U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE

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1.0 Executive Summary

1.1 Abstract

Total return to USA rivers was 2,336; this is the sum of documented returns to traps and returns estimated on selected Maine rivers. Adult salmon returns to USA rivers with traps or weirs totaled 2,194 in 2009, 12% fewer than observed in 2008 and 80% more than returned in 2007. Estimated to return to Gulf of Maine coastal rivers was 160 (90% CI = 114 - 217) adult salmon, the 8th highest for the 1991-2009 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 93% of the total return. Overall, 10% of the adult returns to the USA were 1SW salmon and 90% 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 11,665,000 juvenile salmon (fry, parr, and smolts), 4,011 adults, and 139,700 eggs were stocked, with 601,759 carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 377 sea-run females, 3,448 captive/domestic females, and 119 female kelts. The number of females (3,944) contributing was greater than 2008 (3,480); however total egg take (20,623,000) was lower than 2008 (29,579,000). Production of farmed salmon in Maine was reported to be 6,028 metric tonnes in 2009, approximately two thirds of the 9,014 metric tonnes of production reported in 2008.

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 1,535 broodstock in 2009.

1.3 Adult Returns

Total return to USA rivers was 2,336 (Table 1.3.1), an 11% decrease from 2008 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 2008 within areas were: LIS (- 47%), CNE (- 49%), GOM (- 5%). For the larger rivers changes from 2008 were: Connecticut (- 47%), Saco (- 44%), Merrimack (-34%), Penobscot (-8%). In addition to catches at traps and weirs (2,194), the return of 160 (90% CI = 114 - 217) 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 84% of the total return. Overall, 31% of the adult returns to the USA were 1SW salmon and 69% 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). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2007 was 0.43%, with the 2SW fish return rate 0.30% (Figure 1.3.2). Smolt survival on the Penobscot River correlates well with other large restoration programs in the Connecticut and Merrimack rivers. The estimated return rate for 2SW adults from the 2007 cohort of wild smolts on the Narraguagus was 1.98% (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 7.1 % of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.9 to 12.2 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2009 about 11,664,700 juvenile salmon (91% fry) were released into 15 River systems (Table 1.4.1). The number of juveniles released was less than that in 2008 (13,114,400). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six coastal rivers within the GOM area Maine. The 230,500 parr released in 2009 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 (49,000), CNE Merrimack (91,000), and GOM Penobscot (560,000). In addition to juveniles, 4,011 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 2009 with USA spawners totaling 2,560. Escapement to natural spawning areas was 1,722 (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 601,759 salmon released into USA waters in 2009 was marked or tagged. Tags and marks for parr, smolts and adults included: Floy, Carlin, PIT, radio, acoustical, fin clips, and visual implant elastomer. About 11% of the marked fish were released into the LIS area and 77% into rivers in the GOM area (Table 1.5.1).

1.6 Farm Production

Production of farmed salmon in Maine was reported to be 6,028 metric tonnes in 2009, approximately two thirds of the 9,014 metric tonnes of production reported in 2008 (Table 1.6.1).

1.7 Expanded geographic range of the Endangered populations

A final rule published on June 19, 2009 in the Federal Register (74 FR 29344-29387) expanded Endangered status under the Endangered Species Act (ESA) to all anadromous Atlantic salmon whose freshwater range covers the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, an area which includes the Penobscot and Kennebec rivers. It also applies wherever these fish occur in these rivers' estuaries and marine environment. Hatchery fish used to supplement these natural populations are also included under this listing. As an endangered species, the Gulf of Maine Distinct Population Segment of Atlantic salmon (GOM DPS) receives the full protection of the ESA, including a prohibition against take; take is defined to include harass, harm, pursue, wound, kill, trap, capture, or collect.

1.8 USA Aquaculture Marks

Starting July 30, 2009, the Maine salmon farming industry was required to mark all salmon placed in marine net pens to allow a fish to be linked to a specific rearing site. The Maine Atlantic salmon farming industry has used a variety of marking techniques to comply with these permit requirements in the past and eventually chose genetic marking (e.g., parentage assignments) to achieve the benchmark for mark detection of greater than 95% set by USA Federal Fisheries Agencies. Quality Assurance and Quality Control (QA/QC) audits are used to validate mark detection rates and Chain of Custody documentation prior to stocking (FW hatchery) and immediately following stocking into marine net pens. In 2005, assignment to parents was 93% accurate based on a panel of five markers. In 2009, after several changes in the marker panel and assignment software, parentage accuracy was 100% for QA/QC audits. This genetic based marking system will enable tracking fish through the complete production cycle and will provide sufficient information to identify the facility where the fish was reared.

Table 1.3.1 Documented Atlantic salmon returns to USA by geographic area, 2009. "Natural" includes fish originating from natural spawning and hatchery fry.

Area	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
Long Island Sound LIS	0	0	18	57	0	0	0	0	75
Central New England CNE	5	1	50	32	2	2	0	0	92
Gulf of Maine GOM [1]	197	38	1718	194	2	10	1	9	2169

[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, 1967-2009. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

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

Table 1.3.3 Two sea winter (2SW) returns for 2009 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2009	Percentage of Requirement
Long Island Sound	LIS	10,094	82	1%
Central New England	CNE	3,435	75	2%
Gulf of Maine	GOM	15,670	1,912	12%
Total		29,199	2,069	7%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2009. 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	6,562,000	4,000	0	14,000	5,000	49,000	6,635,000
Central New England	CNE	2: Merrimack, Saco	1,052,000	0	22,000	0	114,000	0	1,188,000
Gulf of Maine	GOM	10: Androscoggin to Dennys	2,580,000	18,000	172,000	0	613,000	900	3,384,000
Outer Bay of Fundy	OBF	1: Aroostook	458,000	0	0	0	0	0	458,000
Totals for USA		15	10,652,000	22,000	194,000	14,000	732,000	49,900	11,665,000

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2009 by geographic area.

		Captive Reared Domestic		Sea Run		Eggs	
River	Purpose	Pre-spawn	Post-spawn	Post-spawn	Total	Eyed	Green
Central New England CNE	Restoration/Recreation	760	775		1,535		
Culf of MaineGOM	Restoration	225	1,708	543	2,476	129,700	10,000

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2009.

Mark Code	Life Stage	LIS	CNE	GOM	Total
AD	Adult			1,054	1,054
AD	Parr	14,413		17,925	32,338
AD	Smolt	52,764	64,317		117,081
FLOY	Adult		1,535		1,535
FLOY	Smolt	900			900
LV	Parr			172,235	172,235
PING	Smolt			404	404
PIT	Adult			1,514	1,514
PIT	Smolt			1,122	1,122
RAD	Adult	9			9
RAD	Smolt	150			150
TEMP	Fry			42,544	42,544
VIA	Smolt			10	10
VIE	Smolt			230,863	230,863
					601,759

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

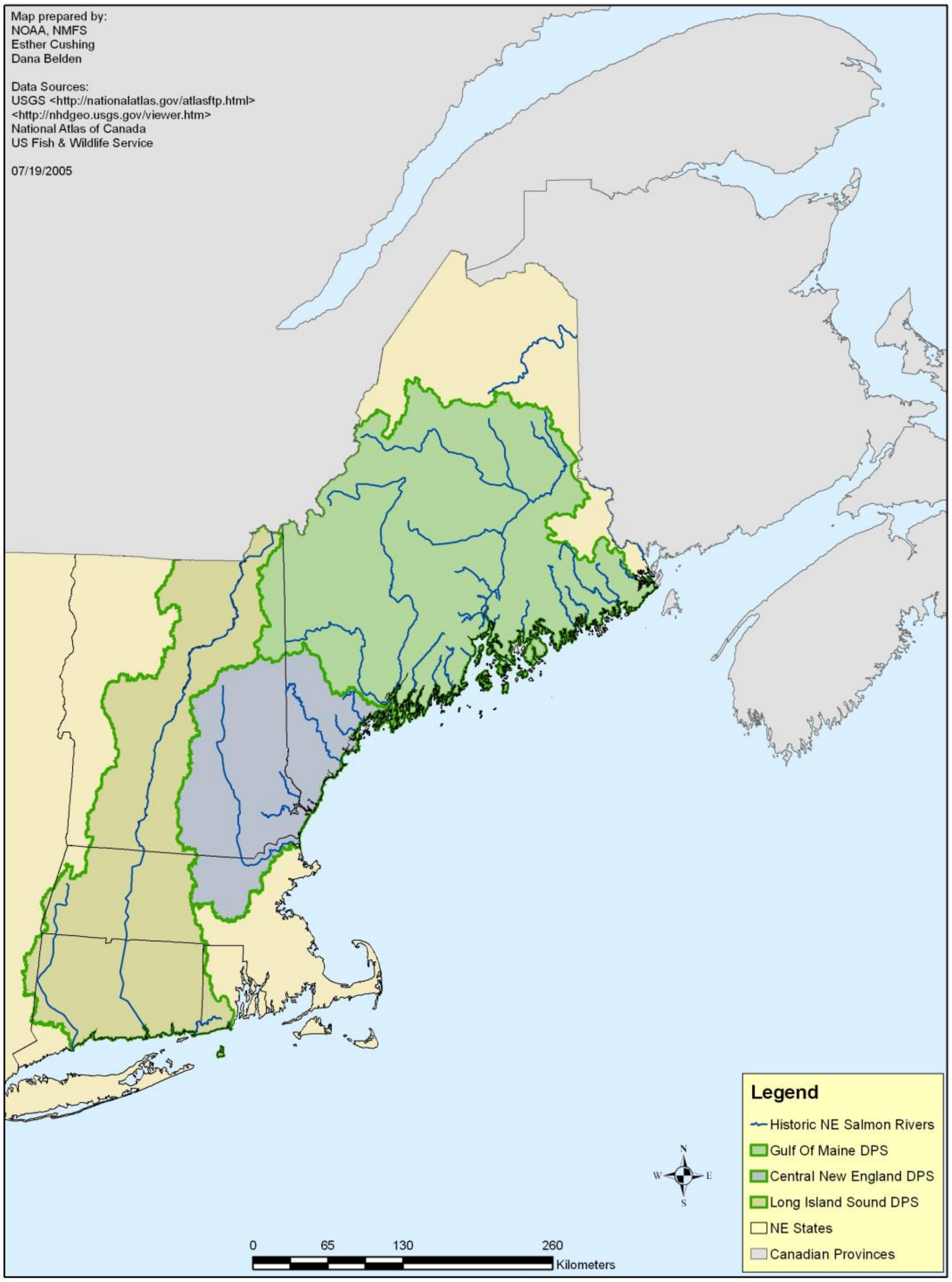


Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2009.

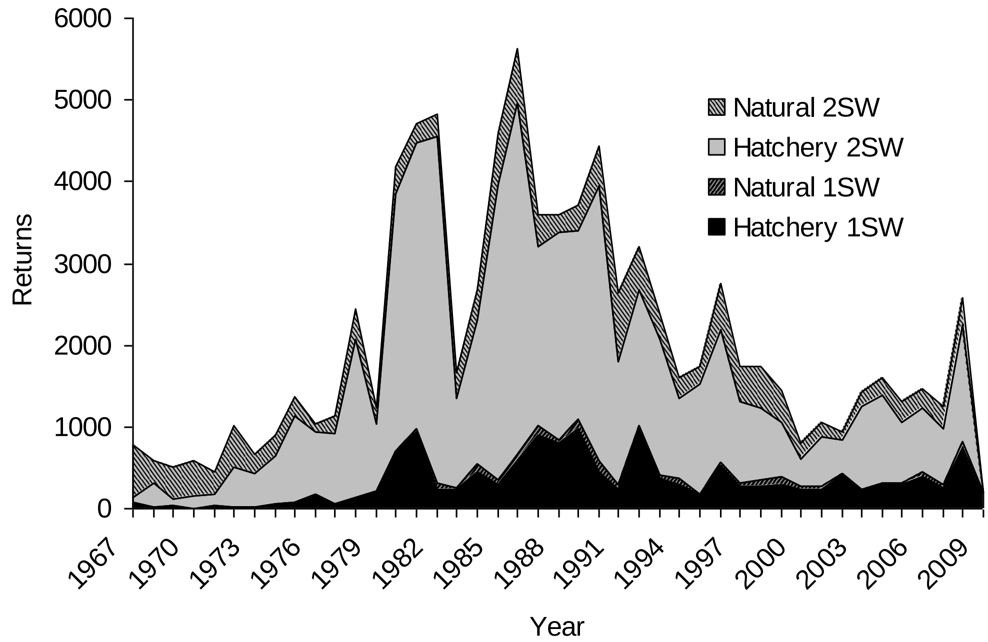


Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2009.

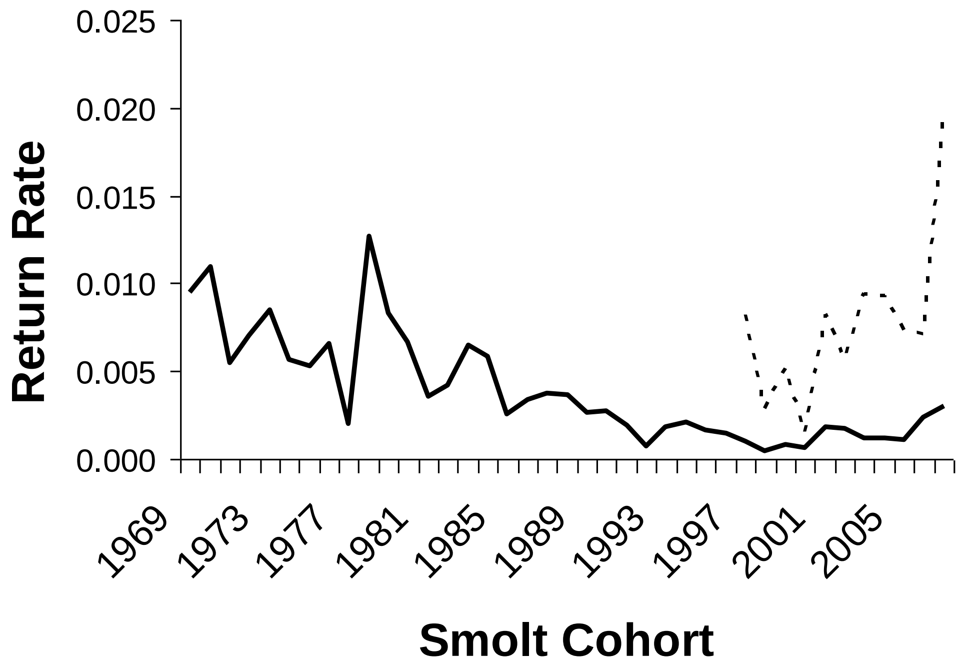


Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2.0 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, they ranged from the Ungava Bay southward to Long Island Sound (Figure 2.1.1). As a consequence of human development, many native New England populations were extirpated. Salmon life history is complex owing to its use of both headwater streams and distant marine habitats (Figure 2.1.2). The typical pattern 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 one to three years. When parr exceed 13 cm in the autumn, they develop into smolts overwinter and 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 or 1SW fish. 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 three sea-winter and repeat-spawning salmon life history patterns becoming rarer (< 5%) with declining stock size.

Strong homing capabilities of Atlantic salmon foster the formation and maintenance of local breeding groups- stocks. 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. Because of significant declines in Atlantic salmon populations in the US, 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. Numerous ecological classification systems were examined which integrated the many factors necessary to discern historic structure (Colligan et al. 1999; Fay et al. 2006). Biologists then delineated US Atlantic salmon populations into four discrete areas that are now managed in differing manners: 1) Long Island Sound Area; 2) Central New England Area; 3) Gulf of Maine Distinct Population Segment and the 4) Outer Bay of Fundy Salmon Fishing Area (Figure 2.1.1). Both the Long Island Sound and Central New England Areas native stocks were extirpated in the 1800's. Remnant native populations of Atlantic salmon in the United States now persist only in Maine in the endangered Gulf of Maine DPS and cross-boundary headwater populations from the Outer Bay of Fundy SFA.

As such, the Gulf of Maine DPS is managed under a recovery program under the ESA. The southern New England Areas are managed under coordinated Federal and Interstate restoration efforts, in the form of stocking and fish passage construction. While, Atlantic salmon stocks from the Penobscot River in Maine were used in the restoration programs in the Connecticut (Long Island Sound DPS) and in the Merrimack and Saco in the (Central New England DPS) these programs are now genetically isolated.

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 is moving forward with a species level assessment of Atlantic salmon in eastern Canada expected to be complete by November, 2010. Sixteen Designatable Units (DUs) and two of these the outer Bay of Fundy (oBoF) and the Southern Uplands (SU) are of particular concern and proactive 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 1600's with records of catch by various methods. Around the time of the American Revolution, weirs became the gear of choice and were modified as 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 1900's (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. Reportedly, the first Atlantic salmon 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 USA 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 by Maine, 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 that 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 completed in 1997 by 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. Effectively this 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 United States is a member. The mixed-stock fisheries in Canada were managed by time-area closures and quotas, however all commercial fisheries for Atlantic salmon in Canada 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 1993-1994, 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 due to continued low spawner abundance since 2002. Starting in 2003, the annual regulatory measures agreed on at NASCO have restricted the annual harvest to that amount used for internal consumption in Greenland, which in the past has been estimated at 20 tons 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 multi-annual 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 multi-annual 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 once 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 as a result of a disease outbreak (Infectious Salmon Anemia) that forced the destruction of large numbers of fish and also a federal judge fining two Maine producers for violating the federal Clean Water Act by fouling the sea floor with excess feed, medications, feces, and other pollutants. With tougher regulations and innovative bay area management creating fallowing areas, farmers have increased production again and gains are expected to continue (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.

2.3 Research Vessel Survey Indices

Atlantic salmon in the ocean are pelagic, highly surface oriented and of relatively limited abundance within a large expansive area and therefore 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. Since 2001, a total of 4,000 postsmolts have been collected and sampled. All postsmolts were counted, weighed and measured. The presence of any marks and clips were also recorded as well as their external appearance in terms of fin condition and deformities, which can aid in origin determination, and the degree of smoltification. These assessments are providing novel information on salmon ecology and status at sea.

2.4 Stock Assessment

US Atlantic salmon populations are assessed by the US Atlantic Salmon Assessment Committee, a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Population status of salmon can be determined by counting returning adults either directly, at traps and weirs, or indirectly using redd surveys. Total returns also include retained fish from angling where allowed. Some mortality can and does occur between counts returns and actual spawners – the actual number of spawners is termed spawning escapement and is not estimated for US populations, though redd counts provide a reasonable proxy for some rivers.

2.4.1 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.

All US Atlantic salmon hatcheries are run by the US Fish and Wildlife Service. Hatchery programs in the US take two forms; 1) conservation hatcheries that produce fish from remnant local stocks within a DPS and stock them into that DPS or 2) 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 that 25 years, the majority of fish reared for 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 isolation from the Penobscot River population is more recent (2009 cohort).

A total of 11.6 million juvenile salmon were stocked in 2009 across 15 river systems, a number typical of the decade. Fry stocking dominates numerically with 10.6 million stocked; fry were planted in all 15 systems. Three river systems were stocked with parr and eight with smolts. Managers stocked around 780,000 smolts in US waters with 560,000 of them stocked in the Penobscot River. This total and the percentage stocked in the Penobscot River are typical for the last decade. Penobscot River smolts consistently produce over 75% of the adult salmon returns to the US. Cost and logistical issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits at the juvenile stage and naturally-reared smolts typically have a higher marine survival rate than hatchery smolts. From a hatchery perspective, rebuilding Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems that successfully reach the ocean and using hatchery production to optimally maintain population diversity, distribution, and abundance. However, survival at sea is a dominant factor constraining stock rebuilding. 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.

2.4.2 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 using redd surveys. Total returns also include retained fish from angling in other regions and historical US time series also include these data. Some mortality can and does occur between trap counts and actual spawning – the actual number of spawners is termed spawning escapement and is not estimated for 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-1990's, most open fisheries were limited to catch and release and because this mortality is lower than retention fisheries impacts on returns or escapement would be lower. The USASAC has continued its efforts to develop metrics to examine juvenile production of large parr (pre-smolts) and emigrating smolts. This report is the second attempt at national summaries of these data and remains largely graphical in nature.

The modern time series of salmon returns to US rivers starts in 1969. Average annual Atlantic salmon returns to US rivers from 1969 to present is 2,156 and the median is 1,645. The time series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figure 2.4.2.1). Because many of these populations in southern New England were extirpated, the salmon returns graph (Figure 2.4.2.1) illustrates the sequential rebuilding of the populations through restoration efforts in the 1970s – with success first in the Penobscot River then the Merrimack and Connecticut Rivers. The remnant populations of the smaller rivers in the Gulf of Maine DPS and the Penobscot River were the donor material for all rebuilding programs during this time. Unfortunately, the trajectory of this recovery did not continue in the late 1980s and early 1990s. Starting in the early 1990s there was a phase shift in marine survival and an overall reduction in marine survival occurred in all US and most Canadian populations (ICES 2003). There has been a downward trend in production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish) that have affected US populations. In addition, recovery from historical impacts was never sufficient so US populations were at low absolute abundance when the period of lower marine survival began.

The modern time series of salmon returns to US Rivers starts in 1967 (Figure 2.4.2.1). Average annual Atlantic salmon returns to US rivers from 1967 to present was 2,173 and the median is 1,670. The time series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figure 2.4.2.1). Because many of the populations in southern New England were extirpated and the Penobscot River was at very low levels, the salmon returns graph illustrates the sequential rebuilding of the populations through restoration efforts in the 1970s – with increased abundance first in the Penobscot River then the Merrimack and Connecticut Rivers. The remnant populations of the smaller rivers in the Gulf of Maine DPS and the Penobscot River were the donor material for all rebuilding programs during this time. Unfortunately, the trajectory of this recovery did not continue in the late 1980s and early 1990s. Starting in the early 1990s there was a phase shift in marine survival and an overall reduction in marine survival occurred in all US and most Canadian populations. Average annual Atlantic salmon returns to US rivers from 1991 to present is 1,878 only 86% of the time series average. There has been a downward trend in production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish) that have affected US populations. In addition, recovery from historical impacts was never sufficient so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2009 were 2,336 fish – this ranks 17 out of the 43 year time series and is nearly 1,000 fish above the median and the second year above median since 1998. Relative to the average during the current marine phase (1991-present), returns were 6th highest out of the 19 years. Given consistency in stocking levels and natural smolt production measurements, increased marine survival is thought to be the primary factor in this increase. To gain a better sense of the relative status of the stocks, it is informative to examine target spawning escapements. Because juvenile rearing habitat can be measured or estimated efficiently, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed Conservation Spawning Escapement (CSE). These values have been calculated for US populations and total 29,199 spawners (Table 2.4.2.1). The average percent of the CSE Target for the time series averaged 7.4% and 2009 was 8.0% of CSE. In the last decade, total returns have accounted for less than 2 percent of this target Long Island Sound and Central New England stock complexes. However, salmon returns to the Gulf of Maine DPS have been as high as 20% of CSE during this period, largely due to hatchery smolt returns to the Penobscot River. In smaller rivers of the Gulf of Maine stock complex CSE ranged from 3-15%. CSE levels are minimal recovery targets since they are based on spawning escapement that could fully seed juvenile habitat. In self-sustaining populations, the number of returns would frequently exceed this amount by 50 to 100 percent allowing for sustainable harvests and buffers against losses between return and spawning. As such, the status of US Atlantic salmon populations is critically low for all stocks, with the remnant populations of the Gulf of Maine stock complex listed as endangered.

Over the past 5 years, the contributions of each stock complex to total US returns averaged: Outer Bay of Fundy (<0.5%), Gulf of Maine (83%), Central New England (7%), and Long Island Sound (9.5%). Returns in 2009 were typical in that the Penobscot River population accounted for the largest percentage 84% of the total return. Overall, 10% of the adult returns to the USA were 1SW salmon and 89% were 2SW fish. From 1967–1985, the ratio of 3SW salmon to 2SW fish averaged 2% and was as high as 7%. However, from 1986 to 2009 this average declined to 0.6% and the highest ratio was only 1.2%. However, in 2009 there were 26 3SW fish and repeat spawners were documented. Most (84%) returns in 2009 were hatchery smolt origin and the balance (16%) originated from fry or parr stocking and natural reproduction.

Return rates also provide an indicator of marine survival. Previous studies have shown that most of the US stock complexes track each other over longer time series for return rates (our best index of marine survival). For a comprehensive look at return rates throughout New England, a cursory examination of returns from smolt stock cohorts provides the most informative comprehensive assessment of all regions (Figure 2.4.2.2). While some subtleties such as age structure of hatchery smolts and subsidies from other larger juvenile stocking such as parr need further analysis this is an informative metric. Median return rates per 10,000 hatchery smolts stocked for the 4 areas are highest in the Gulf of Maine (27.4) and decrease southward for Central New England (5.9) and Long Island Sound (3.8) areas. Return rates for Outer Bay of Fundy stocks (9.8) are intermediate and more variable given lower and more inconsistent stocking numbers and locations.

Maine return rate assessments provide both a return rate for naturally-produced fish (fry stocked or wild spawned) in the Narraguagus River and for Penobscot River hatchery smolts - the longest and least variable in release methods and location (Figure 2.4.2.3). Penobscot median return rates per 10,000 smolts from 1969 to 2006 smolt cohorts were 5.0 for 1SW salmon and 26.7 for 2SW fish. More recently, from 1997-2006 smolt cohorts the 2SW rate was 11.1 for the Penobscot. The median return rates for the Narraguagus River smolts during the same period were 72.9 or 6.5 times higher. In 2009 adult return rate for 2SW hatchery smolts released in the Penobscot River was 27.4 ranking 19th in the 39 year record. While the 2009 return rate for 1SW hatchery grilse was 12.7 ranking 6th in the 40 year record. The overall Penobscot return rate (excluding 3SW fish still at sea) was 28. The return rate in the Narraguagus in 2009 was 199, greater than 3 times that observed in the Penobscot. This analysis points out a challenge to salmon recovery – naturally-reared smolts have a better marine survival rate than do hatchery fish but the capacity of rivers to produce adequate numbers of smolts is generally well below replacement rates under current marine survival rates.

2. 4.3 Juvenile Abundance Metrics

Progress was made this year in utilizing the USASAC databases beyond the traditional role of generating summary tables for the annual report; these databases are rich in information that could be used to develop large-scale stock assessment products that cross life-history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary were used to summarize return rates across New England for hatchery smolts (e.g., Figure 2.4.2.2). Examination of these data in further detail for such a long time-series could provide insights into program-specific challenges and more general global trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, will allow development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation given the broad geographic area (186,500 km^2) with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people with salmon habitat in cities and remote wilderness. However, taken over a long-time series this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

With the addition of Maine juvenile production data going back 50 years, investigations of the production trends over time and more detailed assessments will be possible. A first step towards investigating juvenile data is graphical comparison of large parr densities throughout the region (Figure 2.4.3.1). This time series shows higher densities and variability in Gulf of Maine DPS (5.0) estimates relative to Central New England (2.2) and Long Island Sound (1.8) areas overall, but particularly prior to 1990. Since 1991, these density medians seem to reach a general equilibrium around averages median values of 2.55 (Gulf of Maine DPS), 2.25 (Central New England) and 2.63 (Long Island Sound). Examination of these data relative to other clustering factors such as elevation, temperature, and stocking practices may provide additional insights into management and environmental factors. Another juvenile metric that provides a composite view of freshwater rearing is indices of smolt production. These estimates are relatively limited in New England but two longer time series of data are available and provide a good contrast – the Connecticut River Basinwide estimate and the Narraguagus River smolt assessment (Figure 2.4.3.2). The Narraguagus metric is a two site mark-recapture estimate using rotary screw traps that monitors production of fry-stocked fish and naturally-spawned fish. The Connecticut estimate is a composite estimate of late summer electrofishing density data weighted geographically with a standard assumed overwinter survival. Further analysis of smolt population dynamics is done periodically to examine other abundance indices, age distribution, and run timing.

2. 5 Biological Reference Points

Biological reference points for Atlantic salmon vary from most other 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 since this provides the minimum population number needed to fully utilize available freshwater nursery habitat. This number is based on a single spawning cohort not the standing stock of all age groups. As such, a number for comparison to CSE would be estimated returns. Natural survival of Atlantic salmon in the marine environment is estimated to be 0.03/month resulting in an annual M of 0.36/year.

2.6 Summary

Historic Atlantic salmon abundance in New England probably exceeded 30,000 returns annually. Overfishing and habitat destruction resulted in a severely depressed US population restricted to Maine and by 1950 with adult returns of just a few hundred fish in a handful of rivers. Hatchery-based stock rebuilding occurred from 1970-1990 reaching a peak of 5,624 fish in 1986. A widespread collapse in Atlantic salmon abundance started around 1990. In the past decade, US salmon returns have averaged 1,600 fish and returns in 2005 were 1,320 fish. All stocks are at very low levels, only the Penobscot River population is at 10% or greater of its conservation spawning escapement.   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.

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 1995-1999]

Category	1990-99 Average	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
U. S. Recreational (#) *	123	-	-	-	-	-	-	-	-	-	-
U.S. Aquaculture	8.4	16.5	13.2	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	8.4	16.5	13.2	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0

Table 2.4.2.1 Two-sea winter (2SW) conservation spawning escapement requirements for US River populations and 2SW returns (with % of CSE) in 2009

DPS or Other Composite	CSE	Returns 2009 (%)
Long Island Sound DPS	10,094	75 (0.7%)
Central New England DPS	3,435	92 (2.7%)
Gulf of Maine DPS	15,670	2,169 (13.8%)
Outer Bay of Fundy		
Total	29,199	2,336(8%)

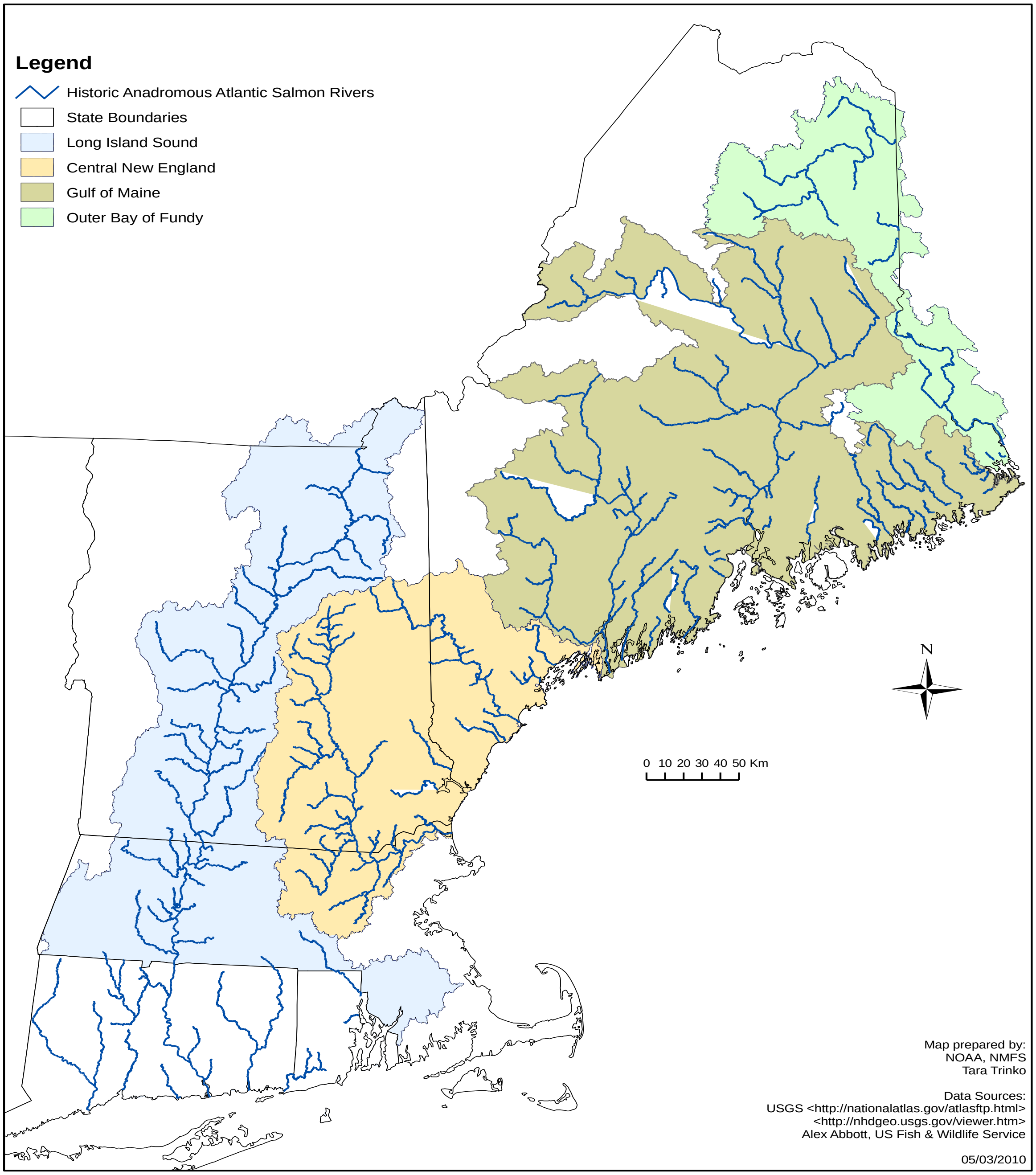


Figure 2.1.1 Map of New England Atlantic Salmon management area by region from north to south- Outer Bay of Fundy (OBF) , Gulf of Maine DPS (GoM), Central New England (CNE), and Long Island Sound (LIS) Regions

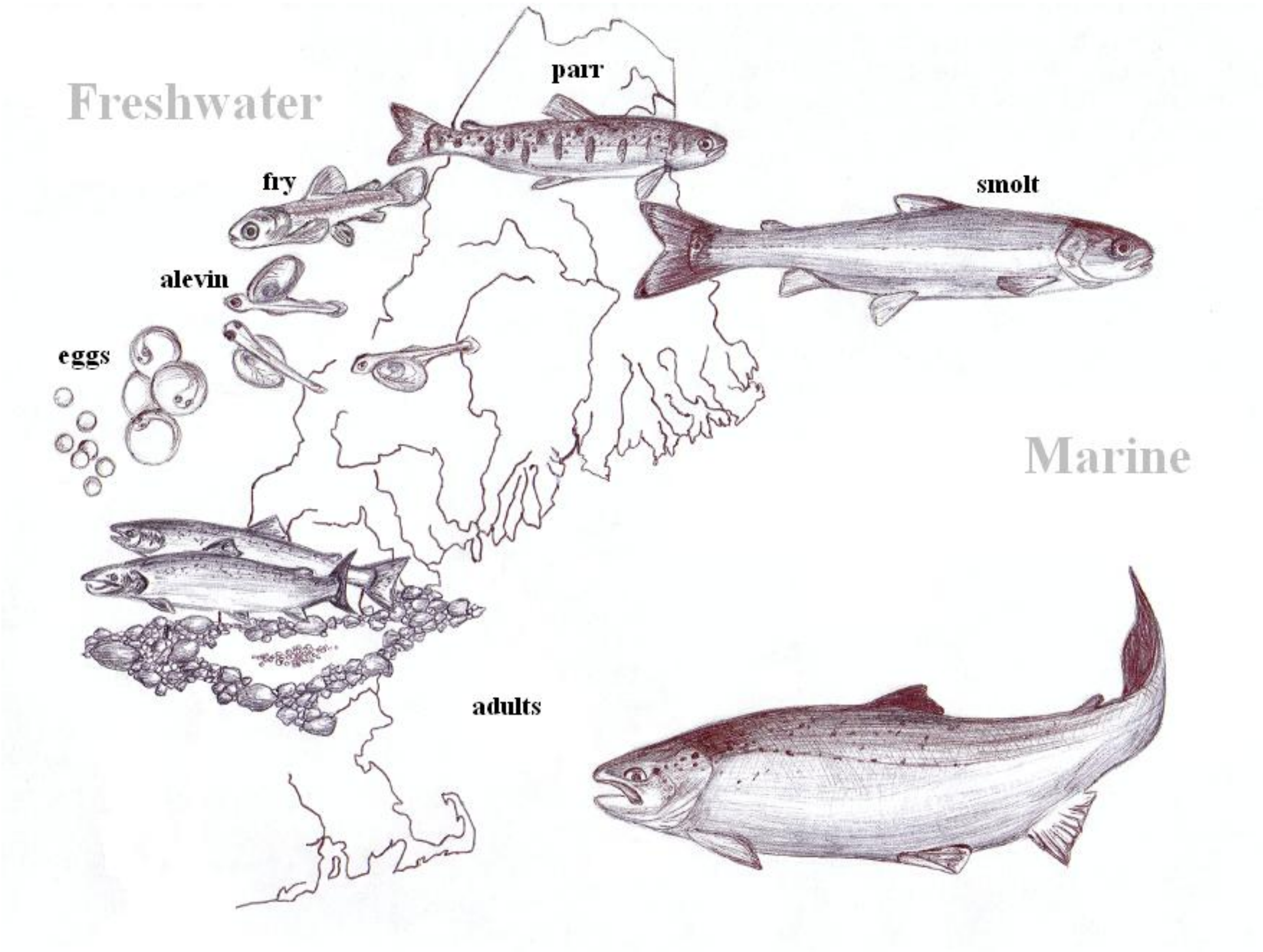


Figure 2.1.2 Life cycle of US Atlantic Salmon illustrating marine and freshwater stages.

