crossing
Unnamed tributary	1.05	0.07	0.0	0.0	Decommission Crossing
Upper Cranberry Lake Tributary	2.42	0.38	0.0	0.0	Decommission Crossing
Unnamed tributary	1.61	0.20	0.0	0.0	Decommission Crossing
5th Lake Machias	35.42	6.54	20.7	7.6	Install Open Arch
Unnamed tributary	1.47	0.36	na	1.8	Install Open Arch
Elwell Brook trib	0.43	0.23	15.3	2.1	Install Open Arch
Elwell Brook	0.77	0.22	15.3	2.1	Install Open Arch
Unnamed tributary	0.53	0.25	0.0	2.4	Install Open Arch
Lake Brook	0.71	0.18	13.4	2.4	Install Open Arch
Colson Brook	2.42	0.38	14.6	3.4	Install Open Arch
Unnamed tributary	0.47	0.05	12.2	1.8	Install Open Arch
Unnamed tributary	0.61	0.09	13.4	2.1	Install Open Arch
Old Strm Tributary	0.34	0.09	15.3	1.8	Install Open Arch
Old Strm Tributary	0.50	0.09	12.2	2.1	Install Open Arch
Tributary to 1st Lake	3.54	0.69	15.9	3.7	Install Open Arch
Lanpher Brook	2.66	0.69	16.5	4.6	Install Open Arch
4th Lake Outlet	0.74	0.14	20.7	3.0	Install Open Arch
Palmer Brook	1.35	0.35	14.6	3.7	Install Open Arch
Holmes Brook	14.49	1.99	18.3	6.1	Install Open Arch
Kerwin Brook	5.31	1.82	17.1	6.1	Install Open Arch
Unnamed tributary	0.63	0.11	11.0	1.8	Install Open Arch
Cranberry Lake Tributary	0.79	0.15		1.8	Install Open Arch
West Branch Machias	0.29	0.04	12.2	1.8	Install Open Arch
Unnamed tributary	0.42	0.04	12.2	1.5	Install Open Arch
Cranberry Lake Tributary	0.47	0.04	13.4	1.8	Install Open Arch
Unnamed tributary	0.50	0.09	11.0	1.8	Install Open Arch
Unnamed tributary	1.09	0.16	14.0	2.7	Install Open Arch
Lower Sabao Tributary	0.24	0.03	15.3	1.8	Install Open Arch
Thompson Brook	1.50	0.22	18.3	3.7	Install Open Arch
Thompson Brook	0.47	0.05	15.3	2.1	Install Open Arch
Sabeo Lake Tributary	1.21	0.20	na	3.4	Install Open Arch
Sabeo Lake Tributary	0.29	0.07	27.5	3.7	Install Open Arch
Lower Sabao Tributary	1.01	0.13	17.1	1.8	Install Open Arch
Humphrey Brook	2.25	0.30	18.9	3.7	Install Open Arch
Bowles Brook	8.05	1.82	0.0	0.0	Remove Remnant Dam
Kerwin Brook	5.31	1.82	0.0	0.0	Remove Remnant Dam
Fletcher Brook	6.60	1.82	0.0	0.0	Remove Remnant Dam

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6 Outer Bay of Fundy

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

6.1 Adult Returns

Aroostook River

Tinker Dam fish lift was from 16 July to 12 November, 2010 (see fish passage section for explanation); with a 2010 trap catch of 35 salmon that was almost twice the catch in 2009 (14 Atlantic salmon). Scale samples are not collected from salmon at the Tinker trap to determine age to minimize handling stress. Instead fish captured at Tinker are assigned to sea-age class (grilse or salmon) based on observed fork lengths or tags if present. Of the 35 fish captured in 2010 there were 18 grilse (≤ 63 cm), 13 multi-sea-winter salmon (> 63 cm), and 2 captive reared stocked adult bearing tags. The relationship between fish length and sea-age for St. John River salmon was developed from known age (scales) and length data collected by DFO scientists at the Mactaquac Dam.

St. Croix River

The research trap at Milltown on the St. Croix was operated 10 May to 19 July, 2010. No salmon were documented during that time period. After July, the trap was opened for free passage.

6.2 Hatchery Operations

Aroostook River

Atlantic Salmon for Northern Maine. Inc. (ASNM) owns and operates the Dug Brook Hatchery in Sheridan, Maine to produce Atlantic salmon fry for the Aroostook River. The hatchery relies on eyed salmon eggs from “St. John River strain” salmon spawned at the Mactaquac Biodiversity Facility. The eggs are tested in compliance with U.S.

Title 50 fish health criteria and then imported to Dug Brook Hatchery for hatching. Transfers in 2010 totaled 663,675 eyed eggs, all from captive reared broodstock held at the Mactaquac Biodiversity Facility in Frenchville, NB.

St. Croix River

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

6.3 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 525,397 non-feeding fry soon after hatching into the Aroostook River in accordance with BSRFH recommendations.

St. Croix River

There were no juvenile salmon stocked in the St. Croix River.

Adult Salmon Releases

Aroostook River

Although there were no adult releases into the Aroostook River, Department of Fisheries and Oceans has an adult release program for the St. John River that results in spawners entering the Aroostook River. In 2010, the two captive-reared adult that passed the Tinker fishway were probably collected as a smolt in the gatewells at Beechwood Dam and reared to maturity at the Mactaquac facility. There were 139 salmon (102 females 37 males) with that capture history released to 'free-swim' to their tributary of origin (i.e. Aroostook R., Salmon R., Tobique R.) from 17 August to 19 October (adipose clip + red or blue Floy tag).

St. Croix River

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

6.4 Juvenile Population Status

Electrofishing Surveys

Median relative abundances (fish /minute) at seven sites in the Aroostook River system ranged from 0 to 0.27 for parr and 1.81 to 4.02 for YOY (Table 6.4.1).

Table 6.4.1 Minimum (min), median, and maximum (max) relative abundance of large parr and YOY Atlantic salmon (fish/minute) based on timed single pass catch-per unit-effort (CPUE) sampling in the Aroostook River, 2010.

Life Stage	Min	Median	Max	n
PARR	0.00	0.00	0.27	7
YOY	1.81	2.87	4.02	7

Smolt Monitoring

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

Tagging

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

6.5 Fish Passage

Aroostook River

The Beechwood Dam fish lift (located downstream of the Tobique Narrows and Aroostook River) remained closed until 23 September, 2010. The shortened operating period likely reduced adult salmon abundance in the Aroostook River and other headwater tributaries. Department of Fisheries and Oceans, Canada (DFO) scientists, in consultation with law enforcement personnel and BSRFH scientists, opted to close the fishway, denying migrating salmon access to headwater tributaries until late

September to reduce salmon losses from rampant poaching and illegal gill nets near the Tobique Narrows (downstream of the Aroostook River). Delaying migration was thought to be less egregious than exposing salmon to the high risk of poaching. Unexpectedly high flows and flooding forced the closure of the Beechwood fish lift a week after it opened (2 October) and it could not be re-opened until 18 days later (19 October). In 2010, 70% of the 1,688 adults released below the Beechwood Dam failed to pass that dam and gain access to the Aroostook River and other upriver tributaries. Returning to full season fish passage and functional free-swim capability for migrating salmon is a high priority for BSRFH and DFO; and DFO is working to increase enforcement protecting migrating salmon in 2011.

Before 23 September, 2010 salmon captured at the head of tide (Macatquac Dam) and identifiable as Tobique River fish (i.e. returns from marked hatchery smolts cohorts) were trucked around the closed fishway and the poaching zone and released in the Tobique River. Because it was possible that some of these fish would drop downriver and stray into the Aroostook River, the Tinker Dam fish lift was from 16 July to 12 November, 2010. The Tinker fish lift was shut down for 32 days from 9 August to 11 September for annual turbine maintenance. DMR staff continue to work with DFO staff and Algonquin Power Company (operators of the Tinker Dam) to find alternatives to prolonged annual closures of the Tinker fish lift during salmon migration.

St. Croix River

In August of 2010, the ad hoc group assembled by the inter-agency St. Croix Fisheries Steering Committee presented an adaptive management plan for restoring alewives to the St. Croix system to the St Croix Watershed Board of the International Joint Commission and to a public information meeting. After an extended comment period, the International St. Croix River Watershed Board forwarded the plan and options for action to the International Joint Commission. The International Joint Commission is currently reviewing the options presented relative to re-open all of the St. Croix's boundary dam fishways to alewife passage under the terms of the 1909 Boundary Waters Treaty.

6.6 Genetics

No genetics samples were collected in 2010.

6.7 General Program Information

6.8 Migratory Fish Habitat Enhancement and Conservation

Connectivity

One culvert within the St Croix watershed was replaced with a bottomless arch (Table 6.8.1). The primary goals of replacement projects are to restore aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment) through the crossing.

Table 6.8.1 Projects restoring stream connectivity in Outer Bay of Fundy Atlantic salmon watersheds, indicating stream, type of work, structure, and km of juvenile salmon habitat upstream.

Subwatershed (HUC 12)	Project (width m)	Long. DD	Lat. DD	Habitat Opened (km)
Little Musquash	Open Arch (3.9)	67.8278	45.0817	1.3

7 Terms of Reference and Emerging Issues in New England Salmon

To be proactive to requests from ICES and NASCO, this section is developed to report on and bring into focus emerging issues and terms of reference beyond scope of stock assessment typically included in earlier sections. The purpose of this section is to provide some additional overview of information presented or developed at the meeting that identifies emerging issues or new science or management activities important to Atlantic salmon in New England. These sections review highlighted working papers and the ensuing discussions to provide information on emerging issues.

The focus topics identified at this meeting were: 7.1) renewable energy development; 7.2) Parr Subsidy of Hatchery Return Rates, Penobscot River, Maine; 7.3) Regional Assessment Product Progress Update; and 7.4) draft terms of reference for next year's meeting are included.

7.1 Renewable Energy Changes

The potential of renewable energy has received great attention throughout New England. This interest has resulted in entrepreneurs starting to develop proposals for offshore wind, tidal power, and small hydroelectric. Salmon managers have been dealing with river-based hydroelectric projects and land-based riverine and coastal development for decades. This new wave of renewable resource development presents new challenges because diverse estuary and marine habitats are involved in these proposals. To provide some context related to renewable energy projects, managers in Maine are processing 15 FERC riverine hydroelectric projects, 5 tidal energy projects, and 1 off-shore wind project as of March 2011. Two to three years prior, there were only riverine proposals. Managers' project that, for new proposals, numbers are likely to be similar overall with expanded tidal and wind proposals coming forward. To provide perspective on project level planning and research needs, we reference a tidal energy project in Cobscook Bay, Maine. The following narrative illustrates information needs and efforts needed to understand potential impacts and manage living marine resources in these areas. It also highlights the fact that little information is available for New England estuaries and the need for this information is essential and time sensitive.

With the development of any power source, sustainable development attempts to balance natural resources impacts within the deployment area and at a broader ecosystem spatial scale. The estimated environmental risks involved with tidal energy depend mainly on design, size, and deployment method. In the Cobscook Bay project, a risk involved with tidal energy is the possibility that marine vertebrates physically encounter the turbines used to capture the energy from the tides. Vertebrates, e.g., fish and seals, could be struck by blades and suffer injury or death. For this reason, observations of what animals may be found within the assumed strike range of the turbine blades and general area should be made. Ongoing studies use two different types of hydroacoustic devices to record the vertical distribution of fishes at proposed turbine deployment sites and control sites in outer Cobscook Bay and lower Passamaquody Bay on seasonal, daily, and tidal time scales. Hydroacoustic data does not give fish species identification so acoustic targets that are recorded using hydroacoustic equipment need to be confirmed to ensure the validity of this type of observation. To achieve this, a comparison of species composition and relative abundance of catches in active capture gear with fish target distributions observed in hydroacoustic monitoring is needed. Federal and state managers have strongly recommended active fish sampling in association with hydroacoustic surveys.

At the ecosystem scale, there are no published studies of the fish community in Cobscook Bay; we are unaware of any unpublished data for the bay. Two studies of fish species composition and relative abundance near the bottom in lower Passamaquoddy Bay are dated – 1971 and 1984. Ocean Renewable Power Company's (ORPC) first deployments were planned for Cobscook Bay in 2010. To understand modern fish distribution, the investigators proposed bay-wide sampling of fishes by trawl-netting in mid-water and near bottom in open areas and beach seining and/or fyke netting in shallow sub-tidal and intertidal areas.

Overall goal at deployment scale: determine species composition and relative abundance of pelagic fishes in outer Cobscook Bay (and possibly Western Passage in lower Passamaquoddy Bay) during spring and summer when fishes are most abundant for comparison with concurrent hydroacoustic data. Specific assessment objectives were: 1) determine fish-species composition at proposed turbine deployment and control sites; 2) estimate the flux of fishes by species past proposed deployment and control sites by depth and at depth of proposed turbines and deployment structures and 3) estimate the flux of fishes by a turbine and its structure once a turbine is deployed.

Overall goal at ecosystem scale: develop a comprehensive understanding of the summer community of fishes in various habitats throughout Cobscook Bay. Specific objectives here are: 1) determine the species composition and relative abundance of fishes in the open-water pelagic and benthic areas, near-shore sub-tidal areas, and intertidal areas of outer, middle, and inner bays that together comprise Cobscook Bay; 2) determine the temporal and spatial characteristics of the composition and abundance over the summer months; 3) determine metrics of species diversity and evenness overall, by habitat, and by sub-bay; and 4) determine abundance-biomass curves by habitat as an indicator of stress on the ecosystem. Sampling to capture fishes will occur in May, June, August and September of 2011-2013. Other months may be added to meet specific needs or requests.

The preceding study overview outlines some of the data needs and approaches that marine scientists will have to provide marine managers. These data gaps will need to be filled and collaborative work in nearby systems or with similar technological project scopes, should be combined in increase information gains on these ecosystems. Marine spatial planning needs will be increasing and the impacts of these projects on Atlantic salmon and their estuarine and coastal ecosystems will need to be addressed. We thank, Gayle B. Zydlewski of the

University of Maine School of Marine Sciences for sharing a synopsis of her work so we could demonstrate a project-specific approach.

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

Atlantic salmon parr are stocked each fall as a byproduct of the U.S. Fish and Wildlife Service's Green Lake National Fish Hatchery's (GLNFH) yearling smolt program. These fall parr constitute 24 – 42% of advanced juvenile hatchery products (parr and smolts) stocked in the Penobscot River, Maine. Between 2002 and 2007, 33% of all fall parr stocked were marked and in 2008, 60% were marked (Table 7.2.1). Approximately, 70% of all smolts stocked were also unmarked. Past calculations of return rates have attributed all unmarked hatchery returns to smolt stocking (Table 7.2.2). This was under an assumption of negligible contributions of fall parr to adult returns. This assumption is violated and recent information indicated that the contribution of unmarked fall parr to hatchery returns overestimates the smolt to adult return rate.

Prior to 2006, marked hatchery smolts were stocked in conjunction with the unmarked smolts. Thus, the smolt-to-adult return rates of the marked groups should be similar to the unmarked group. Starting in 2006, the marked smolts were stocked lower in the drainage than the unmarked smolts and all at the same location, so their return rate is not representative of all hatchery smolts. It is expected that smolts stocked lower in the drainage would experience less dam related mortality and thus have a greater return rate. However, return rates from marked smolt cohorts, stock throughout the drainage (years 2002 to 2005) are lower than return rates from unmarked smolt stocked throughout the drainage. In addition, return rates from marked smolt cohorts, stocked lower in the drainage (year 2006 to 2008), are lower than return rates from unmarked smolt, stocked higher in the drainage. One explanation for the apparent differential survival is the misclassification of the unmarked parr to the hatchery smolt return rate.

Based on a recent fall parr marking efforts, the median parr-to-adult return rate is 0.043% and produced 16 to 54 adults per year. Of the adult returns, 62 to 98% (median, 83%) emigrated after one winter in freshwater. Although this management action was not intended to evaluate all adult contributions from fall parr, it does suggest that adult returns from unmarked fall parr are not negligible and efforts should be made to measure their contributions.

The returns of marked parr represent only one specific hatchery product and stocking location, and are not representative of all parr stocked. In the past, fall parr stocked fish were primarily a graded product - a selective sorter was used to passively grade fish. Larger fish were retained for additional hatchery rearing and stocking the following spring as 1+ smolts. Smaller fish were stocked in September at age 0+ as fall parr. However, the grading practice is contingent on many factors and can vary from year to year. As a result, the size distribution of fall parr currently released into the Penobscot River differs annually. These differences mean that fall parr products represent variable products not a uniform product similar to 1+ smolts.

