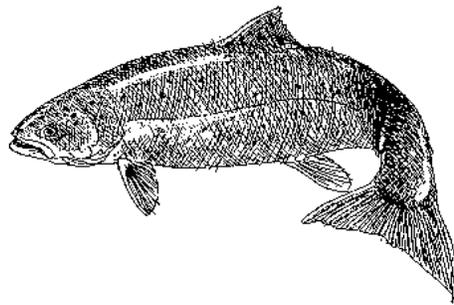


**ANNUAL REPORT OF THE
U.S. ATLANTIC SALMON ASSESSMENT
COMMITTEE**

REPORT NO. 24 - 2011 ACTIVITIES

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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 4,167; 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 4,049 in 2011, 152% more than observed in 2010 and 78% more than returned in 2009. Estimated return to Gulf of Maine coastal rivers was 323 adult salmon (90% CI = 248 – 551), the 4th highest for the 1991-2011 time-series. Most returns occurred to the Gulf of Maine Distinct Population Segment, which includes the Penobscot River and eastern Maine coastal rivers, accounting for 85% of the total return. Overall, 26% of the adult returns to the USA were 1SW salmon and 74% were MSW salmon. Most (83%) returns were of hatchery smolt origin and the balance (17%) originated from either natural reproduction or hatchery fry and eggs. A total of 11,480,000 juvenile salmon (fry, parr, and smolts), 5,709 adults, and 859,000 eggs were stocked, with 505,370 juveniles carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 467 sea-run females, 1,539 captive/domestic and domestic females, and 24 female kelts. The number of females (2,030) contributing was less than 2010 (3,317); and the total egg take (11,594,000) was lower than 2010 (18,340,000). Production of farmed salmon in Maine was not available, but was estimated at 5,100 metric tonnes (95% CI 2,100 to 8,100) based on a regression of production and smolt moved to pens two years before.

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 1,550 broodstock in 2011.

1.3 Adult Returns

Total return to USA rivers was 4,167; (Table 1.3.1), a 152% increase from 2010 returns (Table 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 2010 within areas were: LIS (+121%), CNE (+377%), GOM (+138%). For the larger rivers changes from 2010 were: Connecticut (+118%), Saco (+370%), Merrimack (+379%), Penobscot (+137%). In addition to catches at traps and weirs (4,049), the return of 323 (90% CI = 248 – 551) salmon was estimated for coastal populations within the Gulf of Maine area based on a linear regression [$\ln(\text{returns}) = 0.559 \ln(\text{redd count}) + 1.289$]. 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 75% of the total return. Overall, 26% of the adult returns to the USA were 1SW salmon and 74% were MSW salmon. Most (83%) returns were of hatchery smolt origin and the balance (17%) originated from natural reproduction, planted eggs, or hatchery fry (Figure 1.3.2). The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2009 was 0.46%, with the 2SW fish return rate 0.39% (Figure 1.3.3). Smolt survival on the Penobscot River correlates well with other large restoration programs in the Connecticut and Merrimack rivers. The estimated return rate for 2SW adults from the 2009 cohort of wild smolts on the Narraguagus was 1.78% (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 10.4 % of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.8 to 17.0 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2011 about 11,480,000 juvenile salmon (87% fry) were released into 15 river systems (Table 1.4.1). The number of juveniles released was less than that in 2010 (13,099,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and six coastal rivers within the GOM area Maine. The 438,000 parr released in 2011 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 (81,700), CNE Merrimack (34,900), and GOM Penobscot (554,000). In addition to juveniles, 5,709 adult salmon were released into USA rivers (Table 1.4.2). Unlike previous years, less than half these adults were spent broodstock. On the Dennys River mature pre-spawn salmon stocking is replacing annual fry stocking. In the fall of 2011, 299 gravid adult salmon were stocked into the Dennys River watershed. In each of the next four years (to 2015) a minimum of 218 pre-spawn salmon (sex ratio of 1:1) will be stocked to assess the strategy over variable environmental conditions. These pre-spawn adults and those released into three other coastal rivers in the GOM area produced redds. In both the Penobscot and Merrimack river sea-run salmon were released pre-spawn, after being taken as broodstock, to enhance spawning in selected sub-drainages in the watershed. Mature captive reared 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 2011 with USA spawners totaling 4,994. Escapement to natural spawning areas was 4,559 (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 513,530 salmon released into USA waters in 2011 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 16% of the marked fish were released into the CNE area and 64% into rivers in the GOM area (Table 1.5.1).