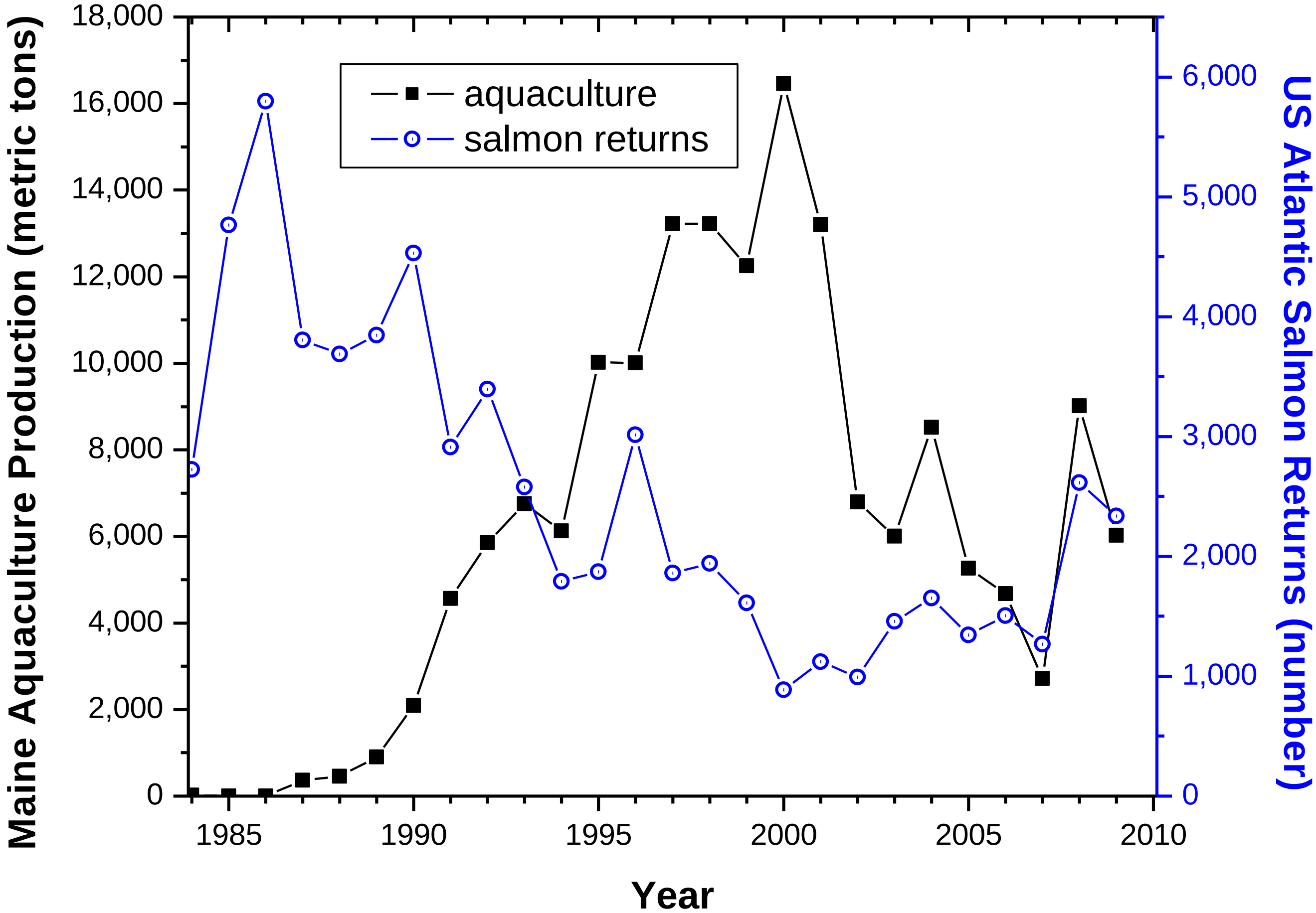


Figure 2.2.1.1 Time series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons).

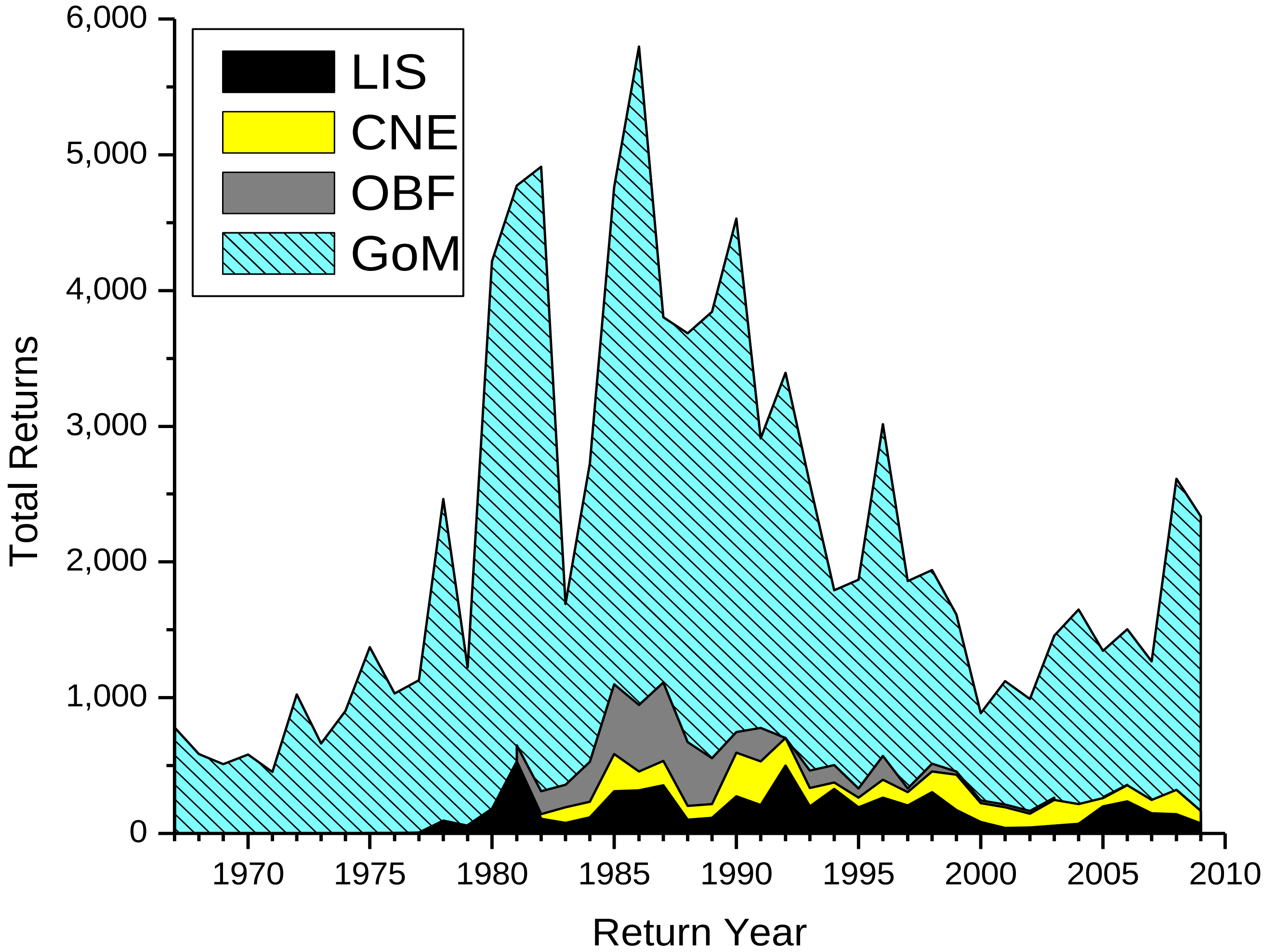


Figure 2.4.2.1 Estimated total returns to New England 1967-2009 from USASAC databases for Outer Bay of Fundy (OBF), Central New England (CNE), and Long Island Sound (LIS) Regions and the Gulf of Maine (GoM) Distinct Population Segment.

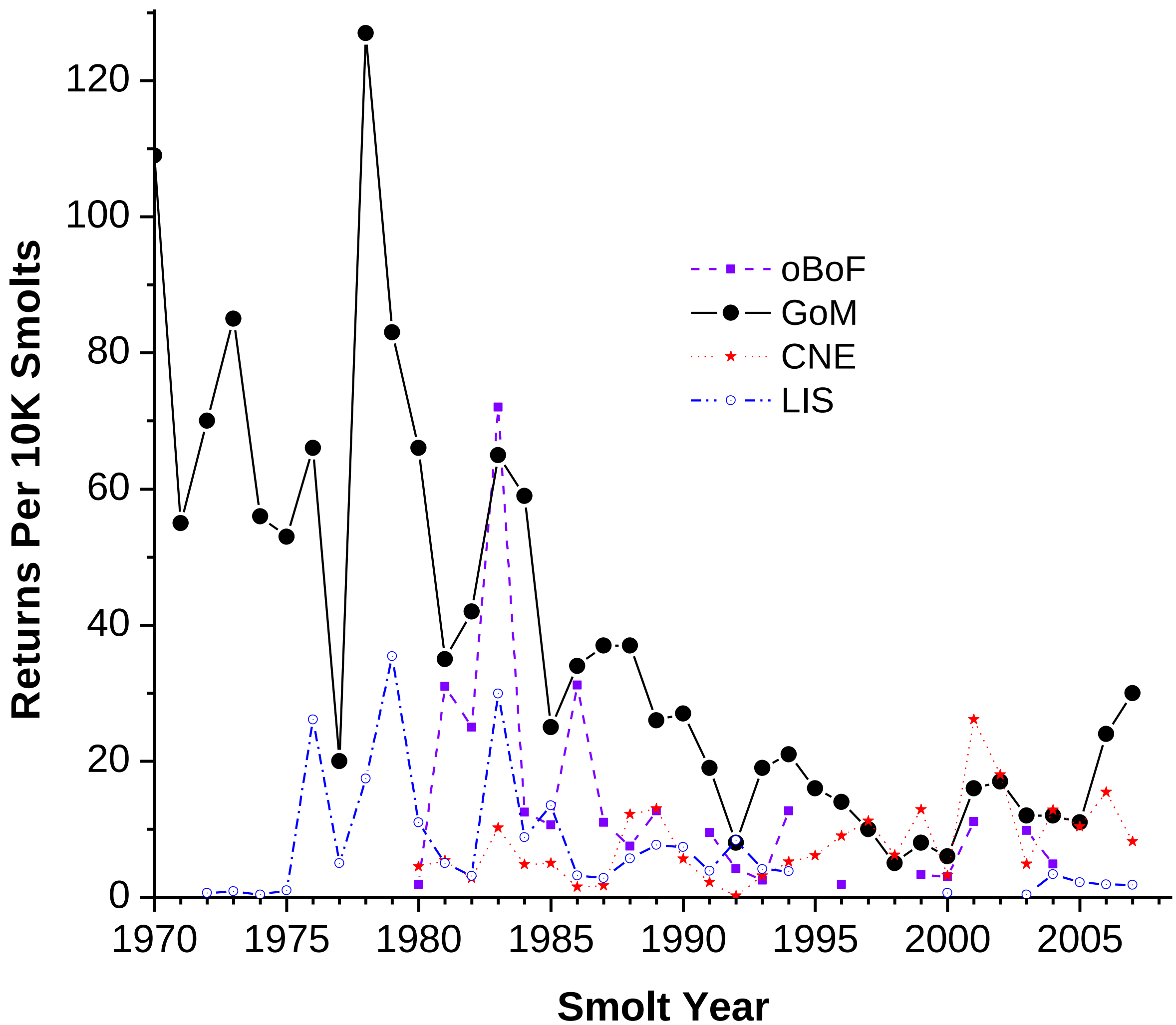


Figure 2.4.2.2 Hatchery return rates of 2SW Atlantic salmon from the Connecticut (LIS), Merrimack (CNE), and Penobscot (GoM) populations estimated from numbers of stocked smolts

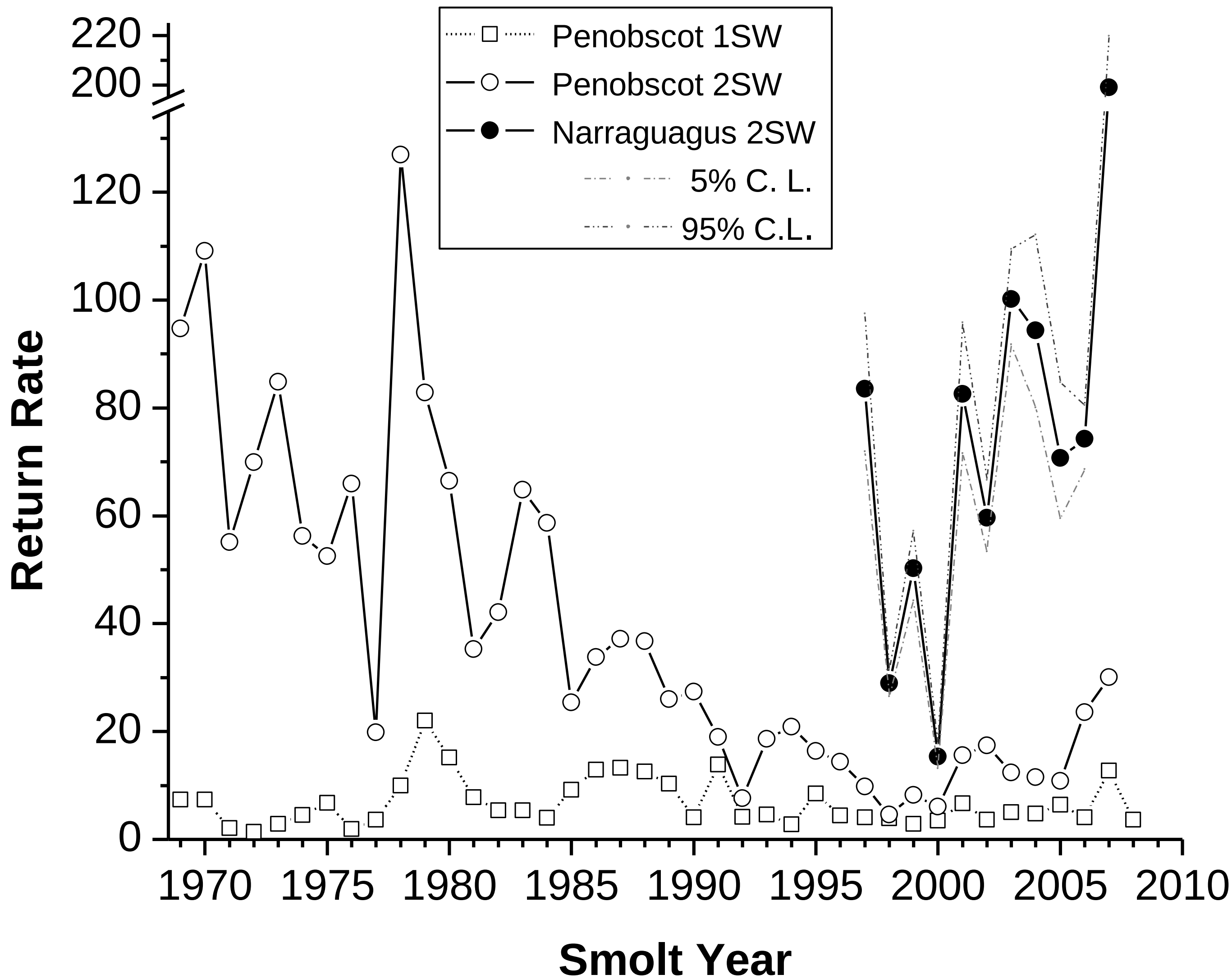


Figure 2.4.2.3 Return rates of Atlantic salmon from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

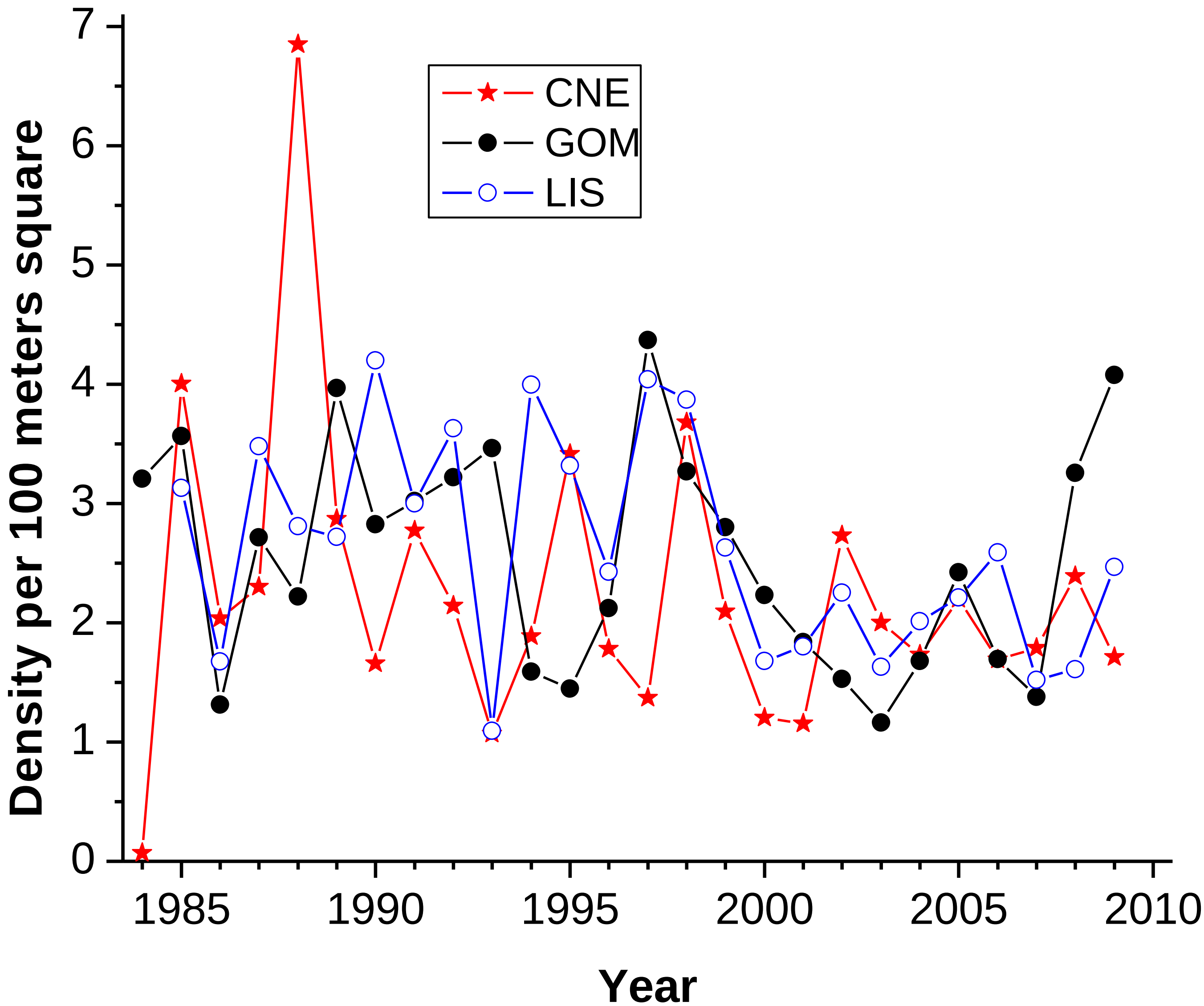


Figure 2.4.3.1 Median large parr densities from electrofishing sites with multiple sample years from 1984 through 2009 from USASAC databases for 3 regions: Long Island Sound and Central New England Regions and in the Gulf of Maine DPS.

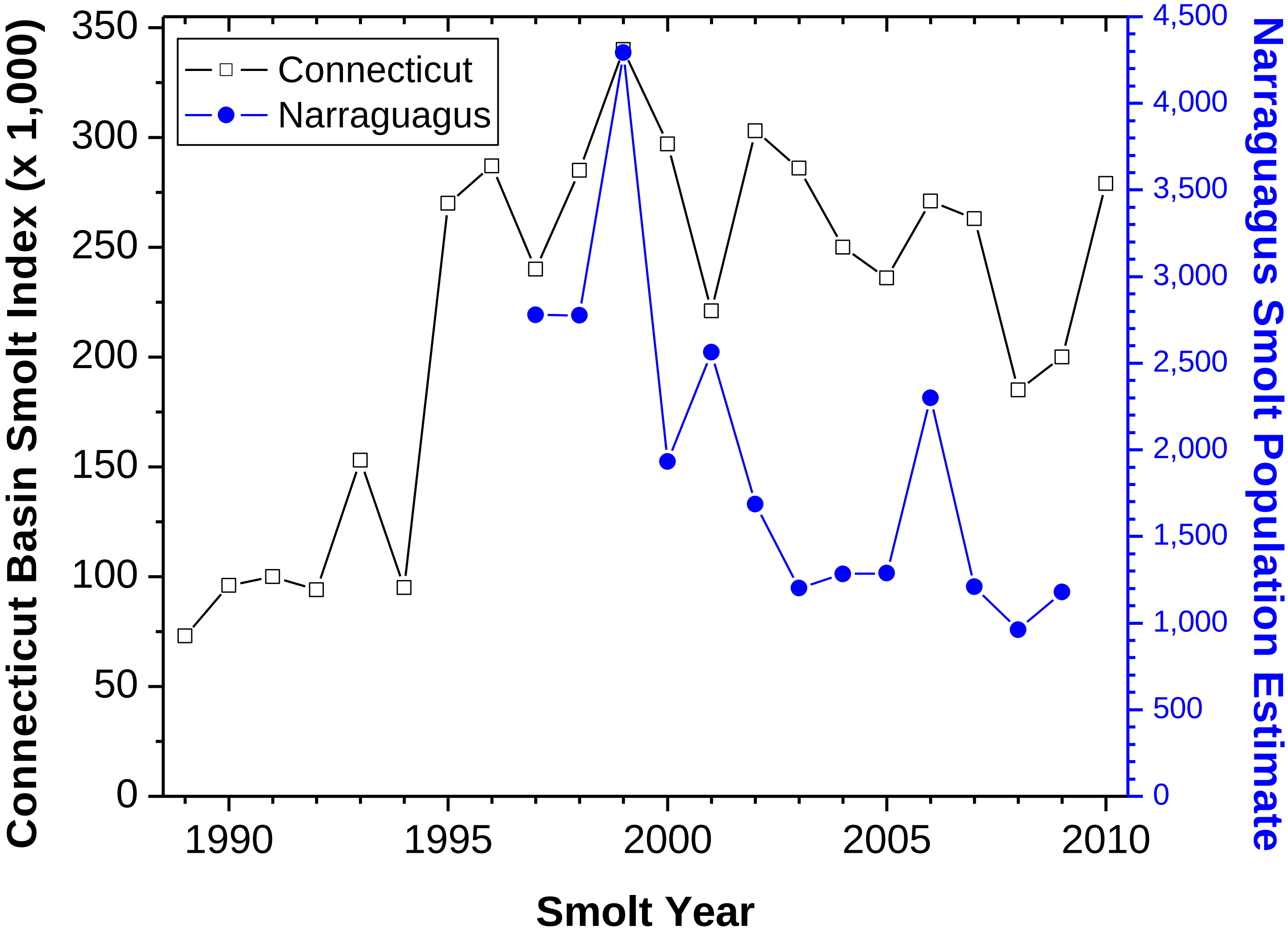


Figure 2.4.3.2 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basis in total, see text for details of estimation methods.

3.1 Long Island Sound: Connecticut River

Connecticut River Atlantic Salmon Commission (CRASC) partner agencies continued their varied work on diadromous fish restoration in 2009. Below is a summary of work on Atlantic salmon.

3.1.1. Adult Returns

A total of 75 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 59 on the Connecticut River mainstem, 12 in the Farmington River, three in the Salmon River and one in the Westfield River. The spring run lasted from May 1 to July 15. A total of 64 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS).

One of the Salmon River fish was not captured. Ten salmon were radio-tagged and released above Holyoke and an additional salmon was known to have escaped Holyoke. One of the radio tagged fish migrated downstream, entered the Farmington River, and was captured for broodstock. Of the remaining nine radio-tagged fish, one entered the Manhan River, one entered the Deerfield River and seven passed the Turners Falls fishways. Of these, one entered the Ashuelot River and six passed the Vernon fishway. Two of these entered the West River, one entered the Saxtons River and three passed the Bellows Falls fishway. Two of these entered the White River and one was not located again. The untagged Holyoke escapee passed all fishways up to and including Wilder. Redds were observed in the Manhan River and a West River tributary.

Eighteen of the salmon observed were of hatchery (smolt-stocked) origin. The remaining 57 were of wild (fry-stocked) origin. All of the returns were 2SW. Freshwater age distribution of wild salmon was 1^+ (7%), 2^+ (87%) and 3^+ (6%).

3.1.2. Hatchery Operations

The program achieved 73% of egg production goals (10.9 million eggs produced, 15 million goal), 65% of fry stocking goals (6.5 million fry stocked, 10 million goal), and 49% of smolt stocking goals (49,000 viable smolts stocked, 100,000 goal) in 2009.

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 2009 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 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, formerly Pittsford National Fish Hatchery) to evaluate smolts prior to stocking in 2009. Based on this evaluation and length measurements, DDENFH produced 13,844 parr (17% of total), 20,278 smolts with fatal fin condition (25%), and 46,355 viable smolts (58%). 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 70,000 1+ presmolts is in production at DDENFH for stocking in 2010. In October, they were marked with an adipose fin clip and vaccinated with a multivalent vaccine for *Vibrio* and *Aeromonas salmonicida* (furunculosis). The presmolts will be evaluated for size and fin condition prior to stocking.

A fin condition survey was conducted at Berkshire National Fish Hatchery (BNFH) prior to smolt stocking. Based on this evaluation and length measurements, BNFH produced 569 parr (13% of total), 1,165 smolts with fatal fin condition (26%), and 2,745 viable smolts (61%). BNFH has 2,500 1+ presmolts in production for stocking in 2010. 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. Because of the threat of Didymo, WRNFH continued to utilize chillers, rather than river water, to provide suitable temperatures for fry incubation. No additional locations of Didymo infestation were discovered in the Connecticut River watershed in 2009.

Jaw deformities were noted in 2-10% of age 3 domestic broodstock at KSSH, Roger Reed State Fish Hatchery (RRSFH), and WRNFH in 2008. Atlantic salmon afflicted with the mandible deformity appeared in poor condition, either due to the cause of the deformity or resulting from complications arising from the deformity including feeding difficulty. The etiology is currently unknown. Concurrent trials are underway at the Northeast Fishery Center (NEFC) and WRNFH to determine whether the trait is heritable and to evaluate the effect of low and high phosphorus diets on deformity incidence.

Age 1+ future broodstock at RRSFH and WRNFH developed cataracts in 2009. These broodstock were created from kelt and kelt/domestic crosses because of the loss of 2007 sea-run returns to IPNv. Histological examination of the eyes and testing of diets to detect nutritional deficiencies or excesses have failed to determine the cause. The broodstock were replaced by fish from smolt production lots at ENFH which contain a representative sample of all WRNFH domestic broodstock spawned in 2007. At maturity, these fish will be spawned with other year classes to minimize the impact of using F2 salmon as broodstock.

Unusual mortality was experienced in 2009 female sea-run kelts transferred from RCNSS to the North Attleboro National Fish Hatchery (NANFH) for reconditioning after spawning. Fish appeared to be in poor condition immediately after transfer and by early January, 45% had died. Samples for fish health testing have been sent to the NEFC.

Egg Collection

A total of 10.9 million green eggs was produced at five state and federal hatcheries within the program. Sea-run broodstock produced 317,000 eggs from 46 females held at RCNSS. Domestic broodstock produced 9.9 million eggs from 1,975 females held at WRNFH, KSSH, and RRSFH. Kelt broodstock produced 642,000 eggs from 62 females held at NANFH. Egg production remained below the prior ten year average of 11.9 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 6.6 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2009. Totals of 778,000 fed fry and 5.7 million unfed fry were stocked into 41 tributary systems with the assistance of hundreds of volunteers. Totals of 49,100 smolts and 18,300 parr were released into the lower Connecticut River mainstem, the Westfield River, and the Farmington River. Numbers of fry stocked increased slightly from last year but remain far short of totals stocked in prior years and program goals.

Surplus Adult Salmon Releases

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

3.1.4. Juvenile Population Status

Smolt Monitoring

FirstLight Power Resources and the USFWS contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2009. This was the seventeenth 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 111,000 (+/- 38,000 95% confidence limits). Favorable flows for marking and recapturing smolts tightened confidence limits compared to prior years.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 200,000 smolts were produced in tributaries basin wide. Of these, 153,000 (77%) were produced above Holyoke in 2009. Actual overwinter mortality is unknown and the estimate does not include smolt mortality during migration. Most smolts have to travel long distances and pass multiple dams to reach Holyoke. Recent research in Connecticut River tributaries and Maine suggests that overwinter survival is lower than assumed in the electrofishing smolt estimate.

Index Station Electrofishing Surveys
Juvenile salmon populations were assessed by electrofishing in late summer and fall at 208 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 43.3 /100m^2 unit and the mean 0+ parr density was 8.5/unit with a mean first summer survival of 20%. The mean density of 1+ parr was 4.1/unit with a mean survival from stocked fry of 10%. Mean total lengths at capture of 0+ and 1+ parr were 84 and 145 mm, respectively.

Most smolts produced are again expected to be two year olds, with some yearlings and three year olds. The basin wide smolt production estimate for 2010 calculated from expanding electrofishing data from index stations and assumed overwinter survival is 279,000. The estimate is higher than the low level of the past two years and similar to prior years in the time series.

3.1.5. Fish Passage

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

Holyoke Dam- Studies and engineering evaluations continue to make progress towards development of a new downstream passage screen and bypass system for the main Holyoke generating station (Hadley Falls). Construction will not begin until at least 2011. The new bypass will also alleviate upstream passage interference caused by the current downstream passage system.

Vernon Dam- Installation of replacement turbines that increased hydraulic capacity at this TransCanada dam was completed in 2008. A radio tagging study was conducted in 2009 to determine route selection by smolts with the new flow regime. Only 62% of smolts were guided to passage routes, with the remaining 38% passing through turbines. TransCanada is evaluating the possibility of providing illumination at bypass entrances to enhance guidance, but no other feasible improvements are evident. This project, along with TransCanada projects at Bellows Falls and Wilder, will be relicensed in 2018.

Vermont Yankee Nuclear Power Plant- Entergy continues to seek a 20 year extension to their operating license scheduled to expire in 2012. 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 3,183 wild smolts was captured and trucked below McIndoes Dam for release, the largest number captured to date. A guidance net was installed for the 2009 season. However, studies showed only 37% guidance efficiency to the bypass, similar to past studies. Flow inducers are planned to be installed for the 2010 smolt run to improve guidance.

Gilman Dam- Designs for downstream fish passage facilities at this upper mainstem Connecticut River dam are being developed and construction is planned for 2010.

Woronoco Dam- A full depth trash rack overlay with ¾ inch spacing will be installed in 2010.

Manhan River Dam- A denil ladder will be constructed in 2010 opening up about 20 miles of habitat in the system.

Deerfield River- A final downstream passage plan was completed for TransCanada dams on the Deerfield involving spill and facility modifications. Construction of downstream passage modifications at Deerfield 3 and Deerfield 4 is underway for completion by spring. The upstream passage construction trigger of radio-tagged adult salmon reaching the first dam was met in 2006. The Agencies and TransCanada are discussing how to proceed.

Crescent Street Dam- Downstream passage on this Millers River dam is being investigated.

Fiske Mill Dam- Fish lift construction has been delayed again and is now planned for Summer, 2010.

Homestead Dam (West Swanzey Dam)- Removal of this Ashuelot River dam was delayed again. Removal is now scheduled for 2010.

Brockways Mills- Improved temporary downstream passage was in place in 2009, but construction of a permanent facility was again delayed at this Williams River dam.

Bethel Mills- Interim spill will be in place for the 2010 smolt run and a permanent downstream facility will be constructed in 2010 at this dam on the Third Branch of the White River.

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

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

3.1.6. Genetics

Tissue samples were taken from all 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 that is a deliberate effort to mate salmon that are not closely related. It is also has been used to create known families so stocked fry can be genetically “marked” for post stocking evaluation and marked families of domestic brood stock can be created. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

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

Sea-run origin fry from last year’s egg take were stocked in Bronson Brook (24,000) and the Williams (181,000) and Sawmill rivers (67,000) in spring of 2009 for mature parr production. Bronson Brook is a Westfield tributary and was added to provide a back up parr collection site in MA.

A 1:1 spawning ratio was observed for domestic brood stock spawned at the WRNFH, KSSH, and RRSFH. Prior to 2002, all genetically marked fry were of sea-run origin. Beginning in 1998, genetically identifiable domestic broodstock have been maintained at the WRNFH. In 2001, these fish were spawned and families of domestic eggs were produced with known genetic marks that are stocked in specific tributaries or groups of tributaries for later identification. The resultant fry were stocked in 2002 to expand the marking and program evaluation efforts. This effort is has continued since then. Partial fin clips were taken from 660 smolts sampled in downstream bypasses at Cabot Station (Turners Falls Dam) 2009 for genetic analysis.
Data analysis has only been completed for six of the ten regions of fry stocked in 2002 and sampled in 2004 smolt 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. Additional funding is needed to complete the remaining four regions from the 2004 smolts and 2006 adults as well as analyze the 2005-2009 smolt samples and 2007-2009 adult samples already collected and 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. Due to the lack of funding to analyze samples and substantial operational costs, the genetic marking program will be ended. Fry stocked in 2011 will be the last group of genetically marked fry. Plans are being developed to fund the genotyping of past and future samples.