The current fall parr grading procedure is based on the goal of producing 550,000 one year smolts. If mortality from eyed egg to grading is consistent with average historic mortality rates (13%), 980,000 eyed eggs are needed to meet this goal. This number accounts for mortality and a 35% parr grade-off, leaving approximately 65% which meet the size requirements for spring smolt production. A size 7/16" (11 mm) grader is used to separate the fish into this 65/35 split when fish are approximately 22 fish/lb (48/kg). This is the ideal situation. If mortality or initial egg numbers received fall outside of this parameter (more or less), the procedure may change to enable Green Lake National Fish Hatchery to achieve a 550,000 smolt production target. A smaller 3/8" (9.5 mm) or larger 1/2" (12.7 mm) grader may need to be used to keep more or less fish. If the 9.5 mm grader is used to hold back more fish in the pools, the number and size of the fall parr being released will decrease. If the larger 12.7 mm grader is used to retain only the largest fish, the number and size of the fall parr being marked will increase.

The size and stocking location influences life history characteristics of the parr, subsequent age at migration, and return rates. For example, in years when a 12.7 mm grader was used, we would expect the parr subsidy to be greater. This is because the larger "parr" tend to emigrate after spending one winter in freshwater, resulting in a scale pattern that is difficult to distinguish from a spring one year smolt. In an effort to understand the contribution of fall parr stockings to adult returns and to assess management, all fall parr have been marked since 2009 (Table 7.2.1). The fall parr marking program is expected to continue until 2014. Enumeration of returning adults from parr stocking during this perios will provide baseline standards for use in allocating unmarked fish and understanding the dynamics of overall hatchery production.

Table 7.2.1. Number of hatchery reared Atlantic salmon parr marked and stocked in the Penobscot River, Maine, since 2002.

Stocking Year	Number of parr stocked	Number of parr marked	Percentage marked
2002	396,738	100,684	25.4
2003	320,700	101,333	31.6
2004	369,182	159,746	43.3
2005	295,353	97,493	33.0
2006	293,500	100,541	34.3
2007	337,755	105,577	31.3
2008	216,623	130,561	60.3
2009	172,235	172,235	100.0
2010	258,800	258,800	100.0

Table 7.2.2. Adult return rates of hatchery smolts (marked + unmarked), marked smolts, and unmarked smolts for the Penobscot River, Maine, since 2002. From 2002 to 2005, the stocking of marked smolts was integrated with the unmarked smolts. Since 2006 to 2008, the marked smolts were stocked lower in the drainage than unmarked smolts.

Smolt Year	Hatchery smolt Return Rate	Marked Smolt Return Rate	Unmarked smolt Returns Rate
2002	0.210%	0.171%	0.228%
2003	0.174%	0.138%	0.201%
2004	0.163%	0.130%	0.187%
2005	0.172%	0.171%	0.184%
2006	0.277%	0.242%	0.305%
2007	0.428%	0.358%	0.464%
2008	0.196%	0.162%	0.216%

7.3 USASAC Regional Assessment Product Progress Update

The USASC moved forward on improving and enhancing assessment products. As noted last year, the USASAC felt that this large undertaking should be accomplished over the course of several intercession meetings. Intercession meetings were limited in 2010 but some forward progress was made especially on recovery metrics for Gulf of Maine DPS that can be used throughout New England. In addition, the structure of the 2011 meeting was such that it was a working meeting and some enhancements to regional assessment were done at the meeting. USASAC suggested that this annual meeting format continue and that the Chair should follow-up with leads of terms-of-reference during summer to encourage intercession meetings to accelerate this effort. Some considerations that the USASAC believed were essential moving forward were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New England and NASCO managers for US data, and 3) making sure that as more data is developed and analyzed it was utilized as a tool to rebuild Atlantic salmon stocks. To this last point, the USASAC recognizes they need to provide core stock assessment information (provide a yardstick of progress) but understands the need to better communicate information to managers as opportunities and threats are recognized (provide rebuilding tools).

7.4 USASAC Draft Terms of Reference 2011

The purpose of this section is to outline potential terms of reference identified at the USASAC annual meeting in March and to start an outline for refinement at our summer teleconference tentatively schedules for 21 June 2011 at 10AM.

1) Anticipated ICES Requests (TOR document pending)
    a. Marine Survival – return rates (rr), returns etc.
        i. Redd-based coastal rivers estimate (Kocik-Lipsky)
        ii. Smolt rr for NG, PN, CT, and MR (Kocik, McMenamy)
            1. age-structured adult return numbers (add 1SW and 3SW)
        iii. Fry rr for LIS, CNE, GoM, BoF (Sweka, Trial, Smithwood) - continuing work on fry equivalents (FE) see below

2) Fry Equivalents - Return Rates for Atlantic salmon stocked as Fry – (**Sweka**, Trial, Smithwood, Bailey, Kocik) Meeting by July 2011
    a. In 2010 Maine fry stocking data was added

   b. Need to develop a redd-based and escapement-based adjustment to account for wild contribution (based on redds and adult stocking) to supplement fry stocking – discount rate
   c. Standardizing Return Rates - returns per 10K fry, standardize for various stocking stages and for areas with natural production (set discount/subsidy rates). Refine goal from USASAC perspective – a regional one compared to needs of USFWS Maine program.

3) Conservation Spawning Escapement Update – 2012 working paper (**Trial**, Kocik, Sweka: Wright, regionally Atkinson (BoF, GoM, CNE); Bailey/Smithwood (CNE), Sprankle (LIS) Meeting by July 2011
   a. revisit and update CSE estimated with revised habitat estimates and recovery regions
   b. develop working paper to document current state of knowledge and document methods
   c. Examine New England productivity and use Legault (2005) as background to determine equilibrium baselines

4) Fish Health – Update on Status of Biosecurity Improvements in New England (**Firmenich** and Bean)
   a. Organize Session with all New England salmon hatchery managers (Fed, State, Private) at future meeting
   b. Update on emerging disease threats
   c. Status of Sea Lice and their control in New England

5) Smolt Parr-Subsidy Issue- core study on accelerated growth fish in Penobscot - update on analysis and data (**Cox**, Firmenich, Flanery, Domina, Lipsky).

6) Regional Juvenile Index and Random sampling Designs –2012 working paper (**Sweka**, Cox, Ardren, Atkinson, Christman, McMenemy, Smithwood)
   a. Continue to examine approaches to use CPUE and M-R sites in a composite continue work on broad regional index – look at trends and take into account density and total production (stocked/seeded) area
   b. Report on progress in GoM DPS, West River in LIS

7) Redd-Based Estimate Benchmark 2010 Revision Working Paper in 2012 – (**Lipsky**, Kocik, Atkinson,
   a. Goal written document outlining 2010 benchmark and interim improvments
   b. In 2012, move Union River and other rivers to this metric to create Coastal River Estimate
   c. Discuss in paper strategy to work on spatial scale for <100% survey given spawner distribution

d. Document fishway issues in the Narraguagus and role of high flows, next steps for moving forward. Next benchmark 2015 – move forward on spatial coverage adjustments and saturation index, scholarly paper looking at old data

8) New England Smolt Summary Benchmark Year 2011Working Paper – (**Hawkes**, Lipsky, Sheehan (ICES), Sprankle, Smithwood)
   a. Summarize population estimates, run timing, smolt age and other biocharacteristics
   b. Add smolt tables into USASAC dbase and paper – Narraguagus, CT Farmington and Mainstem smolt estimate to USASC database

9) Emerging Issues Identified Intercession or at Annual Meeting

8 Meeting Overview and Appendices

8.1 List of Attendees

First Name	Last Name	Primary Email	Agency	Location
Alex	Abbott	alexoabbot@hotmail.com	FWS	Falmouth, ME
Bill	Ardren	william_ardren@fws.gov	FWS	Essex Junction, VT
Ernie	Atkinson	Ernie.Atkinson@maine.gov	ME	Jonesboro, ME
Michael	Bailey	Michael_Bailey@fws.gov	FWS	Nashua, NH
Sebastian	Belle	maineaqua@aol.com	MAA	Hallowell, ME
Denise	Buckley	denise_buckley@fws.gov	FWS	Orland, ME
Carrie	Byron	cbyron@gmri.org	GMRI	Portland, ME
Mary	Colligan	Mary.A.Colligan@noaa.gov	NOAA	Gloucester, MA
Oliver	Cox	Oliver.N.Cox@maine.gov	ME	Bangor, ME
Chris	Domina	chris_domina@fws.gov	FWS	Orland, ME
Anitra	Firmenich	Anitra_Firmenich@fws.gov	FWS	Orland, ME
Kyle	Flanery	Kyle_Flanery@fws.gov	FWS	Nashua, NH
John	Kocik	John.Kocik@noaa.gov	NOAA	Orono, ME
Tara	Lake	Tara.Trinko@noaa.gov	NOAA	Orono, ME
Peter	Lamothe	peter.lamothe@maine.gov	ME	Hallowell, ME
Christine	Lipsky	Christine.Lipsky@noaa.gov	NOAA	Orono, ME
Joe	McKeon	Joe_McKeon@fws.gov	FWS	Nashua, NH
Jay	McMenemy	jay.mcmenemy@state.vt.us	VT	Springfield, VT
Kathy	Mills	kmills@gmri.org	GMRI	Portland, 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
Charles	Soucy	Charles_Soucy@fws.gov	FWS	Falmouth, ME
Ken	Sprankle	ken_sprankle@fws.gov	FWS	Sunderland, MA
John	Sweka	John_Sweka@fws.gov	FWS	Lamar, PA
Joan	Trial	Joan.Trial@maine.gov	ME	Bangor, ME
Jed	Wright	jed_wright@fws.gov	FWS	Falmouth, ME

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

Number	Authors	E-mail Address	Title
PS11-01	Jay McMenemy	jay.mcmenemy@state.vt.us	Connecticut River Update (PPT)
PS11-02	Joe McKeon	Joe_McKeon@fws.gov	Merrimack River Update (PPT)
PS11-03	Joan Trial	Joan.Trial@maine.gov	Maine Rivers Update (PPT)
WP11-01	Tim Sheehan	Tim.Sheehan@noaa.gov	ICES Working Group on North Atlantic Salmon Summary 2010 (PPT)
WP11-02	Rory Saunders	Rory.Saunders@noaa.gov	NASCO: 2010 Highlights and 2011 Key Issues (PPT)
WP11-03	Rory Saunders	Rory.Saunders@noaa.gov	Evaluating the ecological effects of the Penobscot River Restoration Project (PPT)
WP11-04	Christine Lipsky, Rory Saunders	Christine.Lipsky@noaa.gov	Penobscot Estuarine Fish Community and Ecosystem Survey (PPT)
WP11-05	Paul Christman	Paul.Christman@maine.gov	Kennebec River Egg Planting (WP, PPT)
WP11-06	Christine Lipsky, James Hawkes, Ruth Haas-Castro, Oliver Cox, Peter Ruksznis, Mitch Simpson, Randy Spencer, Colby Bruchs, Joan Trial	Christine.Lipsky@noaa.gov	Maine Smolts Update 2010 (WP)

WP11-07	Jim Hawkes, Graham Goulette, John Kocik	James.Hawkes@noaa.gov	Maine Telemetry Update 2010 (WP)
WP11-08	Graham Goulette, James Hawkes	Graham.Goulette@noaa.gov	Maine Water Quality Update 2010 (WP)
WP11-09	Dave Bean, Jon Lewis, Marcy Nelson	David.Bean@noaa.gov	Maine and Neighboring Canadian Commercial Aquaculture Activities and Production (WP)
WP11-10	Paul Music, John Kocik, James Hawkes, Graham Goulette	Paul.Music@noaa.gov	NOAA Fisheries Northeast Fisheries Science Center Acoustic Telemetry Platforms of Opportunity Overview (WP)

8.3 Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Bureau of Sea Run Fisheries and Habitat	BSRFH
Central New England Fisheries Resource Office	CNEFRO
Connecticut River Atlantic Salmon Association	CRASA
Connecticut Department of Environmental Protection	CTDEP
Connecticut River Atlantic Salmon Commission	CRASC
Craig Brook National Fish Hatchery	CBNFH
Decorative Specialities International	DSI
Developmental Index	DI
Dwight D. Eisenhower National Fish Hatchery	DDENFH
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 Aquaculture Association	MAA
Maine Atlantic Salmon Commission	MASC
Maine Department of Marine Resources	MDMR
Maine Department of Transportation	MDOT
Massachusetts Division of Fisheries and Wildlife	MAFW

Massachusetts Division of Marine Fisheries	MAMF
Nashua National Fish Hatchery	NNFH
National Academy of Sciences	NAS
National Hydrologic Dataset	NHD
National Oceanic and Atmospheric Administration	NOAA
National Marine Fisheries Service	NMFS
New England Atlantic Salmon Committee	NEASC
New Hampshire Fish and Game Department	NHFG
New Hampshire River Restoration Task Force	NHRRTF
North Atlantic Salmon Conservation Organization	NASCO
North Attleboro National Fish Hatchery	NANFH
Northeast Fisheries Science Center	NEFSC
Northeast Utilities Service Company	NUSCO
Passive Integrated Transponder	PIT
PG&E National Energy Group	PGE
Pittsford National Fish Hatchery	PNFH
Power Point, Microsoft	PPT
Public Service of New Hampshire	PSNH
Rhode Island Division of Fish and Wildlife	RIFW
Richard Cronin National Salmon Station	RCNSS
Roger Reed State Fish Hatchery	RRSFH
Roxbury Fish Culture Station	RFCS
Salmon Swimbladder Sarcoma Virus	SSSV
Silvio O. Conte National Fish and Wildlife Refuge	SOCNFWR
Southern New Hampshire Hydroelectric Development Corp	SNHHDC

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

8.4 Glossary of Definitions

GENERAL

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

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

LIFE HISTORY RELATED

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

Parr 8	Parr stocked at age 0 that migrate as 1 Smolts (8 months spent in freshwater).
Parr 20	Parr stocked at age 0 that migrate as 2 Smolts (20 months spent in freshwater).
Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
1 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	The period from July 1 to December 31 of the year the salmon became a smolt.
1SW Smolt	A salmon that survives past December 31 since becoming a smolt.
Grilse	A one-sea-winter (SW) salmon that returns to the river to spawn. These fish usually weigh less than five pounds.
Multi-Sea-Winter Salmon	All adult salmon, excluding grilse that return to the river to spawn. Includes terms such as two-sea-winter salmon, three-sea-winter salmon, and repeat spawners. May also be referred to as large salmon.

2SW Salmon	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 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.

8.5 Abstracts

8.5.1 CRASC Connecticut River Research Forum (2011) Program Abstracts

Can Alternative Management of the Striped Bass Fishery in the Connecticut River Help Conserve Blueback Herring?

Justin Davis[1], Eric Schultz[1], Jason Vokoun[2]

[1]Department of Ecology and Evolutionary Biology
[2]Department of Natural Resources and the Environment
University of Connecticut, Storrs CT

Corresponding Author:
Justin Davis
209 Hebron Road
Marlborough, CT 06447
justin.davis@ct.gov

Abstract. - In the Connecticut River, annual returns of anadromous blueback herring (*Alosa aestivalis*) have drastically declined in the last two decades. Increased seasonal presence of striped bass over this period suggests that heavy in-river predation on adult blueback herring may be a contributing factor. If striped bass predation is depressing blueback herring production, then alternative management of in-river striped bass fisheries (e.g. regulations that encourage increased harvest) may facilitate blueback herring recovery. To quantitatively test these hypotheses, we conducted a five-year research program focused on striped bass populations and fisheries in the "upper" Connecticut River (river stretch from Hartford, CT to Holyoke, MA). This program entailed three years of spring-time boat electrofishing surveys (2005-07), one year of intensive mark-recapture sampling (2008), and a two-year creel survey of the Connecticut portion of the river (2008-09). Here we use information on striped bass abundance, size structure, consumption rates, and recreational catch to estimate population-level consumption of blueback herring and to assess the potential for mitigation of predation mortality via increased striped bass harvest. Population-level consumption of blueback herring in the upper Connecticut River was modeled as a simple product of striped bass population size, per-capita daily consumption rates, and in-river residence time. The consumption model was size-structured to incorporate observed predator size-dependency in striped bass predation on blueback herring. A Monte Carlo approach was used to quantify uncertainty associated with population-level consumption estimates. Consumption estimates were compared to estimates of in-river blueback herring abundance derived from the literature and our own sampling to assess natural mortality rates attributable to in-river striped bass predation. Several potential regulatory scenarios resulting from transfer of Connecticut's unused commercial striped bass quota to a special recreational harvest program in the upper Connecticut River were assessed for their potential to reduce blueback herring mortality.