1.6 Farm Production

Production of farmed salmon in Maine was not available, but was estimated at 5,100 (95% CI 2,100 to 8,100) metric tonnes based on a regression of production and smolt moved to pens two years before. The estimate was approximately 45% of the 11,127 metric tonnes of production reported in 2010 (Table 1.6.1).

1.7 Flooding Closes Hatchery

Tropical Storm Irene in August produced severe floods that damaged the White River National Fish Hatchery (WRNFH) and resulted in immediate high losses of domestic broodstock in the outside ponds. The USFWS determined that the hatchery had to be de-populated and shutdown by December, which created huge operational challenges for the Connecticut Program. The Technical Committee quickly modified previous plans to deal with spawning, incubation space limitations, chiller availability, fish health testing and egg transfers. A brief but intensive spawning effort at WRNFH salvaged 1.2M eggs, which were taken to state facilities for incubation. It was decided not to stock any of the older broodstock (ages 1-4) in the basin due to the possible exposure of the WRNFH water system to the nuisance diatom *Didymosphenia geminata* along with other management and fish health concerns. Age-0 parr from inside tanks were stocked in the adjacent White River. In December and early January the remaining broodstock were provided to Northeast Indian Tribes for their ceremonial purposes.

Table 1.3.1 Documented Atlantic salmon returns to USA by geographic area, 2011. "Natural" includes fish originating from natural spawning and hatchery fry.

Area	NUMBER OF RETURNS BY SEA AGE AND ORIGIN								TOTAL
	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	2	31	18	64	0	0	0	0	115
CNE	158	22	191	107	12	5	1	0	496
1 GOM	753	114	2312	353	5	4	13	2	3556

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, 1967-2011. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1SW	2SW	3SW	Repeat	Total	Hatcher	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1,078	3	17	1,650	1,401	249
2011	1,080	3,045	26	16	4,167	3,465	702

Table 1.3.3 Two sea winter (2SW) returns for 2011 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2011	Percentage of Requirement
Long Island Sound	LIS	10,094	82	0.8%
Central New England	CNE	3,435	298	8.7%
Gulf of Maine	GOM	15,670	2,665	17.0%
Total		29,199	3,045	10.4%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2011. 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	6,016,000	5200	9500	10000	0	81700	6,122,400
Central New England	CNE 2: Merrimack, Saco 10: Androscoggin to	1,130,000	109,800	0	0	46,900	0	1,286,700
Gulf of Maine	GOM Dennys	2,841,000	313,000	500	0	679,000	0	3,833,500
Outer Bay of Fundy	OBF 1: Aroostook	237,000	0	0	0	0	0	237,000
Totals for USA	15	10,224,000	428,000	10,000	10,000	725,900	81,700	11,479,600

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2011 by geographic area.

River	Purpose	Captive Reared Domestic		Sea Run		Eggs	
		Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	Total	Eyed
Central New England	CNE Restoration/Recreation	2,050		113		2,163	
Gulf of Maine	GOM Restoration	827	1,996	167	556	3,546	859,000

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

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Adult	58			58
AD	Parr	63,000	15,500	19,481	97,981
AD	Smolt	17,299	307,687	81,681	406,667
FLOY	Adult	2,050			2,050
PING	Smolt		628		628
PIT	Adult	55	5,986		6,041
PIT	Smolt		95		95
RAD	Adult			10	10
Grand Total		82,462	329,896	101,172	513,530

RAD = radio tag

PIT = passive integrated transponder

PING = ultrasonic acoustic tag

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2011. Production for 2011 was estimated, with 95% CI presented.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014
2009	6,028
2010	11,127
2011	2,100 to 8,100