A CRASC Broodstock Management Plan is being developed to assist genetic management and to document practices. A near final draft is under review.

3.1.7. General Program Information

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

The use of salmon egg incubators in school as a tool to teach about salmon, watersheds and conservation continued to expand throughout the basin. The Connecticut River Salmon Association (CRSA), in cooperation with CTDEP conducted their Fish Friends program at schools in Connecticut. Trout Unlimited in cooperation with MADFW carried a similar message to schools in Massachusetts. Several cooperators including CRSA, NHFG, USFS, USFWS, VTFW and the Southern Vermont Natural History Museum cooperatively conducted the program in Vermont and New Hampshire. For the 2009-2010 school year 171 schools participated in this type of salmon education in the four states.

The NEFC developed a population model for Connecticut River Atlantic salmon using available data and presented it for review at the 2009 USASAC meeting. Parameters were adjusted based on discussion at the meeting and the model was used to evaluate potential returns from a major release of domestic broodstock for natural spawning. Data is lacking for some key model parameters, the efficacy of such a release is controversial, and funding is not available to produce additional broodstock for release. The model will be useful to evaluate stocking strategies within the limits of the available data.

3.1.8. Salmon Habitat Enhancement and Conservation

Program cooperators continued their habitat protection efforts in 2009. The USFS completed two habitat restoration projects on approximately one half mile of stream in the Green Mountain National Forest. NHFG, in cooperation with several partners, will conduct additional habitat restoration work on Warren Brook, a Cold River tributary, in 2010.

3.2 Long Island Sound: Pawcatuck River

3.2.1 Adult Returns

No Atlantic salmon were captured at the Potter Hill Fishway in 2009.

3.2.2 Hatchery Operations

Egg Collection

Sea-Run Broodstock

The two sea-run kelts were spawned in November yielding approximately 7,000 eggs total. Milt was provided by the North Attleboro National Fish Hatchery.

Captive/Domestic Broodstock

We currently have five, seven year old fish and three, five year old fish of wild origin at the Perryville Hatchery. These were spawned in 2009 but the eggs were not of good quality and ultimately had to be discarded.

3.2.3 Stocking

Juvenile Atlantic Salmon Releases

Approximately 87,000 Atlantic salmon fry from the North Attleboro National Fish Hatchery were stocked into the Pawcatuck River and its tributaries in early May, 2009. 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 5,435, were raised and fin-clipped at the Arcadia Hatchery. The majority of the smolts were released in April; these totaled 3,964. Mean length and weight for these smolts were 194 mm and 61.2g, respectively. An additional 1,471 smolts were released in early May. When released they averaged 179.4 mm in length and 54.4g. All smolts were stocked at the Stillman Avenue Bridge in Westerly approximately one mile upstream tidal influence.

Adult Salmon Releases

Rhode Island received approximately 180 adult broodstock from the Nashua National Fish Hatchery in December 2009 for recreational fishing. They were released into three Rhode Island ponds including: Olney Pond in Lincoln, Barber Pond in West Kingston and Carbuncle Pond in Coventry.

3.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were conducted in the fall of 2009 and depletion electrofishing was used to estimate salmon densities. Maximum likelihood estimates of population size were made using the procedures of Van Deventer and Platts (1989). Twelve stations were sampled in September and October.

Parr, 0 years old, ranged in length from 51 mm to 98 mm, with an average of 68.9 mm. Parr, 1 year old, ranged in length from 102 mm to 193 mm, averaging 135.6 mm. Mean lengths in 2009 were higher than those found in 2008 for 0 year old parr and lower for 1 year old parr. Mean densities of 0 year old parr and age 1 year old parr were 3.45 and 2.43 per 100 m^2, respectively, an increase from last year.

Smolt Monitoring

No work was conducted on this topic during 2009.

Tagging

All smolts were released with adipose fin clips.

3.2.5 Fish Passage

Problems with upstream fish passage exist at Potter Hill Dam. Although the existing fish ladder seems to work well at normal and low flows, extremely high water levels in early spring can completely flood the ladder, and making access difficult. In addition, broken gates on the opposite side of the dam are creating attraction flow, which draws fish away from the fish ladder. The dam is under private ownership and in 2006 the owner applied for a FERC permit to develop hydropower at this location. In 2009 the owner submitted an application for exemption to FERC which was denied. The owner subsequently reapplied for a permit to develop hydropower at the site and the process starts over again.

3.2.6 Genetics

No genetics samples were collected in 2009.

3.2.7 General Program Information

Fishway reconstruction has been completed at the Bradford Dam, which is the next dam upstream from Potter Hill where our fish trap is located. Initial improvements in the area creating a canoe portage were conducted in 2007. The next phase of the project, which entailed a redesign of the leaky fishway to make it fully functioning, was completed in the fall of 2008. Plans for fishways at dams located upstream including Horseshoe Falls and Shannock are under development.

3.2.8 Salmon Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2009.

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

Eighty-one sea-run Atlantic salmon returned to the Essex Dam, Lawrence, MA and were captured in the fish lift. Captured salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Sex determination was made for 81 of the salmon, with 31 (38.3%) being male and 50 (61.7%) female. Three fish were determined to be broodstock previously released for sport angling; one fish died; and seventy-seven salmon were spawned, including 29 (37.7%) males and 48 (62.3%) females. Following the results of fish health tests to ensure the absence of pathogens, 41 female salmon were transported to the North Attleboro National Fish Hatchery (NANFH), MA in January 2010 for reconditioning.

Scales from 78 sea-run Atlantic salmon were analyzed to determine age and origin. Of the 78 sea-run salmon, 47 (60.3%) were of hatchery smolt origin and 31 (39.7%) were of fry origin. Of the 47 hatchery smolt origin salmon, four (8.5%) were grilse (1SW), 41 (87.2%) were two sea-winter fish (2SW) and two (4.3%) were three sea-winter fish (3SW). Of the 31 fry origin salmon, one (3.2%) was a grilse, 28 (90.3%) were two sea-winter fish, and two (6.5%) were a three sea-winter fish.

In 2009, adult salmon that returned represented four cohorts: 2003 - 2006. The rate of return, per 10,000 fry stocked, increased in the past five years (2001-2005). In these years the return rates were: 0.029, 0.050, 0.150, 0227 and 0.301, respectively (Table 4.1.1.1). Return rates have improved to levels last seen in the mid to late 1990s. However, current return rates are far below the rates of the late 1970s to the mid 1980s, when returns exceeded one fish per 10,000 fry stocked. Beginning in 1999, fry stocking densities were decreased to approximately one half of what had previously been stocked. Concerns had been raised that density dependent factors were contributing to low parr survival and sea-run returns.

Also in 2009, adult salmon of hatchery smolt origin represented three cohorts: 2006 - 2008. The rate of return per 1,000 smolts stocked in years 2003-2007 was: 0.87, 1.48, 1.24, 1.74, and 0.94 respectively (Table 4.1.1.2). Return rates do not differ markedly from rates of return in previous years.

Table 4.1.1.1 Fry origin adult Atlantic salmon returns, Merrimack River, Years 1994 – 2006.

Stocking Year	Sea Run Returns: Fry Stocking Origin							Fry Stocked	Returns (#/10,000)
	2.1	2.2	2.3	3.1	3.2	3.3	Returns		
1994	8	45	0	0	1	0	54	2,816,00	0.192
1995	19	63	0	5	0	0	87	2,827,00	0.308
1996	4	23	0	0	0	0	27	1,795,00	0.150
1997	1	3	0	0	0	0	4	2,000,00	0.020
1998	2	6	0	0	0	0	8	2,589,00	0.031
1999	1	4	0	0	3	0	8	1,756,00	0.046
2000	0	11	0	0	0	0	11	2,217,00	0.050
2001	2	1	0	0	2	0	5	1,708,00	0.029
2002	0	6	1	0	0	0	7	1,414,00	0.050
2003	6	12	1	0	0	1	20	1,335,00	0.150
2004	1	29	1	2	2		35	1,541,50	0.227
2005	3	26	-	-	-		-	962,500	0.301*
2006	1	-	-	-	-		-	1,009,32	-
2007	-	-	-	-	-		-	1,140,00	-
2008								1,765,76	
2009								1,050,94	*Estimate

Table 4.1.1.2 Hatchery smolt origin adult Atlantic salmon returns, Merrimack River, Years 1996 - 2008.

Stocking Year	Sea Run Returns: Hatchery Origin				Smolt Stocked (1,000)	Returns (# /1,000)
	H1.1	H1.2	H1.3	Returns		
1996	9	45	0	54	50.0	1.08
1997	11	65	0	76	52.5	1.45
1998	46	32	0	78	51.9	1.50
1999	26	73	0	99	56.4	1.76
2000	5	17	0	22	52.5	0.42
2001	31	129	2	158	49.5	3.19
2002	12	89	0	101	50.0	2.02
2003	17	25	1	43	49.6	0.87
2004	8	66	0	74	50.0	1.48
2005	10	52	0	62	50.0	1.24
2006	8	77	2	87	50.0	1.74
2007	6	41	-	47	50.0	0.94
2008	4	-	-	-	90.0	-

4.1.2 Hatchery Operations

On January 22, 2009 eyed eggs (20,615) were shipped from NANFH to Green Lake National Fish Hatchery, ME (GLNFH) for smolt production, to be released downstream of Essex Dam as one year olds in 2010. Eggs shipped were selected at random from all kelts. An additional 90,000 eggs were shipped to GLNFH from NNFH, also for smolt production. These eggs were derived equally from all females, both searun and domestics.

NANFH shipped a total of 449,068 domestic eyed eggs to Warren State Fish Hatchery, NH (WSFH) in two shipments on 5 February and 5 March. Resulting fry were released in the upper Merrimack River watershed. NANFH also released 370,016 unfed fry in the lower watershed between 14 April and 21 April. Genetically marked fry released in the lower watershed consisted of 100% kelt progeny. No sea-run eggs were received at NANFH from NNFH this year due to newly implemented bio-security procedures.

Sixty-six new female kelts (2008 sea-run returns) were received at NANFH from NNFH on 2 February for reconditioning. Sixty of the fish were reconditioned and five were spawned in the fall.

Egg Collection

Sea-Run Broodstock

Eighty-one sea-run Atlantic salmon were trapped at the Essex Dam in 2009; one died and the remaining 50 females and 30 males were held at NNFH. Fish were spawned during the period 13 October - 13 November, and produced 369,126 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 88% eye-up in its second year of significant egg incubation. The 48 females produced an average of 7,690 eggs each. Approximately 364,526 (98.75%) sea-run eggs were retained at NNFH for incubation/fry production and subsequent release in the lower watershed. Also, NNFH retained 4,600 (1.25%) sea-run eggs for F1 broodstock production.

Domestic Broodstock

A total of 516 female domestic (F1) broodstock spawned at NNFH provided an estimated 2,380,119 eggs in 2009. Of the 516 females, 100 were four years old and 416 were three years old. The domestic broodstock spawning season began on 15 October, ended 5 January, and included 17 spawning events. Approximately 1,210,614 (50.9 %) eggs from broodstock were shipped to NANFH during the period 9 November to 8 December. Approximately 73,989 (3.1%) green eggs were shipped to Rhode Island for incubation/fry production. Domestic broodstock eggs were also retained at NNFH, and represented 1,095,516 (46%) of the total. Approximately 263,461 eyed eggs (24%) were shipped to the Saco River Salmon Club for incubation/fry production, 832,055 (76%) were retained at NNFH for incubation/fry production and subsequent release in the upper Merrimack River watershed, and for use in educational programs.

NANFH spawned 55 female kelts between 5 November and 9 December. An estimated 576,969 eggs were collected from three year classes. Of the total eggs taken, 44% were from 23 females of the 2006 year class, 46% were from 27 females of the 2007 year class, and 10% were from 5 females of the 2008 year class. Eggs were fertilized with milt collected from kelts. It was necessary to use males multiple times during the season (3 males from 2006 year class and 12 males from 2007 year class) due to the low number of male kelts and limited availability of domestic males.

NANFH received 1,210,614 green domestic eggs from NNFH between 9 November and 8 December. The eggs will be used to meet fry production requirements for the Merrimack River and fry production/outreach and education requirements for the Pawcatuck River Restoration Program, RI**.**

4.1.3 Stocking

In 2009, 1,050,946 Atlantic salmon fry were released into the Merrimack River watershed between 14 April and 18 May. Of this total, 165,000 fry were fed prior to release and the remaining 885,946 were unfed fry at release. Salmon fry were propagated at NNFH, NANFH, and WSFH. NNFH reared 165,000 fed fry, NANFH reared 369,946 unfed fry, and WSFH reared 516,000 unfed fry. Fry were fed due to early maturation, in advance of environmental conditions being conducive to their release. 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 91,117 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 41,117 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 second 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. 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 seven index sites, established as early as 1982, provide an extensive time series of yearling parr catch-per-unit effort, relative abundance, and density ((Table 4.1.4.1). The sites include a total of 169.7 units (one unit = 100 m^2) of habitat. Sites are located on the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers. The index sites on the Baker and South Branch Piscataquog rivers were repositioned in 2009. A repositioning of sites was required due to stream alternations 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 - 2009, 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 suggesting that past high fry stocking densities resulted in density dependent factors that may have adversely affected the growth of parr. In general, the reduction in fry stocking density appears to have affected yearling parr densities. In the upper, more sterile habitat of the watershed the reduced fry stocking densities has had little effect on juvenile parr density.   However, in the lower, more fertile habitat of the watershed, there has been a substantial reduction in yearling parr density following the decrease in fry stocking density. This information along with further analysis of growth parameters at sites could assist in better determining stream specific optimal stocking levels.

Table 4.1.4.1 Yearling parr density (1+ parr/unit) at historic Index Sites (IS) in the Merrimack River watershed, 1994 – 2009

Year	Pemi Rvr.	Baker Rvr.	EB Pemi Rvr.	Mad Rvr.	Smith Rvr.	SB Piscat Rvr.	Souhegan Rvr.	Mean
1994	0.60	1.03	1.59	1.81	3.27	3.31	3.10	2.10
1995	8.80	3.17	3.38	2.90	6.53	2.81	1.83	4.20
1996	0.53	2.00	0.13	0.83	7.13	8.71	4.51	3.41
1997	1.68	1.45	0.00	1.12	0.87	3.67	0.07	1.27
1998	1.20	4.34	0.07	2.39	9.20	5.47	11.69	4.91
1999	1.45	1.45	0.49	0.58	4.60	3.38	0.28	1.75
2000	4.12	0.69	0.46	3.01	0.87	1.51	0.49	1.59
2001	1.15	0.76	0.00	0.91	0.73	2.09	0.14	0.83
2002	3.49	4.21	1.01	2.03	2.80	2.59	1.76	2.56
2003	2.76	1.52	1.36	2.17	1.00	0.14	0.85	1.40
2004	4.67	1.31	0.25	2.14	1.80	1.15	1.47	1.83
2005	5.56	4.20	0.57	2.97	2.20	1.15	0.28	2.42
2006	2.32	2.83	0.08	1.74	0.87	1.22	1.69	1.54
2007	2.62	1.72	0.44	1.67	0.27	2.09	0.56	1.34
2008	3.59	3.72	0.84	1.78	5.47	1.15	2.39	2.71
2009	5.70	1.78	0.95	1.67	3.53	1.33	1.27	2.32
Period	Mean Yearling Parr Density for High (1994 -1998) and Low (1999 - 2009) Fry Stocking Periods							Grand Mean
High	2.56	2.40	1.03	1.81	5.40	4.79	4.24	3.18
Low	3.40	2.20	0.59	1.88	2.19	1.62	1.02	1.84

4.1.5 Impacts of River Obstructions

Approximately 60% of the juvenile production habitat in the Merrimack River watershed is located in the Pemigewasset River, 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.

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 currently captured at Essex Dam, the first upstream dam from tidewater. The construction of additional upstream fish passage facilities at both mainstem and tributary dams to provide fish access to spawning habitat is not likely in the near term, however the results of ongoing studies, as well as the stipulations of recent relicensing agreements for dams in the watershed, could result in significant modification to existing facilities, and the construction of new facilities.

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

Upstream and Downstream Fish Passage – Mainstem Dams

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, would be minimized in extent and duration; and enhanced aesthetics associated with advanced water-control technology and decreased trash loading at the dam. The company 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 June 2010.

Enel is also pursuing studies and implementing measures to improve American shad passage at the Lowell Hydroelectric Project. An alternate street-side fishlift entrance at the powerhouse will be operated exclusively during the 2010 fish passage season based on study results obtained in 2009. In addition, Enel will monitor fish passage at the fish ladder located at the dam to better understand fish movement and use of that facility.

The operating license for the Merrimack River Project (Amoskeag, Hooksett and Garvins Falls dams - FERC No. 1893) was renewed in May 2007. PSNH completed consultation and reached a settlement with fishery resource agencies regarding future prescriptions for fishway construction at the project. The new license includes fishway prescriptions and other provisions that will benefit a number of fish species. The installation of upstream fish passage facilities at Hooksett and Garvins Falls dams will be required in future years when the target spawning stocks of shad and/or river herring reach designated thresholds. For Hooksett Hydroelectric Station, upstream fish passage facilities for anadromous fish will be required within three years after passage of either 9,500 or more shad, or 22,500 or more river herring in any given year at the Amoskeag project. At the Garvins Falls Hydroelectric Station, upstream fish passage facilities will be required to be operational within three years after the passage of: (1) either 9,800 American shad or 23,200 river herring at the Hooksett development; (2) if fish passage has been constructed at the Hooksett Development without a fish counting facility, passage of either 19,300 American shad or 45,800 river herring at the Amoskeag Development. Downstream fish passage facilities are currently installed and operational at all mainstem dams.

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 in conducting eel surveys (juveniles and adults) at Garvins Falls and operating 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 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 2009 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).

Return rates of fry origin adults remain well below replacement levels and have not met program expectations. However, during the past five years the return rate has shown improvement and the percentage of returning adults from fry stocking origin have been trending upwards. The first genetically marked year class returned in Spring 2007, and the most recent draft of the parentage analysis of adult sea-run Atlantic salmon returns for the Merrimack River is based on the results of samples from both the 2007 and 2008 returns. Evaluation of the stocking location of fry produced Merrimack sea-run adults is limited due to both the low number of returns to the Merrimack River and the even smaller contribution of fry stocked individuals returning as adults. The Merrimack River Technical Committee will meet in April 2010 to review the genetic results of samples collected from the 2009 sea-run returns.
Fry from sea-run adults develop at an earlier date due to the time of spawning which subsequently leads to targeting lower watershed tributaries for this group in early spring. A primary point of interest is whether fry-origin adult returns are occurring from areas in proportion to 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. The results of genetic analyses should provide opportunities to better understand genetic relatedness among fish and to subsequently develop improved and refined mating protocols. Genetic analyses of tissue samples for characterization are complete and results will guide culture and management measures to be implemented in future years.

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

Management and restoration goals for the Merrimack River program include river specific stock development, an adaptive fry production/stocking program, and the production of 200,000 smolts. Accordingly, eyed eggs from the Merrimack River program were shipped to 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 and anticipated production level of approximately 30,000 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 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 2009, 775 (age 4) domestic broodstock were released for the fishery. In Fall 2009, an additional 760 (age 2) broodstock were released for a combined total release of 1,535 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 a slight decrease from 1,446 sold in 2006 to 1,359 in 2007, and an increase to 1,416 sold in 2008. Data for the 2009 season is not yet available. Permit sales suggest that anglers continue to value this unique opportunity to fish for Atlantic salmon in northern New England. Alternative methods of monitoring the broodstock fishery, such as an online angler reporting system, will be investigated in the future.

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

Adopt-A-Salmon Family

The 2009 school year marked the seventeenth year in which the Adopt-A-Salmon Family Program has been providing outreach and education to school groups in ME, NH, and MA in support of Atlantic salmon recovery and restoration efforts. The program is administered by the CNEFRO with support from the NNFH, the Amoskeag Fishways, and a corps of very dedicated volunteers and SCA interns. Most participating schools implement the program throughout the school year with highlights including a visit to NNFH for a ninety minute educational program in November, and incubating salmon eggs in the classroom beginning in January/February for release as fry into the watershed in the late Spring. In February 2009, 34 schools received 12,320 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 2009, 1,325 students and 148 teachers and parents from 18 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 2009 was 16,896, including 9,888 students and 7,008 adults. Since its inception Fishways has documented greater than one-half-million visitors, and about 7,500 school programs have been delivered to date. The total number of Outreach and Partly at Center programs offered in 2009 was 151 with 5,512 students and 4,584 adults participating; the total program participants, as well as visitors, and meeting/outreach participants was 23,152. 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.

4.1.8. Migratory Fish Habitat Enhancement and Conservation

Habitat Restoration

In 2009, the multi-agency New Hampshire River Restoration Task Force (NHRRTF) continued to work on identifying dams and fish passage impediments for removal in state waters, as well as pursuing strategic alterations and/or modifications of dams.

Merrimack Village Dam, Souhegan River, NH

With the removal of Merrimack Village Dam on the Souhegan River, migratory and resident fish were provided access to 14.4 miles of main stem river habitat and five miles of tributary habitat. Funding for the project was provided by Pennichuck Water Works, federal and state agencies, and non-government organizations. The National Oceanic and Atmospheric Administration, NOAA (Restoration Center), the lead federal agency for the project, continues to fund ongoing physical parameter studies of the dam site.

In cooperation with NHFGD, NNFH released an estimated 41,000 one-year-old adipose clipped smolts in the river in early Spring 2009, with expectation that adult returns would migrate to the river and use available spawning habitat.

In addition, salmon fry were stocked in the recovering reach above the old dam site and a cursory electrofishing survey was conducted in September, 2009 to ascertain the presence of young-of year parr at two sites within the fry stocked area. At one site, in what was the prior headpond area, and is now a riffle/run habitat, 33 young-of-year parr were captured. At the other site, several miles upstream from the old dam, 29 young-of-year parr were captured.

Pemigewassett River and Headwater Streams, NH

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

Saco River, Atlantic Salmon Fry, Smolt and Parr Production, ME/NH

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. In 2009, the NANFH produced and released to the river an estimated 25,000 one-year-old smolts, and also provided yearling parr for release in the river as well. The agreement is being revised, and it is anticipated that 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.

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 2009 was 14 adult Atlantic salmon. However, the count could exceed 14 due to the possibility of adults ascending Cataract without passing through one of the counting facilities and not being captured at the Skelton trap. Fourteen 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 3 May through late October, 2009. Fourteen adult sea-run Atlantic salmon were captured at Skelton Dam in Dayton and Buxton. This catch could include both salmon observed passing through the Cataract sites and ones that may have passed without being observed. The 14 salmon that were captured at the Skelton Dam were transported by FPLE to the Ossipee River and released. Data on fork length, scales, and marks observed for fish handled at the Skelton facility were collected. Eleven were of hatchery origin (10-2SW, 1-1SW) and 3-2SW naturally reared.

4.2.2 Hatchery Operations

Egg Collection

None in 2009

4.2.3 Stocking

Juvenile Atlantic Salmon Releases

In April 2009, three groups of smolts were transported from North Attleboro National Fish Hatchery and released to the river totaling 23,200. The lower Little Ossipee River received 19,800 parr in November and December 2009. An additional group of approximately 3,000 parr, reared at the Saco River Salmon Club Hatchery, were released into the mainstem and tributaries in Biddeford Maine.

Adult Salmon Releases

No adult Atlantic salmon were stocked into the Saco River.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

A presence/absence survey in the Little Ossipee River resulted in the capture of 22 parr, indicating that the parr released in 2008 survived the first winter and summer after release. We anticipate the first smolts produced from this cohort to migrate to sea in the spring of 2010. In addition, two electrofishing surveys were conducted in lower Swan Pond Brook to document the presents of natural reproduction. Three young of the year were captured in one of the two sites (CPUE = 0.59 YOY/min).

Smolt Monitoring

Tagging

All smolts (23,200) transported from NANFH to the Saco River for release received an adipose fin clip.

4.2.5 Fish Passage

4.2.6 Genetics

Fourteen genetic samples were collected in 2009. The samples were taken from sea-run adult returns captured at the Skelton Dam passage facility. All tissue samples were preserved in 95% ethanol.

4.2.7 General Program Information

Anticipating the expanded range for the endangered GOM DPS, Saco River stakeholders began discussions with resource agencies regarding an acceptable Atlantic salmon stock to supplement the Saco River. Through negotiations, an agreement was reached with United States Fish and Wildlife Service (USFWS), whereby Merrimack Atlantic salmon stock would be used in the Saco River. The initial stocking program relied on one-year old smolts produced at the North Attleboro National Fish Hatchery, with the first smolt cohort released to the Saco River in the spring of 2009. The rearing regime also results in parr that may not reach smolt size in spring being available to stock in the autumn. Additionally, USFWS transferred two lots of eyed eggs to the Saco River Salmon Club in February 2010, totaling 422,813 eyed eggs that will be available for release as fry in 2010.

4.2.8 Salmon Habitat Enhancement and Conservation

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

5.1 Gulf of Maine

5.1.1 Adult Returns

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

Because there was no rod catch, the number of spawners was assumed to equal returns plus released pre-spawn captive broodstock. In 2009, pre-spawn captive broodstock were stocked in the Kennebec, Sheepscot, East Machias and Machias Rivers, and in Hobart Stream. These 224 fish will be included in spawner numbers forwarded to ICES because the number of ripe fish was known and their reproductive capacity may be comparable to returning 2SW females.

Small Coastal Rivers
Dennys River. The Dennys River weir trap was operated from 13 May, 2009 to 23 October, 2009. We captured a total of eight salmon; five female and one male two sea-winter fish, one grilse, one two sea-winter short absence repeat spawner of undetermined sex, and one three sea-winter salmon of undetermined sex. Returns were 4.3% of CSE on the Dennys River. We did not capture any suspected aquaculture escapees in 2009. Ten redds were observed during surveys covering approximately 70 % of spawning area identified in the habitat database (spawning area surveyed/total spawning area).

East Machias River. Twenty one (21) redds attributed to wild returns were counted during redd surveys in 2008 in the East Machias River that included approximately 98 % of known spawning habitat area. An additional 22 redds were located in Northern Stream where 43 pre-spawn captive reared adults from CBNFH were stocked.

Machias River. We counted a total of 49 redds, covering approximately 60 % of the spawning habitat area in the Machias drainage. Fifteen of these redds were likely created by the 68 pre-spawn adult captive broodstock stocked in Mopang Stream, at the outlet of Second Mopang Lake. The remaining 34 redds were in different tributaries and likely from wild returns.

Pleasant River. One redd was found in the Pleasant River in 2009 during surveys of about 85% of spawning habitat area.

Narraguagus River. Bureau of Sea Run Fisheries and Habitat (BSRFH) staff operated the Narraguagus fishway trap from 1 May, 2009 to 26 October, 2009. The total documented return was ten. We captured two female and one male two sea-winter fish, one river-origin grilse, and three hatchery-origin grilse from the 2008 smolt stocking (two with lost VIE). Sea age and origin were determined based on scale reading and marks. One multi sea-winter salmon of unknown sex was witnessed ascending the spillway during trap tending and two salmon has been observed ascending the spillway on video.

In 2009, a total of 51 redds were counted during surveys by canoe and foot covering approximately 90% of spawning habitat area. The 51 redds located on the Narraguagus River indicates that a large number of salmon passed over the Stillwater Dam in Cherryfield without using the trap or being detected on video. A very rainy spring and early summer resulted in lost video coverage from failed solar battery charging and flows over the dam that allowed salmon to pass undetected. The poor condition of the fishway likely contributed to salmon choosing to use the spillway. The estimated return, based on the revised redds regression was used as the documented return. Age and origin were assigned in proportion to the fish handled.

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 six redds were attributed to sea-run returns and three redds were attributed to the 63 adults stocked pre-spawn adults from CBNFH. Surveys encompassed 83% of spawning habitat by area.

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

Total Returns to small coastal rivers.

Scientists estimate the total number of returning salmon to small coastal rivers using capture data on rivers with trapping facilities (Dennys, Pleasant, and Narraguagus Rivers) combined with redd count data from five additional rivers. Estimated returns are extrapolated from redd count data using a return-redd regression [ln (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 for the small coastal rivers was 160 (90% CI = 114 - 217) (Table 5.1.1.1). Estimates for previous years were recalculated using the new regression (Table 5.1.1.1).

Table 5.1.1.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2009.

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

Large Rivers

Penobscot River. The Veazie Dam fishway trap was operated daily from 4 May through 30 October, 2009. We captured 1,958 sea-run salmon during 2009 and released 1,278 salmon back to the Penobscot River (600 females, 539 males, and 139 grilse (one sea-winter, 1SW)) upstream directly from the Veazie Trap. There were no other documented returns to the Penobscot River. An additional 104 salmon (57 females, 32 males, and 15 grilse) were originally 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 2009 was 1,382. Unfortunately, there was one handling mortality, a MSW male. This year's total catch represents a decrease from 2008 (2,117) and an increase from 2007 (1,199). Ten percent of the total run were 1SW fish. The percent of 1SW fish of the total run fluctuates yearly, and this year's rate is the lowest grilse return rate of the past 20 years. The mean for the previous 20 years was approximately 25% with the range was 11% - 48%. In 2008 the 1SW return rate was 35%, near the high end of the normal range. The high 1SW return rate seen last year equated to a high 2SW return rate in 2009. The median capture date for 2009 was 18 June.

Brookfield Power operated the Weldon fishway, Penobscot River in Mattawamkeag from 10 June through 31 October, 2009 on the East Branch of the Penobscot River. Salmon were classified as multi-sea winter (MSW) or one-sea winter (1SW) based on a visual observation of total length. This year, 345 salmon were captured and released upriver into the East Branch of the Penobscot River (279 MSW and 66 1SW) representing an increase of 129 salmon over 2008, in spite of slightly lower escapement above the Veazie trap (1,468 in 2008 and 1,382 in 2009).

The Weldon 1SW count was 19.1% of the Weldon trap count and 42.9% 1SW escapement from the Veazie trap.

In 2006, 2007, and 2008 marked smolts were stocked below Great Works Dam, Penobscot River, Maine. Each year three groups received an identifying visible implant elastomer (VIE) and an adipose fin clip (AC). The primary purpose of these marked groups was to have an index of marine survival, with three pseudo-replicates to estimate the variance associated with the return rate. In 2007, 65 1SW adults with detectable VIEs returned to the adult collection trap, Penobscot River, Veazie, Maine. In 2008, 387 1SW and 2SW adults with detectable VIEs returned to the adult trap. In 2009, 168 1SW and 2SW adults with detectable VIEs returned to the adult trap (Table 5.1.1.2). The percent coefficient of variation (CV) for the 2006 cohort was 8.59% and for 2007 cohort was 26.35% (Table 5.1.1.3).

Table 5.1.1.2 Return rates for marked smolts (by auxiliary and individual VIE mark) released below Great Works Dam, Penobscot River, Maine in 2006 and 2007.

Smolts Cohort	Mark	1SW	2SW	3SW	Total	Number Marked	Return Rate	Return rate per 10,000
2006	AD	73	335	0	408	169,066	0.0024	24.10
2006	Left eye Green	19	82	0	101	56,156	0.0018	18.00
2006	Right eye Green	25	89	0	114	56,870	0.0020	20.00
2006	Right eye Red	21	74	1	96	56,040	0.0017	17.10
2007	AD	203	118		321	147,619	0.0022	21.70
2007	Left eye Green	56	95		151	49,219	0.0031	30.70
2007	Right eye Green	36	53		89	49,122	0.0018	18.10
2007	Right eye Red	50	65		115	49,278	0.0023	23.30
2008	AD	50			50	147,789	0.0003	0.03
2008	Left eye Green	14			14	49,262	0.0003	0.03
2008	Right eye Green	16			16	49,195	0.0003	0.03
2008	Right eye Red	16			16	49,332	0.0003	0.03

Table 5.1.1.3 Average return rates (per 10,000) for VIE marked smolts stocked below Great Works Dam, Penobscot River, Maine in 2006, 2007, and 2008 (1SW only).

Smolts Cohort	Mark	Return Rate	Standard Deviation	Coefficient of Variation %
2006	VIE	18.37	1.484	8.08
2007	VIE	24.03	6.332	26.35
2008	VIE	0.03	0.002	7.53

In 2009, 44 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 (2005-2007) because fall parr can spend 8, 20, or possible 32 months in freshwater before migrating to sea. The marked parr returns included: three grilse with a left ventral fin clip (LV, 2007 stocking cohort), one grilse with adipose and left ventral fin clips (AD + LV, 2006 stocking cohort), 1 2SW Atlantic salmon with a left ventral fin clip (LV, 2005 stocking cohort), and 39 2SW fish with adipose and left ventral fin clips (AD + LV, 2006 stocking cohort).

Androscoggin River. The Brunswick fishway trap was operated from 6 May to 23 October, 2009. The total trap catch was 24 sea-run adult Atlantic salmon. Biological data (fork length, scales, fish condition, and sex) were collected from 21 individuals (3 naturally reared 2SW; 16 hatchery 2SW; 2 hatchery 1SW).

Kennebec River. The Lockwood fish lift was operated by FPLE staff from 1 May to 30 October, 2009. The trap was shut down from 17 August to 27 August for scheduled maintenance. The total trap catch for 2009 was 29 adult sea-run Atlantic salmon (14 2SW hatchery origin and 10 2SW naturally reared). The remaining 5 adults were captive reared Atlantic salmon stocked in the autumn of 2008 in the Sandy River.

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. Benton Falls fish lift was operated from 4 May to 6 August, 2009. The adult Atlantic salmon trap catch for 2009 was 4 (2 2SW hatchery, 1 1SW naturally reared, and 1 captive reared). Two individual salmon were handled and two were observed through a viewing window and images recorded on video tape.

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.

5.1.2 Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 6.2 million eggs for the Maine program in 2009: 2.4 million eggs from Penobscot sea-run broodstock; 2.7 million eggs from six captive broodstock populations; 1.04 million eggs from Penobscot domestic broodstock. At CBNFH, 283 sea-run Penobscot females and 645 captive females were spawned.

Spawning protocols for captive broodstock at CBNFH give priority to first time spawners and utilized 1:1 paired matings. Spawning protocols for Penobscot sea run broodstock also continue to utilize 1:1 paired matings. At GLNFH, 312 age four domestic females were spawned to provide eggs for streamside incubation in the Sandy River. Spawning protocols at GLNFH also used 1:1 paired matings.

Egg Transfers

All three egg sources (sea-run, captive, and domestic) from the 2008 spawning cohort were used for the Salmon-in-Schools (FWS) and Atlantic Salmon Federation Fish Friends programs. Domestic Penobscot eggs from GLNFH 2008 cohort were transferred to: 735K to CBNFH for fry production and 5K to Salmon-in-Schools. CBNFH transferred 0.9 million Penobscot sea run eyed eggs to GLNFH for smolt production, 44K Pleasant eyed eggs to the Wild Salmon Resource Center, 4.5K Penobscot sea run eyed eggs to the USDA, 69K Narraguagus eyed eggs to GLNFH for smolt production and 6.4K to Salmon-in-Schools.

Wild Broodstock Collection and Domestic Broodstock Production

In 2009, 1,114 parr were collected from the following GOM DPS Rivers by staff from the Maine Bureau of Sea-Run Fisheries and Habitat: 163 from the Dennys; 160 from the East Machias; 259

from the Machias; 110 from the Pleasant; 259 from the Narraguagus; and 163 from the Sheepscot. Adult sea-run broodstock collection from the Penobscot River (Veazie dam) was 679 fish in 2009. CBNFH did not start any new pedigree broodstock lines in 2009.