Report on the Future Sustainability of Connecticut River Shad Under the Current In-River Commercial and Recreational Fisheries

Jacque Benway

CTDEP, Marine Fisheries, Old Lyme, CT
Email: jacque.benway@ct.gov

Abstract. - Amendment 3 to the ASMFC Interstate Fishery Management Plan for American shad requires coast-wide commercial and recreational moratoriums by 2013 in all waters, allowing only catch and release recreational fisheries. To remain open, States or jurisdictions must submit a sustainability plan for approval which demonstrates the fishery(ies) will not diminish potential future stock reproduction or recruitment. We present Connecticut River shad data and environmental parameters which were used to model populations. A regionally calculated mortality index (Z30 = 0.98) recommended for New England stocks is a combination of a F value of 0.60 and a M value of 0.38 (ASMFC 2007). The Connecticut River American shad stock size declined by 50% since the mid-1990's, but fishing effort and catch steadily decreased while natural mortality systematically increased. Fishing mortality rates calculated for the times series (1966-2008) did not approach or exceed the 0.60 overfishing value. In contrast, the natural mortality benchmark of 0.38 was exceeded every year. The systematic increase in M, and thus Z was correlated to predator abundance and post-spawning mortality. Simulation modeling exercises demonstrate that a shad fishery moratorium will provide little if any leverage for stock rebuilding.

Status of river herring bycatch at sea and possible management regulatory measures

Jamie Marie Cournane, PhD

Environmental Defense Fund Post-doctoral Researcher
Institute for the Study of Earth, Oceans, and Space
Ocean Process and Analysis Laboratory/Morse Hall 106
University of New Hampshire
8 College Road
Durham, NH 03824
603-978-2121
Jamie.Cournane@unh.edu

Abstract. - River herring undertake extensive migrations during which they encounter numerous impacts in riverine, estuarine, and oceanic habitat. All of these impacts need to be monitored, managed, and ultimately mitigated in a comprehensive restoration strategy. Declines in many river herring runs, despite restoration and management

efforts in rivers, suggest that impacts during their ocean phase might be a factor. Bycatch in ocean fisheries is known to occur, but has received little attention to date.

This research evaluates the time and areas that river herring bycatch has occurred in the directed Atlantic herring fishery. Additionally, I will review the possible management regulatory measures being developed by the New England Fishery Management Council to address river herring bycatch in the Atlantic herring fishery.

Creating Alternative Operating Policies for the Connecticut River

Richard Palmer(1), Kim Lutz(2)

Affiliation: University of Massachusetts (1), The Nature Conservancy (2)
Mailing address: 1) Department Head and Professor,Civil and Environmental Engineering, 222 Marston Hall, University of Massachusetts, 130 Natural Resources Road, Amherst, MA 01003-9293 and 2) The Nature Conservancy, 25 Main Street, Suite 220, Northampton, MA 01060
Email: 1) palmer@ecs.umass.edu and 2) klutz@tnc.org

***Abstract*.** - Dams, and the waters they store, serve many purposes throughout the U.S. Conflicts over the use of such facilities are well documented in the news. Recent, highly reported battles include conflicts over: hydropower and endangered species in the Pacific Northwest; U.S. and Mexico's clashes over irrigation water in the both the Colorado and Rio Grande; drinking water, irrigation water and environmental flows in the California; and water wars in the southeast between the states of Georgia, Florida and Alabama. In many of these conflicts computer models have been used to illustrate the potential range of options in managing water resources.
This paper presents the results of a joint effort between the Nature Conservancy, the USGS, the US Army Corps of Engineers and the University of Massachusetts Amherst to create a decision support system to minimize the conflicts that arise in the Connecticut River, identify opportunities to improve the flows in the river system to meet environmental and habitat concerns, maintain existing functions of the river, that include water supply, flood control, and hydropower production, and to engage stakeholders throughout the process. The decision support system combines both a simulation model and an optimization model to identify operational opportunities, test the feasibility of new operating procedures and to evaluate the potential impacts of climate change on the system. There is a significant need for an integrated, decision support system because the Connecticut River flows through four states (Connecticut, Massachusetts, Vermont, and New Hampshire), contains over 70 major dams (and over 1,000 documented dams), and operational changes may impact many users.
This paper begins with a characterization of the Connecticut River and its major facilities. It then describes both the optimization and simulation models created to evaluate the system. The paper presents existing trade-offs between management policies that emphasize specific uses. It concludes with a discussion of the likely impacts of climate change on the system and ways in which the planning models can be used to minimize conflicts within the basin.

Update of Fish Health Activities Associated with Atlantic salmon Restoration Programs in the Northeast

Patricia Barbash,

USFWS, Fish Health Center, P.O. Box 155, Lamar, PA
Patricia_barbash@fws.gov

Abstract. - The USFWS, Lamar Fish Health Center (FHC) has been focusing on several surveillance activities associated with fish pathogens which have posed a significant risk to programs involved in the restoration of Atlantic salmon in the Northeastern United States.

Infectious salmon anemia virus ISAV) has been considered a significant threat to cultured Atlantic salmon in the Northeastern Atlantic region, and hence to programs involving wild ATS as well since the late 1990's. ISAV is an Orthomyxovirus first diagnosed in Norway in 1984, and has since been detected in virtually every country worldwide that produces ATS. The FHC began non-lethal surveillance for the virus in wild Atlantic salmon captive broodstock, starting with Penobscot River sea runs in 2000. Using molecular detection techniques (polymerase chain reaction – PCR), ISAV was detected in a blood sample from one of 68 fish tested in 2001, but the virus was not successfully cultured and sequence analysis determined that it was not the same strain afflicting the aquaculture industry in Canada and Maine at the time. The FHC has continued to screen for ISAV in all captive sea runs to the Penobscot, Connecticut and Merrimack Rivers since that time. In 2009, we employed a more sensitive, quantitative PCR, which began detecting very low levels of viral RNA in blood samples collected from the Penobscot and Merrimack Rivers. Sequence analysis has determined that the detections are of a non-pathogenic genotype of ISAV referred to as HPRO. Details and management implications will be discussed.

Infectious pancreatic necrosis virus (IPNV) is a Birnavirus with worldwide distribution. Although more commonly diagnosed from cultured and wild salmonids, IPNV has been detected from non-salmonid fishes and can be carried by invertebrate species as well as in the GI tract of birds that feed on infected animals. IPNV was detected from ovarian fluid samples collected during spawning of Connecticut River sea runs in 2007. Most likely, the sea runs were exposed in the wild, and follow-up sampling indicated that there was very little horizontal transmission to other salmon during captivity. However, IPNV poses a significant risk of vertical transmission, where progeny that are infected by the parents suffer mortality during the fry and fingerling stages of development. In order to eliminate the risk of contaminating fish culture facilities which receive and incubate eggs from sea run broodstock, all eggs produced from the 2009 Connecticut River sea runs were destroyed. Management and biosecurity procedures employed following this detection will be discussed.

During the thorough follow-up sampling of the 2009 Connecticut River sea runs infected with IPNV, histological sections made from various organs of each fish revealed the presence of an internal fungal parasite. *Ichthiophonus* species has a wide geographical

and host distribution, and infects blood-rich organs including the heart, kidney and spleen. Earlier fish culture activities that employed unpasteurized fish products in home-made broodstock diets were believed to have lead to *Ichthiophnus* infections at some salmonids facilities. The Lamar FHC has been closely monitoring the occurrence of this parasite in heart tissues of sea run and kelt mortalities originating from the Connecticut and Merrimack Rivers. Findings and potential health effects will be discussed.

Genetic monitoring of Connecticut River Atlantic salmon broodstock at Richard Cronin National Salmon Station

Meredith Bartron, Shannon Julian, and Jeff Kalie

USFWS Northeast Fishery Center
P.O. Box 75, 227 Washington Ave., Lamar, PA 16848, ph: 570-726-4995 x 155, fax: 570-726-3255, Meredith_Bartron@fws.gov

Abstract. - Genetic monitoring of small populations bred in captivity is an important component to long-term preservation of genetic diversity. The number of sea-run adults to the Connecticut River spawned as part of the broodstock program ranged from 40 to 127 between 2008 and 2010. The number of spawning broodstock has remained consistently low in the Connecticut River following the end of stocking salmon from outside of the basin, increasing the risk of decreased genetic diversity and increased potential for inbreeding within the system. To offset the genetic risk of a reduced number of breeders in a given year, precocious male parr are included into the broodstock. Genetic assessment of estimates of genetic variation, inbreeding, and evaluation of the genetic contribution of parr to the broodstock are conducted annually. The number of alleles (allelic richness estimates) present in the Connecticut River sea-run returns between 2008 and 2010 ranged from 9.97 to 10.24, and from 10.01 to 10.26 for the parr spawned in 2008 and 2009. In comparison, the allelic richness estimate for the Penobscot River 2010 sea run returns was 9.71. Average observed heterozygosity for the Connecticut River sea-run returning adults ranged from 0.684-0.706 which was similar to the observed heterozygosity for the parr and for the Penobscot River population, and did not significantly differ from the expected heterozygosity. Likely, intensive management to select spawning pairs and the use of parr to increase the number of breeders has helped to maintain allelic variability within the Connecticut River.

Evaluation of hypotheses for describing temporal trends in Atlantic salmon parr densities in Northeast U.S. Rivers

Tyler Wagner[1] and John A. Sweka[2*]

[1]United States Geological Survey, Pennsylvania Cooperative Fish & Wildlife Research Unit, Pennsylvania State University, 402 Forest Resources Building, University Park, Pennsylvania 16802, United States of America, txw19@psu.edu

[2]United States Fish and Wildlife Service, Northeast Fishery Center, Post Office Box 75, 308 Washington Avenue., Lamar, Pennsylvania 16848, United States of America, John_Sweka@fws.gov

Abstract. - Atlantic salmon *Salmo salar* in the USA have declined dramatically and persistence is heavily dependent upon stocking juvenile fish, predominantly fry. The success of stocking hatchery fry is evaluated annually throughout New England by electrofishing surveys targeting age -1 parr. The objective of this study was to examine temporal trends in Atlantic salmon parr densities throughout New England and determine how trends vary among river basins. We fit generalized additive mixed models to investigate potential linear and nonlinear temporal trends in parr density. Akaike's Information Criterion was used to evaluate competing hypotheses about how temporal trends vary regionally. The top-ranked model suggested two types of trends. The first type, (the Penobscot River) showed a nonlinear trend where parr densities increased until the 1990s and then rapidly decreased to the present time. The second type (all other rivers) showed a linear decrease throughout the time series. Parr density trends reflected trends in spawning escapement for each river group. We conclude that fry stocking has not been able to overcome the decrease in spawning escapement in altered stream ecosystems in New England and additional management strategies should be considered.

Variation in freshwater Atlantic salmon survival among rivers: timing, body size and extent

Ben Letcher[1], Krzysztof Sakrejda-Leavitt[3], Keith Nislow[2], Doug Sigourney[1], Gregg Horton[1]

Affiliation: USGS Conte Anadromous Fish Research Center, USFS Northern Research Station[2], Organismic and Evolutionary Biology, UMass – Amherst[3]
Mailing address: Conte Anadromous Fish Research Center, 1 Migratory Way, Turners Falls, MA 01376, email: ben_letcher@usgs.gov

Abstract. - Understanding how and why freshwater survival differs among rivers can help identify focus areas for management. We conducted detailed PIT tag studies in four rivers to provide data to identify the range of variation in seasonal and size-dependent survival. The four study rivers spanned a spatial range from MA to New Brunswick, CA and ranged in duration from two years to ten years. We tagged over

12,000 individuals during the course of the four studies. We used new hierarchical survival estimation models to accommodate unequal sampling intervals and study lengths among rivers. The hierarchical approach allows robust estimates of 'main' effects, like river, season, and year, even when data are unbalanced (e.g. not collected in every river every year). We can also easily incorporate size-dependent survival into the estimation procedure. Our results indicate marked differences in average survival across rivers, combined with important yearly variation in survival. The strength and direction of size-dependent survival also varied considerably among rivers and seasons.

Diagnosing poor and improved passage performance at Gatehouse Fishway—Differentiating between engineered solutions and environmental effects

Ted Castro-Santos and Alex Haro

Affiliation: USGS-S.O. Conte Anadromous Fish Research Center
P.O. Box 796, One Migratory Way
Turners Falls, MA 01354
Email: tcastrosantos@bio.umass.edu

***Abstract*.** - Efforts have been underway to improve passage of American shad at the Gatehouse Fishway, Turners Falls, MA for several years. A new entrance installed in 2007 initially failed to yield the desired improvements in passage performance. By combining radio and PIT telemetry methods we have been able to isolate and identify rates of movement as shad approach, enter, and pass the structure. We have consistently found that most shad that attempt to pass Gatehouse are able to locate either or both the new and old fishway entrances, and are able to pass the fishway once they enter it. The primary obstacle to passage has been the unwillingness or inability of the shad to actually enter the fishway once they have located it. Improved passage in 2010 led to speculation of environmental causes, such as the outages at the Vermont Yankee Nuclear Plant and the Northfield Mountain Pumped Storage Facility, or possibly to improved condition of the shad resulting from the early onset of the 2010 migration season. Assessment of 6 years of telemetry data, however, suggest that these were not the primary factors driving improved passage, but rather that improved entry rates at the New Entrance resulted from design changes installed before the 2010 season. Nevertheless, serious challenges remain if we are to achieve passage rates that will be acceptable to management agencies.

Upstream Passage of American Shad at Turners Falls Fishways

Alex Haro and Ted Castro-Santos

Affiliation: USGS-S.O. Conte Anadromous Fish Research Center
P.O. Box 796, One Migratory Way
Turners Falls, MA 01354
Email: Alex_Haro@usgs.gov

Abstract. - Upstream passage of adult American shad (*Alosa sapidissima*) has been monitored since the construction of large fishways at the Turners Falls (Massachusetts, Connecticut River) Dam complex in 1980. Initial assessments of passage were largely qualitative in nature, but identified significant passage problems for shad in Cabot and Spillway fishways. Later intensive telemetry studies characterized zones within fishways where passage was problematic, and temporal effects of behavior of shad that exacerbated poor passage. Experimentation with *in-situ* fishway weir structures in Cabot fishway indicated that although passage could be improved locally, retrofitting of weirs throughout the entire fishway would result in only a marginal increase in performance of the entire fishway. Efforts are now underway to consider replacing the Cabot fishway with a fish lift, which potentially could have very high passage performance. Issues of shad passage through Spillway fishway and the Cabot power canal remain.

Large New England Rivers Project: Connecticut River Fish Assemblage Survey

Bryan Apell,

Kleinschmidt Associates
35 Pratt Street, Suite 201
Essex, CT 06426
(860) 767-5069
Bryan.Apell@KleinschmidtUSA.com

Abstract. - Kleinschmidt Associates (Kleinschmidt) and the Midwest Biodiversity Institute (MBI) conducted a fish assemblage survey in the mainstem of the Connecticut River, extending from the First Connecticut Lake (New Hampshire) downstream to the salt wedge in Old Saybrook, CT. The data collected will be used to investigate the relative abundance and distribution of the fish assemblages in relation to an accompanying qualitative habitat assessment and the prevailing summer water quality of the Connecticut River. This project is part of a larger study funded by the USEPA to develop a fish based bioassessment indices in large New England rivers. Work began in the state of Maine in 2002 and was expanded to the Connecticut River in 2008.

A total of 91, 1-km sections of Connecticut River mainstem were sampled utilizing pulsed D.C. boat electrofishing techniques during August and September, 2008 and

2009. Sample sites were strategically located using an intensive pollution survey design (Yoder et al. 2005b) in areas of potential sources of pollution, key tributary confluences, and in reaches of contrasting habitat quality (e.g., free-flowing riverine, impoundments, and other hydrologic modifications). The purpose of this presentation is to summarize the methods used and demonstrate general spatial trends within the dynamic fish assemblage of the Connecticut River.

8.6 List of Appendices

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 and partners. The following appendices are generated as Access query reports from official databases and the numbering sequences have generally been retained for comparisons between years. Pagination of the report is table-specific for appendices 7 and beyond due to table length and quirks of using Access. Please note that some of these appendices are redundant to tables in section 1 but are also placed here for easy access.

Appendix 1. Documented Atlantic salmon returns to USA by geographic area, 2010. "Natural" includes fish originating from natural spawning and hatchery fry.