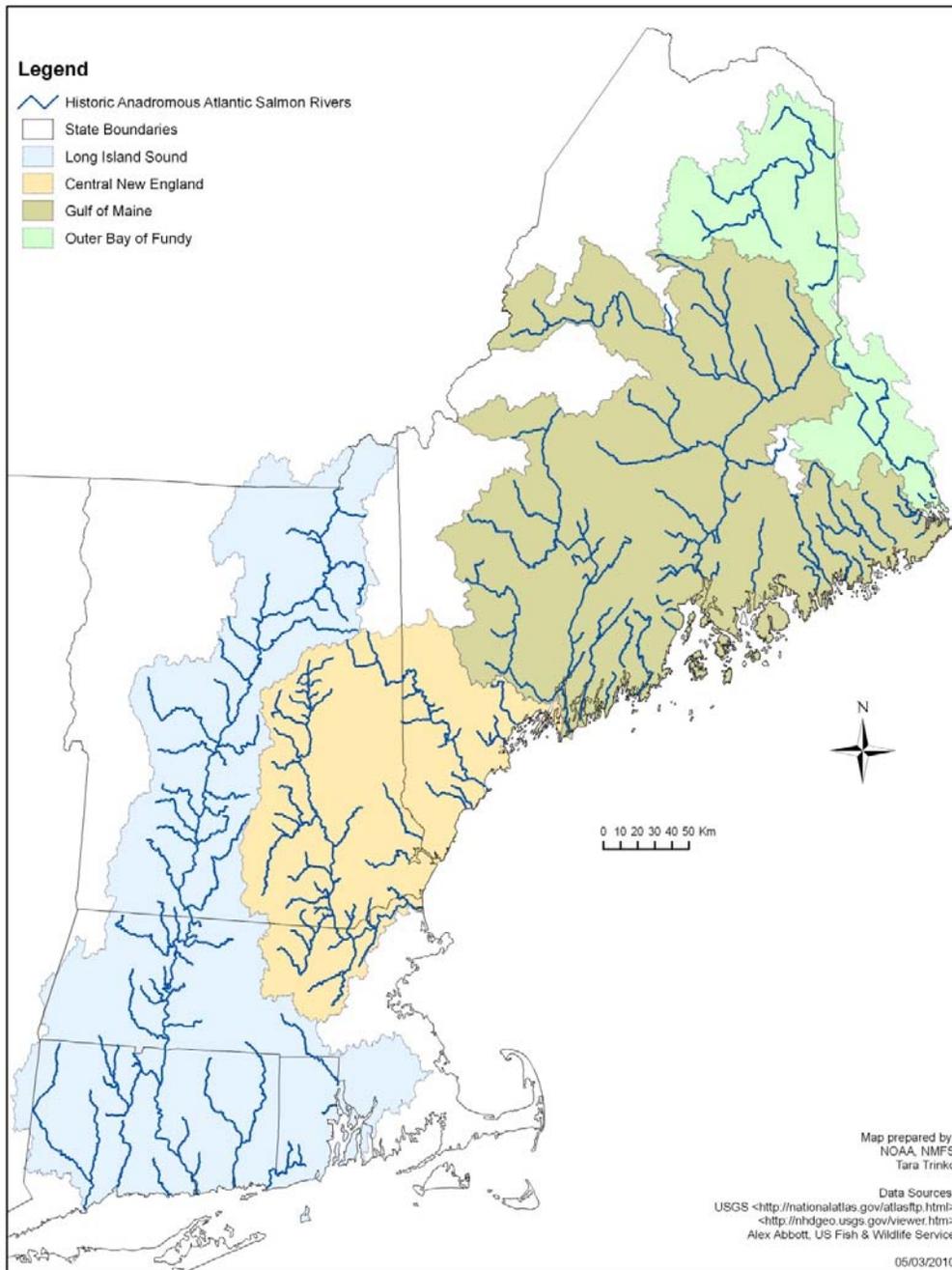


Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2010.