GLNFH retained approximately 1,000 fish from the 2008 year class of sea run Penobscot-strain Atlantic salmon. These fish will be used for F2 domestic egg production at GLNFH for 2-3 years. During the 2009 trapping season 679 salmon were transported to CBNFH. All Penobscot River adults captured for broodstock were marked with PIT tags and genetically characterized. Additional broodstock were collected to allow for an experimental pre-spawn release of 104 adults into the upper Piscataquis River.

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.

Penobscot broodstock at CBNFH were tested for Infectious Salmonid Anemia (ISA) in September 2009. Results from cell culture assays did not show activity, however, the Q-PCR test identified six fish as being ‘suspect’ for ISA. Q-PCR is more sensitive than the AFS Blue Book standard RT-PCR. LFHU conducted further sequencing of the PCR product to determine its identity and strain and sent materials to the USDA NVSL reference laboratory for determination. The six suspect fish were isolated from the remaining population. The remaining population was spawned as per normal procedures. The suspect fish were stripped of eggs and milt, and the eggs sanitized and destroyed; sexual fluids (male and female) were taken and sent to LFHU for further screening. The six suspect fish were culled in mid-November. Spleen and kidney samples were taken and forwarded to LFHU for additional ISA screening.

Analysis of exhaustive testing revealed the six suspect fish were exposed to the HPRO strain of ISA, a non-pathogenic genotype that is not associated with morbidity or mortality. As the six fish were not positively diagnosed with a strain that is associated with fish mortality by two separate tests, it was deemed the population would be suitable for restoration/recovery efforts. Thus, the remaining Penobscot broodstock were released to the Penobscot River in early December.

5.1.3. Stocking

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

Egg, Fry, Parr, and Smolt Stocking

During 2009, approximately 3.5 million juvenile Atlantic salmon were stocked into GOM DPS rivers as fertilized eggs, fry, parr and smolts. Age-1 smolts from GLNFH were stocked into the Penobscot Basin (560K), and Narraguagus (53K); age 0-parr releases into the Penobscot Basin totaled 172K. In 2009 the FWS initiated year one of a three year direct estuary release study in the Penobscot Basin. Approximately 29K smolts, marked with unique VIE tags, were stocked into the West Enfield smolt ponds and held for ten days for imprinting. Following the 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.

CBNFH produced approximately 2.5 million fry, primarily unfed, for release by the BSRFH throughout the DPS. Fry were released to Downeast rivers between April 30 and May 14; releases to the Penobscot Basin were completed between May 6 and May 22. Downeast, fry were released at developmental indices (DI) ranging from 83% to 106%; fry released in the Penobscot Basin had DI ranging from 91% to 117%. All Downeast fry, with the exception of the Pleasant, were taken from the hatchery directly from incubator trays. Keeping unfed fry in the incubator stacks allows the fry to conserve energy. Fry that were expected to reach the feeding stage, primarily Penobscot strain, were moved to troughs. Although the goal was to release unfed fry whenever possible, any lots of fry that reached the feeding stage were introduced to feed. Age-2 smolts, a by-product of domestic broodstock production at CBNFH, were stocked into the Dennys River (576) and Pleasant River (321) and Sheepscot (18K). Small numbers of age 0+ and age 1 parr from the CBNFH visitor Living Stream display pool were stocked into the Machias 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 2009, excess broodstock were released pre-spawn to the Sheepscot (63), East Machias (45), and Machias (70). Pre-spawn release of gravid adults into Hobart Stream, near Dennysville, Maine, was repeated in 2009. The origins of pre-spawn releases into Hobart were Narraguagus (20) and Pleasant (27). The 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.

A three year adult translocation study, utilizing Penobscot sea-run adults, was initiated in 2009. The aim 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 104 adults (15 grilse, 32 males and 57 females) were released in early October; 38 of the females were tagged with radio tags for tracking movements during the spawning season.

Following spawning, 543 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2009. 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. Spent age 5 captive broodstock from CBNFH were released into their natal rivers: Dennys (97); East Machias (40); Machias (157), Narraguagus (207); Pleasant (67); Sheepscot (86). GLNFH released 1,054 excess adults, comprised of four and three year old domestic broodstock, into the Penobscot River.

5.1.4 Juvenile Population Status

BSRFH conducts electrofishing surveys to monitor abundance of Atlantic salmon juveniles, assess management actions, and test hypotheses. In 2009, we conducted 312 electrofishing trips to assess juvenile salmon populations and community ecology. We used three sampling methods: depletion estimates at measured area sites, standardized catch-per-unit-effort (CPUE), and exploratory sampling for presence. Fish abundance is presented as fish per unit, where one unit equals 100 m^2 and relative abundance (CPUE) is resented in fish/minute. All data for 2008 and 2009 were added to the USASAC Juvenile Salmon database. Juvenile densities and CPUE varied considerably among sites in Maine rivers in 2009 (Table 5.1.4.1 and 5.1.4.2). One highlight of the field season was capturing 111 young-of-the-year (YOY) in the Ducktrap River. These fish averaged 63.5mm and 2.6g (n=60) and were the product of the 11 redds dug in autumn 2008.

Table 5.1.4.1 Minimum (min), median, and maximum (max) large parr Atlantic salmon population densities (fish/100m^2) based on multiple pass electrofishing estimates in selected Maine Rivers, 2009.

Drainage	Min	Median	Max	N
Lower Kennebec	1.96	4.23	6.50	2
Dennys	0.00	4.34	6.67	6
Ducktrap	0.00	0.00	0.00	2
East Machias	0.38	5.87	32.53	8
Machias	0.00	3.36	17.80	16
Narraguagus	0.00	0.85	12.10	21
Pleasant	1.95	4.10	4.81	5
Sheepscot	0.00	6.01	21.74	15
Piscataquis	0.63	9.39	20.39	8

Basinwide Estimates of Large Parr Abundance

In 1990, DMR BSRFH and NOAA Fisheries selected sites within the Narraguagus watershed using a Basinwide Geographic and Ecologic Stratification Technique (BGEST) (Kocik et al. 1994) that identified five levels of geographic stratification: upriver forested (above Beddington Lake), forested barrens, transitional barrens, West Branch, and coastal. Within each of these strata, sampling included riffle and run sites (substrata). Annually, one tributary was included in the coastal stratum and at least one in the West Branch stratum. However, tributaries within other geographic strata were placed into two additional strata based primarily on spawner access and habitat quality. In exploring reassigning tributaries to substrata connected to geographic stratum, an error in the total habitat in Lawrence Brook used to calculate proportion of habitat sampled was found and corrected resulting in, on average, an increase in the annual estimate of

Table 5.1.4.2 Minimum (min), median, and maximum (max) relative abundance of large parr Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2009.

Drainage	Min	Median	Max	N
Lower Androscoggin	0.00	0.00	0.00	2
Lower Kennebec	0.00	0.00	0.98	33
Dennys	3.40	3.40	3.40	1
Ducktrap	0.00	0.00	0.00	4
Grand Manan Channel	0.00	0.00	0.20	10
Machias	0.00	0.93	5.45	23
Narraguagus	0.19	1.20	3.17	12
Saint George	0.00	0.00	0.00	3
Sheepscot	0.00	0.10	3.27	8
Penobscot	0.00	0.00	0.00	4
East Branch Penobscot	0.00	0.86	1.76	9
Mattawamkeag	0.00	1.03	2.93	10
Piscataquis	0.00	0.00	2.06	56
Passagassawakeag	0.00	0.00	0.00	2

86 large parr using the old stratification scheme (Table 5.1.4.3). The new substrata scheme (tributary, riffle, and run substrata) was used to calculate large parr estimates for the geographic strata above Beddington Lake for 1991 to 2008 (Table 5.1.4.4). Over the period the upriver forested stratum has produced on average 63 % of the basin large parr (range 37 to 83%).

Table 5.1.4.3 Time series of basin large parr estimates for the Narraguagus River (1991-2006), with, estimate variance, and 95 % CI calculated after correcting the amount of habitat in Lawrence Brook.

Year	Lower 95% CI	Estimate	Upper 95% CI	Variance
1991	10,699	16,666	22,633	8,900,104
1992	10,363	13,473	16,583	2,418,235
1993	16,070	21,400	26,730	7,101,066
1994	6,817	8,654	10,491	843,300
1995	7,044	12,084	17,124	6,350,074
1996	9,944	12,317	14,690	1,407,614
1997	23,210	28,998	34,786	8,376,168
1998	16,545	21,011	25,477	4,985,613
1999	10,782	15,895	21,008	6,534,479
2000	10,520	14,823	19,126	4,629,110
2001	8,632	12,307	15,982	3,376,966
2002	8,708	12,120	15,532	2,910,422
2003	5,256	8,862	12,468	3,250,644
2004	6,136	9,917	13,698	3,573,790
2005	12,858	17,490	22,122	5,363,282
2006	10,364	13,704	17,044	2,788,573

Table 5.1.4.4 Time series of basin large parr estimates for the Narraguagus River and tributaries upstream of Beddington Lake (1991-2008), with estimate variance, and 95 % CI.

Year	Lower 95% CI	Estimate	Upper 95% CI	Variance
1991	3,861	7,266	10,671	2,899,337
1992	6,010	8,360	10,710	1,380,420
1993	6,819	10,342	13,865	3,102,074
1994	3,037	4,620	6,203	626,641
1995	4,292	10,055	15,818	8,302,083
1996	6,900	8,161	9,422	397,216
1997	12,233	23,826	35,419	33,601,331
1998	8,300	16,075	23,850	15,113,574
1999	2,515	5,918	9,321	2,895,941
2000	4,741	7,444	10,147	1,826,975
2001	5,901	9,794	13,687	3,789,378
2002	4,704	7,435	10,166	1,864,136
2003	2,552	5,679	8,806	2,444,324
2004	3,463	6,928	10,393	3,001,341
2005	6,238	10,078	13,918	3,686,191
2006	6,921	10,213	13,505	2,708,501
2007	4,341	12,959	21,577	18,568,804
2008	5,410	8,245	11,080	2,008,956

Smolt Abundance

NOAA-National Marine Fisheries Service (NOAA) and the Maine Bureau of Sea Run Fisheries and Habitat (BSRFH), conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in many of Maine's coastal rivers. Population estimates were calculated using the program DARR 2.0 (Bjorkstedt 2005). 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. Summaries for each river follow.

Narraguagus River.

Of the 349 new smolts captured in the traps upstream of Beddington Lake (river km 47.62), 346 were marked, PIT tagged, and released 5.41 km upstream. The estimate of smolt production above Beddington Lake was 726 ± 39 smolts. The PIT tagged smolts spent an average of 2.20 ±0.15 days at large 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 6.16 ± 0.20 days (n = 19), which is an average 6.15 ± 0.09 kilometers/day (n = 27).

We collected 4,708 smolts and 195 recaptures (4.1%) at the NOAA RST sites (river km 11.16 and 7.65). A subset of smolts was scale sampled (n=132) and tissue sampled for genetics (n=480). The age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) was: 90.9% age 2+, and 9.1% age 3+ (Table 5.1.4.5). Age 2+ smolts averaged 162 ±13 mm fork length and 44.4 ± 11.8 g wet weight (Tables 5.1.4.6 and 5.1.4.7 and Figures 5.1.4.1 and 5.1.4.2). Most of the smolts (88.1%) were hatchery origin, the result of ~54,000 age 1+ salmon smolts stocked during the first week of May. The population estimate for naturally-reared smolts at the NOAA sites was 1,180 ± 91 smolts (Figure 5.2.4.3). We also estimate that 383 ± 140 fall parr stocked smolts and 117 ± 99 residualized smolts migrated this spring. The total estimate of smolts (naturally reared, fall parr, and hatchery stocked smolts) exiting the Narraguagus system was 55,767 ± 8,104.

Sheepscot River. We captured 485 smolts at the Sheepscot River site, 62 of which were marked with an adipose clip, indicating they were stocked as 0+ parr in 2008. A subsample of scales (n=222) and tissue samples (n=423) 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 5.1.4.6 and 5.1.4.7, Figures 3.2.4.1 and 3.2.4.2). This year, the Sheepscot River smolt run was composed of 4.5% age 1+, 91.9% age 2+, and 3.6% age 3+ (Table 3.2.4.5). Age 2+ naturally-reared smolts averaged 186 ± 17 mm fork length (n = 204) and 68.7 ± 18.9 g wet weight (n = 204) (Tables 5.1.4.6 and 5.1.4.7, Figures 3.2.4.1 and 3.2.4.2). The population estimate of emigrating smolts of all origins was 1,809 ± 151. This estimate includes naturally-reared smolts as well as age 0+ fish stocked in the fall of 2008.

Pleasant/Piscataquis River. We collected 597 smolts in the Pleasant River RSTs, 575 (96.3%) of which were marked with a ventral clip, indicating that the fish were stocked as age 0+ parr. Of the 575 marked hatchery fish captured, 8.2% were stocked as fall parr in 2007 and 91.8% were stocked as fall parr in 2008. The age distribution of naturally-reared smolts is as follows: 86.7% age 2+ and 13.3% age 3+, based on scale reading (n=15) (Table 5.1.4.5). Age 2+ naturally-reared smolts averaged 155 ± 13 mm fork length (n = 17) and 37.6 ± 10.4 g wet weight (n = 17) (Tables 5.1.4.6 and 5.1.4.7, Figures 3.2.4.1 and 3.2.4.2).

We collected 945 smolts in the Piscataquis River RSTs, 792 of which were marked and released 3.2 km upstream. Of these marked smolts, 187 were recaptured (23.6%). The age composition of naturally-reared smolts is: 52.2% age 2+, 47.2% age 3+, and 0.6% age 4+, based on scale reading (n=697) (Table 5.1.4.5). Age 2+ naturally-reared smolts averaged 143 ± 11 mm fork length (n = 363) and 28.8 ± 7.3 g wet weight (n = 363) (Tables 5.1.4.6 and 5.1.4.7, Figures 3.2.4.1 and 3.2.4.2). The population estimate of emigrating smolts was 4,794 ± 601.

Smolt Run Timing. In 2009, smolt run timing was similar to 2007 and 2008 on all three rivers (Piscataquis, Narraguagus, and Sheepscot) (Figure 5.1.4.4). Median run dates on the Sheepscot River and the Narraguagus River were within two days of each other in 2009, with the Narraguagus River median being two days earlier than the Sheepscot River median (Figure 5.1.4.5).

Table 5.1.4.5 Freshwater age composition, by percent of sample, for naturally-reared smolts collected in Rotary Screw Traps on selected Maine rivers.

	2009				5 year average (2004-2008)			
River	1+	2+	3+	4+	1+	2+	3+	4+
Narraguagus	0%	90.9%	9.1%	0%	0.7%	87.8%	11.2%	0.3%
Piscataquis-Pleasant River	0%	86.7%	13.3%	0%	0%	87.1%	12.9%	0%
Piscataquis	0%	52.2%	47.2%	0.6%	N/A	N/A	N/A	N/A
Sheepscot	4.5%	91.9%	3.6%	0%	5.6%	90.3%	4.0%	0%

Table 5.1.4.6 Mean fork length (mm) by origin of smolts captured in Rotary Screw Traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2009	n	5 year average ('04-'08)	n	2009	n	5 year average ('04-'08)
Narraguagus	360	167±17	N/A	N/A	120	162±13	633	168±14
Pisq-Pleasant	527	133±9	1,371	134.7±11.9	17	155±13	292	166±14
Piscataquis	N/A	N/A	N/A	N/A	363	143±11	N/A	N/A
Sheepscot	62	156±11	210	141±21	204	186±17	315	182±24

Table 5.1.4.7 Mean smolt wet weight (g) by origin of smolts captured in Rotary Screw Traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2009	n	5 year average ('04-'08)	n	2009	n	5 year average ('04-'08)
Narraguagus	360	48.3±16.0	N/A	N/A	120	44.4± 11.8	633	46.7± 12.4
Pisq-Pleasant	527	22.4±5.4	1,371	21.8±6.3	17	37.6±10.4	292	42.4±9.3
Piscataquis	N/A	N/A	N/A	N/A	363	28.8±7.3	N/A	N/A
Sheepscot	62	42.0±8.8	210	30.7±12.4	204	68.7±18.9	315	62.3±21.6

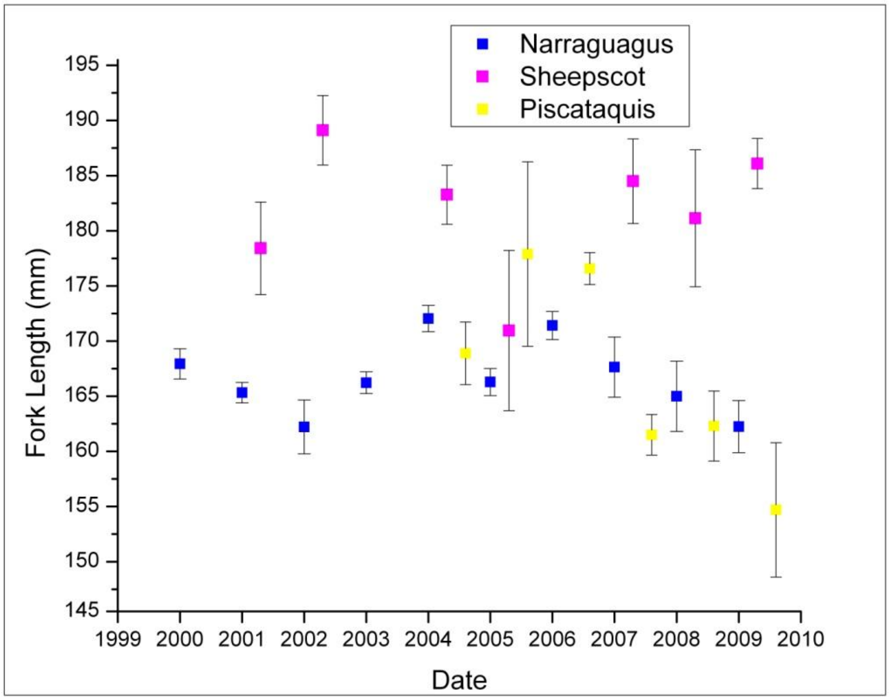


Figure 5.1.4.1 Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2000-2009.

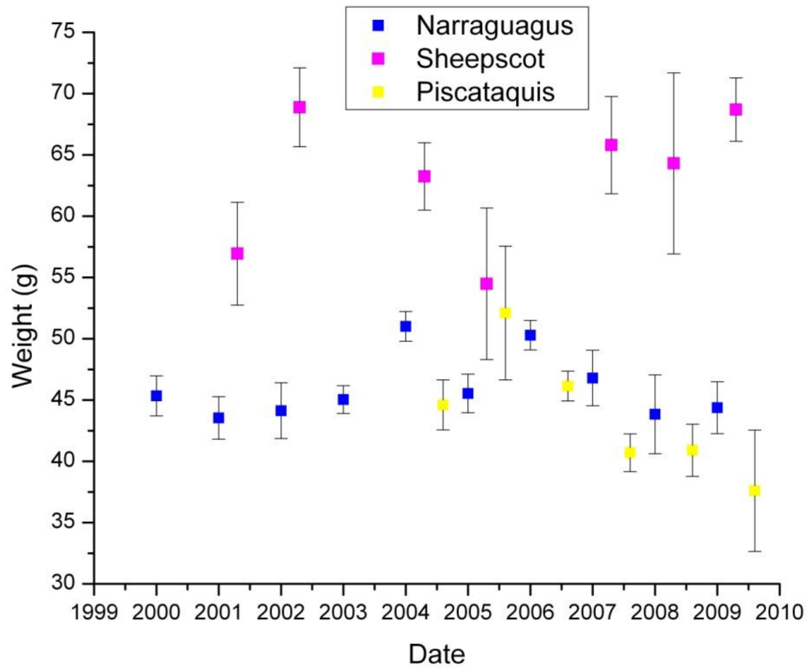


Figure 5.1.4.2 Mean wet weight (g) ± 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2000-2009.

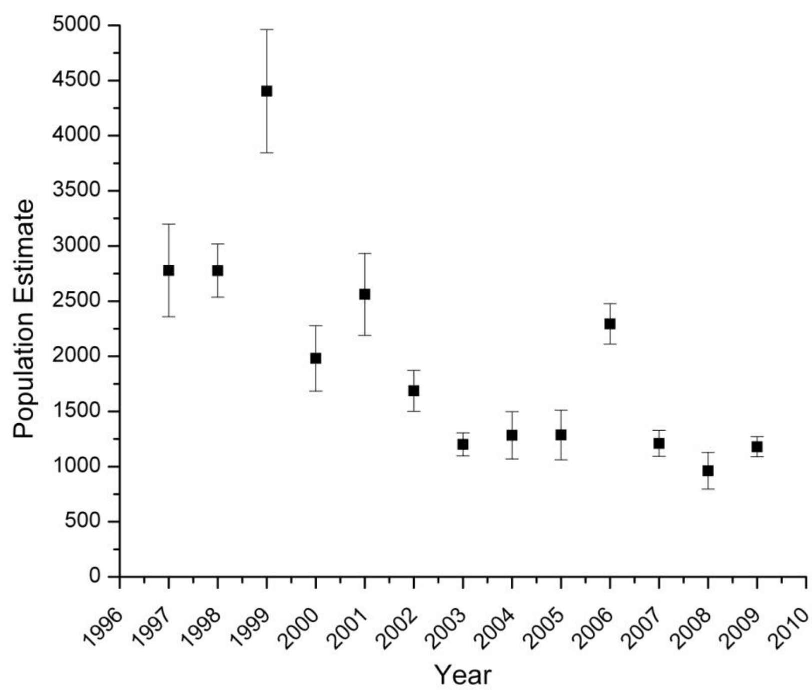


Figure 5.1.4.3 Population Estimates (± Std. Error) of emigrating smolts in the Narraguagus River, Maine from 1997 to 2009 using DARR 2.0.

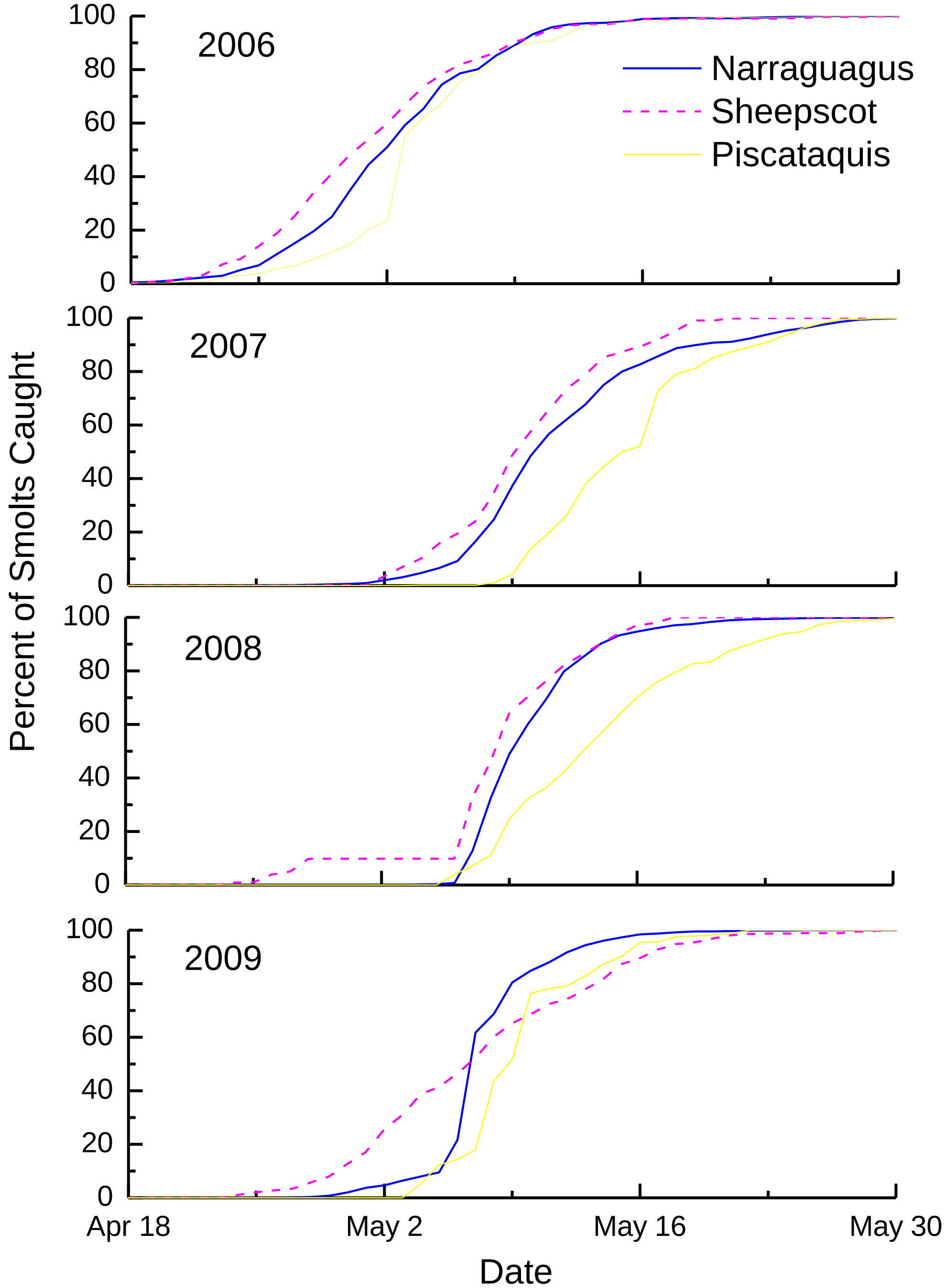


Figure 5.1.4.4 Cumulative percentage catch of smolts of all origins in Rotary Screw Traps by date (run timing) on the Narraguagus, Piscataquis, and Sheepscot Rivers, Maine, for years 2005 to 2009.

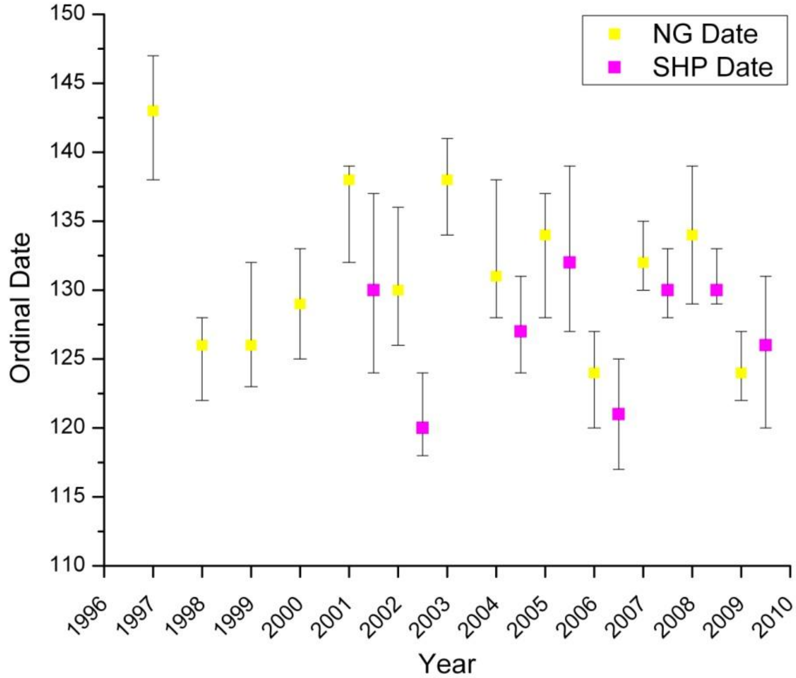


Figure 5.1.4.5 The timing of (Ordinal day = days from January) of the midpoint of emigration (rotary screw trap catch) for naturally-reared smolts on the Narraguagus and Sheepscot Rivers each year from 1997 to 2009. Error bars represent 25^{th} and 75^{th} percentiles of median run dates.

5.1.5 Fish Passage

In 2009 Brookfield Power, conducted a downstream passage study on Atlantic salmon smolts at their Hydro Kennebec Facility. The study was based on a design approved by FERC and used total of 225 pit tagged hatchery smolts.

5.1.6 Genetic sampling

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick, at the Lockwood fish lift on the Kennebec River, and at Benton Falls lift on the Sebasticook River. In total 50 (29 on the Kennebec, 2 on the Sebasticook, and 19 on the Androscoggin) genetic samples were collected in 2009. Three of the fish sampled were captive reared adults stocked in 2008. All were tissue samples were preserved in 95% ethanol.

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

To reduce handling stress, tag loss, and tagging-related mortality, juvenile broodstock are currently tagged one year post-capture at CBNFH. This allows the fish to reach an appropriate size to allow for intramuscular insertion of PIT tags. In October 2009, DPS broodstock (collected in 2007) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.1.7 General Program Information

Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River
Maine fisheries agencies adopted a plan for restoring all twelve diadromous species to the Penobscot River watershed in 2009. An Interagency Technical Committee will coordinate adaptive multispecies management in the watershed. The first steps in developing adaptive management systems for each species, assessing the status of stocks and effectiveness of current population and habitat management, were started during the planning process. As the plan is implemented decisions will be made that balance managing populations (hatcheries, distributing pre-spawn adult, recolonization), habitat (complexity, water quality, non-native species), and connectivity. The challenge is integrating assessment and management of all species into a cohesive ecosystem based program while developing an understanding of how increasing population or distribution of one species affects other diadromous and freshwater fish species.

Expanding the geographic range of the Endangered GOM DPS and Critical Habitat Designation
Endangered status under the Endangered Species Act (ESA) now applies to all anadromous Atlantic salmon whose freshwater range covers the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, an area which includes the Penobscot and Kennebec rivers. It also applies wherever these fish occur in these rivers’ estuaries and marine environment. Hatchery fish used to supplement these natural populations are also included under this final rule that was published on June 19, 2009 in the Federal Register (74 FR 29344-29387). As an endangered species, the Gulf of Maine Distinct Population Segment of Atlantic salmon (GOM DPS) receives the full protection of the ESA, including a prohibition against take; take is defined to include harass, harm, pursue, wound, kill, trap, capture, or collect.

The GOM DPS’ critical habitat includes all specific areas essential to the conservation of the species. This includes 45 occupied HUC 10 watersheds throughout the Kennebec, Androscoggin, Penobscot and Downeast Coastal Basins, containing approximately 12,000 miles of river, stream and estuary habitat and about 300 square miles of lake habitat in Maine. Three HUC 10 watersheds, including Belfast Bay, the Passadumkeag above Grand Falls, and Molunkus Stream were excluded from critical habitat because of correspondingly higher economic costs. No unoccupied areas were designated as critical habitat. This is the first time critical habitat has been determined for the GOM DPS. The final rule designating critical habitat for the GOM DPS was published o June 19, 2009 (74 FR 29300-29341). All federal agencies must ensure that their actions do not adversely modify or destroy critical habitat.

Fish Passage Improvements Receiving Funding from the American Recovery and Reinvestment Act

The Penobscot River Restoration Trust (PRRT) and Project SHARE each received significant funding from the American Recovery and Reinvestment Act (ARRA) to improve connectivity within the freshwater range of the GOM DPS.

The PRRT received approximately $6.1 million to remove the Great Works Dam and as part of a broader initiative to reconnect inland endangered Atlantic salmon habitat to the Gulf of Maine. This regionally significant project will help lead to the restoration of the full assemblage of 11 native migratory fish species to the river, and provide benefits for wildlife, tribal culture, and the Gulf of Maine, as well as spur community and economic development in New England's second largest watershed. This funding includes over $1 million for pre-restoration monitoring activities in the Penobscot River including fish community surveys (electrofishing and hydroacoustics), PIT tag studies, ultrasonic telemetry, and geomorphic assessments. A broad array of state, federal and academic partners have been funded to carry out this work with ARRA funds.

Project SHARE received nearly $1.7 million to address fifty-three fish passage barriers in the Machias River watershed of downeast Maine. These projects will include replacing impassable culverts at road crossings and decommissioning unneeded commercial roads. This project will open 66 miles of habitat for endangered Atlantic salmon and other commercially and recreationally important fish species, restore natural stream function, and reconnect 57 square miles of the upper watershed to downstream areas. The project includes funding for pre-restoration and post-restoration monitoring.

U. S. Fish & Wildlife Service Schools Programs

2009 marked the fifteenth year of FWS' outreach and education program, which focus 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

Over the past several years, the spawn timing of Penobscot broodstock has progressively advanced earlier into October. Following a disappointing egg take in 2008, in which an attempt was made to return to traditional spawn timing, Penobscot broodstock were examined earlier in the season in 2009. However, it was discovered during the initial examination on October 28th that *all* Penobscot females were ready to spawn; all Penobscot fish were spawned the following day. Despite the unprecedented single egg take, the eye-up survival and fecundity was well within normal bounds. Captive broodstock were likewise spawned in an advanced and compressed spawning schedule. Again, despite the unusual nature of the egg take, eye-up survival and fecundity were normal.

The greatest concern with the single and earlier than desired Penobscot egg take is potential developmental issues with fry. CBNFH lacks design and infrastructure to rear fry through the initial feeding period. Taking eggs too early in the fall will compound the problem as water temperatures are typically well below the 10 C Atlantic salmon need to effectively begin feeding. In addition, the large production numbers for the Penobscot result in rearing densities 2 to 3 times the maximum density ceiling used at GLNFH. These factors all conspire to create poor rearing conditions, for much too long a time, at unfavorable water temperatures and excessive densities. The result is a less than high quality fry product being stocked into the Penobscot drainage.

Several strategies are currently being investigated at CBNFH to address these issues. The need for a chiller at CBNFH is paramount and efforts are underway to acquire purchase and operation funds. The ability to chill incubation water early in the spawning season will be advantageous to the long term development of the fry. In addition to a chiller, CBNFH is investigating methods of manipulating the photoperiod broodstock, particularly the Penobscot broodstock, are exposed to in an effort to delay the onset of spawning until environmental conditions are more favorable.

Update on 2008 Egg Survival at CBNFH

Severe egg loss was experienced with brood year 2008 Penobscot River sea-run eggs during the green to eye development at Craig Brook NFH. Fish health investigations conducted to ascertain the cause of this mortality had no conclusive results. Of special note, U.S. Geological Survey's Rocco Cipriano conducted a study in which *Flavobacterium psychrophilum,* the cause of bacterial coldwater disease, was isolated within approximately 25% of the dead eggs sampled, but not found in any live eggs. Rocco concluded that this infection was not the principle cause of mortality.

In addition to this investigation, the staff at Craig Brook NFH conducted an internal review of spawn timing, chemical use, brood handling and spawning protocols, and overall spawning operations management. No positive correlation could be determined at the time. A year later, the 2009 Penobscot River eggtake did not experience similar high mortality during early egg development, although a slightly lower than normal survival rate (83% actual vs 88% expected) was experienced. The hatchery implemented much more stringent management practices, replaced all chemical stocks with newly purchased stock, and acted much more aggressively in assessing and identifying spawn readiness. This resulted in identifying that spawn readiness was significantly earlier than the historical timing. The entire Penobscot population was spawned on October 29; the previous early record date for finishing spawn was November 12. Some of the early run fish were already past prime spawn timing, and most likely were ready to spawn as much as a week earlier, which would have been a new early record for start of spawning activity. Staff now believes that an earlier than historical spawn timing existed in 2008, but spawning operations occurred during historical timing and that this may have had a negative impact on egg quality that was not identified during spawning operations. Poor egg quality due to spawning after prime timing may be a factor in the occurrence of F. *psychrophilum* in the 2008 spawn. Additionally, a correlation may exist with run timing as both the 2008 and 2009 Penobscot River runs were nearly two weeks earlier than the historic run timing. The reason for this is unknown, and factors such as river flow conditions and trap operations confound analysis, but warming sea temperatures may be a factor.