	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
Area	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
LIS	0	1	3	48	0	0	0	0	52
CNE	37	10	45	11	0	1	0	0	104
[1] GOM	443	61	860	111	1	1	12	5	1494

[1] Includes numbers based on redds, ages and origins are pro-rated based upon distributions for GOM coastal rivers with traps

Appendix 2. Documented Atlantic salmon returns to the USA, 1967-2010. "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	Hatcher	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1078	3	17	1,650	1401	249

Appendix 3. Two sea winter (2SW) returns for 2010 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2010	Percentage of Requirement
Long Island Sound	LIS	10,094	51	0.5%
Central New England	CNE	3,435	56	1.6%
Gulf of Maine	GOM	15,670	971	6.2%
Total		29,199	1,078	3.7%

Appendix 4. Number of juvenile Atlantic salmon stocked in USA, 2010. Numbers are rounded to 1,000.

Area		N: Rivers	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Long Island Sound	LIS	2: Connecticut, Pawcatuck	6,299,000	0	6,000	19,000	4,000	43,000	6,371,000
Central New England	CNE	2: Merrimack, Saco	1,783,000	80,000	9,000	0	99,000	0	1,971,000
Gulf of Maine	GOM	10: Androscoggin to Dennys	3,327,000	273,000	0	0	630,000	0	4,230,000
Outer Bay of Fundy	OBF	2: Aroostook, St Croix	527,000	0	0	0	0	0	527,000
Totals for USA		16	11,936,000	353,000	15,000	19,000	733,000	43,000	13,099,000

Appendix 5. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2010 by geographic area.

			Captive Reared Domestic		Sea Run		Eggs
River		Purpose	Pre-spawn	Post-spawn	Post-spawn	Total	Eyed
Long Island Sound	LIS	Restoration			2	2	
Central New England	CNE	Restoration/Recreation	780	400		1,180	
Gulf of Maine	GOM	Restoration	404	1,935	561	2,900	500,000

Appendix 6. Summary of tagged and marked Atlantic salmon released in USA, 2010.

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Parr	89,271	14,500	25,291	129,062
AD	Smolt	72,853	3,912	42,692	119,457
CWT	Parr		258,800		258,800
FLOY	Adult	1,180			1,180
OTOL	Fry		40,200		40,200
PING	Adult		40		40
PING	Smolt		599		599
PIT	Adult		2,692		2,692
PIT	Kelt			2	2
RAD	Adult		44	10	54
RAD	Smolt		59	135	194
VIE	Smolt		246,137	757	246,894
Grand Total		163,304	566,983	68,887	799,174

RAD = radio tag
PIT = passive integrated transponder
PING = ultrasonic acoustic tag
OTOL=thermal marked otolith

Appendix 6a. Aquaculture production (metric tonnes) in New England from 1997 to 2010.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014
2009	6,028
2010	11,127

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2010.

United State

No. of fi h tocked by life tage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connect cut	6,009,000	0	6,300	19,000	0	42,700	6,077,000
Total for Connecticut Program							**6,077,0004**
Androscogg n	1,000	0	0	0	0	0	1,000
Aroostook	527,000	0	0	0	0	0	527,000
Dennys	430,000	0	0	0	0	0	430,000
East Mach as	266,000	0	0	0	0	0	266,000
Kennebec	147,000	0	0	0	0	0	147,000
Mach as	510,000	0	0	0	0	0	510,000
Narraguagus	698,000	0	0	0	62,400	0	760,400
Penobscot	999,000	258,800	0	0	567,100	0	1,824,900
Pleasant	142,000	0	0	0	0	0	142,000
Saco	302,000	0	0	0	26,500	0	328,500
Sheepscot	114,000	14,500	0	0	0	0	128,500
Un on	19,000	0	0	0	0	0	19,000
Total for Maine Program							**5,084,3004**
Merr mack	1,481,000	80,000	9,300	0	72,900	0	1,643,200
Total for Merrimack Program							**1,643,2004**
Pawcatuck	290,000	0	0	0	3,900	0	293,900
Total for Pawcatuck Program							**293,9004**
Total for United States							**13,098,4004**
Grand Total							**13,098,400**

D st nct on between US and CAN stock ngi s based on source of eggs or f sh.

__Appendix 8. Number of adult Atlantic salmon stocked in New England rivers in 2010.__

Drainage	Purpose	Captiv /Domestic Pre-Spawn	Captiv /Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Connect cut	Restorat on	0	0	0	2	2
Dennys	Restorat on	0	78	0	0	78
East Mach as	Restorat on	40	107	0	0	147
Hobart Stream	Restorat on	278	0	0	0	278
Mach as	Restorat on	0	228	0	0	228
Merr mack	Restorat on/Recreat on	780	400	0	0	1,180
Narraguagus	Restorat on	0	238	0	0	238
Penobscot	Restorat on	0	1,091	119	561	1,771
Pleasant	Restorat on	0	96	0	0	96
Sheepscot	Restorat on	86	97	0	0	183
Total		1,184	2,335	119	563	4,201

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.
*****The 119 pre-spawn sea run fish stocked in the Penobscot River were sea run fish that were temporarily held in the hatchery prior to release to the river.***

Appendix 9.1. Atlantic salmon markingxdatabase for New England; marked fish released in 2010 .

Marking Agency	Age	Life Stage	H/W	Stock rigin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
NAI	4	Adult	W	Connect cut	RAD	10	PIT	May	Connect cut
NAI	2	Smolt	H	Connect cut	RAD	135	AD	Mar	Connect cut
NAI	2	Smolt	H	Connect cut	VIE	757	AD	May	Connect cut
USFWS	4	Kelt	W	Connect cut	PIT	1		Dec	Connect cut
USFWS	5	Kelt	W	Connect cut	PIT	1		Dec	Connect cut
USFWS	1+	Parr	H	Connect cut	AD	6,255		Oct	Connect cut
USFWS	2	Parr	H	Connect cut	AD	19,036		April	Connect cut
USFWS	2	Smolt	H	Connect cut	AD	42,692		April	Connect cut
USFWS	4	Adult	H	Dennys	PIT	68		Dec	Dennys
USFWS	5	Adult	H	Dennys	PIT	70		Oct	Hobart Stream
USFWS	4	Adult	H	Dennys	PIT	28		Oct	Hobart Stream
USFWS	5	Adult	H	Dennys	PIT	10		Dec	Dennys
USFWS	4	Adult	H	East Mach as	PIT	42		Dec	East Mach as
USFWS	5	Adult	H	East Mach as	PIT	65		Dec	East Mach as
USFWS	5	Adult	H	East Mach as	PIT	40	Acousti	Oct	East Mach as
USFWS	5	Adult	H	East Mach as	PIT	74		Oct	Hobart Stream
USFWS	5	Adult	H	Mach as	PIT	69		Oct	Hobart Stream
USFWS	4	Adult	H	Mach as	PIT	59		Dec	Mach as
USFWS	5	Adult	H	Mach as	PIT	169		Dec	Mach as
NHFG	2	Adult	H	Merrimack	FLOY	780		Oct	Merrimack
NHFG	3,4	Adult	H	Merrimack	FLOY	400		May	Merrimack
NNFH	0	Parr	H	Merrimack	AD	80,000		Nov	Merrimack
NNFH	1	Parr	H	Merrimack	AD	9,271		Oct	Merrimack
NNFH	1	Smolt	H	Merrimack	AD	72,853		April	Merrimack
NOAA	1	Smolt	H	Narraguagus	VIE	62,367	AD	May	Narraguagus

Marking Agency	Age	Life Stage	H/W	Stock rigin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	4	Adult	H	Narraguagus	PIT	23		Dec	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	23		Oct	Hobart Stream
USFWS	5	Adult	H	Narraguagus	PIT	214		Dec	Narraguagus
RIF&W	1	Smolt	H	Pawcatuck	AD	2,732		April	Pawcatuck
RIF&W	1	Smolt	H	Pawcatuck	AD	1,180		Mar	Pawcatuck
BSRFH		Adult	H	Penobscot	PIT	163		May	Penobscot
BSRFH		Adult	H	Penobscot	PIT	296		June	Penobscot
BSRFH		Adult	H	Penobscot	PIT	110		July	Penobscot
BSRFH		Adult	H	Penobscot	PIT	79		Oct	Penobscot
BSRFH		Adult	H	Penobscot	PIT	24		Sept	Penobscot
BSRFH		Adult	H	Penobscot	PIT	13		Aug	Penobscot
BSRFH		Adult	W	Penobscot	PIT	561		Dec	Penobscot
BSRFH		Adult	W	Penobscot	PIT	1		July	Penobscot
BSRFH		Adult	W	Penobscot	PIT	8		June	Penobscot
BSRFH		Adult	W	Penobscot	PIT	1		May	Penobscot
BSRFH		Adult	W	Penobscot	PIT	44	Rad o	Oct	Penobscot
NOAA	0	Parr	H	Penobscot	CWT	258,800		Oct	Penobscot
NOAA	1	Smolt	H	Penobscot	VIE	183,770	AD	April	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	99		May	Penobscot
NOAA		Smolt	W	Penobscot	PING	100		May	Penobscot
UMO	0	Fry	H	Penobscot	OTOL	40,200		May	Penobscot
UMO	1	Smolt	H	Penobscot	PING	200		April	Penobscot
UMO	1	Smolt	H	Penobscot	PING	50	VIE/A	May	Penobscot
UMO	1	Smolt	H	Penobscot	RADIO	59		May	Penobscot
UMO	2	Smolt	W	Penobscot	PING	150		May	Penobscot
USDA		Adult	H	Penobscot	PIT	75	AD	Dec	Penobscot
USDA		Adult	H	Penobscot	PIT	152	CWT/	Dec	Penobscot

Marking Agency	Age	Life Stage	H/W	Stock rigin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	5	Adult	H	Pleasant	PIT	81		Nov	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	14		Oct	Hobart Stream
USFWS	4	Adult	H	Pleasant	PIT	15		Nov	Pleasant
USFWS	4	Adult	H	Sheepscot	PIT	26		Nov	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	22		Oct	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	71		Nov	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	66		Oct	Sheepscot
USFWS	0	Parr	H	Sheepscot	AC	14,500		Sept	Sheepscot

TAG/MARK CODES: AD = ad pose cl p; RAD = rad o tag; AP = ad pose punch; RV = RV Cl p; BAL = Balloon tag; VIA = v s ble mplant, alphanumeric; CAL = Calce ni mmers on; VIE = v s blei mplant elastomer; FLOY = floy tag; VIEAC = v s blei mplant elastomer and anal cl p; DYE = MetaJet Dye; PIT = PIT tag; VPP = VIE tag, PIT tag, and ultrason c p nger; PTC = PIT tag and Carl n tag; TEMP = temperature mark on otol th or other hard part; VPT = VIE tag and PIT tag; ANL = anal cl p/punch; HI-Z = HI-Z Turb'N tag

Appendix 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2010.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	1,255	75	3,341
Hatchery Juvenile	481,048	481,048	794,956
Wild Adult			625
Wild Juvenile			252
Total			**799,174**

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2010.

	1SW		2SW		3SW		Repeat			2006-2010
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	2	0	5	2	0	0	0	0	**9**	15
Connecticut	0	1	3	47	0	0	0	0	**51**	124
Dennys	1	0	1	4	0	0	0	0	**6**	6
Kennebec	0	1	2	2	0	0	0	0	**5**	18
Merrimack	29		40		0	1	0	0	**84**	89
Narraguagus	30	3	33	6	1	0	1	2	**76**	27
Pawcatuck	0	0	0	1	0	0	0	0	**1**	1
Penobscot	410	23	819	53	0	0	11	0	**1316**	1,472
Saco	8	3	5	4	0	0	0	0	**20**	30
Union	0	0	0	0	0	0	0	0	**0**	0
Total	**480**	**38**	**908**	**126**	**1**	**1**	**12**	**2**	**1,568**	**1,781**

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2010.

Source River	Origin	Females Spawned	Total Egg Production
Connect cut	Domest c	1935	10,021,000
Merr mack	Domest c	135	721,000
Dennys	Capt ve	25	105,000
East Mach as	Capt ve	48	228,000
Mach as	Capt ve	108	480,000
Narraguagus	Capt ve	97	694,000
Pleasant	Capt ve	12	42,000
Sheepscot	Capt ve	68	264,000
Total	**Captive/Domestic**	**2,428**	**12,555,000**
Dennys	Domest c	87	596,000
Penobscot	Domest c	314	1,269,000
Pleasant	Domest c	30	186,000
Total	**Domestic**	**431**	**2,051,000**
Connect cut	Kelt	55	593,000
Merr mack	Kelt	57	669,000
Total	**Kelt**	**112**	**1,262,000**
Connect cut	Sea Run	26	180,000
Merr mack	Sea Run	28	201,000
Penobscot	Sea Run	289	2,091,000
Total	**Sea Run**	**343**	**2,472,000**
Grand Total for Year 2010		**3,314**	**18,340,000**

Capt ve refers to adults produced from w ld parr that were captured and reared to matur tyi n the hatchery.

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale
Cocheco															
1993-2000	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															
1977-2000	1,359	15,984,000	8,000	13,793	96,600,000	6,000	0	0		1,645	21,283,000	10,300	16,797	133,867,000	6,700
2001	20	162,000	8,100	1,955	9,870,000	5,000	0	0		102	1,003,000	9,800	2,077	11,036,000	5,300
2002	25	181,000	7,300	1,974	10,826,000	5,500	0	0		83	827,000	10,000	2,082	11,835,000	5,700
2003	34	245,000	7,200	2,152	11,600,000	5,400	0	0		67	660,000	9,800	2,253	12,505,000	5,600
2004	37	280,000	7,600	1,875	11,750,000	6,300	0	0		53	489,000	9,200	1,965	12,519,000	6,400
2005	102	758,000	7,400	1,382	9,050,000	6,500	0	0		37	384,000	10,400	1,521	10,192,000	6,700
2006	116	896,000	7,700	1,782	10,020,000	5,600	0	0		47	460,000	9,800	1,945	11,376,000	5,800
2007	95	723,000	7,600	1,598	9,390,000	5,900	0	0		113	1,190,000	10,500	1,806	11,303,000	6,300
2008	85	602,000	7,100	1,633	8,980,000	5,500	0	0		101	1,190,000	11,800	1,819	10,772,000	5,900
2009	46	317,000	6,900	1,975	9,906,000	5,000	0	0		62	642,000	10,400	2,083	10,865,000	5,200
2010	26	180,000	6,900	1,935	10,021,000	5,200	0	0		55	593,000	10,800	2,016	10,794,000	5,400
Total Connecticut	1,945	20,328,000	7,400	32,054	198,013,000	5,600	0	0		2,365	28,721,000	10,300	36,364	247,064,000	5,900
Dennys															
1939-2000	26	214,000	7,600	0	0		551	2,024,000	3,700	40	330,000	7,700	617	2,568,000	5,100
2001	0	0		0	0		82	359,000	4,400	0	0		82	359,000	4,400
2002	0	0		0	0		68	352,000	5,200	0	0		68	352,000	5,200
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300

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

Note: Totals of eggs/fe ale includes only the years for which information on nu ber of fe ales is available. It is a si ple ratio of eggs/fe ale and should not be used as an age specific fecundity easure because this can vary with age co position and broodstock type.

Note: Connecticut data are preli inary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300
2009	0	0		38	91,000	2,400	61	360,000	5,900	0	0		99	451,000	4,600
2010	0	0		87	596,000	6,900	25	105,000	4,200	0	0		112	701,000	6,300
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,324	5,679,000	4,664	40	330,000	7,700	1,515	6,910,000	4,900
East Machias															
1995-2000	0	0		0	0		500	1,811,000	3,800	0	0		500	1,811,000	3,800
2001	0	0		0	0		67	400,000	6,000	0	0		67	400,000	6,000
2002	0	0		0	0		92	466,000	5,100	0	0		92	466,000	5,100
2003	0	0		0	0		93	456,000	4,900	0	0		93	456,000	4,900
2004	0	0		0	0		65	252,000	3,900	0	0		65	252,000	3,900
2005	0	0		0	0		88	281,000	3,200	0	0		88	281,000	3,200
2006	0	0		0	0		82	328,000	4,000	0	0		82	328,000	4,000
2007	0	0		0	0		78	456,000	5,800	0	0		78	456,000	5,800
2008	0	0		0	0		85	350,000	4,100	0	0		85	350,000	4,100
2009	0	0		0	0		81	311,000	3,800	0	0		81	311,000	3,800
2010	0	0		0	0		48	228,000	4,800	0	0		48	228,000	4,800
Total East Machias	0	0		0	0	0	1,279	5,339,000	4,491	0	0		1,279	5,339,000	4,500
Kennebec															
1979-2000	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 fro wild parr that were captured and reared to aturity in the hatchery.

Note: Totals of eggs/fe ale includes only the years for which information on nu ber of fe ales is available. It is a si ple ratio of eggs/fe ale and should not be used as an age specific fecundity easure because this can vary with age co position and broodstock type.