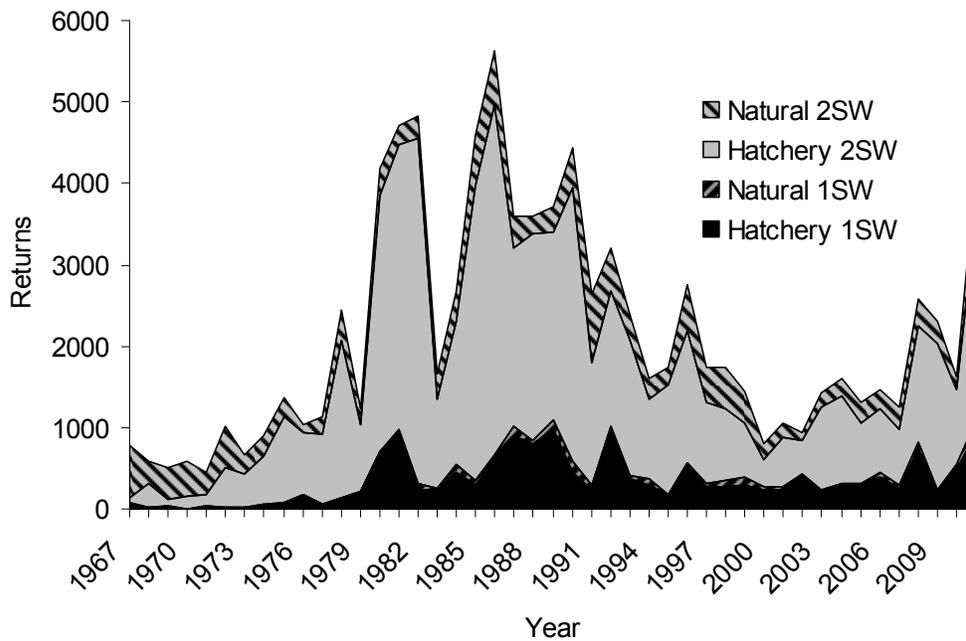


Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2011.