5.1.8 Salmon Habitat Enhancement and Conservation

Habitat Connectivity

In 2009, 37 stream-road related habitat connectivity projects were completed in four Downeast Rivers using funds from USDA-WHIP, USFWS, NOAA Fisheries, Project SHARE, and private landowners such as the Downeast Lakes Land Trust. These rivers and number of associated projects consisted of Narraguagus (1), Pleasant (1), and Machias (35). Twenty nine stream-road crossings were retrofitted with bankfull spanning open arch structures, four sites had complete road decommissions, 1 culvert was decommissioned with bridge abutments installed, 2 crossings were replaced with 24 ft wooden ATV/Snowmobile bridges, and 1 culvert was replaced with an all purpose wood bridge. The total fish bearing stream habitat above these (37) stream-road locations was estimated at 63.9 kilometers (Table 5.1.8.1). Atlantic salmon parr (n=56) were observed at five restoration sites in 2009.

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. Annual monitoring is performed to determine if the projects withstand natural flood and beaver activity threats. Ongoing monitoring of 57 restoration sites in Downeast salmon rivers since 2005, have found no failures from high flow events or beaver activity. In 2009, three open arch culverts were partially obstructed by beavers (debris) but, these actions did not affect the structure or road.

Habitat Complexity

The large wood (LW) habitat improvement project was initiated by BSRFH staff to improve habitat complexity and suitability by placing trees into the river at a rate of one tree per ten meters of river length. In 2009, seven sites on tributaries to the Narraguagus sites were treated. A combination of “cut and drop” trees and trees with root balls were added to the treatment sites with the objective of having the LW move less and stay oriented to best create geomorphologic change. Five to fifteen trees with root balls were added to the stream depending on the length of the treatment site. Trees with root balls were felled at the top, bottom, and within the site to be used as key pieces to catch natural LW moving through the system or to catch the “cut and drop” LW. LW with root balls were added manually using a “Grip Hoist” and cable equipment. Trees were selected that were along the bank full margin of the stream with exposed root systems. Conifers were chosen over hardwoods because they do not have a deep root system, however some hardwoods were taken. After the selected LW with root balls were added to the stream the remainder of the LW needed to achieve twelve per 100 meters were “cut and dropped”.

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

Subwatershed (HUC 12)	Project (width m)	Previous Structure (N) @ Width (m)	Long. DD	Lat. DD	Habitat Opened (km)
1st Machias Lake	Bridge (4.3)	1@1.9	67.934	45.164	1
1st Machias Lake	Open Arch (2.7)	1@0.7	67.858	45.074	1
1st Machias Lake	Open Arch (4.6)	1@0.9	67.917	45.06	6.6
4th Machias Lake	Open Arch (3.4)	1@0.6+2@0.8	68.01	45.166	1.8
Mopang Stream	Open Arch (3.4)	1@0.3	67.931	44.841	3.4
Old Stream	Decommission	1@1.1	67.813	44.994	0.8
Old Stream	Open Arch (1.8)	1@0.3+1@0.6	67.79	45	0.3
Old Stream	Open Arch (1.8)	1@1.2	67.788	45.02	0.5
Old Stream	Open Arch (1.8)	1@1.0	67.821	44.984	0.7
Old Stream	Open Arch (2.1)	1@1.2	67.803	45.035	0.9
Old Stream	Open Arch (2.4)	1@0.7	67.843	45.028	0.5
Old Stream	Open Arch (2.7)	1@0.9	67.752	44.938	0.8
Old Stream	Open Arch (3)	1@1.2	67.836	45.036	0.7
Old Stream	Open Arch (3.4)	1@2.1	67.751	44.936	3.4
Old Stream	Open Arch (3.7)	1@0.6	67.823	44.99	1.8
Old Stream	Open Arch (3.7)	1@0.6	67.825	45.032	1
Old Stream	Open Arch (4.3)	1@0.5	67.673	44.833	1.9
Old Stream	Open Arch (6.1)	1@1.0	67.796	44.973	8.2
WB Machias	ATV Bridge (7.3)	1@0.6	68.059	45.032	1.4
WB Machias	ATV bridge (7.3)	1@0.9	68.056	45.031	6.4
WB Machias	Decommission	1@1.7	68.014	45.013	0.5
WB Machias	Decommission	1@0.5	68.015	45.016	0.5
WB Machias	Decommission	1@1.0	67.939	44.995	2.9
WB Machias	Decommission	1@0.5	67.983	45.004	0.4
WB Machias	Open Arch (1.8)	1@1.4	67.952	44.917	0.4
WB Machias	Open Arch (1.8)	1@0.6	68.052	45.032	0.5
WB Machias	Open Arch (1.8)	1@0.6	68.041	45.026	0.4
WB Machias	Open Arch (2.1)	1@1.2	68.068	45.032	0.5
WB Machias	Open Arch (2.1)	1@0.8	67.957	44.923	0.2
WB Machias	Open Arch (2.4)	1@0.5	68.038	44.997	1.3
WB Machias	Open Arch (3.0)	1@0.4	67.954	45.011	0.8
WB Machias	Open Arch (3.0)	2@0.8	67.917	44.965	0.8
WB Machias	Open Arch (3.0)	1@0.8	67.951	44.992	1.3
WB Machias	Open Arch (3.7)	1@0.4	68.032	44.974	1.8
WB Machias	Open Arch (3.7)	1@0.8	68.068	44.988	1.9
Schoodic Brook	Open Arch (3.7)	1@0.6	67.95	44.694	4.2
Pleasant (Epping)	Open Arch (3.7)	1@1.8	67.937	44.75	2.4
			Total (km)		63.9

Literature Cited

Bjorkstedt, E. P. 2005. DARR 2.0: updated software for estimating abundance from stratified mark-recapture data. NOAA Technical Memorandum NMFS-SWFSC-368.13 p.

6.1 Outer Bay of Fundy

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

6.1.1 Adult Returns

Aroostook River. The Tinker fish lift and trap was opened on 15 June following the first releases of salmon trapped downriver at Mactaquac, and closed on 2 November, with a 31 day closure for maintenance from 15 August to 14 September. The Tinker Dam trap catch in 2009 was 14 Atlantic salmon compared to 44 salmon in 2008. Based on observed fork lengths or tags, the sea-ages of sea-run salmon trapped in 2009 were: eight –1SW, five-2SW, and one- captive reared stocked adult.

Trap catch in 2009 may have been reduced by the extended maintenance shutdown and an unplanned modification of the "free-swim" and adult release strategies in the St. John River. A legal dispute between New Brunswick Power and First Nations representatives disrupted hydro operations and discharge patterns at the Tobique Narrows Dam, which compromised fish passage efficiency. Consequently, many of the adult salmon originally allocated by the Department of Fisheries and Oceans (DFO) for release downstream of the Aroostook and Tobique Rivers (permitting them free-swim access to the tributary of choice) were released in the Tobique River above the dam. Salmon would have had to drop downstream over the Tobique Dam to locate and access the Aroostook River via the Tinker trap.

St. Croix River The research trap at Milltown on the St. Croix operated from 11 May to 4 July, 2009. No salmon were documented during that time period. After July, the trap was opened for free passage.

6.1.2. Hatchery Operations

Aroostook River. Atlantic Salmon for Northern Maine. Inc. (ASNM) owns and operates the Dug Brook Hatchery in Sheridan, Maine to produce Atlantic salmon fry for the Aroostook River. The hatchery relies on eyed salmon eggs from "St. John River strain" salmon spawned at the Mactaquac Biodiversity Facility. The eggs are tested in compliance with U.S. Title 50 fish health criteria and then imported to Dug Brook Hatchery for hatching. Transfers in 2009 totaled 555,389 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.

6.1.3. Stocking

Juvenile Atlantic Salmon Releases

Aroostook River. ASNM stocked a total of 455,916 non-feeding fry soon after hatching into the Aroostook River in accordance with BSRFH recommendations. As in 2008, tributary streams (e.g. Mooseleuk, Big Machias, Little Madawaska) were targeted for stocking.

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 2009, the captive-reared adult that passed the Tinker fishway was probably collected as a smolt in the gatewells at Beechwood Dam and reared to maturity at the Mactaquac facility. They were 165 salmon (111 females 54 males) with that capture history released to 'free-swim' to their tributary of origin (i.e. Aroostook R., Salmon R., Tobique R.) on 9 October (adipose clip + red Floy tag).

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

6.1.4. Juvenile Population Status

Electrofishing Surveys

Median relative abundances (fish /minute) at eight sites in the Aroostook River system ranged from 0 to 2.06 for parr and 0 to 6.52 for YOY (Table 6.1.4.1).

Table 6.1.4.1 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, 2009.

Life Stage	Min	Median	Max	n
PARR	0.00	0.30	2.06	8
YOY	0.60	1.95	6.52	8

Smolt Monitoring

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

Tagging

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

6.1.5 Fish Passage

Aroostook River. The Tinker trap was closed for routine maintenance for 31 days from 15 August to 14 September. Tinker trap catch in 2009 may have been reduced by this extended maintenance shutdown and an unplanned modification of the "free-swim" and adult release strategies in the St. John River. A legal dispute between New Brunswick Power and First Nations representatives disrupted hydro operations and discharge patterns at the Tobique Narrows Dam, which compromised fish passage efficiency. Consequently, many of the adult salmon originally allocated by the Department of Fisheries and Oceans (DFO) for release downstream of the Aroostook and Tobique Rivers (permitting them free-swim access to the tributary of choice) were released in the Tobique River above the dam. Salmon would have had to drop downstream over the Tobique Dam to locate and access the Aroostook River via the Tinker trap.

St. Croix River. In March of 2008, the Maine Legislature's Marine Resources Committee heard testimony on LD 1957, an act to overturn the 1995 state law closing fishways at the Woodland and Grand Falls Dam to anadromous alewives. While the original bill would have provided access to 52% of the spawning habitat available in the 1980s, an amended bill was passed, opening fish passage at the Woodland Dam only and restoring alewives to just over 2% of that habitat. In May 2009, Maine and New Brunswick conservation interests petitioned the US/Canada International Joint Commission to re-open all of the St. Croix's boundary dam fishways to alewife passage under the terms of the 1909 Boundary Waters Treaty. In November 2009, the International Joint Commission responded by asking the inter-agency St. Croix Fisheries Steering Committee to propose an adaptive management plan for restoring alewives to the St. Croix system. An ad hoc group is currently drafting a plan for the IJC.

6.1.6 Genetics

No genetics samples were collected in 2009.

6.1.7 General Program Information

6.1.8 Salmon Habitat Enhancement and Conservation

Connectivity

One culvert within the St Croix watershed was replaced with a bottomless arch (Table 6.1.8.1). 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 6.1.8.1 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)	Previous Structure (N) @ Width (m)	Long. DD	Lat. DD	Habitat Opened (km)
Pocumcus Lake	Open Arch (3.0)	Wood Bridge	67.883	45.139	0.9

7.0 Terms of Reference and Emerging Issues in New England Salmon

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

The focus topics for this meeting were 1) continuing efforts toward regional assessment products; 2) Fish Health Issues; 3) Aquaculture marking; and 4) marine survival – acoustic telemetry studies. In addition to these summaries, the draft terms of reference for next year's meeting are included.

7.1 Regional Assessment Product Progress Update

Starting in 2008, the USASAC began the process of transitioning the USASAC Report from a collection of individual reports to a more integrated regional assessment product. The goal was to retain information for each individual population and consolidate population information within each of the four regions in geographic summary sections (Sections 3-6). In addition, our goal was to consolidate information throughout New England to take a broader look at the program and provide a US Status of Stocks synthesis as well as attempt to identify factors impeding restoration and recovery at a regional level. A key to these value-added analyses is the high quality integrated Access database that has been brought to a higher level of utility through the expertise and stewardship of Dr. John Sweka. The current 2010 version is a highly useful collection of age-specific population (parr, smolt, and adult) and hatchery supplementation data. His approach of including the group in development and focusing design around relevant questions has made a useful data resource. In addition, having a database leader has made all groups more responsive to populating this database in a timely manner. The current database can now generate most of the historical tables for this report (Tables 7-10). The USASC is just now mining this information resource to develop stock assessment products beyond adult return counts and percentage of conservation spawning escapement. In particular, the incorporation of more juvenile data across the regions, especially incorporation of additional data from the Maine juvenile database is facilitating new opportunities for regional assessment of juvenile production and the development of new metrics to gage recovery and restorations trajectories and identify important trends.

One outcome of the regional assessment has been a meta-analysis of juvenile salmon productivity throughout New England. John Sweka has developed a manuscript in collaboration with biologists throughout New England. This manuscript is being reviewed by biologists and was presented at the annual USASAC meeting. Atlantic salmon populations in the United States have declined dramatically in the early 1990's following some initial success in rebuilding depressed populations. US salmon populations are 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 parr densities throughout New England and determine if 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 groups of rivers. The first group, (the Penobscot River) showed a nonlinear trend where parr densities increased until the 1990's and then rapidly decreased to the present time. The second group (all other rivers) showed a linear decrease throughout the time series. This decrease is estimated to be between 0.8 and 3.3%. These parr density trends reflected similar trends in spawning escapement for both groups of rivers. Sweka concluded that current fry stocking efforts have not been able to overcome the decrease in spawning escapement and altered stream ecosystems in New England to increase populations.

Looking forward, the USASC identified an opportunity to refine the approach for juvenile population assessment for New England. As defined in the 2009 USASAC report, work had been completed on development of a spatially stratified random sampling framework to assess juvenile salmon abundance in the Gulf of Maine DPS. This frame work was not implemented for the 2009 sampling season because several details had not been refined in time. Following discussions at the 2010 USASAC meeting a working group was created and charged with expanding the effort to include the expanded DPS and other New England Atlantic salmon drainages. The goal of this expansion is to apply the same methodology presented in the 2009 report to this expanded dataset. The results of their discussions will be presented at the 2011 USASAC meeting

The USASAC made additional headway in 2009 intersession and at the 2010 meeting on creating synthesis products that combine data from different programs/regions. Initial progress has been in developing more graphical summaries of juvenile data across New England. We successfully, completed some of these summary graphics and they are presented in section 2.0 Status of Stocks. That section includes parr density summaries and smolt return rate summaries. Efforts are ongoing in the Gulf of Maine DPS to develop new metrics to track stock status and stage-specific survival to monitor management actions. Stock assessment scientists believe that some of these metrics can be used regionally as well to compare and contrast progress and gain more information. The USASC believes that the time saved by pre-meeting assembly and the opportunity of having the region's salmon scientists together to graph and visualize data as well as to analyze and discuss new metrics provides additional opportunities to use the integrated dataset annually.

The USASC felt that this is a large undertaking and should be accomplished over the course of several meetings and intercessions. We believe we made some significant progress in 2009 and have several intersession workgroups established (see section 7.5) to accelerate this effort. Some considerations that the USASAC believed were essential were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New England and NASCO managers for US data, and 3) making sure that as more data is developed and analyzed it was utilized as a tool to rebuild Atlantic salmon stocks. To this last point, the USASAC recognizes they need to provide core stock assessment information (provide a yardstick of progress) but understands the need to better communicate information to managers as opportunities and threats are recognized (provide rebuilding tools).

7.2 Fish Health Issues

Infectious pancreatic necrosis (IPN) continues to be a concern throughout the U.S. Atlantic salmon recovery and restoration program. Although no IPN identifications occurred in 2009, the sea-run brood populations and egg production continue to be at risk to IPN introductions. In particular, the Penobscot and Merrimack River sea-run brood populations are at greatest risk due to the minimal to moderate mitigation practices in place. Since the IPN discovery at Richard Cronin National Salmon Station in 2007, the Maine program has not implemented any additional risk mitigation procedures, while the Merrimack program has developed new brood and egg handling procedures that separate brood holding tank and incubator bank areas into linked but bio-secure groups, thus lessoning the chance of an entire adult return cohort loss due to IPN identification. The risk to the Connecticut River population has been effectively mitigated with state-of-the-art brood and egg holding facilities and procedures. The USASAC calls for continued attention to developing effective risk mitigation strategies for the endangered river-specific populations in Maine.

All sea-run hatchery brood fish are screened for infectious salmon anemia (ISA) in the Penobscot, Merrimack, and Connecticut River populations each year prior to spawning. ISA infection is a serious concern to sea-run brood populations, and methods have been investigated to decrease risk. Although positive ISA infections have not been confirmed in hatchery brood populations, in 2009 the Penobscot River hatchery brood population had six fish identified as ISA suspects (please see section 5.1.2. Hatchery Operations, Disease Monitoring and Control for details). As a result of the need for better risk management practices, Craig Brook National Fish Hatchery completed construction in 2009 on an ISA screening building that will allow for enhanced risk mitigation practices to be implemented on the Penobscot River sea-run brood population. The new screening building will be used in 2010 to hold each day’s entry of hatchery broodstock in isolation until health screening can be completed and found to be free of the virus, which currently is estimated to take 3-4 days to complete. At that time the screened brood would be placed in large holding pools with other brood that have been previously screened and found to be ISA free. There are only five bays in the screening building, and it is assumed the holding capacity of each bay will be between 50-75 fish each. Since brood is brought to the hatchery seven days a week, and occasional issues with testing turnaround time are expected, it is anticipated all the bays will be full at some points during brood collection, and some segment of the population will need to be placed directly into an overflow pool to be screened in the conventional manner. The overflow fish will be minimized to the extent possible, with a draft goal of 25% or less of the overall population bypassing the screening building and being placed directly in the overflow pool. Logistics to implementing the enhanced ISA screening program are very complex, and will be a notable challenge to both the U.S. Fish and Wildlife Service and the Maine Department of Marine Resources. Standard operating procedures for handling brood and disease screening practices, as well as a decision tree to provide guidance with fish movement and positive ISA identifications, will be developed prior to the 2010 Penobscot River return.

7.3 Update on the US Aquaculture Industry Marking

The US has implemented measures to minimize the potential effects from commercial Atlantic salmon aquaculture on the GOM DPS. Accordingly, the Atlantic salmon farming industry in Maine is required to implement protective measures to minimize the risk from farmed fish interactions. These specific measures are anticipated to provide much needed data to determine the efficacy of the containment measures implemented with a goal of eliminating losses of farmed fish. Annual third party audits validate the CMS plans and annual state and federal Services reviews monitor these protective measures in place for compliance with the permit requirements.

Specifically, the measures in place for the protection of Atlantic salmon include;

- use of North American broodstock for production;
- Containment Management System;
- prohibition on the use of transgenic salmon;
- auditing and reporting requirements including losses, gear, inventory, and feed records and;
- marking of individual fish to identify origin.

Starting July 30, 2009, the Maine salmon farming industry was required to mark all salmon placed in marine net pens to enable the identification of the specific site the fish is being reared. The Maine Atlantic salmon farming industry used different marking techniques to comply with these permit requirements and eventually chose genetic marking (e.g., parentage assignments) to achieve the benchmark for mark detection of greater than 95% set by the Services. Annual Quality Assurance and Quality Control (QA/QC) audits (Table 7.1.3) validate mark detection rates and Chain of Custody documentation prior to stocking (FW hatchery) and immediately following stocking into marine net pens. This genetic based marking system will enable tracking fish through the complete production cycle and will provide sufficient information to identify the facility where the fish was reared.

Table. 7.3.1 Results from parentage assignment tests for marking compliance

Generation	% correct assignment*	Marker Panel	Software
2005	93%	US 5	Cervus
2006	84%	US 5	Cervus
2007	91%	US 5/ RPC 7	Cervus
2008	88%	CUSA7	Offspring A
2009	100%	CUSA	Offspring B

*Data from Cooke 2009 marking plan

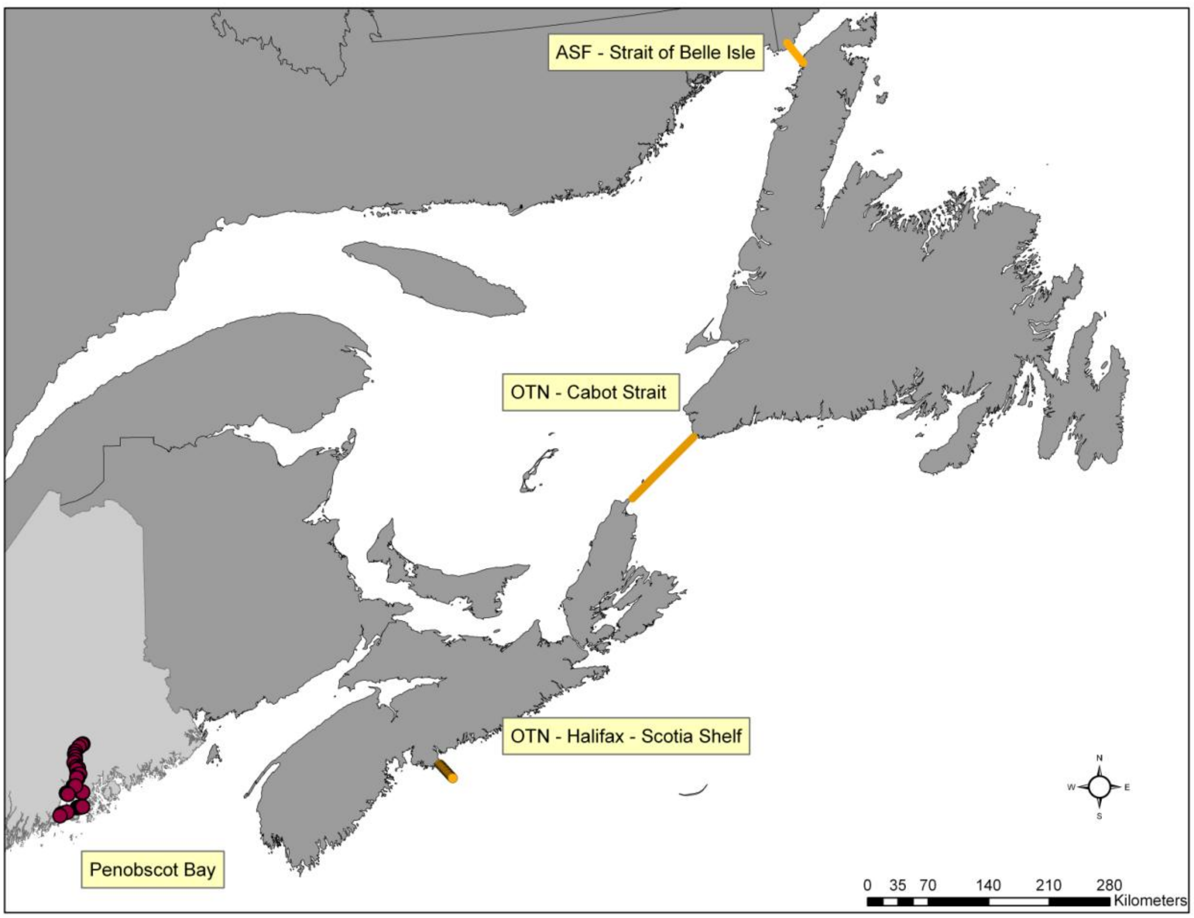
7.4 Marine Survival: Acoustic Telemetry Studies

Marine survival of Atlantic salmon is a major factor inhibiting recovery and restoration. Ongoing smolt marking programs allow managers to monitor overall marine survival. Overall marine survival rates are reported in section 2 of this document. However, additional information is needed on Atlantic salmon at sea to understand mechanisms causing lower marine survival than in the past. One of the tools used to estimate early marine survival and migration paths is ultrasonic telemetry.

NOAA's National Marine Fisheries Service (NOAA) has used ultrasonic telemetry to assess Atlantic salmon smolt migration since 1997. In 2009, fall parr (n=38) and hatchery smolts (n = 121) were tagged and released into the Penobscot River estuary on seven dates in May. Movements were passively monitored via moored ultrasonic receivers through the estuarine and near-shore marine environment to observe migration dynamics. Beyond Penobscot Bay, NEFSC attached receivers to seven Gulf of Maine Ocean Observing System (GoMOOS; www.gomoos.org) buoys. Additionally, NOAA collaborates with the Ocean Tracking Network (OTN; www.ocenatrackingnetwork.org) headquartered out of Dalhousie University (Halifax, NS) which has deployed a continuous operating telemetry array extending approximately 15 km off the coast of Halifax.

Hatchery stocked smolts were significantly larger (Kruskal-Wallis: Test Statistic 76.9 < 0.05) than fall parr stocked smolts (181 vs 151 mm FL). Preliminary estimates of survival of smolts to the outer Penobscot Marine Array was estimated to be 0.58 (95% CL 0.34-0.80 for fall parr and 0.66 (95% CL 0.42-0.86) for hatchery smolts. Both groups partitioned habitat use in the bay similarly. In the middle array, 90.0% of Fall Parr and 70.6% of Hatchery smolts traveled on the eastern side of Islesboro (Dice Head). Through the outer array, the majority of smolts exited through the western (Owls Head) passage (Fall Parr 80.0 % and Hatchery 89.7%). Fall Parr stocked smolts traveled faster though the array (release to outer array; 3.68 versus 3.90 days), but these findings were not significantly different (ANOVA: F-Ratio 0.15; $p = 0.70$). Of the 159 smolts that were tagged and released, five (3.1%) were detected on the GoMOOS array and 16 (10.1%) were detected by the OTN array. The first detection on the OTN was 13 June and the last was 18 June, with the median days at large (Penobscot Array to Halifax) 23.25 days.

Figure 7.4.1 Map showing the location of the Penobscot Telemetry Array and the OTN-Halifax Array and proposed Cabot Strait Array. To the north is the Atlantic Salmon Federation Strait of Belle Isle Array.



7.5 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.

1) Suspected ICES Requests (TOR document pending)
    a. Marine Survival – return rates (rr)
        i. Redd-based coastal rivers estimate (Kocik)
        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)
    b. Marine Survival – biological characteristics – (ongoing ICES work; Sheehan)

2) Fish Health
    a. Status of Biosecurity Improvements in New England (Santavy and Bean)
        i. Organize Session with all New England salmon hatchery managers
    b. Update on emerging disease threats
    c. Sea Lice in New England

3) Conservation Spawning Escapement Update – 2011 working paper
    a. revisit and update with revised habitat estimates and recovery regions
    b. develop working paper to document current state of knowledge and document
    c. Examine New England productivity and use Legault (2005) as background to determine equilibrium baselines
    d. Intercession Study Group: Kocik, Sweka: regionally Atkinson (BoF, GoM, CNE); McKeon/Smithwood (CNE), Sprankle (LIS)

4) Smolt Parr-Subsidy Issue-
    a. Document in working paper:
        i. info on grading over time from FWS
        ii. data sets of known origin – marked fish
        iii. Nomenclature of Fall Parr (grading types), Smolts, Spring Smolts etc. – clarify by sizes and ages and add to glossary
    b. Ongoing Study track: All parr marked (2010-2014) CWT 100%
        i. Report on juvenile and adult known-origin scale samples
        ii. Assess potential of isolating parr stocking in another drainage or subdrainage
    c. Intercession Study Group: Cox, Firmenich, Flanery, Domina, Lipsky

5) Regional Juvenile Index and Random sampling Designs – summer workshop
    a. Examine Bayesian approach 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
        i. BoF – 6 CPUE sites on Aroostook
        ii. GoM – 200-300 index and CPUE sites wants valid estimate and reduce effort
        iii. CNE --MR – 7 index sites Saco 2 site
        iv. LIS - CT – 200+ sites wants valid estimate and reduce effort
    b. Intercession Study Group: Sweka, Cox, Atkinson, Christman, McMenemy, Smithwood

6) Return Rates for Atlantic salmon stocked as Fry – related to Paul S. request through CHAT for juvenile metrics
    a. In 2010 Maine fry stocking data added
    b. Need to develop a redd-based subsidy
        i. 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.

7) Redd-Based Estimate Benchmark 2010 Revision in 2011 – Kocik, Atkinson, Lipsky
    a. Create working paper to document 2010 benchmark
    b. In 2011, move Union River 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.

8) New England Smolt Summary Benchmark Year 2011 – Hawkes
    a. develop specific TOR and working group
    b. Add Narraguagus smolt estimate to USASC database

9) Emerging Issues

8.0 Appendices

8.1 List of Attendees

First Name	Last Name	Primary Email	Agency	Location
Ernie	Atkinson	Ernie.Atkinson@maine.gov	ME	Jonesboro, ME
Dave	Bean	David.Bean@Noaa.gov	NOAA	Gloucester, MA
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Paul	Christman	Paul.Christman@maine.gov	ME	Hallowell, ME
Mary	Colligan	Mary.A.Colligan@noaa.gov	NOAA	Gloucester, MA
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Steve	Mierzykowski	Steve_Mierzykowski@fws.gov	FWS	Orono, ME
Paul	Santavy	Paul_Santavy@fws.gov	FWS	Orland, ME
Rory	Saunders	Rory.Saunders@noaa.gov	NOAA	Orono, ME
Doug	Smithwood	doug_smithwood@fws.gov	FWS	Nashua, NH
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
BK10-01	Tim Sheehan	Tim.Sheehan@noaa.gov	2009 WGNAS 4 Delegation (PPT)
BK10-02	Rory Saunders	Rory.Saunders@noaa.gov	USA NASCO Section 2009 Summary and Focus Area Report on Protection, Restoration and Enhancement of Salmon Habitat (PPT)
PS10-01	Jay McMenemy	Jay.McMenemy@state.vt.us	Connecticut River Atlantic salmon restoration, 2009 (WP, PPT)
PS10-02	Joseph McKeon	Joe_McKeon@fws.gov	Merrimack River Atlantic salmon restoration, 2009 (PPT)
PS10-03	Joan Trial	Joan.Trial@maine.gov	Maine Atlantic salmon restoration, 2009 (PPT)
WP10-01	Christine Lipsky James Hawkes Ruth Haas-Castro Oliver Cox Peter Ruksznis Mitch Simpson Randy Spencer Justin Stevens Joan Trial	Christine.Lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smolt Studies: 2009 (WP)
W10-02	James Hawkes Graham Goulette John Kocik Paul Music	James.Hawkes@noaa.gov	Update on NOAA Fisheries Service Coastal Maine Atlantic Salmon Smolt Telemetry Studies: 2009 (WP)
WP10-03	Dave Bean John Lewis	Dave.Bean@noaa.gov	Maine and Neighboring Canadian Commercial Aquaculture Activities (WP, PPT)
WP10-04	Ben Letcher,	Ben_Letcher@USGS.gov	Atlantic Salmon

	Krzysztof Sakrejda-Leavitt, Scott Davidson and Keith Nislow		Freshwater Production Model (PPT)
WP10-05	Tyler Wagner and John Sweka	John_Sweka@fws.gov	Temporal trends in Atlantic salmon parr densities in Northeast U.S. Rivers (PPT)
WP10-06	Paul Christman	Paul.Christman@maine.gov	Utilizing Eggs to Restore Atlantic Salmon (WP,PPT)
WP10-07	John Sweka	John_Sweka@fws.gov	Status of U.S. Atlantic Salmon Assessment Committee Databases (2010) (PPT)
WP10-08	Joan Trial	Joan.Trial@maine.gov	BGEST **B**asinwide **G**eographic and **E**cological **S**tratification **T**echnique (PPT)
WP10-09	Tyler Wagner and John Sweka	John_Sweka@fws.gov	Evaluation of hypotheses for explaining temporal trends in Atlantic salmon parr densities in Northeast U.S. Rivers

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

8.3 Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Bureau of Sea Run Fisheries and Habitat	BSRFH
Central New England Fisheries Resource Office	CNEFRO
Connecticut River Atlantic Salmon Association	CRASA
Connecticut Department of Environmental Protection	CTDEP
Connecticut River Atlantic Salmon Commission	CRASC
Craig Brook National Fish Hatchery	CBNFH
Decorative Specialities International	DSI
Developmental Index	DI
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 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 from Maine Atlantic Salmon and Their Ecosystems Forum

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

8.5.1 Maine Atlantic Salmon and Their Ecosystems Forum (2010 Meeting January 6-7, 2010)

New insights into the marine life of Atlantic salmon

Gilles L. Lacroix
Department of Fisheries and Oceans, St. Andrews Biological Station, St. Andrews, NB, Canada

Atlantic salmon kelts from three different regions of the Bay of Fundy were tagged with pop-up satellite archival tags (PSATs) with 4-month pop-off delay as they left the rivers in the fall and spring for reconditioning at sea. Kelts from one region migrated thousands of kilometers to the northern edge of the Labrador Sea and as far east as the Flemish Cap, whereas those from the other two regions remained in the Bay of Fundy and Gulf of Maine. Detailed migration tracks were obtained from the archived light data (geo-positioning using sunrise and sunset times and day length). Preliminary examination of the water temperature and depth data archived at 2-15 min intervals revealed some interesting and common behaviour. Although kelts encountered a wide temperature range (-1˚C to 20˚C) they tended to exploit areas within a narrow range (5-10˚C). Kelts spent most of their time near the surface (depth <2 m) while migrating but there were nevertheless frequent periods of repeated diving to 25-50 m, possibly associated with feeding. There were also occurrences of deep diving in the 100-500 m range (maximum depth 700 m). Mortality during migration was high and the archived parameters revealed that predation was a frequent cause. Changes in diving behaviour and temperature also allowed for identification of a common predator for several cases in the Gulf of Maine.

Sonic tracking of Atlantic salmon smolts to sea: correlates of survival and lessons on the migration pathway

Fred Whoriskey
Atlantic Salmon Federation, St. Andrews, NB, Canada

We have used sonic telemetry to document Atlantic salmon smolt migration patterns and survival from fresh water river release sites to: 1) the head of tide, 2) through the estuary, and 3) across the Gulf of St. Lawrence to the Strait of Belle Isle. The rivers studied (Miramichi, Restigouche, Cascapedia, Margaree and St. Jean (North Shore) Rivers) fell on an approximately 600 km south-to-north gradient. Survival patterns of smolts in fresh water and through the estuary were generally similar among years for a given river. We also found consistent differences in survival to the head of tide and across the estuary among rivers. However, these differences did not clearly correlate with latitude. Heavy losses occurred in most river estuaries. Twenty to 30% of the smolts that survived to exit the estuaries of the Miramichi, Restigouche and Cascapedia Rivers passed through the Strait of Belle Isle enroute to ocean feeding grounds off Greenland. Travel rates in the Gulf were estimated as 17- 25 km/d, and survivals and travel speeds were not correlated with fish body lengths. The results show that Atlantic salmon from different rivers migrate together in the sea, and suggest that behavioral and social factors may be important in determining smolt survival.

Environmental and biological factors affecting the survival of Atlantic salmon in Maine

Kevin D. Friedland[1], James P. Manning[2] and Jason S. Link[2]
[1]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Narragansett, RI; [2]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA

The general parameters of a recruitment mechanism for North American salmon have emerged that suggests sea mortality is a punctuated event that occurs within the first two months at sea. The post-smolt population is most likely decremented by predation, mediated by the changing nature of the predator field in the Gulf of Maine. We examined a suite of environmental and biological factors in order to test and extend the hypothesis formulated for the North American stock complex to the stocks that would utilize the Gulf of Maine as post-smolts. The marine survival of Atlantic salmon in the Gulf of Maine appears to be influenced by a complex set of physical and biological interactions. Marine survival has declined as sea surface temperature in the coastal ocean has increased, and there also appears to have been a deterioration of synchronization between smolt migration and ocean conditions for post-smolts. There has been a change in spring wind conditions in the Gulf of Maine area, which could be modifying the post-smolt migration across the Gulf of Maine and Georges Bank regions. The shift in environmental conditions have also affected the distribution in time and space of many predators that likely prey upon salmon post-smolts. Notably, hake species have increased in abundance in the areas that serve as migration corridors for post-smolts. The time series changes in environmental conditions and predator distribution is consistent with the hypothesis that Gulf of Maine salmon experience a growth-independent mortality during the first months at sea, thus forming the basis of recruitment control for these populations.