Note: Connecticut data are preli inary 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
Lamprey															
1992-2000	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															
1941-2000	456	3,263,000	7,300	0	0		973	3,310,000	3,400	8	52,000	6,400	1,437	6,625,000	6,300
2001	0	0		0	0		108	672,000	6,200	0	0		108	672,000	6,200
2002	0	0		0	0		111	533,000	4,800	0	0		111	533,000	4,800
2003	0	0		0	0		121	763,000	6,300	0	0		121	763,000	6,300
2004	0	0		0	0		120	613,000	5,100	0	0		120	613,000	5,100
2005	0	0		0	0		160	677,000	4,200	0	0		160	677,000	4,200
2006	0	0		0	0		160	720,000	4,500	0	0		160	720,000	4,500
2007	0	0		0	0		150	714,000	4,800	0	0		150	714,000	4,800
2008	0	0		0	0		141	650,000	4,600	0	0		141	650,000	4,600
2009	0	0		0	0		144	557,000	3,900	0	0		144	557,000	3,900
2010	0	0		0	0		108	480,000	4,400	0	0		108	480,000	4,400
Total Machias	456	3,263,000	7,300	0	0	0	2,296	9,689,000	4,745	8	52,000	6,400	2,760	13,004,000	5,000
Merrimack															
1983-2000	994	7,415,000	7,500	7,180	40,235,000	5,400	0	0		117	1,352,000	11,900	8,291	49,001,000	6,500
2001	37	296,000	8,000	726	2,585,000	3,600	0	0		22	294,000	13,400	785	3,176,000	4,000
2002	16	232,000	14,500	361	1,816,000	5,000	0	0		21	232,000	11,000	398	2,279,000	5,700
2003	60	499,000	8,300	489	1,914,000	3,900	0	0		20	236,000	11,800	569	2,649,000	4,700
2004	59	494,000	8,400	229	811,000	3,500	0	0		42	48,000	1,200	330	1,353,000	4,100
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

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. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
2009	48	369,000	7,700	516	2,380,000	4,600	0	0		55	577,000	10,500	619	3,326,000	5,400
2010	28	201,000	7,200	135	721,000	5,300	0	0		57	669,000	11,700	220	1,591,000	7,200
Total Merrimack	1,398	10,826,000	8,700	11,058	55,855,000	4,200	0	0		540	5,709,000	10,600	12,996	72,390,000	5,300
Narraguagus															
1962-2000	0	1,303,000		0	0		920	2,955,000	3,200	0	0		920	4,258,000	3,200
2001	0	0		0	0		93	404,000	4,300	0	0		93	404,000	4,300
2002	0	0		0	0		159	704,000	4,400	0	0		159	704,000	4,400
2003	0	0		0	0		120	624,000	5,200	0	0		120	624,000	5,200
2004	0	0		0	0		119	453,000	3,800	0	0		119	453,000	3,800
2005	0	0		0	0		146	449,000	3,100	0	0		146	449,000	3,100
2006	0	0		0	0		165	702,000	4,300	0	0		165	702,000	4,300
2007	0	0		0	0		186	854,000	4,600	0	0		186	854,000	4,600
2008	0	0		0	0		169	820,000	4,900	0	0		169	820,000	4,900
2009	0	0		0	0		178	848,000	4,800	0	0		178	848,000	4,800
2010	0	0		0	0		97	694,000	7,200	0	0		97	694,000	7,200
Total Narraguagus	0	1,303,000		0	0	0	2,352	9,507,000	4,527	0	0		2,352	10,810,000	4,500
Orland															
1967-2000	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															
1992-2000	14	137,000	9,900	0	0		0	0		5	43,000	8,600	19	180,000	9,700

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

Note: Totals of eggs/fe ale includes only the years for which information on nu ber of fe ales is available. It is a si ple ratio of eggs/fe ale and should not be used as an age specific fecundity easure because this can vary with age co position and broodstock type.

Note: Connecticut data are preli inary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/female	Domestic No. females	Domestic Egg production	Domestic Eggs/female	Captive No. females	Captive Egg production	Captive Eggs/female	Kelt No. females	Kelt Egg production	Kelt Eggs/female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/female
2001	0	0		2	2,000	1,100	0	0		1	8,000	7,800	3	10,000	3,300
2002	0	0		0	0		0	0		3	10,000	3,300	3	10,000	3,300
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
2006	0	0		4	4,000	1,000	0	0		0	0		4	4,000	1,000
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
2008	0	0		0	0		0	0		2	10,000	5,000	2	10,000	5,000
2009	0	0		0	0		0	0		2	5,000	2,500	2	5,000	2,500
Total Pawcatuck	18	152,000	5,800	6	6,000	1,000	0	0		13	76,000	5,400	37	234,000	4,000
Penobscot															
1871-2000	17,067	146,010,000	7,800	4,255	10,937,000	2,600	0	0		0	0		21,322	156,947,000	7,500
2001	282	2,451,000	8,700	453	1,206,000	2,700	0	0		0	0		735	3,657,000	5,000
2002	218	2,001,000	9,200	484	1,300,000	2,700	0	0		0	0		702	3,301,000	4,700
2003	362	3,194,000	8,800	0	0		0	0		0	0		362	3,194,000	8,800
2004	353	3,229,000	9,100	477	1,200,000	2,500	0	0		0	0		830	4,429,000	5,300
2005	296	2,458,000	8,300	359	1,314,000	3,700	0	0		0	0		655	3,772,000	5,800
2006	325	3,034,000	9,300	0	0		329	1,400,000	4,300	0	0		654	4,434,000	6,800
2007	315	2,697,000	8,600	394	1,595,000	4,000	0	0		0	0		709	4,292,000	6,100
2008	297	2,500,000	8,400	352	1,420,000	4,000	0	0		0	0		649	3,920,000	6,000
2009	283	2,433,000	8,600	312	1,040,000	3,300	0	0		0	0		595	3,473,000	5,800
2010	289	2,091,000	7,200	314	1,269,000	4,000	0	0		0	0		603	3,360,000	5,600
Total Penobscot	20,087	172,098,000	8,500	7,400	21,281,000	3,300	329	1,400,000	4,300	0	0		27,816	194,779,000	6,100
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. fe ales	Sea-Run Egg production	Sea-Run Eggs/ fe ale	Domestic No. fe ales	Domestic Egg production	Domestic Eggs/ fe ale	Captive No. fe ales	Captive Egg production	Captive Eggs/ fe ale	Kelt No. fe ales	Kelt Egg production	Kelt Eggs/ fe ale	TOTAL No. fe ales	TOTAL Egg production	TOTAL Eggs/ fe ale
2003	0	0		0	0		11	92,000	8,300	0	0		11	92,000	8,300
2004	0	0		0	0		23	179,000	7,800	0	0		23	179,000	7,800
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400
2010	0	0		30	186,000	6,200	12	42,000	3,500	0	0		42	228,000	5,400
Total Pleasant	0	0		47	272,000	5,800	409	1,631,000	4,580	0	0		456	1,902,000	4,800
Sheepscot															
1995-2000	18	125,000	6,900	0	0		340	1,175,000	3,200	45	438,000	9,900	403	1,739,000	4,300
2001	0	0		0	0		56	351,000	6,300	0	0		56	351,000	6,300
2002	0	0		0	0		100	455,000	4,600	0	0		100	455,000	4,600
2003	0	0		0	0		92	433,000	4,700	0	0		92	433,000	4,700
2004	0	0		0	0		78	308,000	3,900	0	0		78	308,000	3,900
2005	0	0		0	0		70	251,000	3,600	0	0		70	251,000	3,600
2006	0	0		0	0		83	277,000	3,300	0	0		83	277,000	3,300
2007	0	0		0	0		81	349,000	4,300	0	0		81	349,000	4,300
2008	0	0		0	0		75	340,000	4,500	0	0		75	340,000	4,500
2009	0	0		0	0		86	329,000	3,800	0	0		86	329,000	3,800
2010	0	0		0	0		68	264,000	3,900	0	0		68	264,000	3,900
Total Sheepscot	18	125,000	6,900	0	0	0	1,129	4,532,000	4,191	45	438,000	9,900	1,192	5,096,000	4,300
St Croix															
1993-2000	36	271,000	7,500	0	0		0	0		0	0		36	271,000	7,500

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

Note: Totals of eggs/fe ale includes only the years for which information on nu ber of fe ales is available. It is a si ple ratio of eggs/fe ale and should not be used as an age specific fecundity easure because this can vary with age co position and broodstock type.

Note: Connecticut data are preli inary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale
2003	3	21,000	6,900	0	0		0	0		0	0		3	21,000	6,900
Total St Croix	39	292,000	7,200	0	0	0	0	0		0	0		39	292,000	7,200
Union															
1974-2000	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 fro wild parr that were captured and reared to aturity in the hatchery.

Note: Totals of eggs/fe ale includes only the years for which information on nu ber of fe ales is available. It is a si ple ratio of eggs/fe ale and should not be used as an age specific fecundity easure because this can vary with age co position and broodstock type.

Note: Connecticut data are preli inary prior to 1990.

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

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale	No. fe ales	Egg production	Eggs/ fe ale
Cocheco	3	21,000	7,100	0	0		0	0		0	0		3	21,000	7,100
Con ecticut	1,945	20,329,000	7,400	32,054	198,013,000	5,600	0	0		2,365	28,721,000	10,200	36,364	247,063,000	5,900
Den ys	26	214,000	7,600	125	687,000	4,600	1,324	5,678,000	4,700	40	330,000	7,700	1,515	6,909,000	4,900
East Machias	0	0		0	0		1,279	5,339,000	4,500	0	0		1,279	5,339,000	4,500
Ken ebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Machias	456	3,263,000	7,300	0	0		2,296	9,688,000	4,700	8	52,000	6,400	2,760	13,003,000	5,000
Merrimack	1,398	10,826,000	8,700	11,058	55,855,000	4,200	0	0		540	5,709,000	10,600	12,996	72,390,000	5,300
Narraguagus	0	1,303,000		0	0		2,352	9,507,000	4,500	0	0		2,352	10,810,000	4,500
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	18	152,000	5,800	6	6,000	1,100	0	0		13	76,000	5,400	37	234,000	4,000
Penobscot	20,087	172,098,000	8,600	7,400	21,280,000	3,300	329	1,400,000	4,300	0	0		27,816	194,779,000	6,100
Pleasant	0	0		47	271,000	5,800	409	1,630,000	4,600	0	0		456	1,902,000	4,800
Sheepscot	18	125,000	6,900	0	0		1,129	4,531,000	4,200	45	438,000	9,900	1,192	5,095,000	4,300
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	**24,640**	**213,585,000**	**8,700**	**50,690**	**276,112,000**	**5,400**	**9,118**	**37,773,000**	**4,100**	**3,011**	**35,326,000**	**11,700**	**87,459**	**562,799,000**	**6,400**

Note: Eggs/fe ale represents the overall average nu ber of eggs produced per fe ale and includes only years for which information on the nu ber of fe ales is available.

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

	Number of fish stocked by life stage						
	Fry	0 P rr	1 P rr	2 P rr	1 Smolt	2 Smolt	Tot l
Andro coggin							
20015	3,0005	05	05	05	05	05	3,0005
20025	05	05	05	05	05	05	05
20035	1,0005	05	05	05	05	05	1,0005
20045	2,0005	05	05	05	05	05	2,0005
2005	05	05	05	05	05	05	05
20065	1,0005	05	05	05	05	05	1,0005
20075	1,0005	05	05	05	05	05	1,0005
20085	1,0005	05	05	05	05	05	1,0005
20095	2,0005	05	05	05	05	05	2,0005
20105	1,0005	05	05	05	05	05	1,0005
Totals:Androscoggin	**12,000**	**0**	**0**	**0**	**0**	**0**	**12,000**
Aroo took							
1978-20005	1,511,0005	317,1005	38,6005	05	32,6005	29,8005	1,929,1005
20015	182,0005	3005	05	05	05	05	182,3005
20025	122,0005	05	05	05	05	05	122,0005
20035	138,0005	05	05	05	05	05	138,0005
20045	169,0005	05	05	05	05	05	169,0005
2005	133,0005	05	05	05	05	05	133,0005
20065	324,0005	05	05	05	05	05	324,0005
20075	854,0005	05	05	05	05	05	854,0005
20085	365,0005	05	05	05	05	05	365,0005
20095	458,0005	05	05	05	05	05	458,0005
2010	527,0005	05	05	05	05	0	527,0005
Totals:Aroostook	**4,783,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**5,201,400**
Cocheco							
1988-20005	1,449,0005	50,0005	10,5005	0	5,3005	05	1,514,8005
20015	165,000	05	05	05	05	05	165,0005
20025	181,0005	05	05	05	05	05	181,0005
20035	163,0005	05	05	05	05	05	163,0005
Totals:Cocheco	**1,958,000**	**50,000**	**10,500**	**0**	**5,300**	**0**	**2,023,800**
Connecticut							
1967-20005	68,807,0005	2,825,2005	1,810,3005	05	3,768,5005	1,011,4005	78,222,4005
20015	9,591,0005	1,6005	05	05	7005	05	9,593,3005
20025	7,283,0005	7005	05	0	5005	05	7,284,2005
20035	7,038,0005	05	05	05	05	90,1005	7,128,1005
20045	7,683,0005	3,1005	2,5005	05	05	96,4005	7,785,0005
2005	7,805,0005	05	05	05	05	85,1005	7,890,1005
20065	,848,0005	3,7005	05	12,6005	1,000	52,1005	,917,4005
20075	6,345,0005	05	6005	2,3005	6005	99,0005	6,447,5005
20085	6,041,0005	05	05	2,4005	0	50,0005	6,093,4005
20095	6,476,0005	3,9005	05	14,4005	05	49,1005	6,543,4005
20105	6,009,0005	05	6,3005	19,0005	05	42,7005	6,077,0005

	Number of fish stocked by life stage						
	Fry	**0 P rr**	**1 P rr**	**2 P rr**	**1 Smolt**	**2 Smolt**	**Tot l**
Totals:Connecticut	**138,926,000**	**2,838,200**	**1,819,700**	**50,700**	**3,771,300**	**1,575,900**	**148,981,800**
Denny							
1975-20005	1,124,0005	52,2005	3,4005	05	152,7005	29,2005	1,361,5005
2001	59,0005	16,5005	1,4005	05	49,8005	05	126,7005
20025	84,0005	33,0005	1,9005	05	49,0005	05	167,9005
20035	133,0005	30,4005	6005	0	55,2005	05	219,2005
20045	219,0005	44,0005	05	0	56,3005	05	319,3005
2005	215,0005	21,7005	05	0	56,7005	05	293,4005
20065	295,0005	27,6005	05	0	56,5005	05	379,1005
20075	257,0005	05	05	0	56,5005	05	313,5005
20085	292,0005	05	05	05	05	2005	292,2005
20095	317,0005	05	05	05	05	6005	317,6005
20105	430,000	05	05	05	05	05	430,0005
Totals:Denny	**3,425,000**	**225,400**	**7,300**	**0**	**532,700**	**30,000**	**4,220,400**
Ducktrap							
1986-20005	68,0005	05	05	05	05	05	68,0005
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
Ea t Machia							
1973-20005	965,0005	7,5005	42,6005	05	108,4005	30,4005	1,153,9005
20015	242,0005	05	05	05	05	05	242,0005
20025	236,0005	05	05	05	05	05	236,0005
20035	314,0005	05	05	05	05	05	314,0005
20045	319,0005	05	05	05	05	05	319,0005
2005	216,0005	05	05	05	05	05	216,0005
20065	199,0005	05	05	05	05	05	199,0005
20075	245,0005	05	05	05	05	05	245,0005
20085	261,0005	05	05	05	05	05	261,0005
20095	186,0005	05	05	05	05	05	186,0005
20105	266,0005	05	05	05	05	05	266,0005
Totals:East Machias	**3,449,000**	**7,500**	**42,600**	**0**	**108,400**	**30,400**	**3,637,900**
Kennebec							
20015	3,0005	05	05	05	05	05	3,0005
20025	7,0005	05	05	05	05	05	7,0005
20035	42,0005	05	05	05	05	05	42,000
2004	52,0005	05	05	05	05	05	52,0005
2005	30,0005	05	05	05	05	05	30,0005
20065	8,0005	05	05	05	05	05	8,0005
20075	20,0005	05	05	05	05	05	20,0005
20085	3,0005	05	05	05	05	05	3,0005
20095	2,0005	05	05	05	2005	05	2,2005
20105	147,0005	05	05	05	05	05	147,0005
Totals:Kennebec	**314,000**	**0**	**0**	**0**	**200**	**0**	**314,200**
Lamprey							
1978-20005	1,272,0005	427,700	58,5005	05	141,4005	32,8005	1,932,4005