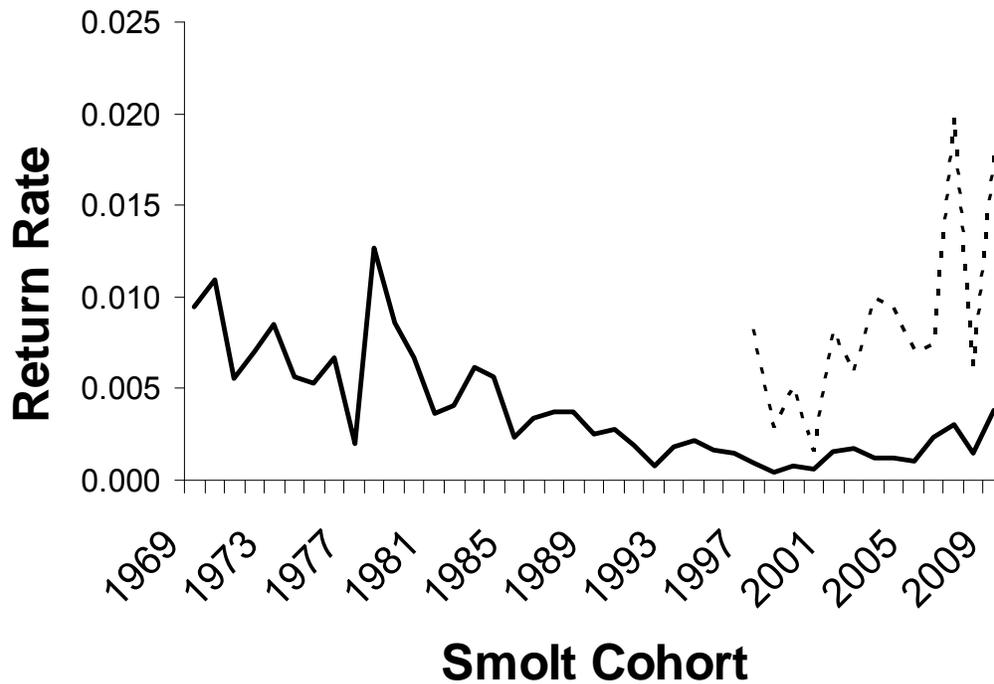


Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2 Status of Stocks

2.1 Distribution, Biology and Management

Atlantic salmon, *Salmo salar*, is a highly prized game and food fish with a circumpolar distribution. In North America, the species originally ranged from the Ungava Bay southward to Long Island Sound, encompassing most coastal New England river basins (2.1.1). As a consequence of human development, many native New England populations were extirpated (Fay et al. 2006). Salmon life history is complex because of fish use of both headwater streams and distant marine habitats (2.1.2). The life cycle for US Atlantic salmon begins with spawning in rivers during autumn, and eggs remain in the gravel and hatch during winter. Fry emerge from the gravel in spring. Juvenile salmon (parr) remain in rivers 1–3 years. When parr exceed 13 cm (5 in) in the autumn, they typically develop into smolts, overwinter, and then migrate to the ocean in spring. Tagging data indicates that US salmon commonly migrate as far north as West Greenland. After their first winter at sea, a portion (~20%) of the cohort, typically males, become sexually mature and return to spawn as 1 sea-winter (1SW) fish (grilse). Non-maturing adults remain at sea, feeding in the coastal waters of West Greenland, Newfoundland, and Labrador. Historically, gillnet fisheries for salmon occurred in coastal waters. After their second winter at sea (2SW), most US salmon return to spawn, with 3 sea-winter and repeat-spawning salmon life history patterns being less common and becoming rarer (<3%) with declining stock size.

Strong homing capabilities of Atlantic salmon foster the formation and maintenance of local breeding groups or stocks (National Research Council 2002; Verspoor et al. 2002; Spidle et al. 2003). These stocks exhibit heritable adaptations to their home range in rivers and likely at sea. The importance of maintaining local adaptations has demonstrated utility in salmon conservation (National Research Council 2004). Because of significant declines in Atlantic salmon populations in the US, an analyses of population structure was conducted, and some populations are managed under the Endangered Species Act (ESA, 74 Federal Register 29346, June 19, 2009). The Act required that subgroups must be separable from the remainder of, and significant to, the species to which it belongs to warrant ESA protection. Assessing population structure required broad scale consideration of geologic and climatic features that shape population structure through natural selection. For Atlantic salmon, factors such as climate, soil type, and hydrology were particularly important because these factors influence ecosystem structure and function, including transfer of energy in aquatic food chains (Fay et al. 2006). Numerous ecological classification systems were examined,

which integrated the many factors necessary to discern historic structure. Biologists then delineated US Atlantic salmon populations into four discrete stock complexes that are managed discretely: (i) **Long Island Sound** complex; (ii) **Central New England** complex; (iii) **Gulf of Maine** distinct population segment (DPS), and (iv) the **Outer Bay of Fundy** designatable unit (Figure 2.1.1).

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

The **Gulf of Maine DPS** represents the last naturally spawning stocks of Atlantic salmon in the US and is managed under an ESA recovery program (Anon 2005). There are several extant stocks in the DPS that are divided into three geographic Salmon Habitat Recovery Units (SHRUs): (i) Downeast Coastal; (ii) Penobscot Bay and (iii) Merrymeeting Bay. Seven rivers (Dennys, East Machias, Machias, Pleasant, Narraguagus, Penobscot, and Sheepscot) have ongoing hatchery-supplementation programs that use river-specific broodstock. ESA recovery programs using donor stocks are ongoing in the Union, Kennebec, and Androscoggin Rivers. The Ducktrap River stock has no hatchery component but a small wild run persists. Like the restoration programs, fry stocking makes up the majority of the hatchery inputs to the system, but in

the Penobscot and selected river systems, smolt stocking is a major contributor that results in returns for broodstock collection and natural spawning. In addition, these extant stocks represent potential donor populations for other watersheds. While at low levels, natural reproduction still represents an important element of the management system, and redd surveys both document this contribution and facilitate management of stocked fish to protect naturally spawned offspring.