Coastal migration and survival of Atlantic salmon smolts in the Narraguagus River

John F. Kocik[1], James P. Hawkes[1], Timothy F. Sheehan[2], Paul A. Music[1] and Kenneth F. Beland[3]
[1]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Maine Field Station, Orono, ME; [2]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA; [3]Maine Atlantic Salmon Commission (retired), Bangor, ME

We studied the estuarine and early marine ecology of Atlantic salmon smolts within the relatively large and spatially dynamic environments of eastern Maine using ultrasonic transmitters and a large network of fixed receivers. We monitored natural smolt migration in the Narraguagus River, Bay, and coastal environment of the Gulf of Maine (GoM). Our 30 km long study area began in the lower river, extended 8 km downstream to head-of-tide, 7 km through the estuary then fanned out seaward 15 km in the western GoM along the interface with the Maine Coastal Current. From 1997 to 2004, we increased sampling network density in the estuary and expanded marine arrays further into the GoM. We designed receiver networks to monitor all smolt exit routes and were able to: (a) estimate smolt survival to the GoM; (b) map primary migration paths; and (c) document emigration timing. Survival ranged from 36% to 47% to the GoM. Median migration rates were 0.7 km/h in the estuary to Middle Bay and 1.0 km/h in the Outer Bay. Smolts generally traveled with the tides and upon entering saltwater and most commonly used the western 6 km of a 23 km wide embayment. These are among the first quantitative data to estimate survival during early marine migration of wild Atlantic salmon smolts. A Cormack-Jolly-Seber model estimated site efficiency and smolt survival simultaneously, providing a useful methodology and information benchmarks for other studies to better understand emigration dynamics and to help identify mortality factors at sea.

Evaluating the influence of environmental conditions on the survival of out-migrating Atlantic salmon smolts within the Narraguagus River system, Maine

Michael S. Cooperman*, John F. Kocik and James Hawkes
NOAA's National Marine Fisheries Service, Maine Field Station, Orono, ME

The out-migration of anadromous salmon smolts from freshwater to saltwater is a time of elevated mortality, but factors contributing to mortality have not been well quantified. During 2002-4, we used acoustic telemetry to explore how environmental conditions affect Atlantic salmon smolt survival during their migration through the Narraguagus River system of Downeast Maine. Each year approximately 85 wild smolt in Narraguagus River were tagged and smolt survival monitored within the eco-zones of the lower river (FW), estuary (EST) and bay (SW). Tagged smolts were partitioned into one of 16 four-day cohorts based on date of entry to each eco-zone. There were large among-cohort differences in survival within each zone (all χ^2 test $p < 0.03$), with mean cohort survival (i.e., # exiting an eco-zone / # which entered) in FW of 0.85 (range 0.60 – 1.0), 0.70 in EST (range 0.25 – 1.0), and 0.65 in the SW (range 0.38 – 1.0). Our results suggest smolts survived best when delaying migration until after the cold temperatures of early season, that late season river water temperatures can be stressful to smolts but rain events could improve survival, and that surface oriented predators (i.e., birds) may be a primary source

of mortality. These findings are consistent with other studies, but the observed relationships were weak (all r^2_{adj}. of models with ΔAICc < 2 were < 25.2). In contrast, wind speed and direction, tidal amplitude, lunar phase, and mean and variability of river discharge were not related to survival. When smolt cohorts were partitioned into groups of good (> 75%) and bad (< 60%) survival, MANOVA (all p > 0.37), MRPP (all p> 0.18), and NMS ordination each failed to identify environmental differences experienced by the groups. In total, our results suggest abiotic conditions were not a primary driver of among-cohort differences in survival in the Narraguagus system, and therefore provides evidence that predation is perhaps the principle mechanism of smolt mortality.

Atlantic salmon diet in coastal waters: spatial and temporal forage patterns with inferences from alternative sampling platforms

Mark D. Renkawitz and Timothy F. Sheehan
NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA

Atlantic salmon populations in the Northwest Atlantic have significantly declined in abundance. Conditions in the marine environment are at least partially responsible for these declines and are hampering recovery efforts. Populations in the southern extent of the species range are extinct, and the existing populations in the USA are currently classified as 'endangered'. These populations undertake extensive round trip migrations from natal rivers to feeding grounds off the coast of Greenland, utilizing different coastal environments over multiple life stages. To understand how Atlantic salmon forage in coastal environs, NOAA's National Marine Fisheries Service collected postsmolt stomachs from different rearing origins in Penobscot Bay, Maine, USA, and from immature adults off the west coast of Nuuk, Greenland. Significant dietary differences were found between years and between salmon life stages. Post-smolts in USA waters primarily fed on juvenile Atlantic herring (*Clupea harengus*) and euphausiids, while adults in Greenland primarily fed on capelin (*Mallotus villosus*) and amphipods (*Parathemisto* sp.). Significant differences were found in the quantity and quality of food items consumed by postsmolts from different rearing origins. Contemporary adult salmon diets at Greenland differed from those determined from studies conducted four decades earlier. Overall, considerable interannual variation was evident in the composition, availability, and abundance of prey species consumed by Atlantic salmon in coastal USA and Greenland waters. Similar interannual variations in the diets of co-occurring seabird species have been linked to patterns in fitness, and may influence Atlantic salmon survival and reproductive success as well. It is unclear whether these dietary changes are related to cyclic interannual variations in the forage base or to permanent shifts caused by large scale climatic factors. No matter which, fluctuating foraging conditions at various life stages may be negatively impacting the marine survival of Atlantic salmon.

Detection of carrier state infectious pancreatic necrosis in post-spawned sea-run Atlantic salmon at the Richard Cronin National Salmon Station

Gavin Glenney, Patricia Barbash, John Coll and William Quartz.
US Fish and Wildlife Service, Lamar Fish Health Center, Lamar PA

The pathogen Infectious Pancreatic Necrosis Virus (IPNv) was isolated and identified from two pools of Connecticut River sea-run Atlantic salmon ovarian fluid during the 2007 spawning season at the Richard Cronin National Salmon Station. A small 130 base-pair (bp) PCR product was amplified (USFWS and AFS-FHS, 2003) and sent to the USGS Western Fisheries Research Center for sequence analysis. The isolate closely resembled the Canada_3 strain falling into genogroup V described by Romero-Brey et al. (2009), which is different from the more common genogroup I in the USA. This information allows us to speculate that the Cronin ATS was not infected with IPNv during the freshwater life stage in the Connecticut River watershed. On November 20, 2007, the Connecticut River Atlantic Salmon Commission (CRASC) voted to depopulate the infected stock at Cronin and the entire suspect egg lots held at White River National Fish Hatchery. Approximately 4 weeks following confirmation of IPN at Cronin, 121 Connecticut River Atlantic salmon sea-runs were euthanized and sampled for a follow up investigation to determine the location and prevalence of infection and to perform a comparison between the standard tissue samples (kidney/spleen -lethal) with various blood fractions for development of a reliable non-lethal screening tool for future years. Although no IPNv positive blood samples were detected, one kidney/spleen homogenate (male-#55) exhibited cytopathic effect on chinook salmon embryo (CHSE) cell line and tested positive for IPNv via PCR. A total of 2,943 bp of segment A was sequenced and determined to be a new strain of IPNv closely resembling Canada_2 and Canada_3 of genogroup V. Further work is being conducted to develop a qPCR assay to detect a variety of IPNv isolates and increase sensitivity for potential non-lethal testing.

References

Romero-Brey, I., I. Bandin, J.M. Cutrin, V.N. Vakharia and C.P. Dopazo. Genetic analysis of aquabirnaviruses isolated from wild fish reveals occurrence of natural reassortment of infectious pancreatic necrosis virus. J. Fish Diseases 32: 585-595.

US Fish and Wildlife Service and American Fisheries Society-Fish Health Section. 2003. Standard procedures for aquatic animal health inspections. *In* AFS-FHS. FHS blue book: suggested procedures for the detection and identification of certain finfish and shellfish pathogens, 2003 edition. AFS-FHS, Bethesda, MD.

Non-lethal detection of Infectious Salmon Anemia Virus (ISAv) in Penobscot River sea-run Atlantic salmon using real-time Reverse Transcription – Polymerase Chain Reaction

Patricia A. Barbash, Gavin Glenney and John Coll
US Fish and Wildlife Service, Fish Health Center, Lamar, PA

Since 2000, the US Fish and Wildlife Service's Lamar Fish Health Center (LFHC) has been monitoring for ISAv in Atlantic salmon (ATS) migrating to New England rivers, using tissue culture and polymerase chain reaction (PCR) techniques on whole blood. Standard PCR detected ISAv in one of 60 ATS sampled from the Penobscot River in 2001, but the virus did not cause cytopathic effect (CPE) on targeting cell lines. This was later determined to be the HPR0 genotype of ISAv, which had been reported in wild ATS in Europe, and thought to have low or no pathogenicity. In 2009, the LFHC implemented a real-time RT-PCR assay (Snow et al 2006) in ATS sea-run broodstock health screening protocols. The more sensitive molecular tool produced positive detections of ISAv from 6 of 570 pre-spawn ATS sea-run blood samples screened from the Penobscot River. No CPE was observed in tissue culture assays. Sequence analysis of the PCR product targeting segment 8 of the ISAv genome confirmed the positive detection. Preliminary sequence analysis indicated the genotype to be similar to European ISAv types. In order to prevent possible viral transmission of the virus to progeny, and subsequently to facilities where progeny are cultured for stocking and domestic broodstock, the two females and 4 male fish suspected of carrying the virus were removed from the spawning population. Results from subsequent genotyping of the haemagglutinin (HA) gene in the highly polymorphic region (HPR) will be presented, as well as a discussion of fish health management implications for feral broodstock programs.

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Mercury accumulation in stream-dwelling juvenile Atlantic salmon and brook trout (*Salvelinus fontinalis*)

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We measured mercury concentrations in juvenile Atlantic salmon and brook trout at 20 sites in tributary streams of the Connecticut River in 2008. All study streams were in largely forested watersheds with no point source inputs of mercury pollution. Mercury concentrations of both species varied widely across sites, with a >10-fold range in site mean concentrations for salmon (60-800 ppb dry) and a >5-fold range for trout 60-330 ppb dry) and frequently exceeded critical values for protection of piscivorous wildlife (ca. 100 ppb for birds, 500 ppb for mammals). For both species, variation in mercury concentrations across sites increased with environmental factors that reflect increased mercury bioavailability and accumulation in the stream food web (e.g. low pH, low ANC, high mercury concentrations in prey invertebrates) and decreased with factors that reflect increased secondary productivity (high prey biomass, high fish growth rate). Mercury concentrations in salmon and trout were significantly correlated across sites ($r=0.77$, $P<0.0001$). However, while salmon and trout concentrations were similar at sites with low mercury levels, salmon mercury concentrations were up to 3 times higher than mean trout concentrations at the most contaminated sites. This species-specific pattern may reflect bioenergetic differences in mercury and biomass accumulation or a differential switch to relatively uncontaminated terrestrial prey by trout at unproductive sites with high mercury levels.

Developing non-lethal biomarkers for waterborne organic contaminants

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Threatened and endangered fish species are in decline due to many factors, including polluted habitats. A common approach to assessing contaminant exposure in fish is to measure chemical body burdens or to assess physiological, developmental, reproductive or biochemical changes; both approaches are typically lethal. Our objective is to develop non-lethal approaches for determining pollutant exposure and response for use with T&E species. The monooxygenase enzyme, cytochrome P4501A (CYP1A), is an established biomarker that is rapidly and strongly induced by many of the most toxic organic pollutants found in aquatic systems, including dioxin, polynuclear aromatic hydrocarbons, and polychlorinated biphenyls (PCBs). We hypothesized that CYP1A could be measured non-lethally using gill filaments and scales. We exposed Atlantic salmon parr to two aqueous concentrations of 3,4,3',4',5'-pentachlorobiphenyl (PCB-126, 0.01 µM & 0.001 µM, static exposure), vehicle (32.25 ppm acetone), or untreated water for 24 h before transferring the fish to clean, flow-through water. At 6 and 24 h during exposure, and at 2, 14 and 34 days post-exposure we sampled gill filaments and scales (non-lethally) and whole livers (lethally). PCB-126 treatment strongly and significantly induced CYP1A activity (measured as ethoxyresorufin-o-deethylase, EROD) in all tissues, with the strongest induction seen in the gills (up to 414 fold over controls), followed by the liver (up to 25 fold over controls), and the scales (up to 17 fold over controls). Significant elevation occurred within 6 hours of exposure and persisted for at least 34 days after fish were placed in clean water. Signs of disease and distress were not observed in fish sampled non-lethally and held for 34 days post sampling. We conclude that CYP1A activity in salmon gills and scales shows great promise as a non-lethal biomarker of organic pollutant exposure and response for use with threatened and endangered fish species.

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Passage of hatchery-reared Atlantic salmon smolts at dams and movement through estuary and bay on the Penobscot River, Maine

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The Penobscot River hosts the largest return of adult Atlantic salmon in the US, but runs are very low compared to historic numbers. Stocking of hatchery reared smolts is a major restoration tool but has had only moderate success in recent years. Previous telemetry studies have shown that downstream passage success is variable among years and sites. We used acoustic telemetry to quantify downstream passage success and movement through the estuary in 2009. We also assessed the success of survival for three stocking areas: Milo, Passadumkeag and Verona Island. The heavily dammed sections of the river accounted for over 10% mortality in some study reaches. Our best fit model comparing reaches with and without dams demonstrates the lower survival of dam influenced sections. We found variable survival through the estuary for the different hatchery releases.

Monitoring changes in resident and anadromous fish communities in Sedgeunkedunk Stream (Penobscot Co., Maine) after barrier removal

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Sedgeunkedunk Stream is a third order tributary to the Penobscot River. The stream once supported anadromous fish runs that have declined or disappeared due to two dams. A restoration project has been completed on the Sedgeunkedunk which removed the lowermost dam and replaced an upstream dam with a rock-ramp fishway. This project provides an opportunity to characterize the responses of resident fish communities and anadromous fish populations to dam removal. We anticipate dramatic impacts on the stream system associated with connectivity, hydrology, temperature and marine derived nutrient influx. In order to assess fish community response, we have collected data on abundance, length, and mass of all fish species present. The fish community in the stream sections above the dam shows reduced biomass, species richness and species diversity, compared to the section below the dam. The immediate response to the removal of the lower dam was a drop in fish abundance and species richness downstream of the removal. Fish abundance above the site of the former dam increased, which could be caused by the more common species moving upstream in response to the disturbance caused by the dam removal. Sea lamprey, an anadromous fish already present in the stream, are being monitored for both abundance and habitat use. This restoration will serve as a model for other small streams in the watershed, and elsewhere, targeted for dam removal.

Barrier removal in Sedgeunkedunk Stream: sea lamprey colonization and implications for Atlantic salmon habitat restoration

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Sedgeunkedunk Stream is a tributary of the lower Penobscot River, debouching downstream of several impassible barriers on the main-stem Penobscot. Historically, Sedgeunkedunk Stream provided spawning habitat for several native anadromous fish species including endangered Atlantic salmon, but several small dams reduced or eliminated spawning runs entirely. Currently, only a small population of sea lamprey (*Petromyzon marinus*) uses the accessible portion of Sedgeunkedunk Stream regularly for spawning and rearing. As part of the Sedgeunkedunk Stream Restoration Project (SSRP), the abandoned Mill Dam was decommissioned in August 2009, and this latest restoration effort has opened up an additional 5 km of potential lotic habitat. Consequently, Sedgeunkedunk Stream provides a unique opportunity to examine ecological interactions within a suite of diadromous species in the context of long-term restoration efforts. We hypothesize that semelparous sea lamprey may provide an influx of marine derived nutrients and energy (MDNE) in Maine streams, similar to that documented for Pacific salmon in western streams. Furthermore, we hypothesize that sea lamprey spawning will condition habitat to better suit Atlantic salmon spawning. Sea lamprey spawning activities rearrange gravel and small cobble substrate in the process of nest construction. Lamprey nest building also releases fine sediments while reducing embeddedness. Atlantic salmon prefer loose gravel substrate free of fine sediments for redd construction and as lamprey colonize previously inaccessible habitat beyond the former Mill Dam, lamprey conditioning may attract salmon spawners. Comparing lamprey abundances, stream productivity, and fine-scale changes in habitat before and after dam removal as well as comparisons with a nearby control stream will test these hypotheses. Johnson Brook is a stream similar to Sedgeunkedunk Stream but with a natural barrier waterfall excluding diadromous fishes. Comparisons with Johnson Brook will elucidate whether changes in Sedgeunkedunk Stream were a function of colonization and expanded range for diadromous species.

Evaluating changes in diadromous species distributions and habitat accessibility following the Penobscot River Restoration Project

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The Penobscot River Restoration Project (PRRP) is a multimillion-dollar endeavor that aims to restore native sea-run fish through the removal of two mainstem dams and improved fish passage at a third dam on the Penobscot River. We used geographic information systems (GIS) to quantify changes in species distribution and habitat accessibility for 11 diadromous species in the Penobscot Basin following the PRRP. Using previously compiled accounts of historic range, barrier survey data, and simulated barrier passage data, we modeled species-specific distributions and river access for 11 species following the proposed dam removals and compared these against the current ranges and accessibility. For some species such as Atlantic sturgeon (*Acipenser oxyrhinchus oxyrhinchus*), the PRRP will provide access to 100% of their historic freshwater habitat. However, for alewives (*Alosa pseudoharengus*), approximately 46% of historic spawning and rearing habitat will remain inaccessible due to the presence of other passage barriers. These results demonstrate that the PRRP is an important step toward ecosystem recovery in the Penobscot Basin, but other restoration activities will be needed in order to realize the full potential of the PRRP.

The growth and survival of stocked juvenile Atlantic salmon in first and second order streams of the Machias River watershed

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The Machias River, located in Downeast Maine, harbors one of the few remaining wild populations of anadromous Atlantic salmon in the US. This study focuses on Atlantic salmon habitat in first and second order streams of the Machias River watershed. Over the past century, the Machias River watershed has experienced much alteration due to anthropogenic disturbances. These activities, mainly the construction of roads for timber harvest and log driving, have severely disrupted the structure and function of the river and its tributaries. The extensive network of logging roads required the construction of dozens of culverts on many of these headwater streams. Currently, these poorly designed and malfunctioning culverts impede the movement of juvenile Atlantic salmon into tributaries that historically provided nursery and rearing habitat. These productive habitats are essential to the growth and survival of juvenile Atlantic salmon, as they provide thermal refuge, protection from predators, and abundant food supply. However, current management of Atlantic salmon in the Machias River involves stocking fry in larger tributaries because many of these smaller tributaries are blocked by culverts and thus would be inaccessible to returning adults. The objectives of this study are to determine the growth and survival of stocked Atlantic salmon fry in these headwater streams, better understand those habitat characteristics most significant to juvenile salmon production, and assess the benefits of culvert removal in the context of Atlantic salmon restoration.

Restoring stream connectivity in the Machias River watershed: a watershed-based focus area approach to salmonid restoration

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Since 2001 Project SHARE (Salmon Habitat and River Enhancement) has organized aquatic habitat restoration work intended to improve Atlantic salmon populations in the Downeast Distinct Population Segment (DPS) rivers. The overreaching goal of the restoration strategy is to improve aquatic and riparian habitat conditions on a watershed scale. The restoration thought process is based on correction of stream process rather than technical modifications of a site-specific reach to achieve short-term habitat improvements. Recognition that stream process begins in small headwater streams that influence the entire downstream water course provides the basis for a top-down approach. Therefore, the restoration strategy intends to identify and address multiple habitat threats at many relatively small restoration sites on a watershed scale. Working within the context of SHARE’s mission and authority, specific goals are to increase watershed connectivity (including fish passage), increase instream habitat complexity, decrease anthropogenic sedimentation inputs, and mitigate anthropogenic changes in water chemistry (pH, temperature). Identification of high priority sub-watersheds and threats assessment within selected focus areas allows limited resources to be focused in a manner that improves the potential for long-term success and benefit to the resource. It is generally recognized that dams and culverts can present barriers to both upstream and downstream fish passage. Less obvious disruptions of the continuum of stream ecological processes have not reached a similar level of mainstream awareness among land-use planners, regulators, and conservation groups. Road-stream crossings have been identified as a principle impact to stream connectivity and subsequently to salmon recovery in the Machias River watershed. Working cooperatively with landowners, state and federal agency partners, SHARE has replaced 50+ undersized round culverts with open bottom arch culverts and has decommissioned 10+ road crossings in the Machias River watershed. Funding is in place to complete 30+ additional road crossings in 2010. Although dams are recognized as a similar threat to salmon restoration in other areas of the DPS, it is generally recognized that most of the dams on the Machias River were removed at the end of the log drive era. SHARE has documented the existence of 50+ historic dam sites in the Machias River drainage. In most cases the sites do not present impairment to fish passage. However, remnant structures and the reservoirs associated with the sites do present an anthropogenic impact to channel morphology that continues to affect hydrology, sediment transport and water temperature. We will present an overview of the Machias Watershed restoration strategy including: identified threats, symptoms of altered stream connectivity, and habitat restoration efforts to date.

The interactive ecology of Atlantic salmon and smallmouth bass: competition for habitat

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We are investigating competition for habitat between native Atlantic salmon (ATS) and invasive smallmouth bass (SMB). Our major objectives are to determine if: (1) the two species overlap in habitat use, and at what time of year; (2) the overlap causes ATS to shift in their habitat use; and (3) the presence of SMB negatively impacts ATS growth rates. The first objective will be met through a series of snorkel observations of habitat use of both fish in sympatry and allopatry. A simulated stream and an *in situ* "controlled invasion" experiment are being used to meet objective two. Measurements incorporated into a Wisconsin Bioenergetic Model will allow us to calculate ATS growth rates in sympatry and allopatry. Initial results indicate that ATS and SMB age 0+ fish overlap significantly in habitat use during the late summer months, and the overlap does cause shifts in ATS habitat use. Results from this study will be used to better inform managers on the interactive ecology of two of Maine's most culturally and economically important fish.

Assessing juvenile Atlantic salmon habitat suitability within small catchments (<2 km^2) in Downeast Maine

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The US Fish and Wildlife Service's Maine Fishery Resources Office has been collaborating with multiple partners to restore ecological stream processes within small catchments in Downeast Maine. In the past four years, over 80 projects have restored aquatic organism passage and ecological stream functions within fish bearing catchments varying in area from 0.2 to 61.7 km^2 (mean 3.8 km^2). In 2009 we collected pre-restoration stream data to quantify juvenile Atlantic salmon "Habitat Suitability" as defined by Stanley and Trial (1995). This habitat suitability index (HSI) model is useful for evaluating stream habitats for production and survival of juvenile Atlantic salmon. HSI results of fry, parr and water quality components will be summarized for tributaries ranging in size from 0.3 to 2.0 km^2.

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Effects of ice on juvenile Atlantic salmon in New Brunswick, Canada

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Winter is often considered to be a bottleneck for survival of juvenile stream salmonids in temperate and arctic latitudes. Due to logistical difficulties in following fish behavior in ice-covered streams, the effects of different ice formations have not been thoroughly understood. The study used Passive integrated Transponder (PIT) technology that allows fish monitoring throughout the winter and was carried out over three years to understand how different winter periods, distinguished by contrasting ice condition, affect the ecology of the species. The steepest decline in apparent survival of salmon parr was observed during the pre-ice period in late autumn/early winter, whereas relatively high apparent survivals was observed during the period dominated by ice. Apparent survival possibly decreased again in early spring. Large-sized pre-smolt individuals obtained positive growth during winter. Salmon parr showed plasticity in their winter behavior in relation to prevailing ice conditions. The activity pattern remained generally nocturnal throughout the winter regardless of ice conditions. The level of activity was adjusted, however, being reduced during subsurface ice events while more daytime activity was observed when the amount of surface ice increased. Salmon parr were sedentary during winter, showing generally short and non-random movements. Movement tactics were adjusted relative to the prevailing ice conditions. Subsurface ice did not preclude tagged salmon parr from large areas. The presence of ice cover allowed salmon parr to disperse to areas where no other cover was available. Overall, negative effects of ice on Atlantic salmon parr were minimal and the presence of stable surface ice cover was considered beneficial for salmon parr when water temperatures remained close to 0^{o}C. In the future, anthropogenic impacts such as climate change and hydropower regulation can lead to changes in the natural ice regime of fluvial waters. Therefore, consideration of winter at a sub-period level will be crucial in order to assess how different salmon populations and their behaviors will be affected.

Spawning behavior, reproductive success, and production of juvenile offspring by stocked adult Atlantic salmon in four Maine streams

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Management strategies used to restore endangered populations of Atlantic salmon within the Gulf of Maine DPS have included fry stocking, smolt stocking, egg planting, and stocking gravid adults. Management focusing on fry and smolt stocking have not resulted in significant adult returns and natural reproduction. Adult stocking circumvents much of the hatchery influence on mate selection and potentially results in progeny that are more likely to survive and reproduce in the wild. However, stocking adults sacrifices numerical production advantages achieved by traditional hatchery methods. In 2005 an adaptive management project began in Mopang Stream (Machias), Chase Mill Stream (East Machias) and the Sheepscot River in which river-specific Atlantic salmon adults, reared to maturity from captive large parr, were stocked in the autumn.

In 2006, a similar project began on Hobart Stream. Results varied across streams, stocked adults successfully spawned and fry were captured during the following spring. However, the number of redds per female was less than expected two redds per wild female spawners. Movements of stocked adults were highly variable. The captive reared pre-spawn salmon often left the study reach but did not move upstream of passable obstacles such as waterfalls. Juvenile assessments documented that 0+ and 1+ parr densities were similar to densities in fry stocked areas. However, stocked adults produced fewer 0+ and large parr per capita than adults spawned for fry stocking. Managers need to consider lifetime fitness in evaluating large scale gravid adult stocking projects.

Ontogenetic selection on hatchery salmon in the wild: natural selection on artificial phenotypes

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Captive rearing often alters the phenotypes of organisms that are destined for release into the wild. Natural selection on these unnatural phenotypes could have important consequences for the utility of captive rearing as a restoration approach. We show that normal hatchery practices significantly advance the development of endangered Atlantic salmon fry by 30+ days. As a result, hatchery fry might be expected to face strong natural selection resulting from their developmental asynchrony. We investigated patterns of ontogenetic selection acting on hatchery produced salmon fry by experimentally manipulating fry development stage at stocking. Contrary to simple predictions, we found evidence for strong stabilizing selection on the ontogeny of unfed hatchery fry, with weaker evidence for positive directional selection on the ontogeny of fed fry. These selection patterns suggest a seasonally independent tradeoff between abiotic or biotic selection favoring advanced development and physiological selection linked to risk of starvation in unfed fry. We show through a heuristic exercise how such selection on ontogeny may exacerbate problems in restoration efforts by impairing fry productivity and reducing effective population sizes by 13 to 81%.

Historical summer base-flow trends for New England rivers

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River base-flow is important to aquatic ecosystems, particularly because of its influence on water temperatures. Summer (June through September) daily mean streamflows were separated into baseflow and storm-flow components by use of an automated method at 25 stations in the New England region of the United States that have long-term record and drain predominantly natural basins. Summer monthly mean baseflows increased at most stations in western New England from 1950 to 2006 with many large increases (>20%) and some very large increases (>50%) in New Hampshire and Vermont. The same was true for increases in summer 7-day low baseflows in New Hampshire and Vermont during this same period; in contrast, there were small and large decreases in 7-day low baseflows in northern and coastal areas of Maine. Seven-day low baseflow trends at the 10 stations with record from 1930 to 2006 were similar to trends from

1950 to 2006. Summer stormflows increased from 1950 to 2006 by more than 50% at many stations in New England, particularly in New Hampshire and Vermont. Summer rainfall increased at most weather stations in New England from 1950 to 2006 with many increases of more than 20% in western New England.

Evaluating management strategies by individual-based simulation

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Allocating resources between different habitat improvements and stocking strategies is key to optimal use of resources in salmon conservation. Currently it is difficult to evaluate the trade-offs inherent in management decisions because no single model incorporates all the relevant aspects of the salmon life cycle. We developed an individual-based simulation model of freshwater growth, movement, and survival for the Atlantic salmon life cycle from stocking to smolting. All three parts of the simulation are driven by a common set of factors: local density, water temperature, discharge volume, seasonality, and habitat quality. The simulation model is parameterized based on statistical models developed directly from a mark-recapture study on a stocked population. These features allow us to evaluate the trade-offs between management strategies in terms of the effect on the number and size distribution of salmon smolts.

Basinwide Geographic and Ecological Stratification Technique (BGEST): parr populations, habitat and management

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Basin large parr populations have been estimated on the Narraguagus River (1991 to 2006), the Dennys River (2001-2005), and the Sheepscot River (2003 - 2006). The estimates, based on stratifying the watersheds (geographic) and habitat (ecological) and expanding population parr estimates from sites based on the proportion of habitat sampled, have annual confidence intervals (±) that averaged 29 % of the estimate on the Narraguagus River, 34% of the Dennys River estimates, and 45 % of the Sheepscot River estimates. The estimates represent a large investment in planning, field work, and data management and computation. While the parr numbers track population trends, their strengths are in what can be learned about habitat and as the basis of adaptive management. On the Narraguagus River in most years (10/16), tributaries containing only 1.6 % of the surveyed juvenile rearing habitat reared approximately 19 % of the annual estimates (range 13 % to 33 %). In three of four years, the Upper West Branch of the Sheepscot River reared on average 49% of the large parr (range 37 % to 59 %), yet contained only 17 % of the surveyed habitat. In 2005 and 2006 the lower mainstem Sheepscot strata population was over 6 times higher than the two previous years, corresponding to 0+ parr stocking in 2004 and

2005. Following an assessment year, 0+ parr stocking was continued in this portion of the Sheepscot River. The switch from scatter to clump stocking in the mainstem Narraguagus strata immediately below Beddington Lake in 2005 did not result in lower parr populations, and clump stocking fry will be continued in this portion of the Narraguagus. The key to using ecologically stratified large parr estimates in adaptive management is to geographically and temporally segregate management strategies.

American shad in the Penobscot River –choosing recovery tools

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The planned restoration efforts in Penobscot River include the removal of two main-stem dams and the improvement of passage at the lowest remaining dam, Milford. This ambitious undertaking has generated optimism for the recovery of anadromous fish such as Atlantic salmon, but also for alosine fishes such as American shad. Shad are present in the Penobscot River, though presumed to be few in number, fueling concerns that unaided recovery could either fail or be unnecessarily protracted after access to upriver habitat is restored. While supplementation is a commonly used tool in fisheries management, the use of hatchery products is often a contentious issue. Concerns include impacts of hatchery reared fish on natural populations via behavioral, ecological and genetic effects. The cost-effectiveness of supplementation strategies can also be questionable. In order to assess the possible benefits of artificial supplementation on the rate of recovery, we applied data from several sources to build a deterministic population model. In this model, the shad population was represented by age classes up to 11 years (representative of age structure of shad observed in the Gulf of Maine) and iteroparity was included. Age of first maturation, at sea mortality and fecundity were derived from Atlantic States Marine Fisheries Commission reporting. Shad stocked as fed larvae were assumed to have ten-fold higher survival than wild spawned fish. As expected, the model was very sensitive to initial population. Presuming a current run of 1000 shad to the river and a population that stabilizes at 600,000 upon restored connectivity, the population would increase to 15,000 within 15 years and stabilize in less than 40 years. A stocking scenario that adds 12 million fry annually would accelerate stabilization to less than 30 years. It is hoped that this heuristic exercise may inform decisions associated with an intensive shad stocking program.

American shad population genetics: focus on Maine drainages

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American shad (*Alosa sapidissima*) are an important component of the diadromous fish community and ecosystem for Atlantic salmon. Evaluation of the genetic structure of American shad stocks, with particular focus on northeastern and Maine drainages, can be used to understand the genetic relationships among drainages and provide information for management and conservation. Samples were obtained in 2008 from five drainages in Maine, and genetic results obtained from 15 variable microsatellite loci were compared to other primary American shad rivers in the northeast: Merrimack, Connecticut, Hudson, Susquehanna, and Delaware. Observed estimates of genetic diversity were slightly lower in Maine drainages relative to other populations examined. Mean observed heterozygosity (H_o) and mean allelic richness (A_r) were lower among Maine populations (H_o=0.795 and A_r=9.414) compared to estimates observed among other populations (H_o=0.809 and A_r=10.061). Comparisons of differences in allele frequencies among all rivers sampled indicated that samples obtained from the Narraguagus River were significantly different (P<0.01) from all rivers analyzed, including Maine rivers. Samples from the Merrimack River, which has been and is currently used as a source for American shad stocking throughout New England, did not differ significantly in allele frequencies from the Androscoggin, Kennebec, Saco, or Sheepscot drainages, but did significantly differ in allele frequencies from the Narraguagus River (P<0.01). Allele frequencies from American shad sampled from the Hudson, Susquehanna, and Delaware rivers generally were significantly different from the Connecticut, Merrimack, and Maine rivers (P<0.01). Resulting information about the genetic structure of American shad populations and knowledge of the history of stock transfer can be used to evaluate past and current reintroduction efforts, and to assist ongoing management and conservation efforts for American shad in New England.

Outside the box: coastal movements of shortnose sturgeon and implications for management

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The shortnose sturgeon (*Acipenser brevirostrum*) is managed as 19 river-specific distinct population segments under the US Endangered Species Act. River-specific information about population size, distribution and habitat use are critical to the management of this species. Recently, answering such questions has become complicated by evidence of movement between distant river systems, e.g. the Penobscot and Kennebec rivers in Maine (>140km direct path). Closed population estimates for the Penobscot and Kennebec rivers are 1,531 (95% CI: 885 – 5,681), and 9,488 (95% CI: 6,942 to 13,358), respectively. In 2006 and 2007, 40 shortnose sturgeon captured in the Penobscot River were implanted with acoustic tags; ten of these tags were subsequently detected in the Kennebec River. The high rate of exchange between these systems indicates that we are likely sampling individuals from multiple sources. We have been using mark recapture methods and acoustic telemetry to estimate the proportion of sturgeon moving between these two rivers. In 2008, individuals were documented using three additional coastal Maine rivers. Sampling techniques since 2008 reflect the open nature of this population and abundance estimates based on discrete closed population periods bounded by periods of emigration and immigration. Our current population estimates are: for summer 2008: 1,739 (95% CI: 847-3653) and fall 2008: 1,007 (95% CI: 674 – 1531). These estimates will be applied to data collected in 2009. These, along with movement patterns, will provide more accurate information for the management of this endangered species.

Using acoustic telemetry to track the movements of alewives (*Alosa pseudoharengus*) in a freshwater and coastal zone

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We used acoustic telemetry to assess the pre- to post-spawning movement and survival of alewives in a Canadian river. A total of 40 alewives were tagged (20 each in 2007 and 2008) after they ascended a fish ladder at the Magaguadavic River's head of tide hydroelectric dam. Fish resided in the lower river reaches and a nearby lake during the spawning period. Six and two alewives are presumed to have died during the 2007 and 2008 spawning periods, respectively. During the return to sea, signals from five (2007) and two (2008) fish were lost near the top of the dam. Nine (2007) and four (2008) fish passed the dam via the turbines and suffered a mortality rate of 62%. No alewives used the downstream fish bypass facility in 2007. However, twelve fish used the bypass facility in 2008 when increased attraction flow was provided. Fish passing the dam alive were subsequently tracked through the river estuary and up to 28 km through the coastal zone. This study has demonstrated that sonic telemetry can be successfully employed for this species.