	Number of fish stocked by life stage						
	Fry	0 P rr	1 P rr	2 P rr	1 Smolt	2 Smolt	Tot l
20015	111,0005	05	3005	05	05	05	111,3005
20025	103,0005	05	05	05	60,0005	05	163,0005
20035	106,0005	05	05	05	05	05	106,0005
Totals:Lamprey	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**
Machia							
1970-20005	1,536,0005	93,8005	117,8005	05	191,3005	44,1005	1,983,0005
20015	267,0005	05	05	05	05	05	267,0005
20025	327,0005	05	05	05	05	05	327,0005
20035	341,0005	05	3005	05	05	05	341,3005
20045	379,0005	3,1005	05	05	05	05	382,1005
2005	476,0005	05	2005	05	05	05	476,2005
20065	638,0005	2,0005	1,5005	05	05	05	641,5005
20075	470,000	05	2,2005	05	05	05	472,200
20085	585,0005	1005	4005	05	05	05	85, 5005
20095	291,000	3005	05	05	05	05	291,300
20105	510,0005	05	05	05	05	05	510,0005
Totals:Machias	**5,820,000**	**99,300**	**122,400**	**0**	**191,300**	**44,100**	**6,277,100**
Merrimack							
1975-20005	26,332,0005	227,5005	94,9005	05	1,269,9005	635,9005	29,060,2005
20015	1,708,0005	05	05	05	49,5005	05	1,757,5005
20025	1,414,0005	05	1,9005	0	50,0005	1,2005	1,467,1005
20035	1,335,0005	05	9005	05	49,6005	1,0005	1,386,5005
20045	1,556,0005	3,7005	05	0	50,0005	05	1,609,7005
2005	962,0005	1,4005	4005	0	50,0005	05	1,013,8005
20065	1,011,0005	05	05	0	50,0005	05	1,061,0005
20075	1,140,0005	05	05	0	50,0005	05	1,190,0005
20085	1,766,0005	3,4005	9,6005	05	88,9005	05	1,867,9005
20095	1,051,0005	05	05	05	91,1005	05	1,142,1005
20105	1,481,0005	80,0005	9,3005	05	72,9005	05	1,643,2005
Totals:Merrimack	**39,756,000**	**316,000**	**617,000**	**0**	**1,871,900**	**638,100**	**43,199,000**
Narraguagu							
1970-20005	1,265,0005	62,9005	14,6005	05	107,8005	84,0005	1,534,3005
20015	353,0005	05	05	05	05	05	353,0005
20025	261,0005	05	05	05	05	05	261,0005
20035	623,0005	05	05	05	05	05	623,0005
20045	468,0005	05	05	05	05	05	468,0005
2005	352,0005	05	05	05	05	05	352,0005
20065	478,0005	17,5005	05	05	05	05	495,5005
20075	346,0005	15,7005	05	05	05	05	361,700
20085	485,0005	21,0005	05	0	54,1005	05	560,100
20095	449,0005	05	05	0	52,8005	05	501,8005
20105	698,0005	05	05	05	62,4005	05	760,4005
Totals:Narraguagu	**5,778,000**	**117,100**	**14,600**	**0**	**277,100**	**84,000**	**6,270,800**
Pawcatuck							
1979-20005	3,686,0005	1,209,2005	263,2005	0	56,600	5005	,215,5005

	Number of fish stocked by life stage						
	Fry	**0 P rr**	**1 P rr**	**2 P rr**	**1 Smolt**	**2 Smolt**	**Tot l**
20015	423,0005	05	05	05	8,5005	05	431,5005
20025	403,0005	05	05	05	05	05	403,0005
20035	313,0005	05	05	0	5,2005	05	318,2005
2004	557,0005	05	05	05	6,1005	0	563,1005
2005	5,0005	05	05	05	16,6005	05	21,6005
20065	85,0005	05	05	05	12,8005	05	97,8005
20075	115,0005	05	4,9005	05	6,4005	05	126,3005
20085	313,0005	05	05	05	6,0005	05	319,0005
20095	86,0005	05	05	0	5,4005	05	91,4005
20105	290,0005	05	05	05	3,9005	05	293,9005
Totals:Pawcatuck	**6,276,000**	**1,209,200**	**268,100**	**0**	**127,500**	**500**	**7,881,300**
Penob cot							
1970-20005	12,084,0005	2,950,4005	1,388,4005	05	10,502,2005	2,508,2005	29,433,2005
20015	364,0005	235,8005	2,1005	0	544,0005	05	1,145,9005
20025	746,0005	396,7005	1,8005	0	547,0005	05	1,691,5005
20035	741,0005	320,7005	2,1005	0	547,3005	05	1,611,1005
20045	1,812,0005	369,2005	05	0	566,0005	05	2,747,2005
2005	1,899,0005	295,4005	05	0	530,6005	05	2,725,0005
20065	1,509,0005	293,5005	05	0	549,2005	05	2,351,7005
20075	1,606,0005	337,8005	05	0	559,9005	05	2,503,7005
20085	1,248,0005	216,6005	05	0	512,5005	05	1,977,1005
20095	1,023,0005	05	172,2005	0	559,8005	05	1,755,0005
20105	999,0005	258,8005	05	0	567,1005	05	1,824,9005
Totals:Penobscot	**24,031,000**	**5,674,900**	**1,566,600**	**0**	**15,985,600**	**2,508,200**	**49,766,300**
Plea ant							
1975-20005	187,0005	2,5005	1,8005	0	54,7005	18,1005	264,1005
20015	05	05	05	05	05	05	05
20025	05	13,5005	05	05	05	05	13,5005
2003	53,0005	05	05	05	2,8005	0	55,8005
20045	47,0005	05	05	05	05	8,8005	55,8005
2005	76,0005	05	05	0	5,9005	0	81,9005
20065	284,0005	05	05	05	05	15,2005	299,2005
20075	177,0005	05	05	05	05	05	177,0005
20085	171,0005	05	05	05	05	05	171,0005
20095	97,0005	05	05	05	05	3005	97,3005
20105	142,0005	05	05	05	05	05	142,0005
Totals:Pleasant	**1,234,000**	**16,000**	**1,800**	**0**	**63,400**	**42,400**	**1,357,600**
Saco							
1975-20005	2,858,0005	418,7005	201,2005	05	327,4005	9,5005	3,814,8005
20015	479,0005	05	05	05	4,0005	05	483,0005
2002	597,0005	05	05	05	4,1005	05	601,1005
20035	501,0005	20,0005	05	05	3,2005	05	524,2005
2004	375,0005	05	05	0	5,4005	0	380,4005
2005	340,0005	05	18,0005	05	1,7005	05	359,7005
20065	106,0005	05	05	05	05	05	106,0005

	Number of fish stocked by life stage						
	Fry	**0 P rr**	**1 P rr**	**2 P rr**	**1 Smolt**	**2 Smolt**	**Tot l**
20075	576,0005	05	05	05	05	05	576,0005
20085	358,0005	9,1005	05	05	05	05	367,1005
20095	1,0005	05	05	05	05	05	1,0005
2010	302,0005	05	05	05	26,5005	0	328,5005
Totals:Saco	**6,493,000**	**447,800**	**219,200**	**0**	**372,300**	**9,500**	**7,541,800**
Sheep cot							
1971-20005	1,094,0005	84,8005	20,6005	05	92,2005	7,1005	1,298,7005
20015	171,0005	05	05	05	05	05	171,0005
20025	172,0005	05	05	05	05	05	172,0005
20035	323,0005	05	05	05	05	05	323,0005
20045	298,0005	15,6005	05	05	05	05	313,6005
2005	201,0005	15,9005	05	05	05	05	216,9005
20065	151,0005	16,6005	05	05	05	05	167,6005
20075	198,0005	05	05	05	05	05	198,0005
20085	218,0005	13,0005	05	05	05	05	231,0005
20095	185,0005	17,9005	05	05	05	05	202,9005
20105	114,0005	14,5005	05	05	05	05	128,5005
Totals:Sheepscot	**3,125,000**	**178,300**	**20,600**	**0**	**92,200**	**7,100**	**3,423,200**
St Croix							
1981-20005	1,265,0005	429,1005	158,3005	05	788,5005	20,1005	2,661,0005
20015	1,0005	6,3005	05	05	8,1005	05	15,4005
20025	1,0005	15,4005	05	05	4,1005	05	20,5005
20035	1,0005	16,8005	05	05	3,2005	05	21,0005
20045	05	2,8005	05	05	4,1005	05	6,9005
20065	05	05	05	05	05	05	05
20075	05	05	05	05	05	05	05
20085	05	05	05	05	05	05	05
20105	05	05	05	05	05	05	05
Totals:St Croix	**1,268,000**	**470,400**	**158,300**	**0**	**808,000**	**20,100**	**2,724,800**
Union							
1971-20005	423,0005	371,4005	05	05	379,7005	251,0005	1,425,1005
20015	2,000	05	05	05	05	05	2,000
20025	5,0005	05	05	05	05	05	5,0005
20035	3,0005	05	05	05	05	05	3,0005
20045	3,0005	05	05	05	05	05	3,0005
2005	2,0005	05	05	05	05	05	2,0005
20065	2,0005	05	05	05	05	05	2,0005
20075	22,0005	05	05	05	05	05	22,0005
20085	23,0005	05	05	05	05	05	23,0005
20095	28,0005	05	05	05	05	05	28,0005
20105	19,0005	05	05	05	05	05	19,0005
Totals:Union	**532,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,534,100**
Upper StJohn							
1979-20005	2,165,0005	1,456,7005	14,7005	0	5,1005	27,7005	3,669,2005

	Number of fish stocked by life stage						
	Fry	0 P rr	1 P rr	2 P rr	1 Smolt	2 Smolt	Tot l
Totals:Upper StJohn	**2,165,000**	**1,456,700**	**14,700**	**0**	**5,100**	**27,700**	**3,669,200**

Appendix 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 P rr	1 P rr	2 P rr	1 Smolt	2 Smolt	Tot l
Androscoggin	11,0003	0	0	03	0	03	**11,2008**
Aroostook	4,783,0003	317,4003	38,6003	03	32,6003	29,8003	**5,201,2008**
Cocheco	1,958,0003	50,0003	10,5003	03	5,3003	03	**2,024,2008**
Connecticut	138,925,0003	2,838,2003	1,819,7003	50,800	3,771,3003	1,575,9003	**148,929,7008**
Dennys	3,425,0003	225,4003	7,3003	03	532,8003	0,0003	**4,220,6008**
Ducktr p	68,000	03	03	03	03	03	**68,0008**
E st M chi s	3,448,0003	7,5003	42,6003	03	108,4003	0,4003	**3,637,1008**
Kennebec	314,0003	03	03	03	2003	03	**314,3008**
L mprey	1,593,0003	427,7003	58,8003	03	201,4003	2,8003	**2,313,7008**
M chi s	5,819,0003	99,3003	122,3003	03	191,3003	44,1003	**6,276,0008**
Merrim ck	39,756,000	315,9003	616,9003	03	1,871,9003	638,1003	**43,198,4008**
N rr gu gus	5,779,0003	117,1003	14,6003	03	277,1003	84,0003	**6,272,0008**
P wc tuck	6,275,0003	1,209,2003	268,1003	03	127,5003	5003	**7,880,5008**
Penobscot	24,030,0003	5,674,9003	1,566,6003	03	15,985,7003	2,508,2003	**49,765,6008**
Ple s nt	1,234,0003	16,0003	1,8003	03	63,4003	42,4003	**1,358,0008**
S co	6,492,0003	447,8003	219,2003	0	372,3003	9,5003	**7,540,9008**
Sheepscot	3,125,0003	178,4003	20,6003	03	92,2003	7,1003	**3,423,5008**
St Croix	1,269,0003	470,4003	158,3003	03	808,0003	20,1003	**2,726,3008**
Union	531,000	371,4003	03	0	379,7003	251,0003	**1,532,8008**
Upper StJohn	2,165,0003	1,456,7003	14,7003	03	5,1003	27,7003	**3,669,2008**
TOTALS	**251,001,0008**	**14,223,1008**	**4,980,7008**	**50,8008**	**24,826,3008**	**5,331,7008**	**300,363,3008**

Summaries for ach river vary by length of time series.

Appendix 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 atural reproduction and adults produced from fry releases.

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin									
1983-2000	26	507	6	2	6	83	0	1	**631**
2001	1	4	0	0	0	0	0	0	**5**
2002	0	2	0	0	0	0	0	0	**2**
2003	0	3	0	0	0	0	0	0	**3**
2004	3	7	0	0	0	1	0	0	**11**
2005	2	8	0	0	0	0	0	0	**10**
2006	5	1	0	0	0	0	0	0	**6**
2007	6	11	0	0	1	2	0	0	**20**
2008	8	5	0	0	2	1	0	0	**16**
2009	2	19	0	0	0	3	0	0	**24**
2010	2	5	0	0	0	2	0	0	**9**
Total or Androscoggin	55	572	6	2	9	92	0	1	**737**
Cocheco									
1992-2000	0	0	1	1	5	7	0	0	**14**
2003	0	0	0	0	1	3	0	0	**4**
Total or Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2000	35	3,500	28	2	41	1,293	9	0	**4,908**
2001	1	0	0	0	4	34	1	0	**40**
2002	0	3	0	0	2	38	1	0	**44**
2003	0	0	0	0	0	42	1	0	**43**
2004	0	0	0	0	5	64	0	0	**69**
2005	0	4	0	0	23	159	0	0	**186**
2006	13	33	0	0	20	147	0	1	**214**
2007	0	19	0	0	1	120	1	0	**141**
2008	7	10	0	0	3	118	1	2	**141**
2009	0	18	0	0	0	57	0	0	**75**
2010	0	3	0	0	1	47	0	0	**51**
Total or Connecticut	56	3,590	28	2	100	2119	14	3	**5,912**
Dennys									
1967-2000	20	306	0	1	30	734	3	31	**1,125**
2001	9	2	0	0	1	9	0	0	**21**
2002	2	0	0	0	0	0	0	0	**2**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2003	4	5	0	0	0	1	0	0	**10**
2004	0	1	0	0	0	0	0	0	**1**
2006	2	2	0	0	1	1	0	0	**6**
2007	1	1	0	0	0	1	0	0	**3**
2008	0	1	0	0	1	3	0	3	**8**
2009	0	0	0	0	0	6	1	1	**8**
2010	1	1	0	0	0	4	0	0	**6**
Total or Dennys	39	319	0	1	33	759	4	35	**1,190**
Ducktrap									
1985-2000	0	0	0	0	3	30	0	0	**33**
Total or Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2000	21	250	1	2	12	329	1	10	**626**
Total or East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2000	12	189	5	1	0	9	0	0	**216**
2006	4	6	0	0	3	2	0	0	**15**
2007	2	5	1	0	2	6	0	0	**16**
2008	6	15	0	0	0	0	0	0	**21**
2009	0	16	0	6	1	10	0	0	**33**
2010	0	2	0	0	1	2	0	0	**5**
Total or Kennebec	24	233	6	7	7	29	0	0	**306**
Lamprey									
1979-2000	10	17	1	0	9	16	0	0	**53**
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 or Lamprey	10	17	1	0	13	16	0	0	**57**
Machias									
1967-2000	32	329	9	2	33	1,592	41	131	**2,169**
Total or Machias	32	329	9	2	33	1592	41	131	**2,169**
Merrimack									
1982-2000	242	900	19	8	116	961	26	0	**2,272**
2001	5	73	0	0	2	3	0	0	**83**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**
2007	8	52	0	0	1	12	1	0	**74**
2008	6	77	0	0	5	29	1	0	**118**
2009	4	41	2	0	1	28	2	0	**78**
2010	29	40	0	0	7	7	1	0	**84**
Total or Merrimack	371	1,510	24	8	141	1075	31	0	**3,160**
Narraguagus									
1967-2000	92	648	19	53	79	2,342	68	153	**3,454**
2001	0	2	0	0	5	22	2	1	**32**
2002	0	0	0	1	4	3	0	0	**8**
2003	0	0	0	0	0	21	0	0	**21**
2004	0	0	0	0	1	10	0	1	**12**
2005	0	0	0	0	1	12	0	0	**13**
2006	0	0	0	0	3	12	0	0	**15**
2007	0	0	0	0	2	9	0	0	**11**
2008	0	0	0	0	4	17	1	1	**23**
2009	3	0	0	0	1	5	0	0	**9**
2010	30	33	1	1	3	6	0	2	**76**
Total or Narraguagus	125	683	20	55	103	2459	71	158	**3,674**
Pawcatuck									
1982-2000	2	148	1	0	1	9	0	0	**161**
2003	0	0	0	0	0	5	1	0	**6**
2004	0	0	0	0	0	1	0	0	**1**
2005	0	0	0	0	0	2	0	0	**2**
2006	0	0	0	0	0	0	0	0	**0**
2007	0	2	0	0	0	0	0	0	**2**
2008	0	0	0	0	0	0	0	0	**0**
2009	0	0	0	0	0	0	0	0	**0**
2010	0	0	0	0	0	1	0	0	**1**
Total or Pawcatuck	2	150	1	0	1	18	1	0	**173**
Penobscot									
1968-2000	9,433	39,898	276	659	624	3,445	29	91	**54,455**
2001	195	466	0	3	21	98	2	0	**785**
2002	363	344	0	15	14	41	1	2	**780**
2003	196	847	1	4	6	56	0	2	**1,112**
2004	276	952	10	16	5	59	3	2	**1,323**
2005	269	678	0	8	6	22	0	2	**985**
2006	338	653	1	4	15	33	0	0	**1,044**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2007	226	575	0	1	35	88	0	0	**925**
2008	713	1,295	0	4	23	80	0	0	**2,115**
2009	185	1,683	2	1	12	74	1	0	**1,958**
2010	410	819	0	11	23	53	0	0	**1,316**
Total or Penobscot	12,604	48,210	290	726	784	4049	36	99	**66,798**
Pleasant									
1967-2000	5	12	0	0	12	217	2	2	**250**
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 or Pleasant	5	12	0	0	14	228	3	2	**264**
aco									
1985-2000	89	452	3	5	16	44	3	0	**612**
2001	15	49	0	0	0	5	0	0	**69**
2002	3	37	0	2	3	2	0	0	**47**
2003	2	23	0	0	2	12	0	0	**39**
2004	3	10	0	0	2	4	0	0	**19**
2005	5	12	0	0	1	7	0	0	**25**
2006	8	15	0	0	4	3	0	0	**30**
2007	4	16	0	0	0	4	0	0	**24**
2008	11	26	2	0	8	12	3	0	**62**
2009	1	9	0	0	0	4	0	0	**14**
2010	8	5	0	0	3	4	0	0	**20**
Total or Saco	149	654	5	7	39	101	6	0	**961**
heepscot									
1967-2000	6	38	0	0	30	358	10	0	**442**
Total or Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2000	302	1,815	9	28	1	15	0	0	**2,170**
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**
2005	0	0	0	0	0	0	0	0	**0**
2006	0	0	0	0	0	0	0	0	**0**
2007	0	0	0	0	0	0	0	0	**0**
2008	0	0	0	0	0	0	0	0	**0**
2009	0	0	0	0	0	0	0	0	**0**
2010	0	0	0	0	0	0	0	0	**0**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Total or Union	303	1,821	9	28	1	16	0	0	**2,178**