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

2.2 The Fishery

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

Recreational angling for Atlantic salmon had historically been important. The first US Atlantic salmon reportedly caught on rod and reel was captured in the Dennys River, Maine in 1832 by an unknown angler (Baum 1997). The dynamics of Atlantic salmon fishing are very ritualistic, with fly fishing being the most generally acceptable method of angling, and the advent of salmon clubs among many US rivers creating an important and unique cultural and historical record (Beland and Bielak 2002). Recreational angling has been closed in the US for decades, with the

exception of Maine, where regulations became more restrictive and harvest was discontinued in the early 1990's in all Maine Rivers but a catch-and-release fishery remained open (Table 2.2.1). However, in 1999, when low salmon returns threatened sustainability of even hatchery populations, the remaining catch-and-release fishery was closed. In Maine, an experimental Penobscot River autumn (2006 and 2007) and spring (2008) catch-and-release fishery was authorized, but then closed again until populations rebuild. There remains a unique fishery for Atlantic salmon in New Hampshire, where fish retired from hatchery broodstock are reconditioned and released for angling in tributaries to the Merrimack River, which historically contained sea-run populations. License sales for this fishery are stable at about 1,300 per year.

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

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

assuming that the Framework of Indicators used in the interim years indicated that there was no significant change in the previously provided multiannual catch advice. The Framework of Indicators allows for an interim check on the stock status of the West Greenland salmon complex, based on a variety of production measures, such as adult abundance and marine survival rates measured at monitoring facilities in rivers across the range of the species. A similar multiannual regulatory measure was adopted to cover the 2009–2011 fishing seasons. A new agreement is forthcoming at the 2012 NASCO Meeting.

2.2.1 Aquaculture

Despite declining natural populations, the Atlantic salmon mariculture industry continues to develop worldwide. In eastern Maine and Maritime Canada, companies typically rear fish to smolt stage in private freshwater facilities, transfer them into anchored net pens or sea cages, feed them, and harvest the fish when they reach market size. In the Northwest Atlantic, 66% of production is based in Canada, with 99.4% of Canadian production in the Maritimes and 0.6% in Newfoundland. The balance (44%) of Northwest Atlantic production is in eastern Maine. US production trends for Maine facilities and areas occupied by marine cages have grown exponentially for two decades. By 1998, there were at least 35 freshwater smolt-rearing facilities and 124 marine production facilities in eastern North America. Since the first experimental harvest of Atlantic salmon in 1979 of 6 mt, the mariculture industry in eastern North America has grown to produce greater than 32,000 mt annually since 1997. In Maine, production increased rapidly and peaked at about 16,500 mt in 2000, but abruptly declined to below 6,000 mt in 2005 because of a disease outbreak (infectious salmon anemia) that forced the destruction of large numbers of fish. Production practices also had to change due to federal judge fining producers for violating the federal Clean Water Act through fouling the sea floor with excess feed, medications, feces, and other pollutants. With improved regulations targeting sustainable best management practices with innovative bay-area management creating fallowing areas, farmers have increased sustainability and production, and production has rebuilt (Figure 2.2.1.1). Maine production in 2010 was over 11,000 mt the 6th highest in the 27 year time series. With one company in production in 2011, privacy issues prevent detailed reporting but scientists estimate a harvest between 2,100 and 8,100 mt. With fallowing of production areas, annual production will vary depending upon areas occupied but should average over 6,000 mt under recent conditions.

Current management efforts focus on the recovery of natural populations and support of sustainable aquaculture to ensure both resource components are managed in a fashion to protect wild stocks and marine habitats.

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

2.4 Stock Assessment

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. US Atlantic salmon hatcheries are run by the US Fish and Wildlife Service and state agencies. Hatchery programs in the US take two forms: (i) conservation hatcheries that produce fish from remnant local stocks within a DPS and stock them into that DPS, or (ii) restoration hatcheries that produce salmon from broodstock originally established from donor populations outside their native DPS. Hatchery programs for the Gulf of Maine DPS are conservation hatcheries. All other New England hatcheries are restoration hatcheries. These restoration hatcheries developed broodstock primarily from donor stocks of Penobscot River origin. However, because these programs have been ongoing for more than 25 years, the majority of fish reared for the Long Island

Sound and Central New England DPS units are progeny of fish that completed their life cycle in these regions for 3 or more generations. For Central New England, their complete isolation from the Penobscot River population is more recent (2009 year class).