Tidal power development in Maine: preliminary laboratory tests and field assessments in Western Passage and Cobscook Bay

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Waterfront communities are changing nation-wide and Maine is no exception. One change that some communities will face is the development of alternative energy, including wind and tidal power. It is only when the value of the energy resource is balanced against the environmental and social impact that the potential for developing a site can be understood. While environmental impacts of tidal turbines will be complex, the most acute impacts are likely to be observed as direct contact of aquatic species with turbines. Because open turbine designs are new technology, studies examining the ability of fishes and other aquatic organisms to avoid a turbine are not standardized. Test procedures necessarily will be different from those used with conventional (enclosed) hydroelectric turbines. We have initiated laboratory studies to consider how Gorlov turbines may impact free-swimming fish, examining turbine blade strike and turbine avoidance. In addition we have examined individuals for injury (bruising, descaling) and stress levels. We have also initiated field testing. Baseline fisheries data were collected in Western Passage and Cobscook Bay in summer/fall of 2009. Baseline data include stationary acoustic surveys (24 h) of proposed turbine deployment sites to determine vertical distribution of aquatic organisms. In fall of 2009 a barge-deployed turbine will be tested by Ocean Renewable Power Company in Cobscook Bay and a field deployment is scheduled for fall 2010. Barge-deployment will be assessed using DIDSON (Dual-frequency Identification SONAR) in fall of 2009. Laboratory and field results will be used to inform engineers about turbine design and/or operation to minimize environmental impacts as well as informing resource agencies in permitting decisions.

POSTER ABSTRACTS

Diadromous Species Restoration Research Network: A Five-Year Collaborative Research Effort.

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The goal of the Diadromous Species Restoration Research Network (DSRRN) is to advance the science of diadromous fish restoration and promote state-of-the-art scientific approaches to multiple-species restoration at the ecosystem level. DSRRN integrates many diverse activities that improve the understanding of ecosystems and enhance restoration outcomes, facilitates the study of questions fundamental to diadromous fish ecology and restoration through scientific meetings, workshops and local networking, and enhances coordination of diadromous species restoration efforts of academic, government, and watershed stakeholders. The Network which is funded through the National Science Foundation, provides information and networking on research and restoration funding opportunities, research and restoration project partnerships, conferences and meetings, the Penobscot Science Exchange, fisheries and restoration links, and the Gulf of Maine Knowledge Base which provides access to spatially referenced bibliographic information so that users can locate information using text-based and map-based searches by state/province and by watershed.

Atlantic and shortnose sturgeon management and research needs

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NOAA's National Marine Fisheries Service (NMFS) has jurisdiction for both Atlantic and shortnose sturgeon. Atlantic sturgeon is currently designated as NMFS Species of Concern and Candidate species. In 2007, a status review team completed a status review for Atlantic sturgeon indicating that there are five distinct population segments of Atlantic sturgeon in the United States and recommending that three of the five DPSs be listed under the Endangered Species Act (ESA). The five DPSs are as follows: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. NMFS is currently in the process of considering the existing information to determine if listing is warranted for Atlantic sturgeon, and the Northeast Regional Office will be publishing a listing determination for the three DPSs in the Northeast early in 2010.

Shortnose sturgeon is listed as endangered throughout its range. NMFS recently assembled a status review team to update the existing status of shortnose sturgeon. The status review report is expected in 2010, and it is possible that based on the information in this report, NMFS could propose to list DPSs of shortnose sturgeon. Consequently, the listing status of shortnose sturgeon in Maine could change in the near future.

The Northeast Regional Office has been working with sturgeon researchers for several years to compile information on both species of sturgeon. Much of this research effort has been focused in Maine in recent years including projects on the Penobscot, Kennebec, and Saco Rivers. The various research efforts have provided crucial information that is being considered by NMFS in recovery efforts and in consultations under Section 7 of the ESA. While a significant amount of information has been collected in recent years, there are still many remaining questions that need to be answered including: information on the distribution, abundance, and movements of all life stages, particularly for young-of-the year and juveniles; identification of particular spawning locations; developing population estimates for both species where they occur in Maine; assessing impacts of water quality and contaminants on sensitive life stages; assessing interbasin movements and potential for colonization; and basic habitat characterizations.

Major Histocompatibility Complex Class II alleles: genetic and functional variation in the Antigen Binding Site of Atlantic salmon

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Our strategy is to use comparative genomic analysis to study the evolution of immune system genes in response to differences in life history strategies, specifically the differences in the suites of parasites experienced by landlocked versus anadromous fish. Here we report early results from a comparison between landlocked and anadromous populations of Atlantic salmon distributed throughout the Distinct Population Segment (DPS). Preliminary work in our laboratory indicated high levels of heterozygosity (H) for the Major Histocompatibility Complex (MHC) Class-II β gene. Analysis of Single-Stranded Conformational Polymorphisms (SSCP) from the Machias, East Machias, and Dennys rivers indicates a general pattern of shared polymorphism within the DPS, and with fish from Atlantic Canada. Extensive sharing of alleles among closely related species is well-known for MHC alleles. We demonstrate that our SSCP patterns are repeatable, and that SSCP patterns derived from cloned DNA are identical to alleles observed in our source fish. DNA sequencing demonstrates that at least some DPS fish alleles are similar to those previously reported from Atlantic Canada. Future work includes identification of the corresponding amino acid changes in the Antigen Binding Site (ABS) for each allele sampled, and broad correlation of functional allelic diversity with life history differences. This study will be expanded to other immune system genes, especially MHC Class-II α, as well as MHC Class-I and a Minor Histocompatibility Complex gene such as Transporter Associated with Antigen Processing (TAP). This will allow multilocus genotyping of fish, and determination of the existence of unique immune system genotypes within the DPS.

Monitoring progress for the Penobscot River Restoration Project

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In June 2009, the National Oceanic and Atmospheric Administration (NOAA) announced it would invest $6.1 million through the American Recovery and Reinvestment Act of 2009 (Recovery Act) to help rebuild the sea-run fisheries of Maine's Penobscot River. A grant to the Penobscot River Restoration Trust will fund removal of the Great Works dam. It will also initiate scientific baseline monitoring to allow tracking of physical, chemical and biological changes in the river following the removal of Great Works and Veazie dams, and the decommissioning and bypass of the dam at Howland. Understanding the effectiveness of dam removal requires systematic project monitoring and data reporting. Toward that end, a diverse group of government agency staff, academic researchers, and non-profit representatives established the Penobscot River Science Steering Committee (PRSSC) and developed a conceptual framework for monitoring. Concurrently, the Gulf of Maine Council on the Marine Environment (GOMC) sponsored a similar effort to develop regional guidance for stream barrier removal monitoring. NOAA was represented in both of these efforts, and their priorities for Recovery Act funding were aligned with metrics identified as both "core" to the PRSSC monitoring framework, and "critical" within the GOMC guidance. This includes monitoring of: (1) fish community structure and function, passage at barriers, assembly of diadromous species at the seaward-most dam, and import of marine derived nutrients and organic matter; (2) monumented river cross-sections to document vertical and horizontal channel adjustments; (3) sediment grain size distribution at the above cross-sections to document changes in bed material; (4) photos taken quarterly at permanent stations to provide a visual record of riparian vegetation and channel configuration; (5) basic water quality for assessing and understanding changes in fish habitat use, population numbers, and community structure; (6) benthic macroinvertebrate community structure as an indicator of aquatic ecosystem habitat quality; and (7) wetland and riparian plant communities. This baseline monitoring will provide an objective basis for evaluating restoration outcomes, and a framework for researchers to address additional PRSSC and GOMC monitoring priorities.

Apparent channel alterations associated with historic log drives in the Machias River drainage

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Spring log drives were an annual event on the Machias River from the 1800's through 1977. Remnants of the infrastructure associated with the drives are scattered throughout the watershed. Landings used for transferring logs onto the river or lakes and water control dams are the most commonly identified structures. Rock footings and earthen and wood berms are the most common structural remnants of the water control dams both on the mainstem of the river and its tributaries. These channel alterations potentially degrade Atlantic salmon spawning and rearing habitat by creating a hydraulic check in the stream. As a result, the channel is artificially widened up-stream, and sediment deposition occurs both up- and down-stream of the check. Project SHARE in partnership with faculty and students at the University of Maine at Machias have removed the dam remnants at some sites in the Machias and East Machias watersheds. A new type of log drive relic has been identified along the mainstem of the Machias River between Second and Third Machias lakes: rock and log walls appear to have been constructed along bends in the river essentially cutting off portions of the channel, and creating artificial ox bows behind the walls. During the fall of 2009 a project was initiated to map the locations of the rock walls, the extent of the ox bows behind each wall, and the estimated change in channel characteristics of the main channel associated with these artificial structures. These data will be combined with existing salmon habitat survey data for the same reach of river. Future studies will focus on 1) habitat recovery following removal of the remnants of water control dams; 2) assessment of effects of channel straightening on Atlantic salmon habitat availability; 3) evaluation of habitat unit gains (or losses) potentially realized by removal of selected channel-altering structures.

Focus area approach to salmonid restoration: basin-wide stream-road crossing and fisheries assessments

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In 2007 and 2008, the USFWS Maine Fishery Resources Office and Project SHARE completed culvert and fisheries assessments at all stream-road crossings in two high priority salmonid sub-basins in Downeast Maine – WB Machias River and Old Stream (above Rt. 9). We identified fish bearing stream-road crossings for a restoration strategy designed to restore ecological stream processes within watersheds that have exceedingly high conservation merit in terms of both existing high quality salmonid habitat *and* projected long-term protection from threats such as urbanization and increased road development. Identification of high priority focus areas allows limited resources to be focused in a manner that improves the potential for long-term success and benefit to the natural resource. It should be noted that private landowner support was established prior to conducting surveys. Working within the context of the Project SHARE Restoration Strategy (2009), specific goals are to increase watershed connectivity and instream habitat complexity, decrease anthropogenic sedimentation inputs, and mitigate anthropogenic changes in water chemistry (pH, temperature). The principle target species are Atlantic salmon (federally endangered) and brook trout.

Restoring fish passage and natural stream function in eastern Maine

Katrina Mueller and Steven Koenig
Project SHARE (Salmon Habitat and River Enhancement)

Undersized round culverts at road-stream crossings on first and second order perennial streams are the principle impediment to fish passage in the Downeast coastal region of Maine. Whereas rivers draining this region are relatively free of mainstem dams, the impact of commercial road networks on connectivity and natural stream function is extensive. Road-stream crossings can create fish passage barriers through hanging outfalls and excessive or insufficient velocity and flow. En masse, they can alter temperature, hydrologic and sediment transport regimes and subsequently decrease the quality and quantity of available habitat for native fishes. Recent habitat assessments suggest that legacies from the log driving era might also be wide-ranging, significant, and wholly negative from a native species standpoint. Since 2005 SHARE has focused its on-the-ground efforts on restoring natural function to all first and second order perennial streams within high priority sub-watersheds draining the Machias River (a historically important and well-protected Atlantic salmon migration corridor). These sub-watersheds are considered the "best of the best" in terms of habitat quality (existing and potential) by regional salmon biologists and also rank very high in terms of habitat quality for native eastern brook trout and future security from urbanization. In 2009 SHARE received funding under the American Recovery and Reinvestment Act to decommission or replace 53 undersized round culverts with open-bottom structures in its current geographical focus area. With half of these sites completed in 2009, we are actively working towards our goals of reconnecting headwaters to the mainstem and lower watershed; re-establishing fish passage and natural temperature, sediment and nutrient transport regimes at all fish-bearing sites; and continuing to expand our capacity as an organization to coordinate with regional stocking efforts and engage a broader base of youth and professionals on-the-ground.

8.6 Historical Tables

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

Table 1. Documented Atlantic salmon returns to USA by geographic area, 2009. "Natural" includes fish originating from natural spawning and hatchery fry.

Area	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
Long Island Sound LIS	0	0	18	57	0	0	0	0	75
Central New England CNE	5	1	50	32	2	2	0	0	92
Gulf of Maine GOM [1]	197	38	1718	194	2	10	1	9	2169

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

Table 2. Documented Atlantic salmon returns to the USA, 1967-2009. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

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

Table 3. Two sea winter (2SW) returns for 2009 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2009	Percentage of Requirement
Long Island Sound	LIS	10,094	82	1%
Central New England	CNE	3,435	75	2%
Gulf of Maine	GOM	15,670	1,912	12%
Total		29,199	2,069	7%

Table 4a. Number of juvenile Atlantic salmon stocked in USA, 2009. 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	6,562,000	4,000	0	14,000	5,000	49,000	6,635,000
Central New England	CNE	2: Merrimack, Saco	1,052,000	0	22,000	0	114,000	0	1,188,000
Gulf of Maine	GOM	10: Androscoggin to Dennys	2,580,000	18,000	172,000	0	613,000	900	3,384,000
Outer Bay of Fundy	OBF	1: Aroostook	458,000	0	0	0	0	0	458,000
Totals for USA		15	10,652,000	22,000	194,000	14,000	732,000	49,900	11,665,000

Table 4b. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2009 by geographic area.

		Captive Reared Domestic		Sea Run		Eggs	
River	Purpose	Pre-spawn	Post-spawn	Post-spawn	Total	Eyed	Green
Central New England CNE	Restoration/Recreation	760	775		1,535		
Culf of MaineGOM	Restoration	225	1,708	543	2,476	129,700	10,000

Table 5. Summary of tagged and marked Atlantic salmon released in USA, 2009.

Mark Code	Life Stage	LIS	CNE	GOM	Total
AD	Adult			1,054	1,054
AD	Parr	14,413		17,925	32,338
AD	Smolt	52,764	64,317		117,081
FLOY	Adult		1,535		1,535
FLOY	Smolt	900			900
LV	Parr			172,235	172,235
PING	Smolt			404	404
PIT	Adult			1,514	1,514
PIT	Smolt			1,122	1,122
RAD	Adult	9			9
RAD	Smolt	150			150
TEMP	Fry			42,544	42,544
VIA	Smolt			10	10
VIE	Smolt			230,863	230,863
					601,759

Table 6. 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

Table 7. Juvenile Atlantic salmon stocking summary for New England in2009.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,476,000	3,900	0	14,400	0	49,100	6,543,400
Total for Connecticut Program							**6,543,400**
Androscoggin	2,000	0	0	0	0	0	2,000
Aroostook	458,000	0	0	0	0	0	458,000
Dennys	317,000	0	0	0	0	600	317,600
East Machias	186,000	0	0	0	0	0	186,000
Kennebec	2,000	0	0	0	200	0	2,200
Machias	291,000	300	0	0	0	0	291,300
Narraguagus	449,000	0	0	0	52,800	0	501,800
Penobscot	1,023,000	0	172,200	0	559,800	0	1,755,000
Pleasant	97,000	0	0	0	0	300	97,300
Saco	1,000	0	0	0	0	0	1,000
Sheepscot	185,000	17,900	0	0	0	0	202,900
Union	28,000	0	0	0	0	0	28,000
Total for Maine Program							**3,843,100**
Merrimack	1,051,000	0	0	0	91,100	0	1,142,100
Total for Merrimack Program							**1,142,100**
Pawcatuck	86,000	0	0	0	5,400	0	91,400
Total for Pawcatuck Program							**91,400**
Total for United States							**11,620,000**
Grand Total							**11,620,000**

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

Table 8. Number of adult Atlantic salmon stocked in New England rivers in 2009.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	97	0	97
East Machias	Restoration	45	40	0	85
Hobart Stream	Restoration	47	0	0	47
Machias	Restoration	70	157	0	227
Merrimack	Restoration/Recreation	760	775	0	1,535
Narraguagus	Restoration	0	207	0	207
Penobscot	Restoration	0	1,054	543	1,597
Pleasant	Restoration	0	67	0	67
Sheepscot	Restoration	63	86	0	149
Total		985	2,483	543	4,011

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

Table 9.1. Atlantic salmon marking database for New England; marked fish released in 2009 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
NAI	4	Adult	W	Connecticut	RAD	9	PIT	May	Connecticut
NAI	2	Smolt	H	Connecticut	FLOY	900	AD	May	Connecticut
NAI	2	Smolt	H	Connecticut	RAD	150	AD	May	Connecticut
USFWS	2	Parr	H	Connecticut	AD	14,413		April	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	49,100		April	Connecticut
USFWS	5	Adult	H	Dennys	PIT	97		Nov	Dennys
USFWS	2	Smolt	H	Dennys	PIT	576		April	Dennys
USFWS	4	Adult	H	East Machias	PIT	6	CARLI	Oct	East Machias
USFWS	5	Adult	H	East Machias	PIT	40		Nov	East Machias
USFWS	5	Adult	H	East Machias	PIT	37	CARLI	Oct	East Machias
USFWS	5	Adult	H	Machias	PIT	157		Nov	Machias
USFWS	5	Adult	H	Machias	PIT	70		Oct	Machias
NHFG	4	Adult	H	Merrimack	FLOY	775		May	Merrimack
NNFH	2	Adult	H	Merrimack	FLOY	760		Sept	Merrimack
NNFH	1	Smolt	H	Merrimack	AD	41,117		Mar	Merrimack
NOAA	1	Smolt	H	Narraguagus	VIE	52,829	AD	May	Narraguagus
NOAA	1	Smolt	H	Narraguagus	LV	94	AD	May	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	207		Nov	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	19		Oct	Narraguagus
RIF&W	1	Smolt	H	Pawcatuck	AD	3,664		April	Pawcatuck
BSRFH		Adult	H	Penobscot	PIT	29	RADIO	Oct	Penobscot
BSRFH		Adult	H	Penobscot	PIT	543		Dec	Penobscot
BSRFH		Adult	H	Penobscot	PIT	66		Oct	Penobscot
BSRFH	1	Parr	H	Penobscot	LV	132,456		Sept	Piscataquis
BSRFH	1	Parr	H	Penobscot	LV	39,779		Oct	Piscataquis

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
KLEINSCHMID	1	Smolt	H	Penobscot	PIT	134		June	Lower Kenneb
KLEINSCHMID	1	Smolt	H	Penobscot	PIT	91		May	Lower Kenneb
NOAA	1	Smolt	H	Penobscot	PING	37	LV/AD	May	Penobscot
NOAA	2	Smolt	H	Penobscot	VIA	10	AD	May	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	122		May	Penobscot
NOAA	1	Smolt	H	Penobscot	VIE	148,560	AD	April	Penobscot
NOAA	2	Smolt	H	Penobscot	VIE	29,474	AD	May	Penobscot
UMO	0	Fry	H	Penobscot	TEMP	42,544		May	Penobscot
UMO	1	Smolt	H	Penobscot	PING	100		April	Piscataquis
UMO	1	Smolt	H	Penobscot	PING	100		April	Penobscot
UMO	1	Smolt	H	Penobscot	PING	45	VIE/A	May	Penobscot
USFWS	3	Adult	H	Penobscot	AD	544	AD	Dec	Penobscot
USFWS	4	Adult	H	Penobscot	AD	510	AD	Dec	Penobscot
USFWS	5	Adult	H	Pleasant	PIT	67		Nov	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	27		Oct	Pleasant
USFWS	2	Smolt	H	Pleasant	PIT	321		April	Pleasant
BSRFH	0	Parr	H	Sheepscot	AD	17,925		Sept	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	63		Oct	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	86		Nov	Sheepscot

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

Table 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2009.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,589	1,054	4,103
Hatchery Juvenile	530,471	358,236	574,541
Wild Adult			9

Table 10. Documented Atlantic salmon returns to New England rivers in 2009.

	1SW		2SW		3SW		Repeat			2005-2009
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	2	0	19	3	0	0	0	0	**24**	15
Connecticut	0	0	18	57	0	0	0	0	**75**	151
Dennys	0	0	0	6	0	1	0	1	**8**	6
Kennebec	0	1	16	10	0	0	0	0	**27**	20
Merrimack	4	1	41	28	2	2	0	0	**78**	79
Narraguagus	3	1	0	6	0	0	0	0	**10**	14
Pawcatuck	0	0	0	0	0	0	0	0	**0**	1
Penobscot	185	12	1683	74	2	1	1	0	**1958**	1,405
Saco	1	0	9	4	0	0	0	0	**14**	31
Union	0	0	0	0	0	0	0	0	**0**	0
Total	**195**	**15**	**1,786**	**188**	**4**	**4**	**1**	**1**	**2,194**	**1,723**

Table 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2009.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	1975	9,906,000
Dennys	Domestic	38	91,000
Merrimack	Domestic	516	2,380,000
Penobscot	Domestic	312	1,040,000
Pleasant	Domestic	3	20,000
Dennys	Captive	61	360,000
East Machias	Captive	81	311,000
Machias	Captive	144	557,000
Narraguagus	Captive	178	848,000
Pleasant	Captive	54	230,000
Sheepscot	Captive	86	329,000
Total	**Captive/Domestic**	**3,448**	**16,072,000**
Connecticut	Kelt	62	642,000
Merrimack	Kelt	55	577,000
Pawcatuck	Kelt	2	5,000
Total	**Kelt**	**119**	**1,224,000**
Connecticut	Sea Run	46	317,000
Merrimack	Sea Run	48	369,000
Penobscot	Sea Run	283	2,433,000
Total	**Sea Run**	**377**	**3,119,000**
Grand Total for Year	**2009**	**3,944**	**20,415,000**

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

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco															
1993-1999	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															
1977-1999	1,310	15,684,000	8,200	11,322	84,400,000	6,100	0	0		1,503	#########	10,300	14,135	120,017,000	6,800
2000	49	300,000	6,100	2,471	12,200,000	4,900	0	0		142	1,350,000	9,500	2,662	13,850,000	5,200
2001	20	162,000	8,100	1,955	9,870,000	5,000	0	0		102	1,003,000	9,800	2,077	11,036,000	5,300
2002	25	181,000	7,300	1,974	10,826,000	5,500	0	0		83	827,000	10,000	2,082	11,835,000	5,700
2003	34	245,000	7,200	2,152	11,600,000	5,400	0	0		67	660,000	9,800	2,253	12,505,000	5,600
2004	37	280,000	7,600	1,875	11,750,000	6,300	0	0		53	489,000	9,200	1,965	12,519,000	6,400
2005	102	758,000	7,400	1,382	9,050,000	6,500	0	0		37	384,000	10,400	1,521	10,192,000	6,700
2006	116	896,000	7,700	1,782	10,020,000	5,600	0	0		47	460,000	9,800	1,945	11,376,000	5,800
2007	95	723,000	7,600	1,598	9,390,000	5,900	0	0		113	1,190,000	10,500	1,806	11,303,000	6,300
2008	85	602,000	7,100	1,633	8,980,000	5,500	0	0		101	1,190,000	11,800	1,819	10,772,000	5,900
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
Total Connecticut	1,919	20,148,000	7,400	30,119	187,992,000	5,600	0	0		2,310	28,128,000	10,100	34,348	236,270,000	5,900
Dennys															
1939-1999	26	214,000	7,600	0	0		487	1,741,000	3,600	40	330,000	7,700	553	2,285,000	5,200
2000	0	0		0	0		64	283,000	4,400	0	0		64	283,000	4,400
2001	0	0		0	0		82	359,000	4,400	0	0		82	359,000	4,400
2002	0	0		0	0		68	352,000	5,200	0	0		68	352,000	5,200
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500

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

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

Note: Connecticut data are preliminary prior to 1990.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300
2009	0	0		38	91,000	2,400	61	360,000	5,900	0	0		99	451,000	4,600
Total Dennys	26	214,000	7,600	38	91,000	2,400	1,299	5,574,000	4,673	40	330,000	7,700	1,403	6,209,000	4,700
East Machias															
1995-1999	0	0		0	0		432	1,417,000	3,400	0	0		432	1,417,000	3,400
2000	0	0		0	0		68	394,000	5,800	0	0		68	394,000	5,800
2001	0	0		0	0		67	400,000	6,000	0	0		67	400,000	6,000
2002	0	0		0	0		92	466,000	5,100	0	0		92	466,000	5,100
2003	0	0		0	0		93	456,000	4,900	0	0		93	456,000	4,900
2004	0	0		0	0		65	252,000	3,900	0	0		65	252,000	3,900
2005	0	0		0	0		88	281,000	3,200	0	0		88	281,000	3,200
2006	0	0		0	0		82	328,000	4,000	0	0		82	328,000	4,000
2007	0	0		0	0		78	456,000	5,800	0	0		78	456,000	5,800
2008	0	0		0	0		85	350,000	4,100	0	0		85	350,000	4,100
2009	0	0		0	0		81	311,000	3,800	0	0		81	311,000	3,800
Total East Machias	0	0		0	0	0	1,231	5,111,000	4,545	0	0		1,231	5,111,000	4,500
Kennebec															
1979-1999	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Total Kennebec	5	50,000	10,000	0	0	0	0	0		0	0		5	50,000	10,000

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run 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															
1992-1999	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															
1941-1999	456	3,263,000	7,300	0	0		863	2,893,000	3,300	8	52,000	6,400	1,327	6,208,000	6,400
2000	0	0		0	0		110	417,000	3,800	0	0		110	417,000	3,800
2001	0	0		0	0		108	672,000	6,200	0	0		108	672,000	6,200
2002	0	0		0	0		111	533,000	4,800	0	0		111	533,000	4,800
2003	0	0		0	0		121	763,000	6,300	0	0		121	763,000	6,300
2004	0	0		0	0		120	613,000	5,100	0	0		120	613,000	5,100
2005	0	0		0	0		160	677,000	4,200	0	0		160	677,000	4,200
2006	0	0		0	0		160	720,000	4,500	0	0		160	720,000	4,500
2007	0	0		0	0		150	714,000	4,800	0	0		150	714,000	4,800
2008	0	0		0	0		141	650,000	4,600	0	0		141	650,000	4,600
2009	0	0		0	0		144	557,000	3,900	0	0		144	557,000	3,900
Total Machias	456	3,263,000	7,300	0	0	0	2,188	9,209,000	4,682	8	52,000	6,400	2,652	12,524,000	5,000
Merrimack															
1983-1999	956	7,104,000	7,500	6,584	37,610,000	5,600	0	0		55	604,000	11,800	7,595	45,318,000	6,600
2000	38	311,000	8,200	596	2,625,000	4,400	0	0		62	748,000	12,100	696	3,683,000	5,300
2001	37	296,000	8,000	726	2,585,000	3,600	0	0		22	294,000	13,400	785	3,176,000	4,000
2002	16	232,000	14,500	361	1,816,000	5,000	0	0		21	232,000	11,000	398	2,279,000	5,700
2003	60	499,000	8,300	489	1,914,000	3,900	0	0		20	236,000	11,800	569	2,649,000	4,700
2004	59	494,000	8,400	229	811,000	3,500	0	0		42	48,000	1,200	330	1,353,000	4,100
2005	13	111,000	8,500	191	691,000	3,600	0	0		65	697,000	10,700	269	1,499,000	5,600

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
2006	42	377,000	9,000	269	1,097,000	4,100	0	0		49	582,000	11,900	360	2,056,000	5,700
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
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
Total Merrimack	1,370	10,625,000	8,800	10,923	55,134,000	4,200	0	0		483	5,040,000	10,600	12,776	70,799,000	5,200
Narraguagus															
1962-1999	0	1,303,000		0	0		783	2,523,000	3,200	0	0		783	3,826,000	3,200
2000	0	0		0	0		137	432,000	3,200	0	0		137	432,000	3,200
2001	0	0		0	0		93	404,000	4,300	0	0		93	404,000	4,300
2002	0	0		0	0		159	704,000	4,400	0	0		159	704,000	4,400
2003	0	0		0	0		120	624,000	5,200	0	0		120	624,000	5,200
2004	0	0		0	0		119	453,000	3,800	0	0		119	453,000	3,800
2005	0	0		0	0		146	449,000	3,100	0	0		146	449,000	3,100
2006	0	0		0	0		165	702,000	4,300	0	0		165	702,000	4,300
2007	0	0		0	0		186	854,000	4,600	0	0		186	854,000	4,600
2008	0	0		0	0		169	820,000	4,900	0	0		169	820,000	4,900
2009	0	0		0	0		178	848,000	4,800	0	0		178	848,000	4,800
Total Narraguagus	0	1,303,000		0	0	0	2,255	8,813,000	4,164	0	0		2,255	10,116,000	4,200
Orland															
1967-1999	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															
1992-1999	14	137,000	9,900	0	0		0	0		0	0		14	137,000	9,900

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run 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
2000	0	0		0	0		0	0		5	43,000	8,600	5	43,000	8,600
2001	0	0		2	2,000	1,100	0	0		1	8,000	7,800	3	10,000	3,300
2002	0	0		0	0		0	0		3	10,000	3,300	3	10,000	3,300
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
2006	0	0		4	4,000	1,000	0	0		0	0		4	4,000	1,000
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
2008	0	0		0	0		0	0		2	10,000	5,000	2	10,000	5,000
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	4,600
Penobscot															
1871-1999	16,871	144,451,000	7,800	3,715	9,603,000	2,600	0	0		0	0		20,586	154,054,000	7,600
2000	196	1,559,000	8,000	540	1,334,000	2,500	0	0		0	0		736	2,893,000	3,900
2001	282	2,451,000	8,700	453	1,206,000	2,700	0	0		0	0		735	3,657,000	5,000
2002	218	2,001,000	9,200	484	1,300,000	2,700	0	0		0	0		702	3,301,000	4,700
2003	362	3,194,000	8,800	0	0		0	0		0	0		362	3,194,000	8,800
2004	353	3,229,000	9,100	477	1,200,000	2,500	0	0		0	0		830	4,429,000	5,300
2005	296	2,458,000	8,300	359	1,314,000	3,700	0	0		0	0		655	3,772,000	5,800
2006	325	3,034,000	9,300	0	0		329	1,400,000	4,300	0	0		654	4,434,000	6,800
2007	315	2,697,000	8,600	394	1,595,000	4,000	0	0		0	0		709	4,292,000	6,100
2008	297	2,500,000	8,400	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
Total Penobscot	19,798	170,007,000	8,600	7,086	20,012,000	3,100	329	1,400,000	4,300	0	0		27,213	191,419,000	6,000
Pleasant															
2001	0	0		0	0		13	46,000	3,500	0	0		13	46,000	3,500

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
2002	0	0		0	0		19	84,000	4,400	0	0		19	84,000	4,400
2003	0	0		0	0		11	92,000	8,300	0	0		11	92,000	8,300
2004	0	0		0	0		23	179,000	7,800	0	0		23	179,000	7,800
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		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
Total Pleasant	0	0		17	86,000	5,600	397	1,589,000	4,700	0	0		414	1,674,000	4,800
Sheepscot															
1995-1999	18	125,000	6,900	0	0		280	929,000	3,000	45	438,000	9,900	343	1,493,000	4,300
2000	0	0		0	0		60	246,000	4,100	0	0		60	246,000	4,100
2001	0	0		0	0		56	351,000	6,300	0	0		56	351,000	6,300
2002	0	0		0	0		100	455,000	4,600	0	0		100	455,000	4,600
2003	0	0		0	0		92	433,000	4,700	0	0		92	433,000	4,700
2004	0	0		0	0		78	308,000	3,900	0	0		78	308,000	3,900
2005	0	0		0	0		70	251,000	3,600	0	0		70	251,000	3,600
2006	0	0		0	0		83	277,000	3,300	0	0		83	277,000	3,300
2007	0	0		0	0		81	349,000	4,300	0	0		81	349,000	4,300
2008	0	0		0	0		75	340,000	4,500	0	0		75	340,000	4,500
2009	0	0		0	0		86	329,000	3,800	0	0		86	329,000	3,800
Total Sheepscot	18	125,000	6,900	0	0	0	1,061	4,268,000	4,191	45	438,000	9,900	1,124	4,832,000	4,300
St Croix															
1993-1999	36	271,000	7,500	0	0		0	0		0	0		36	271,000	7,500

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
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															
1974-1999	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Total Union	600	4,611,000	7,900	0	0	0	0	0		0	0		600	4,611,000	7,900

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

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

Note: Connecticut data are preliminary prior to 1990.