Appendix 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	55	572	6	2	9	92	0	1	**737**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	56	3,590	28	2	100	2,119	14	3	**5,912**
Denny	39	319	0	1	33	759	4	35	**1,190**
Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec	24	233	6	7	7	29	0	0	**306**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	371	1,510	24	8	141	1,075	31	0	**3,160**
Narraguagu	125	683	20	55	103	2,459	71	158	**3,674**
Pawcatuck	2	150	1	0	1	18	1	0	**173**
Penobscot	12,604	48,210	290	726	784	4,049	36	99	**66,798**
Pleasant	5	12	0	0	14	228	3	2	**264**
Saco	149	654	5	7	39	101	6	0	**961**
Sheepscot	6	38	0	0	30	358	10	0	**442**
Union	303	1,821	9	28	1	16	0	0	**2,178**

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

Year	Total ry (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	.400	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1979	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	9	8	2.022	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1981	5	9	.261	0	0	0		89	0	0	0	0	0	0		89	0	0
1982	3	31	2.429	0	0	0	0	90	0	0	0	0	0	0	0	90	0	0
1983	7		0.143	0	00	0	0	0	0	0	0	0	0	0	00	0	0	0
1984	46		0.022	0	0	0	0	0	00	0	0	0	0	0	0	0	00	0
1985	29	35	.224	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1986	0	27	2.791	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	98	44	0.449	0	6	0	0	68	2	0	4	0	0	0	6	68	6	0
1988	93	92	0.992	0	0	0	0	97		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	3	85	2	0
1990	76	53	0.693	0	3	0	0	87	0	0	0	0	0	0	3	87	0	0
1991	98	25	0.255	0	20	0	0	64	0	0	6	0	0	0	20	64	6	0
1992	93	84	0.904	0		0	0	85		0	3	0	0	0		85	4	0
1993	261	94	0.361	0	0	0	2	87	0	0		0	0	0	2	87		0
1994	393	97	0.502	0	0	0		93	0	0	6	0	0	0		93	6	0

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

Appendix 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	0.1 5	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	2	0	0	0	6	82	2	0
2000	693	43	0.062	0	0	0	0	86	0	0	4	0	0	0	0	86	4	0
2001	699	5	0.165	0	2	0		89	0	2	7	0	0	0	3	90	7	0
2002	490	88	0.179	0	0	0		69		2	6	0	0	0	22	72	7	0
2003	482	02	0.21	0	7	0	2	75		0	5	0	0	0	9	75	6	0
2004	526	74	0.141		9	0	0	86	0	0	3	0	0		9	86	3	0
2005	542	48	0.089	2	2	0	2	92	0	0	2			2	4	92	2	
2006	397	36	0.091	0	0	0	0	00		0				0	0	00		
2007	455	2	0.004	0	50		50							0	00			
2008	424	0	0.000	0										0				
Total	**8,676**	**1,511**																
Mean			**0.499**	**0**	**7**	**0**	**4**	**69**	**4**	**0**	**4**	**0**	**0**	**0**	**11**	**69**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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	.400	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1979	5	3	0.561	0	00	0	0	0	0	0	0	0	0	0	00	0	0	0
1980	29	8	0.630	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1981	7	9	.129	0	0	0		89	0	0	0	0	0	0		89	0	0
1982	29	46	.565	0	0	0	0	89		0	0	0	0	0	0	89		0
1983	23	2	0.088	0	00	0	0	0	0	0	0	0	0	0	00	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 3	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1986	8	28	.592	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	7	51	0.436	0	8	0	0	67	2	0	4	0	0	0	8	67	6	0
1988	31	08	0.825	0	0	0	0	97		0	2	0	0	0	0	97	3	0
1989	24	67	0.539	0	22	0	7	69	0	0		0	0	0	30	69		0
1990	35	68	0.505	0	9	0	0	79	0	0		0	0	0	9	79		0
1991	221	35	0.159	0	7	0	0	63	0	0	20	0	0	0	7	63	20	0
1992	201	8	0.587	0	5	0	0	82		0	2	0	0	0	5	82	3	0
1993	415	85	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 2005 - 2008 year class fish.

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

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

1995	678	43	0.21		3	0	7	78	0	0	2	0	0		20	78	2	0
1996	664	01	0.152	0	6	0		71		0		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	3	0	0	0	4	82	3	0
2000	929	66	0.071	0	6	0	0	80	0	0	4	0	0	0	6	80	4	0
2001	956	51	0.158	0	3	0	3	88	0		5	0	0	0	5	89	5	0
2002	725	65	0.228		0	0	2	72			3	0	0		22	73	4	0
2003	700	46	0.208		3	0	2	70		0	4	0	0		25	70	5	0
2004	765	21	0.158			0	0	86	0	0	2	0	0			86	2	0
2005	776	63	0.081	2	3	0	5	79	0	0	2			2	7	79	2	
2006	581	48	0.083	0	8	0	0	92		0				0	8	92		
2007	631	3	0.005	0	67		33							0	00			
2008	601	0	0.000	0										0				
Total	**12,580**	**2,232**																
Mean			**0.390**	**0**	**13**	**0**	**4**	**67**	**2**	**0**	**5**	**0**	**0**	**0**	**17**	**67**	**6**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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	.034	0	00	0	0	0	0	0	0	0	0	0	00	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	7	5	0.902	0	0	0	0	87	3	0	0	0	0	0	0	87	3	0
1983	6		0.064	0	00	0	0	0	0	0	0	0	0	0	00	0	0	0
1984	3	2	0.156	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0
1985	4	2	0.881	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1986	8		0.126	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
1988	33	3	0.391	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1989	28	9	0.680	0	63	0		26	0	0	0	0	0	0	74	26	0	0
1990	27		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	5	0.271	0	20	0	0	67	0	0	3	0	0	0	20	67	3	0
1993	77	52	0.673	0	3	0	6	77	0	0	4	0	0	0	9	77	4	0
1994	0	49	0.447	0	31	0	4	63	0	0	2	0	0	0	35	63	2	0
1995	5	42	0.367	2	38	0	5	52	0	0	2	0	0	2	43	52	2	0
1996	91	9	0.208	0	58	0		26	0	0	5	0	0	0	68	26	5	0
1997	48	4	0.027	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1998	9	2	0.017	0	0	0	0	00	0	0	0	0	0	0	0	00	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 2005 - 2008 year class fish.

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

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

2000	25	9	0.072	0	0	0	0	89	0	0		0	0	0	0	89		0
2001	25	2	0.096	0	8	0	7	75	0	0	0	0	0	0	25	75	0	0
2002	9	22	0.185	5	5	0	4	77	0	0	0	0	0	5	8	77	0	0
2003	2	8	0.071	0	38	0	25	38	0	0	0	0	0	0	63	38	0	0
2004	8		0.093	0	8	0	0	82	0	0	0	0	0	0	8	82	0	0
2005	24	2	0.097	0	58	0	8	33	0	0	0			0	67	33	0	
2006	86	5	0.058	0	60	0	0	40		0				0	60	40		
2007	91		0.01	0	00		0							0	00			
2008	88	0	0.000	0										0				
Total	**2,025**	**349**																
Mean			**0.272**	**0**	**28**	**0**	**3**	**56**	**0**	**0**	**8**	**0**	**0**	**0**	**31**	**56**	**9**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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		8	.698	0	0	0	0		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	4	0
1980	3	42	3.333	0	0	0	0	9	5	9	52	5	0	0	0	38	57	5
1981	6	78	3.684	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	0	0	0	0	2	79	9	0
1983		23	27.479	0	4	4	7	65	4	0	4	0	0	0	22	70	9	0
1984	53	47	0.894	0	3	0	4	77	2	0	4	0	0	0	7	77	6	0
1985	5	59	3.986	0	2	0	7	69	2	0	20	0	0	0	8	69	22	0
1986	53		2.1 4	0		0	0	77		0	9	0	2	0		77	0	2
1987	08	264	2.449	0	2	0	9	85	0	0	4	0	0	0		85	4	0
1988	72	93	0.541		5	0	0	90	0	0	3	0	0		5	90	3	0
1989	03	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	0	81	0	0	5	0	0	5	0	81	5	0
1991	46	7	0.1 7	0	6	0	6	76	2	0	0	0	0	0	2	76	2	0
1992	2	5	0.134	0	0	0	0	93	7	0	0	0	0	0	0	93	7	0
1993	6		0.095	0	0	0	27	45	0	9	8	0	0	0	27	55	8	0
1994	282	53	0.188	0	0	0	3	85	0	0	2	0	0	0	3	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 2005 - 2008 year class fish.

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

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

1996	80	27	0.150	0	0	0	5	85	0	0	0	0	0	0	5	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	76	8	0.046	0	0	0	3	50	0	0	38	0	0	0	3	50	38	0
2000	222	2	0.054	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
2001	71	5	0.029	0	0	0	40	20	0	0	40	0	0	0	40	20	40	0
2002	41	8	0.057	0	0	0	0	88	3	0	0	0	0	0	0	88	3	0
2003	33	20	0.150	0	0	0	30	60	5	0	0	5	0	0	30	60	5	5
2004	56	35	0.225	0	0	0	3	83	3	6	6	0	0	0	3	89	9	0
2005	96	32	0.332	0	0	0	9	81	3	0	6			0	9	81	9	
2006	01	5	0.049	0	0	0	20	80		0				0	20	80		
2007	4	8	0.070	0	3		88							0	00			
2008	77	0	0.000	0										0				
Total	**3,722**	**1,247**																
Mean			**2.179**	**0**	**2**	**0**	**13**	**64**	**3**	**2**	**9**	**1**	**0**	**0**	**15**	**66**	**12**	**1**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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	00	0	0	0	0	0	0	0	00	0	0
1994	56	2	0.036	0	0	0	0	00	0	0	0	0	0	0	0	00	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	0	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	00	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	00	0	0	0	0	0	0	0	00	0	0
2002	40	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	31	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	56	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005			.923	0	0	0	0	0	0	0	00			0	0	0	00	
2006	8	0	0.000	0	0	0	0	0		0				0	0	0		
2007	2	0	0.000	0	0		0							0	0			
2008	31	0	0.000	0										0				
Total	**574**	**20**																
Mean			**0.148**	**0**	**3**	**1**	**1**	**36**	**0**	**0**	**8**	**0**	**0**	**0**	**5**	**38**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

Appendix 18.8: Return rates for Atlantic salmon that were stocked as fry in the Penobscot River .

Year	Total ry (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	0	76	8.000	0	0	0	39	33	7		20	0	0	0	39	34	26	0
1980	0	25	0.000	0	0	0	2	89		2	6	0	0	0	2	91	6	0
1981	20	410	20.297	0	0	0	6	79		2		0	0	0	6	81	2	0
1982	25	478	9.274	0	0	0	4	89		2	5	0	0	0	4	90	6	0
1983	0	82	0.000	0	0	0	8	79	0	8	5	0	0	0	8	87	5	0
1984	8	00	2.500	0	0	0	25	66		5	3	0	0	0	25	71	4	0
1985	20	71	8.680	0	0	0		62	2	6	9	0	0	0		68	20	0
1986	23	332	4.690	0	0	0	20	62	0	5	3	0	0	0	20	67	3	0
1987	33	603	8.108	0	0	0	5	72	0	2	2	0	0	0	5	73	2	0
1988	43	219	5.081	0	0	0	6	78	0	0	6	0	0	0	6	78	7	0
1989	8	2	4.545	0	0	0	20	75	0	3	3	0	0	0	20	78	3	0
1990	32	8	3.722	0	0	0	9	76	0	3	3	0	0	0	9	79	3	0
1991	40	26	3.166	0	0	0	30	59	2	0	9	0	0	0	30	59		0
1992	93	315	3.405	0	0	0	2	93			4	0	0	0	2	94	4	0
1993	32	58	.197	0	0	0	5	89	0		4	0	0	0	5	91	4	0
1994	95	53	.612	0	0	0		82	0	4	2	0	0	0		86	2	0
1995	50	32	2.629	0	0	0	9	67	0	5	8	0	0	0	9	73	8	0
1996	24	7	0.942	0	0	0	36	50	2	7	6	0	0	0	36	56	8	0
1997	47	5	0.781	0	0	0	7	79		8	5	0	0	0	7	87	6	0
1998	93	49	0.527	0	0	0	24	71	0	0	2	2	0	0	24	71	2	2
1999	50	79	0.527	0	0	0	8	70	3	0	0	0	0	0	8	70	3	0

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

Appendix 18.8: Return rates for Atlantic salmon that were stocked as fry in the Penobscot River .