A total of 11.5 million juvenile salmon were stocked in 2011 across 15 river systems, a number typical of the decade. Fry stocking dominates numerically, with 10.2 million stocked; fry were planted in all 15 systems. Four river systems were stocked with parr and six with smolts. Managers stocked around 800,000 smolts in US waters, with 560,000 stocked in the Penobscot River. This total and the percentage stocked in the Penobscot River are typical for the last decade. Penobscot River smolts consistently produce over 75% of the adult salmon returns to the US. Cost and hatchery capacity issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits at the juvenile stage, and naturally reared smolts typically have a higher marine survival rate than hatchery smolts. From a management 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 across all river systems. 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 (redd surveys). Total returns also include retained fish from angling in other regions, and historical US time-series (pre 1996) also include these data. Some mortality can and does occur between trap counts and actual spawning—the actual number of spawners is termed “spawning escapement” and is not estimated for many US populations. However, redd counts provide a reasonable proxy for rivers with populations surveyed with that method. Fisheries could impact escapement as well, but since the mid-1990s, most open fisheries were limited to catch

and release because this mortality is lower than retention-fisheries impacts on returns or escapement would be lower. The USASAC is continuing its efforts to develop metrics to examine juvenile production of large parr (pre-smolts) and emigrating smolts.

The modern time-series of salmon returns to US rivers began in 1967 (Figure 2.4.2.1). Average annual Atlantic salmon returns to US rivers from 1967 to the present was 2,201, and the median is 1,690. The time-series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figures 2.2.1.1 and 2.4.2.1). 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 and then in the Merrimack and Connecticut rivers. The remnant populations of the smaller rivers in the Gulf of Maine DPS and the Penobscot River were the donor material for all rebuilding programs during this time. Unfortunately, the trajectory of this recovery did not continue in the late 1980s and early 1990s. Starting in the early 1990s, there was a phase shift in marine survival, and an overall reduction in marine survival occurred in all US and most Canadian populations. The average annual Atlantic salmon returns to US rivers from 1991 to the present is 1,983 fish, only 82% of the time-series average. There has been a downward trend in the production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish), that has affected US populations. In addition, recovery from historical impacts was never sufficient, so US populations were at low absolute abundance when the current period of lower marine survival began.

However, returns since 2008 have averaged 2,702 fish suggesting marine survival may be increasing. Returns to US waters in 2011 were 4,167 fish, which ranks 7th in the 45 year time-series and was well above the median for of the time series. Relative to the average during the current marine phase (1991–present), returns were the highest in 21 years. To gain a better sense of the relative status of the stocks, it is informative to examine target spawning escapements. Because juvenile rearing habitat can be measured or estimated efficiently, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed “conservation spawning escapement” (CSE). These values have been calculated for US populations, and total 29,199 spawners (Table 2.4.2.1). The average percent of the CSE target for the time-series was less than 5%, and 2011 was 10.4% of the CSE. In the last decade, total returns have accounted for less than 2% of this target for the Long Island Sound and

Central New England stock complexes. However, salmon returns to the Gulf of Maine DPS have been as high as 20% of the CSE during this period, largely because of hatchery smolt returns to the Penobscot River. In smaller rivers of the Gulf of Maine stock complex, the CSE ranged from 3 to 15%. The Outer Bay of Fundy DU is assessed by the Department of Fisheries and Oceans Canada.

CSE levels are minimal recovery targets because they are based on spawning escapement that could fully seed juvenile habitat. In self-sustaining populations, the number of returns would frequently exceed this amount by 50–100%, allowing for sustainable harvests and buffers against losses between return and spawning. As such, the status of US Atlantic salmon populations is critically low for all stocks, and the remnant populations of the Gulf of Maine stock complex remain endangered.

Over the past 5 years, the contributions of each stock complex to the total US returns averaged <0.5% for the Outer Bay of Fundy, 88% for the Gulf of Maine, 8% for Central New England, and 4% for Long Island Sound. Returns in 2011 were typical, in that the Penobscot River population accounted for the largest percentage (75%) of the total return.