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

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco	3	21,000	7,100	0	0		0	0		0	0		3	21,000	7,100
Connecticut	1,919	20,150,000	7,400	30,119	187,992,000	5,600	0	0		2,310	28,128,000	10,100	34,348	236,269,000	5,900
Dennys	26	214,000	7,600	38	91,000	2,400	1,299	5,573,000	4,700	40	330,000	7,700	1,403	6,208,000	4,700
East Machias	0	0		0	0		1,231	5,111,000	4,500	0	0		1,231	5,111,000	4,500
Kennebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Machias	456	3,263,000	7,300	0	0		2,188	9,208,000	4,700	8	52,000	6,400	2,652	12,523,000	5,000
Merrimack	1,370	10,624,000	8,800	10,923	55,134,000	4,200	0	0		483	5,040,000	10,600	12,776	70,799,000	5,200
Narraguagus	0	1,303,000		0	0		2,255	8,813,000	4,200	0	0		2,255	10,116,000	4,200
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	4,600
Penobscot	19,798	170,007,000	8,600	7,086	20,011,000	3,100	329	1,400,000	4,300	0	0		27,213	191,419,000	6,000
Pleasant	0	0		17	85,000	5,600	397	1,588,000	4,700	0	0		414	1,674,000	4,800
Sheepscot	18	125,000	6,900	0	0		1,061	4,267,000	4,200	45	438,000	9,900	1,124	4,831,000	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	**24,297**	**211,113,000**	**8,700**	**48,189**	**263,319,000**	**5,500**	**8,760**	**35,960,000**	**4,100**	**2,899**	**34,064,000**	**11,800**	**84,145**	**544,459,000**	**6,500**

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

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

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin							
2001	3,000	0	0	0	0	0	3,000
2002	0	0	0	0	0	0	0
2003	1,000	0	0	0	0	0	1,000
2004	2,000	0	0	0	0	0	2,000
2005	0	0	0	0	0	0	0
2006	1,000	0	0	0	0	0	1,000
2007	1,000	0	0	0	0	0	1,000
2008	1,000	0	0	0	0	0	1,000
2009	2,000	0	0	0	0	0	2,000
Totals:Androscoggin	**11,000**	**0**	**0**	**0**	**0**	**0**	**11,000**
Aroostook							
1978-1999	1,511,000	317,100	38,600	0	32,600	29,800	1,929,100
2000	0	0	0	0	0	0	0
2001	182,000	300	0	0	0	0	182,300
2002	122,000	0	0	0	0	0	122,000
2003	138,000	0	0	0	0	0	138,000
2004	169,000	0	0	0	0	0	169,000
2005	133,000	0	0	0	0	0	133,000
2006	324,000	0	0	0	0	0	324,000
2007	854,000	0	0	0	0	0	854,000
2008	365,000	0	0	0	0	0	365,000
2009	458,000	0	0	0	0	0	458,000
Totals:Aroostook	**4,256,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**4,674,400**
Cocheco							
1988-1999	1,303,000	50,000	10,500	0	5,300	0	1,368,800
2000	146,000	0	0	0	0	0	146,000
2001	165,000	0	0	0	0	0	165,000
2002	181,000	0	0	0	0	0	181,000
2003	163,000	0	0	0	0	0	163,000
Totals:Cocheco	**1,958,000**	**50,000**	**10,500**	**0**	**5,300**	**0**	**2,023,800**
Connecticut							
1967-1999	59,482,000	2,824,600	1,810,300	0	3,767,800	963,200	68,847,900
2000	9,325,000	600	0	0	700	48,200	9,374,500
2001	9,591,000	1,600	0	0	700	0	9,593,300
2002	7,283,000	700	0	0	500	0	7,284,200
2003	7,038,000	0	0	0	0	90,100	7,128,100
2004	7,683,000	3,100	2,500	0	0	96,400	7,785,000
2005	7,805,000	0	0	0	0	85,100	7,890,100
2006	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
2007	6,345,000	0	600	2,300	600	99,000	6,447,500
2008	6,041,000	0	0	2,400	0	50,000	6,093,400
2009	6,476,000	3,900	0	14,400	0	49,100	6,543,400

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Connecticut	**132,917,000**	**2,838,200**	**1,813,400**	**31,700**	**3,771,300**	**1,533,200**	**142,904,800**
Dennys							
1975-1999	1,028,000	21,700	3,400	0	152,700	29,200	1,235,000
2000	96,000	30,500	0	0	0	0	126,500
2001	59,000	16,500	1,400	0	49,800	0	126,700
2002	84,000	33,000	1,900	0	49,000	0	167,900
2003	133,000	30,400	600	0	55,200	0	219,200
2004	219,000	44,000	0	0	56,300	0	319,300
2005	215,000	21,700	0	0	56,700	0	293,400
2006	295,000	27,600	0	0	56,500	0	379,100
2007	257,000	0	0	0	56,500	0	313,500
2008	292,000	0	0	0	0	200	292,200
2009	317,000	0	0	0	0	600	317,600
Totals:Dennys	**2,995,000**	**225,400**	**7,300**	**0**	**532,700**	**30,000**	**3,790,400**
Ducktrap							
1986-1999	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-1999	768,000	7,500	42,600	0	108,400	30,400	956,900
2000	197,000	0	0	0	0	0	197,000
2001	242,000	0	0	0	0	0	242,000
2002	236,000	0	0	0	0	0	236,000
2003	314,000	0	0	0	0	0	314,000
2004	319,000	0	0	0	0	0	319,000
2005	216,000	0	0	0	0	0	216,000
2006	199,000	0	0	0	0	0	199,000
2007	245,000	0	0	0	0	0	245,000
2008	261,000	0	0	0	0	0	261,000
2009	186,000	0	0	0	0	0	186,000
Totals:East Machias	**3,183,000**	**7,500**	**42,600**	**0**	**108,400**	**30,400**	**3,371,900**
Kennebec							
2001	3,000	0	0	0	0	0	3,000
2002	7,000	0	0	0	0	0	7,000
2003	42,000	0	0	0	0	0	42,000
2004	52,000	0	0	0	0	0	52,000
2005	30,000	0	0	0	0	0	30,000
2006	8,000	0	0	0	0	0	8,000
2007	20,000	0	0	0	0	0	20,000
2008	3,000	0	0	0	0	0	3,000
2009	2,000	0	0	0	200	0	2,200
Totals:Kennebec	**167,000**	**0**	**0**	**0**	**200**	**0**	**167,200**
Lamprey							
1978-1999	1,168,000	427,700	58,500	0	141,400	32,800	1,828,400
2000	104,000	0	0	0	0	0	104,000

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
	Number of fish stocked by life stage						
2001	111,000	0	300	0	0	0	111,300
2002	103,000	0	0	0	60,000	0	163,000
2003	106,000	0	0	0	0	0	106,000
Totals:Lamprey	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**
Machias							
1970-1999	1,327,000	93,800	117,800	0	191,300	44,100	1,774,000
2000	209,000	0	0	0	0	0	209,000
2001	267,000	0	0	0	0	0	267,000
2002	327,000	0	0	0	0	0	327,000
2003	341,000	0	300	0	0	0	341,300
2004	379,000	3,100	0	0	0	0	382,100
2005	476,000	0	200	0	0	0	476,200
2006	638,000	2,000	1,500	0	0	0	641,500
2007	470,000	0	2,200	0	0	0	472,200
2008	585,000	100	400	0	0	0	585,500
2009	291,000	300	0	0	0	0	291,300
Totals:Machias	**5,310,000**	**99,300**	**122,400**	**0**	**191,300**	**44,100**	**5,767,100**
Merrimack							
1975-1999	24,115,000	227,500	594,900	0	1,217,400	635,900	26,790,700
2000	2,217,000	0	0	0	52,500	0	2,269,500
2001	1,708,000	0	0	0	49,500	0	1,757,500
2002	1,414,000	0	1,900	0	50,000	1,200	1,467,100
2003	1,335,000	0	900	0	49,600	1,000	1,386,500
2004	1,556,000	3,700	0	0	50,000	0	1,609,700
2005	962,000	1,400	400	0	50,000	0	1,013,800
2006	1,011,000	0	0	0	50,000	0	1,061,000
2007	1,140,000	0	0	0	50,000	0	1,190,000
2008	1,766,000	3,400	9,600	0	88,900	0	1,867,900
2009	1,051,000	0	0	0	91,100	0	1,142,100
Totals:Merrimack	**38,275,000**	**236,000**	**607,700**	**0**	**1,799,000**	**638,100**	**41,555,800**
Narraguagus							
1970-1999	1,013,000	62,900	14,600	0	107,800	84,000	1,282,300
2000	252,000	0	0	0	0	0	252,000
2001	353,000	0	0	0	0	0	353,000
2002	261,000	0	0	0	0	0	261,000
2003	623,000	0	0	0	0	0	623,000
2004	468,000	0	0	0	0	0	468,000
2005	352,000	0	0	0	0	0	352,000
2006	478,000	17,500	0	0	0	0	495,500
2007	346,000	15,700	0	0	0	0	361,700
2008	485,000	21,000	0	0	54,100	0	560,100
2009	449,000	0	0	0	52,800	0	501,800
Totals:Narraguagus	**5,080,000**	**117,100**	**14,600**	**0**	**214,700**	**84,000**	**5,510,400**
Pawcatuck							
1979-1999	3,360,000	1,209,200	263,200	0	56,600	500	4,889,500

	Number of fish stocked by life stage						
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
2000	326,000	0	0	0	0	0	326,000
2001	423,000	0	0	0	8,500	0	431,500
2002	403,000	0	0	0	0	0	403,000
2003	313,000	0	0	0	5,200	0	318,200
2004	557,000	0	0	0	6,100	0	563,100
2005	5,000	0	0	0	16,600	0	21,600
2006	85,000	0	0	0	12,800	0	97,800
2007	115,000	0	4,900	0	6,400	0	126,300
2008	313,000	0	0	0	6,000	0	319,000
2009	86,000	0	0	0	5,400	0	91,400
Totals:Pawcatuck	**5,986,000**	**1,209,200**	**268,100**	**0**	**123,600**	**500**	**7,587,400**
Penobscot							
1970-1999	11,571,000	2,661,600	1,387,700	0	9,939,000	2,508,200	28,067,500
2000	513,000	288,800	700	0	563,200	0	1,365,700
2001	364,000	235,800	2,100	0	544,000	0	1,145,900
2002	746,000	396,700	1,800	0	547,000	0	1,691,500
2003	741,000	320,700	2,100	0	547,300	0	1,611,100
2004	1,812,000	369,200	0	0	566,000	0	2,747,200
2005	1,899,000	295,400	0	0	530,600	0	2,725,000
2006	1,509,000	293,500	0	0	549,200	0	2,351,700
2007	1,606,000	337,800	0	0	559,900	0	2,503,700
2008	1,248,000	216,600	0	0	512,500	0	1,977,100
2009	1,023,000	0	172,200	0	559,800	0	1,755,000
Totals:Penobscot	**23,032,000**	**5,416,100**	**1,566,600**	**0**	**15,418,500**	**2,508,200**	**47,941,400**
Pleasant							
1975-1999	187,000	2,500	1,800	0	54,700	18,100	264,100
2000	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0
2002	0	13,500	0	0	0	0	13,500
2003	53,000	0	0	0	2,800	0	55,800
2004	47,000	0	0	0	0	8,800	55,800
2005	76,000	0	0	0	5,900	0	81,900
2006	284,000	0	0	0	0	15,200	299,200
2007	177,000	0	0	0	0	0	177,000
2008	171,000	0	0	0	0	0	171,000
2009	97,000	0	0	0	0	300	97,300
Totals:Pleasant	**1,092,000**	**16,000**	**1,800**	**0**	**63,400**	**42,400**	**1,215,600**
Saco							
1975-1999	2,259,000	370,500	201,200	0	304,800	9,500	3,145,000
2000	599,000	48,200	0	0	22,600	0	669,800
2001	479,000	0	0	0	4,000	0	483,000
2002	597,000	0	0	0	4,100	0	601,100
2003	501,000	20,000	0	0	3,200	0	524,200
2004	375,000	0	0	0	5,400	0	380,400
2005	340,000	0	18,000	0	1,700	0	359,700

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2006	106,000	0	0	0	0	0	106,000
2007	576,000	0	0	0	0	0	576,000
2008	358,000	9,100	0	0	0	0	367,100
2009	1,000	0	0	0	0	0	1,000
Totals:Saco	**6,191,000**	**447,800**	**219,200**	**0**	**345,800**	**9,500**	**7,213,300**
Sheepscot							
1971-1999	883,000	84,800	20,600	0	92,200	7,100	1,087,700
2000	211,000	0	0	0	0	0	211,000
2001	171,000	0	0	0	0	0	171,000
2002	172,000	0	0	0	0	0	172,000
2003	323,000	0	0	0	0	0	323,000
2004	298,000	15,600	0	0	0	0	313,600
2005	201,000	15,900	0	0	0	0	216,900
2006	151,000	16,600	0	0	0	0	167,600
2007	198,000	0	0	0	0	0	198,000
2008	218,000	13,000	0	0	0	0	231,000
2009	185,000	17,900	0	0	0	0	202,900
Totals:Sheepscot	**3,011,000**	**163,800**	**20,600**	**0**	**92,200**	**7,100**	**3,294,700**
St Croix							
1981-1999	1,264,000	410,100	158,300	0	768,500	20,100	2,621,000
2000	1,000	19,000	0	0	20,000	0	40,000
2001	1,000	6,300	0	0	8,100	0	15,400
2002	1,000	15,400	0	0	4,100	0	20,500
2003	1,000	16,800	0	0	3,200	0	21,000
2004	0	2,800	0	0	4,100	0	6,900
2006	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0
Totals:St Croix	**1,268,000**	**470,400**	**158,300**	**0**	**808,000**	**20,100**	**2,724,800**
Union							
1971-1999	423,000	371,400	0	0	379,700	251,000	1,425,100
2001	2,000	0	0	0	0	0	2,000
2002	5,000	0	0	0	0	0	5,000
2003	3,000	0	0	0	0	0	3,000
2004	3,000	0	0	0	0	0	3,000
2005	2,000	0	0	0	0	0	2,000
2006	2,000	0	0	0	0	0	2,000
2007	22,000	0	0	0	0	0	22,000
2008	23,000	0	0	0	0	0	23,000
2009	28,000	0	0	0	0	0	28,000
Totals:Union	**513,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,515,100**
Upper StJohn							
1979-1999	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
Totals:Upper StJohn	**2,165,000**	**1,456,700**	**14,700**	**0**	**5,100**	**27,700**	**3,669,200**

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

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

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin	10,000	0	0	0	0	0	**10,100**
Aroostook	4,256,000	317,400	38,600	0	32,600	29,800	**4,674,200**
Cocheco	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	132,915,000	2,838,200	1,813,500	31,800	3,771,300	1,533,200	**142,871,400**
Dennys	2,995,000	225,400	7,300	0	532,800	30,000	**3,790,900**
Ducktrap	68,000	0	0	0	0	0	**68,000**
East Machias	3,182,000	7,500	42,600	0	108,400	30,400	**3,370,900**
Kennebec	167,000	0	0	0	200	0	**167,100**
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	5,309,000	99,300	122,300	0	191,300	44,100	**5,765,600**
Merrimack	38,275,000	235,900	607,700	0	1,799,000	638,100	**41,555,300**
Narraguagus	5,081,000	117,100	14,600	0	214,700	84,000	**5,511,400**
Pawcatuck	5,985,000	1,209,200	268,100	0	123,600	500	**7,586,600**
Penobscot	23,031,000	5,416,100	1,566,600	0	15,418,600	2,508,200	**47,940,800**
Pleasant	1,093,000	16,000	1,800	0	63,400	42,400	**1,216,200**
Saco	6,190,000	447,800	219,200	0	345,800	9,500	**7,212,400**
Sheepscot	3,011,000	163,900	20,600	0	92,200	7,100	**3,294,500**
St Croix	1,269,000	470,400	158,300	0	808,000	20,100	**2,725,900**
Union	512,000	371,400	0	0	379,700	251,000	**1,513,900**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**239,065,000**	**13,869,800**	**4,965,200**	**31,800**	**24,093,500**	**5,289,000**	**287,282,300**

Summaries for each river vary by length of time series.

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

Documented returns include rod and trap caught fish. Returns are unknown where blanks occur.
Returns from juveniles of hatchery origin include age 0 and 1 parr, and age 1 and 2 smolt releases.
Returns of wild origin include adults produced from natural reproduction and adults produced from fry releases.

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin									
1983-1999	26	504	6	2	6	83	0	1	**628**
2000	0	3	0	0	0	0	0	0	**3**
2001	1	4	0	0	0	0	0	0	**5**
2002	0	2	0	0	0	0	0	0	**2**
2003	0	3	0	0	0	0	0	0	**3**
2004	3	7	0	0	0	1	0	0	**11**
2005	2	8	0	0	0	0	0	0	**10**
2006	5	1	0	0	0	0	0	0	**6**
2007	6	11	0	0	1	2	0	0	**20**
2008	8	5	0	0	2	1	0	0	**16**
2009	2	19	0	0	0	3	0	0	**24**
Total for Androscoggin	53	567	6	2	9	90	0	1	**728**
Cocheco									
1992-1999	0	0	1	1	5	5	0	0	**12**
2000	0	0	0	0	0	2	0	0	**2**
2003	0	0	0	0	1	3	0	0	**4**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-1999	35	3,500	28	2	40	1,217	9	0	**4,831**
2000	0	0	0	0	1	76	0	0	**77**
2001	1	0	0	0	4	34	1	0	**40**
2002	0	3	0	0	2	38	1	0	**44**
2003	0	0	0	0	0	42	1	0	**43**
2004	0	0	0	0	5	64	0	0	**69**
2005	0	4	0	0	23	159	0	0	**186**
2006	13	33	0	0	20	147	0	1	**214**
2007	0	19	0	0	1	120	1	0	**141**
2008	7	10	0	0	3	118	1	2	**141**
2009	0	18	0	0	0	57	0	0	**75**
Total for Connecticut	56	3,587	28	2	99	2072	14	3	**5,861**
Dennys									
1967-1999	20	305	0	1	30	733	3	31	**1,123**
2000	0	1	0	0	0	1	0	0	**2**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2001	9	2	0	0	1	9	0	0	**21**
2002	2	0	0	0	0	0	0	0	**2**
2003	4	5	0	0	0	1	0	0	**10**
2004	0	1	0	0	0	0	0	0	**1**
2006	2	2	0	0	1	1	0	0	**6**
2007	1	1	0	0	0	1	0	0	**3**
2008	0	1	0	0	1	3	0	3	**8**
2009	0	0	0	0	0	6	1	1	**8**
Total for Dennys	38	318	0	1	33	755	4	35	**1,184**
Ducktrap									
1985-1999	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-1999	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-1999	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	0	1	10	0	0	**27**
Total for Kennebec	24	231	6	1	6	27	0	0	**295**
Lamprey									
1979-1999	10	17	1	0	7	14	0	0	**49**
2000	0	0	0	0	2	2	0	0	**4**
2003	0	0	0	0	2	0	0	0	**2**
2004	0	0	0	0	0	0	0	0	**0**
2005	0	0	0	0	0	0	0	0	**0**
2006	0	0	0	0	2	0	0	0	**2**
Total for Lamprey	10	17	1	0	13	16	0	0	**57**
Machias									
1967-1999	32	329	9	2	33	1,592	41	131	**2,169**
Total for Machias	32	329	9	2	33	1592	41	131	**2,169**
Merrimack									
1982-1999	216	868	19	8	115	938	26	0	**2,190**
2000	26	32	0	0	1	23	0	0	**82**
2001	5	73	0	0	2	3	0	0	**83**
2002	31	17	0	0	1	6	0	0	**55**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2003	12	129	0	0	0	4	0	0	**145**
2004	17	92	2	0	2	15	0	0	**128**
2005	8	25	0	0	0	1	0	0	**34**
2006	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**
Total for Merrimack	342	1,470	24	8	134	1068	30	0	**3,076**
Narraguagus									
1967-1999	92	647	19	53	66	2,334	68	152	**3,431**
2000	0	1	0	0	13	8	0	1	**23**
2001	0	2	0	0	5	22	2	1	**32**
2002	0	0	0	1	4	3	0	0	**8**
2003	0	0	0	0	0	21	0	0	**21**
2004	0	0	0	0	1	10	0	1	**12**
2005	0	0	0	0	1	12	0	0	**13**
2006	0	0	0	0	3	12	0	0	**15**
2007	0	0	0	0	2	9	0	0	**11**
2008	0	0	0	0	4	17	1	1	**23**
2009	3	0	0	0	1	6	0	0	**10**
Total for Narraguagus	95	650	19	54	100	2454	71	156	**3,599**
Pawcatuck									
1982-1999	2	147	1	0	1	9	0	0	**160**
2000	0	1	0	0	0	0	0	0	**1**
2003	0	0	0	0	0	5	1	0	**6**
2004	0	0	0	0	0	1	0	0	**1**
2005	0	0	0	0	0	2	0	0	**2**
2006	0	0	0	0	0	0	0	0	**0**
2007	0	2	0	0	0	0	0	0	**2**
2008	0	0	0	0	0	0	0	0	**0**
2009	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	150	1	0	1	17	1	0	**172**
Penobscot									
1968-1999	9,266	39,633	276	644	608	3,376	29	89	**53,921**
2000	167	265	0	15	16	69	0	2	**534**
2001	195	466	0	3	21	98	2	0	**785**
2002	363	344	0	15	14	41	1	2	**780**
2003	196	847	1	4	6	56	0	2	**1,112**
2004	276	952	10	16	5	59	3	2	**1,323**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2005	269	678	0	8	6	22	0	2	**985**
2006	338	653	1	4	15	33	0	0	**1,044**
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**
Total for Penobscot	12,194	47,391	290	715	761	3996	36	99	**65,482**
Pleasant									
1967-1999	5	12	0	0	11	215	2	2	**247**
2000	0	0	0	0	1	2	0	0	**3**
2001	0	0	0	0	1	9	1	0	**11**
2003	0	0	0	0	1	1	0	0	**2**
2004	0	0	0	0	0	1	0	0	**1**
Total for Pleasant	5	12	0	0	14	228	3	2	**264**
Saco									
1985-1999	58	438	3	5	16	40	3	0	**563**
2000	31	14	0	0	0	4	0	0	**49**
2001	15	49	0	0	0	5	0	0	**69**
2002	3	37	0	2	3	2	0	0	**47**
2003	2	23	0	0	2	12	0	0	**39**
2004	3	10	0	0	2	4	0	0	**19**
2005	5	12	0	0	1	7	0	0	**25**
2006	8	15	0	0	4	3	0	0	**30**
2007	4	16	0	0	0	4	0	0	**24**
2008	11	26	2	0	8	12	3	0	**62**
2009	1	9	0	0	0	4	0	0	**14**
Total for Saco	141	649	5	7	36	97	6	0	**941**
Sheepscot									
1967-1999	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-1999	301	1,814	9	28	1	15	0	0	**2,168**
2000	1	1	0	0	0	0	0	0	**2**
2002	0	5	0	0	0	0	0	0	**5**
2003	1	0	0	0	0	0	0	0	**1**
2004	0	1	0	0	0	1	0	0	**2**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2009	0	0	0	0	0	0	0	0	**0**
Total for Union	303	1,821	9	28	1	16	0	0	**2,178**

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

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

	Grand Total by River								
	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin	53	567	6	2	9	90	0	1	**728**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	56	3,587	28	2	99	2,072	14	3	**5,861**
Dennys	38	318	0	1	33	755	4	35	**1,184**
Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec	24	231	6	1	6	27	0	0	**295**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	342	1,470	24	8	134	1,068	30	0	**3,076**
Narraguagus	95	650	19	54	100	2,454	71	156	**3,599**
Pawcatuck	2	150	1	0	1	17	1	0	**172**
Penobscot	12,194	47,391	290	715	761	3,996	36	99	**65,482**
Pleasant	5	12	0	0	14	228	3	2	**264**
Saco	141	649	5	7	36	97	6	0	**941**
Sheepscot	6	38	0	0	30	358	10	0	**442**
Union	303	1,821	9	28	1	16	0	0	**2,178**

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

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

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

1995	451	83	0.184	0	2	0	6	89	0	0	2	0	0	0	8	89	2	0
1996	478	55	0.115	0	4	0	5	89	2	0	0	0	0	0	9	89	2	0
1997	589	24	0.041	0	0	0	4	88	4	0	4	0	0	0	4	88	8	0
1998	661	33	0.050	0	0	0	6	88	0	0	3	0	3	0	6	88	3	3
1999	456	33	0.072	0	0	3	6	79	0	0	12	0	0	0	6	82	12	0
2000	693	43	0.062	0	0	0	0	86	0	0	14	0	0	0	0	86	14	0
2001	699	115	0.165	0	2	0	1	89	0	2	7	0	0	0	3	90	7	0
2002	490	88	0.179	0	10	0	11	69	1	2	6	0	0	0	22	72	7	0
2003	482	102	0.211	0	7	0	12	75	1	0	5	0	0	0	19	75	6	0
2004	526	74	0.141	1	9	0	0	86	0	0	3			1	9	86	3	
2005	542	47	0.087	2	2	0	2	94		0				2	4	94		
2006	397	0	0.000	0	0		0							0	0			
2007	455	0	0.000	0										0				
Total	**8,253**	**1,472**																
Mean			**0.511**	**0**	**6**	**0**	**2**	**68**	**4**	**0**	**4**	**0**	**0**	**0**	**8**	**68**	**8**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

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

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

1995	678	143	0.211	1	13	0	7	78	0	0	2	0	0	1	20	78	2	0
1996	664	101	0.152	0	16	0	11	71	1	0	1	0	0	0	27	71	2	0
1997	850	37	0.044	0	3	0	3	89	3	0	3	0	0	0	5	89	5	0
1998	908	44	0.048	0	0	0	9	84	0	0	5	0	2	0	9	84	5	2
1999	639	45	0.070	0	0	2	4	80	0	0	13	0	0	0	4	82	13	0
2000	929	66	0.071	0	6	0	0	80	0	0	14	0	0	0	6	80	14	0
2001	956	151	0.158	0	3	0	3	88	0	1	5	0	0	0	5	89	5	0
2002	725	165	0.228	1	10	0	12	72	1	1	3	0	0	1	22	73	4	0
2003	700	146	0.208	1	13	0	12	70	1	0	4	0	0	1	25	70	5	0
2004	765	121	0.158	1	11	0	0	86	0	0	2			1	11	86	2	
2005	776	62	0.080	2	13	0	5	81		0				2	18	81		
2006	581	4	0.007	0	100		0							0	100			
2007	631	0	0.000	0										0				
Total	**11,979**	**2,184**																
Mean			**0.399**	**0**	**14**	**0**	**3**	**66**	**2**	**0**	**5**	**0**	**0**	**0**	**17**	**66**	**6**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

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

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

2000	125	9	0.072	0	0	0	0	89	0	0	11	0	0	0	0	89	11	0
2001	125	12	0.096	0	8	0	17	75	0	0	0	0	0	0	25	75	0	0
2002	119	22	0.185	5	5	0	14	77	0	0	0	0	0	5	18	77	0	0
2003	112	8	0.071	0	38	0	25	38	0	0	0	0	0	0	63	38	0	0
2004	118	11	0.093	0	18	0	0	82	0	0	0			0	18	82	0	
2005	124	12	0.097	0	58	0	8	33		0				0	67	33		
2006	86	3	0.035	0	100		0							0	100			
2007	91	0	0.000	0										0				
Total	**1,938**	**346**																
Mean			**0.280**	**0**	**27**	**0**	**4**	**56**	**1**	**0**	**8**	**0**	**0**	**0**	**30**	**56**	**9**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

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

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

1996	180	27	0.150	0	0	0	15	85	0	0	0	0	0	0	15	85	0	0
1997	200	4	0.020	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1998	259	8	0.031	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1999	176	8	0.046	0	0	0	13	50	0	0	38	0	0	0	13	50	38	0
2000	222	12	0.054	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2001	171	5	0.029	0	0	0	40	20	0	0	40	0	0	0	40	20	40	0
2002	141	8	0.057	0	0	0	0	88	13	0	0	0	0	0	0	88	13	0
2003	133	20	0.150	0	0	0	30	60	5	0	0	5	0	0	30	60	5	5
2004	156	35	0.225	0	0	0	3	83	3	6	6			0	3	89	9	
2005	96	29	0.301	0	0	0	10	90		0				0	10	90		
2006	101	1	0.010	0	0		100							0	100			
2007	114	0	0.000	0										0				
Total	**3,546**	**1,232**																
Mean			**2.240**	**0**	**2**	**0**	**13**	**64**	**3**	**2**	**9**	**1**	**0**	**0**	**15**	**66**	**12**	**1**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1993	38	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	20	80	0	0
1996	29	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	10	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	91	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	59	5	0.085	0	0	20	0	80	0	0	0	0	0	0	0	100	0	0
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
2001	42	2	0.047	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	40	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	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	
2005	1	0	0.000	0	0	0	0	0		0				0	0	0		
2006	8	0	0.000	0	0		0							0	0			
2007	12	0	0.000	0										0				
Total	**542**	**19**																
Mean			**0.030**	**0**	**4**	**2**	**1**	**39**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**41**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1979	10	76	8.000	0	0	0	39	33	7	1	20	0	0	0	39	34	26	0
1980	0	125	0.000	0	0	0	2	89	1	2	6	0	0	0	2	91	6	0
1981	20	410	20.297	0	0	0	6	79	1	2	11	0	0	0	6	81	12	0
1982	25	478	19.274	0	0	0	4	89	1	2	5	0	0	0	4	90	6	0
1983	0	182	0.000	0	0	0	8	79	0	8	5	0	0	0	8	87	5	0
1984	8	100	12.500	0	0	0	25	66	1	5	3	0	0	0	25	71	4	0
1985	20	171	8.680	0	0	0	11	62	2	6	19	0	0	0	11	68	20	0
1986	23	332	14.690	0	0	0	20	62	0	5	13	0	0	0	20	67	13	0
1987	33	603	18.108	0	0	0	15	72	0	2	12	0	0	0	15	73	12	0
1988	43	219	5.081	0	0	0	16	78	0	0	6	0	0	0	16	78	7	0
1989	8	112	14.545	0	0	0	20	75	0	3	3	0	0	0	20	78	3	0
1990	32	118	3.722	0	0	0	19	76	0	3	3	0	0	0	19	79	3	0
1991	40	126	3.166	0	0	0	30	59	2	0	9	0	0	0	30	59	11	0
1992	93	315	3.405	0	0	0	2	93	1	1	4	0	0	0	2	94	4	0
1993	132	158	1.197	0	0	0	5	89	0	1	4	0	0	0	5	91	4	0
1994	95	153	1.612	0	0	0	1	82	0	4	12	0	0	0	1	86	12	0
1995	50	132	2.629	0	0	0	19	67	0	5	8	0	0	0	19	73	8	0
1996	124	117	0.942	0	0	0	36	50	2	7	6	0	0	0	36	56	8	0
1997	147	115	0.781	0	0	0	7	79	1	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	150	79	0.527	0	0	0	18	70	3	0	10	0	0	0	18	70	13	0

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

2000	51	63	1.228	0	0	0	10	81	0	2	8	0	0	0	10	83	8	0
2001	36	24	0.659	0	0	0	17	71	0	8	4	0	0	0	17	79	4	0
2002	75	40	0.536	0	0	0	10	80	0	0	10	0	0	0	10	80	10	0
2003	74	106	1.430	0	0	0	14	79	0	2	5	0	0	0	14	81	5	0
2004	181	117	0.646	0	0	0	28	64	1	0	7			0	28	64	8	
2005	190	91	0.479	0	0	0	25	73		2				0	25	75		
2006	151	10	0.066	0	0		100							0	100			
2007	161	0	0.000	0										0				
Total	**2,063**	**4,621**																
Mean			**4.991**	**0**	**0**	**0**	**19**	**73**	**1**	**3**	**8**	**0**	**0**	**0**	**19**	**76**	**9**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.2**	**2**	**3**	**4**	**5**	**6**
1987	12	2	0.165	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0	0	0	0	33	67	0	0
2003	25	13	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	
2005	26	2	0.076	0	0	0	0	100		0				0	0	100		
2006	25	1	0.040	0	100		0							0	100			
2007	28	0	0.000	0										0				

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Total	**405**	**85**																
Mean			**0.215**	**0**	**24**	**0**	**3**	**55**	**0**	**0**	**0**	**0**	**0**	**0**	**27**	**55**	**0**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1988	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	63	0	0	13	0	0	0	25	63	13	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3			0	11	86	3	
2005	84	1	0.012	0	0	0	100	0		0				0	100	0		
2006	73	0	0.000	0	0		0							0	0			
2007	57	0	0.000	0										0				

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Total	**1,384**	**281**																
Mean			**0.194**	**0**	**4**	**0**	**9**	**75**	**0**	**0**	**6**	**0**	**0**	**0**	**13**	**75**	**6**	**0**

Mean return rate computation includes incomplete return rates for 2004 - 2007 year class fish.

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

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

Year Stocked	Number of adult returns per 10,000 fry stocked						
	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	5.584		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	5.081
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	0.255	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	0.559	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	0.301	0.000	0.080	0.087	0.076	0.097	0.012	0.479
2006	0.010	0.000	0.007	0.000	0.040	0.035	0.000	0.066
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	**PW**	**CT**	**CTAH**	**SAL**	**FAR**	**WE**	**PN**
Mean	**2.240**	**0.030**	**0.399**	**0.511**	**0.215**	**0.280**	**0.194**	**4.991**
StndDev	**5.426**	**0.043**	**0.468**	**0.728**	**0.251**	**0.313**	**0.189**	**6.523**

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 2004 (5 year olds), 2005 (4 year olds), 2006 (3 year olds), and 2007 (2 year olds).

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

	Mean age class (smolt age.sea age) distribution (%)										Mean age (years) (%)				
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
Connecticut (basin)	0.00	0.08	0.00	0.04	0.82	0.01	0.00	0.05	0.00	0.00	0.00	0.12	0.82	0.05	0.00
Connecticut (above Holyoke)	0.00	0.04	0.00	0.03	0.86	0.01	0.00	0.05	0.00	0.00	0.00	0.07	0.87	0.06	0.00
Farmington	0.01	0.26	0.00	0.05	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	0.24	0.00	0.13	0.62	0.00	0.00	0.00	0.00	0.00	0.01	0.36	0.62	0.00	0.00
Westfield	0.00	0.06	0.00	0.05	0.85	0.00	0.00	0.04	0.00	0.00	0.00	0.10	0.85	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	0.07	0.00	0.00	0.00	0.11	0.78	0.09	0.00
Pawcatuck	0.00	0.05	0.05	0.05	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.89	0.00	0.00
Overall Mean:	**0.00**	**0.09**	**0.01**	**0.07**	**0.77**	**0.01**	**0.01**	**0.04**	**0.00**	**0.00**	**0.00**	**0.17**	**0.78**	**0.05**	**0.00**

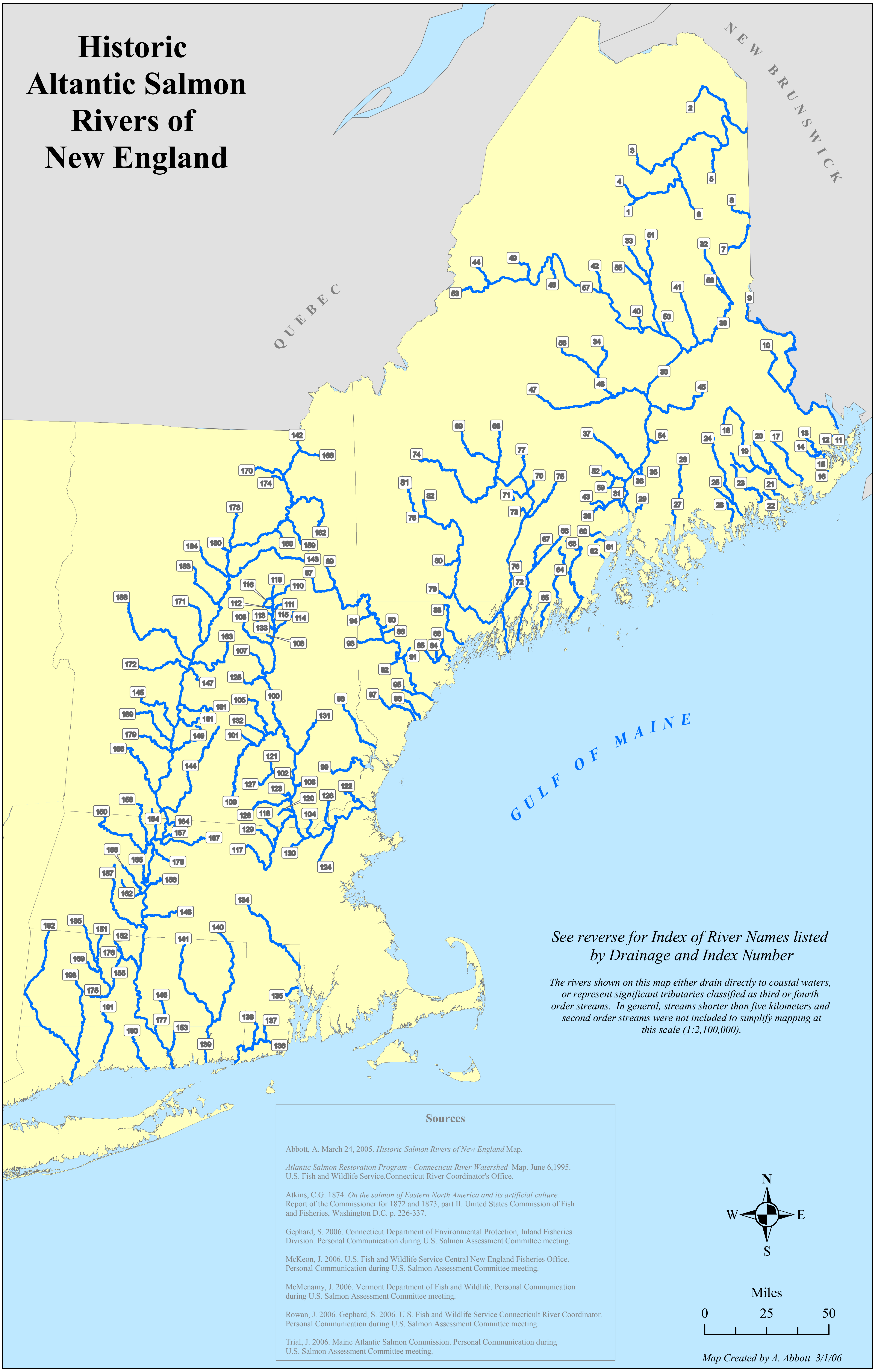
Program summary age distributions vary in time series length; refer to specific tables for numbers of years utilized.

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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