2000	51	63	.228	0	0	0	0	81	0	2	8	0	0	0	0	83	8	0
2001	36	24	0.659	0	0	0	7	71	0	8	4	0	0	0	7	79	4	0
2002	75	40	0.536	0	0	0	0	80	0	0	0	0	0	0	0	80	0	0
2003	74	06	.430	0	0	0	4	79	0	2	5	0	0	0	4	81	5	0
2004	81	7	0.646	0	0	0	28	64		0	7	0	0	0	28	64	8	0
2005	90	91	0.479	0	0	0	25	73	0	2	0			0	25	75	0	
2006	51	66	0.437	0	0	0	5	80		5				0	5	85		
2007	61	20	0.125	0	0		00							0	00			
2008	25	0	0.000	0										0				
Total	**2,188**	**4,697**																
Mean			**4.841**	**0**	**0**	**0**	**19**	**73**	**1**	**3**	**7**	**0**	**0**	**0**	**19**	**76**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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	2	2	0.165	0	00	0	0	0	0	0	0	0	0	0	00	0	0	0
1988	4	3	0.693	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1989		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	2	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993		2	0.190	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24		0.041	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1996	25	5	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		0.039	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
1999	3	6	0.454	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
2000	28	3	0.108	0	00	0	0	0	0	0	0	0	0	0	00	0	0	0
2001	25	4	0.160	0	0	0	0	00	0	0	0	0	0	0	0	00	0	0
2002	26	21	0.799	0	0	0	24	67	0	0	0	0	0	0	33	67	0	0
2003	25	3	0.526	8	38	0	8	46	0	0	0	0	0	8	46	46	0	0
2004	28	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	26	2	0.076	0	0	0	0	00	0	0	0			0	0	00	0	
2006	25	3	0.1 9	0	33	0	0	67		0				0	33	67		
2007	28	0	0.000	0	0		0							0	0			

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

2008	27	0	0.000	0										0				
Total	**432**	**87**																
Mean			**0.209**	**0**	**20**	**0**	**3**	**56**	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**56**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year	Total ry (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		0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989			0.095	0	0	0	0	00	0	0	0	0	0	0	0	00	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	5	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	00	0	0	0	0	0	0	0	00	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	7	0.192	0	0	0	8	82	0	0	0	0	0	0	8	82	0	0
1996	71	2	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	00	0	0	0	0	0	0	0	00	0	0
1998	02	8	0.078	0	0	0	25	63	0	0	3	0	0	0	25	63	3	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84		0.131	0	9	0	0	73	0	0	8	0	0	0	9	73	8	0
2001	07	20	0.188	0	5	0	5	90	0	0	0	0	0	0	0	90	0	0
2002	89	34	0.381	0	5	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	7	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0		0	0	86	0	0	3	0	0	0		86	3	0
2005	84		0.012	0	0	0	00	0	0	0	0			0	00	0	0	
2006	73	4	0.055	0	0	0	0	00		0				0	0	00		
2007	57	0	0.000	0	0		0							0	0			
2008	63	0	0.000	0										0				

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Total	**1,447**	**285**																	
Mean			**0.187**	**0**	**4**	**0**	**9**	**76**	**0**	**0**	**6**	**0**	**0**	**0**	**13**	**76**	**6**	**0**	

Mean return rate computation includes incomplete return rates for 2005 - 2008 year class fish.

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

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

Year S ocked	Number of adul re urns per 10,000 fry s ocked							
	MK	**PW**	**CT**	**CTAH**	**SAL**	**FAR**	**WE**	**PN**
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	.584		0.561	0.000		1.034		8.000
1980	3.333		0.630	2.022		0.000		0.000
1981	13.684		1.129	1.261		0.000		20.297
1982	9.600		1.565	2.429		0.902		19.274
1983	27.479		0.088	0.143		0.064		0.000
1984	0.894		0.051	0.022		0.156		12.500
1985	3.986		1.113	1.224		0.881		8.680
1986	2.114		1.592	2.791		0.126		14.690
1987	2.449		0.436	0.449	0.165	0.740		18.108
1988	0.541		0.825	0.992	0.693	0.391	0.000	.081
1989	0.435		0.539	0.629	0.000	0.680	0.095	14.545
1990	0.215		0.505	0.693	0.000	0.407	0.146	3.722
1991	0.117		0.159	0.25	0.000	0.054	0.099	3.166
1992	0.134		0.587	0.904	0.322	0.271	0.373	3.405
1993	0.095	0.078	0.446	0.361	0.190	0.673	0.5 9	1.197
1994	0.188	0.036	0.495	0.502	0.166	0.447	0.652	1.612
1995	0.308	0.136	0.211	0.184	0.041	0.367	0.192	2.629
1996	0.150	0.000	0.152	0.115	0.607	0.208	0.170	0.942
1997	0.020	0.000	0.044	0.041	0.134	0.027	0.066	0.781
1998	0.031	0.000	0.048	0.050	0.039	0.017	0.078	0.527
1999	0.046	0.085	0.070	0.072	0.454	0.020	0.056	0.527
2000	0.054	0.061	0.071	0.062	0.108	0.072	0.131	1.228
2001	0.029	0.047	0.158	0.165	0.160	0.096	0.188	0.659
2002	0.057	0.000	0.228	0.179	0.799	0.185	0.381	0.536
2003	0.150	0.000	0.208	0.211	0.526	0.071	0.284	1.430
2004	0.225	0.000	0.158	0.141	0.000	0.093	0.389	0.646
2005	0.332	1.923	0.081	0.089	0.076	0.097	0.012	0.479
2006	0.049	0.000	0.083	0.091	0.119	0.058	0.05	0.437
2007	0.070	0.000	0.005	0.004	0.000	0.011	0.000	0.125
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Year S ocked	Number of adul re urns per 10,000 fry s ocked							
	MK	PW	CT	CTAH	SAL	FAR	WE	PN
Mean	**2.179**	**0.148**	**0.390**	**0.499**	**0.209**	**0.272**	**0.187**	**4.841**
S ndDev	**5.355**	**0.475**	**0.464**	**0.720**	**0.247**	**0.311**	**0.186**	**6.461**

Note: MK = Merrimack, PW = Pawcatuck, CT = Connecticut (basin), CTAH = Connecticut (above Holyoke), SAL = Salmon, FAR = Farmington, WE = Westfield, PN = Penobscot. Maine rivers not included in this table until adult returns from natural reproduction and fry stocking can be distinguished. Return rates (returns/10,000 fry) are calculated from stocked fry numbers and do not include any natural fry production.

Note: Summary mean and standard deviation computations includes incomplete return rates from 2005 (5 year olds), 2006 (4 year olds), 2007 (3 year olds), and 2008 (2 year olds).

Appendix 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**	**46**	**5**	
Connecticut (basin)	0.00	0.08	0.00	0.04	0.82	0.01	0.00	0.05	0.00	0.00	0.00	0.12	0.82	0.05	0.00
Connecticut (above Holyoke)	0.00	0.04	0.00	0.03	0.87	0.01	0.00	0.05	0.00	0.00	0.00	0.07	0.87	0.06	0.00
Farmington	0.01	0.26	0.00	0.05	0.63	0.01	0.00	0.04	0.00	0.00	0.01	0.32	0.63	0.04	0.00
Salmon	0.01	0.23	0.00	0.13	0.63	0.00	0.00	0.00	0.00	0.00	0.01	0.36	0.63	0.00	0.00
Westfield	0.00	0.06	0.00	0.05	0.86	0.00	0.00	0.04	0.00	0.00	0.00	0.10	0.86	0.04	0.00
Penobscot	0.00	0.00	0.00	0.13	0.75	0.01	0.03	0.08	0.00	0.00	0.00	0.13	0.78	0.09	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	0.80	0.00	0.00	0.05	0.00	0.00	0.00	0.10	0.85	0.05	0.00
Overall Mean:	**0.00**	**0.09**	**0.01**	**0.07**	**0.76**	**0.01**	**0.01**	**0.05**	**0.00**	**0.00**	**0.00**	**0.17**	**0.78**	**0.05**	**0.00**

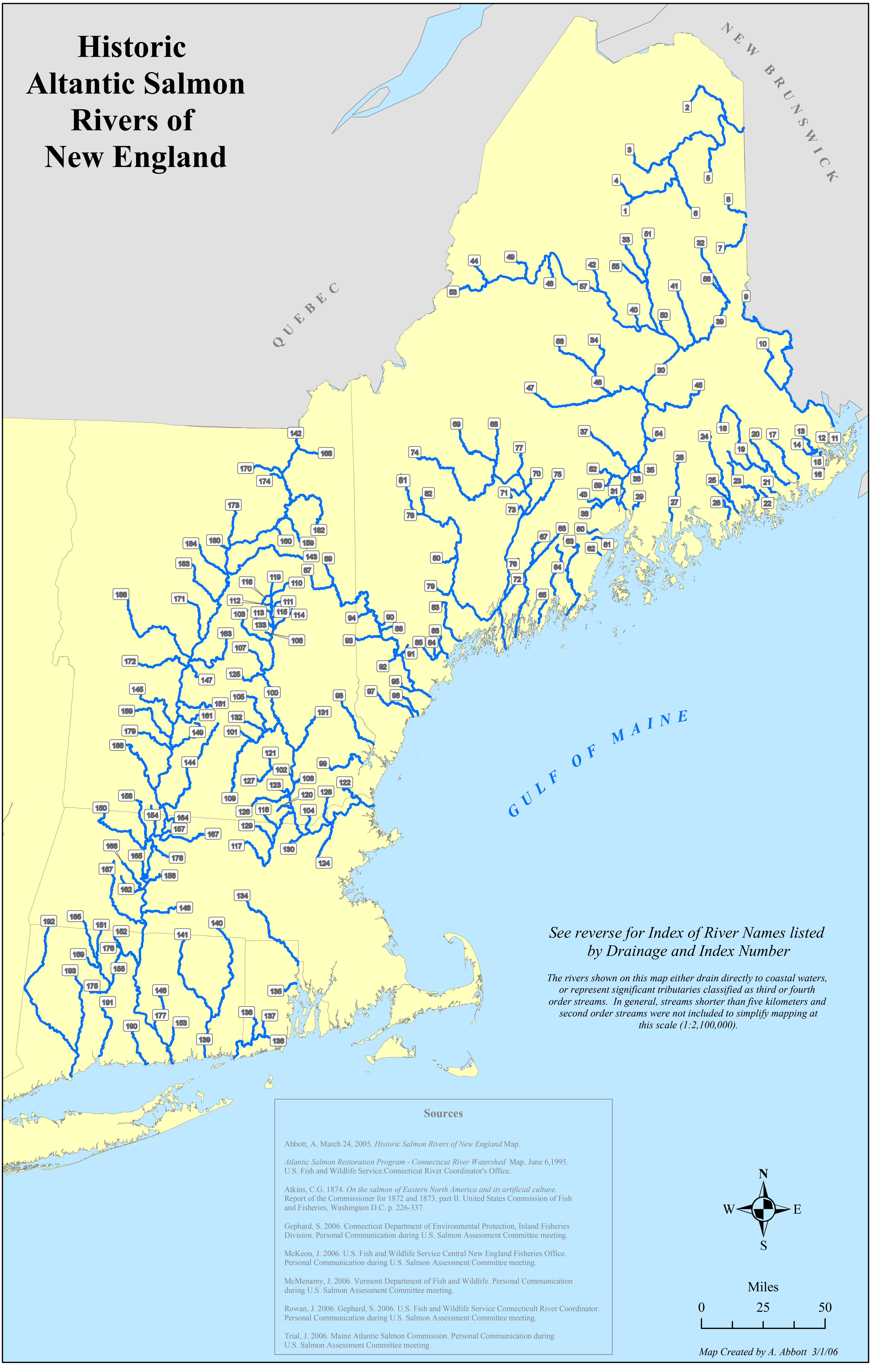
Program summary age distributions vary in time series length; refer to specific tables for numbers of years utilized.

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

Historic Atlantic Salmon Rivers of New England – Index

Drainage	River Name	Index
Aroostook	Aroostook River	1
	Little Madawaska River	2
	Big Machias River	3
	Mooseleuk Stream	4
	Presque Isle Stream	5
	Saint Croix Stream	6
St. John	Meduxnekeag River	7
	North Branch Meduxnekeag River	8
St. Croix	Saint Croix River	9
	Tomah Stream	10
Boyden	Boyden Stream	11
Pennamaquan	Pennamaquan River	12
Dennys	Dennys River	13
	Cathance Stream	14
Hobart	Hobart Stream	15
Orange	Orange River	16
East Machias	East Machias River	17
Machias	Machias River	18
	Mopang Stream	19
	Old Stream	20
Chandler	Chandler River	21
Indian	Indian River	22
Pleasant	Pleasant River	23
Narraguagus	Narraguagus River	24
	West Branch Narraguagus River	25
Tunk	Tunk Stream	26
Union	Union River	27
	West Branch Union River	28
Penobscot	Orland River	29
	Penobscot River	30
	Cove Brook	31
	East Branch Mattawamkeag River	32
	East Branch Penobscot River	33
	East Branch Pleasant River	34
	Eaton Brook	35
	Felts Brook	36
	Kenduskeag Stream	37
	Marsh Stream	38
	Mattawamkeag River	39
	Millinocket Stream	40
	Molunkus Stream	41
	Nesowadnehunk Stream	42
	North Branch Marsh Stream	43
	North Branch Penobscot River	44
	Passadumkeag River	45
	Pine Stream	46
	Piscataquis River	47
	Pleasant River (Penobscot)	48
	Russell Stream	49
	Salmon Stream	50
	Seboeis River	51
	Souadabscook Stream	52
	South Branch Penobscot River	53
	Sunkhaze Stream	54
	Wassataquoik Stream	55
	West Branch Mattawamkeag River	56
	West Branch Penobscot River	57
	West Branch Pleasant River	58
	West Branch Souadabscook Stream	59
Passagassawakeag	Passagassawakeag River	60
Little	Little River	61
Ducktrap	Ducktrap River	62
Saint George	Saint George River	63
Medomak	Medomak River	64
	Pemaquid River	65
Sheepscot	Sheepscot River	66
	West Branch Sheepscot River	67
Kennebec	Kennebec River	68
	Carrabassett River	69
	Carrabassett Stream	70
	Craigin Brook	71
	Eastern River	72
	Messalonskee Stream	73
	Sandy River	74
	Sebasticook River	75
	Togus Stream	76
	Wesserunsett Stream	77
Androscoggin	Androscoggin River	78
	Little Androscoggin River	79
	Nezinscot River	80
	Swift River	81
	Webb River	82
Royal	Royal River	83
Presumpscot	Presumpscot River	84
	Mill Brook (Presumpscot)	85
	Piscataqua River (Presumpscot)	86
Saco	Saco River	87
	Breakneck Brook	88
	Ellis River	89
	Hancock Brook	90
	Josies Brook	91
	Little Ossipee River	92
	Ossipee River	93
	Shepards River	94
	Swan Pond Brook	95
Kennebunk	Kennebunk River	96
Mousam	Mousam River	97
Cocheco	Cocheco River	98
Lamprey	Lamprey River	99
Merrimack	Merrimack River	100
	Amey Brook	101
	Baboosic Brook	102
	Baker River	103
	Beaver Brook	104
	Blackwater River	105
	Bog Brook	106
	Cockermouth River	107
	Cohas Brook	108
	Contoocook River	109
	East Branch Pemigewasset River	110
	Eastman Brook	111
	Glover Brook	112
	Hubbard Brook	113
	Mad River	114
	Mill Brook (Merrimack)	115
	Moosilauke Brook	116
	Nashua River	117
	Nissitissit River	118
	Pemigewasset River	119
	Pennichuck Brook	120
	Piscataquog River	121
	Powwow River	122
	Pulpit Brook	123
	Shawsheen River	124
	Smith River	125
	Souhegan River	126
	South Branch Piscataquog River	127
	Spicket River	128
	Squannacook River	129
	Stony Brook	130
Merrimack	Suncook River	131
	Warner River	132
	West Branch Brook	133
Blackstone	Blackstone River	134
Pawtuxet	Pawtuxet River	135
Pawcatuck	Pawcatuck River	136
	Beaver River	137
	Wood River	138
Thames	Thames River	139
	Quinebaug River	140
	Shetucket River	141
Connecticut	Connecticut River	142
	Ammonoosuc River	143
	Ashuelot River	144
	Black River	145
	Blackledge River	146
	Bloods Brook	147
	Chicopee River	148
	Cold River	149
	Deerfield River	150
	East Branch Farmington River	151
	East Branch Salmon Brook	152
	Eightmile River	153
	Fall River	154
	Farmington River	155
	Fort River	156
	Fourmile Brook	157
	Green River	158
	Israel River	159
	Johns River	160
	Little Sugar River	161
	Manhan River	162
	Mascoma River	163
	Mill Brook (Connecticut)	164
	Mill River (Hatfield)	165
	Mill River (Northhampton)	166
	Millers River	167
	Mohawk River	168
	Nepaug River	169
	Nulhegan River	170
	Ompompanoosuc River	171
	Ottauquechee River	172
	Passumpsic River	173
	Paul Stream	174
	Pequabuck River	175
	Salmon Brook	176
	Salmon River	177
	Sawmill River	178
	Saxtons River	179
	Stevens River	180
	Sugar River	181
	Upper Ammonoosuc River	182
	Waits River	183
	Wells River	184
	West Branch Farmington River	185
	West River	186
	Westfield River	187
	White River	188
	Williams River	189
Hammonasset	Hammonasset River	190
Quinnipiac	Quinnipiac River	191
Housatonic	Housatonic River	192
	Naugatuck River	193

Historic Altantic Salmon Rivers of New England



See reverse for Index of River Names listed by Drainage and Index Number

The rivers shown on this map either drain directly to coastal waters, or represent significant tributaries classified as third or fourth order streams. In general, streams shorter than five kilometers and second order streams were not included to simplify mapping at this scale (1:2,100,000).

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