In the Penobscot this year, 24% of the adult returns were 1SW salmon and 76% were 2SW fish. From 1967 to 1990, the ratio of 3SW salmon to 2SW fish averaged 1.5%, and was as high as 7%. However, from 1991 to present, this average declined to 0.3%, and only exceeded 1% for one cohort. Most Penobscot returns (92%) in 2011 were hatchery-smolt origin, and the balance (8%) originated from fry stocking or natural reproduction. This is typical of the time series.

Return rates provide a consistent indicator of marine survival. Previous studies have shown that most of the US stock complexes track each other over longer time-series for return rates (strongest index of marine survival). For a comprehensive look at return rates throughout New England, a cursory examination of returns from smolt stocked cohorts provides the most informative comprehensive assessment of all regions (Figure 2.4.2.2). 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. Average smolt to adult return (SAR- number of adult returns per 10,000 hatchery smolts stocked) over the last 5 years was highest in the Gulf of Maine (23.4) and decreased southward for the Central New England (11.1) and Long Island Sound (2.0) stock indices.

Maine return-rate assessments of SAR 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 average return rates per 10,000 smolts from 1969 to 2011 smolt cohorts was 5.1 for 1SW salmon and 37.3 for 2SW fish. These return rates have been lower since 1991, when a phase shift in North Atlantic ecosystem production occurred (Chaput et al. 2005). Smolt cohorts from 1991 to 2009 median values were 3.4 for 1SW salmon and 15.0 for 2SW fish. Starting in 1997, NOAA began a program to estimate production of naturally-reared smolts in the Narraguagus River, Maine. The average return rate for naturally reared Narraguagus River smolt 1997–2009 cohorts was 84.6 per 10,000. That rate was 5.6 times higher than the Penobscot 2SW hatchery average of 15.0 for the same time-period.

In 2011, the adult return rate for 2SW hatchery smolts released in the Penobscot River was 38.6, ranking 15th in the 41-year record, while the 2011 return rate for 1SW hatchery grilse was 12.3, ranking 8th in the 42-year record. The 2SW return rate in the Narraguagus River in 2011 was 178.4, more than 4.6 times the SAR observed in the Penobscot River. This analysis points out a challenge to modern salmon recovery: naturally reared smolts typically have better marine survival than hatchery fish, but the capacity of rivers to produce adequate numbers of smolts is generally well below replacement rates, under current marine survival rates.

2.4.3 Juvenile Abundance Metrics

The USASAC again made progress utilizing databases to develop regional-scale stock assessment products that assess various life history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary has been used to summarize return rates across New England for hatchery smolts (e.g. Figure 2.4.2.2 and 2.4.2.3). Examination of these data in further detail for such a long time-series is providing insights into program-specific challenges and more general regional trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, is facilitating the development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation, given the broad geographic area (186,500 km²), with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people, with salmon habitat in cities and remote wilderness. However, taken over a long time-series, this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

Since 2009, USASAC has consolidated datasets across New England for juvenile production since at least the 1980's (some Maine data dates back > 50 years). Investigations of the juvenile production trends over time and more detailed assessments were initiated with the 2009 assessment. The first step towards investigating juvenile data was a graphical comparison of large parr densities throughout the region. In this year's assessment, parr metrics have been further refined with new model. The model used sites with > 10 years of density estimates that are a product of electrofishing surveys throughout New England. For the model, large parr densities were $\ln+0.1$ transformed then were analyzed with a mixed random effects model (years were fixed effects, 10 digit USGS hydrologic unit code within years were random effects, sites within 10 digit USGS hydrologic unit codes were random effects, and a "no intercept" model specification). The predicted year effects were then back-transformed to density units for presentation (Figure 2.4.3.1). An examination of average densities (# per 100 m² habitat units) across the 1984 to present time-series shows generally higher densities in Gulf of Maine DPS (2.3) estimates, relative to the Central New England (1.9) and Long Island Sound (1.5) but with substantial inter-

annual variability. In the past decade, these averages seem to have reached a general equilibrium around densities of 1.6 in Central New England and 1.3 in Long Island Sound. However, densities in the Gulf of Maine have increased in the past five years with the 2000's decade median at 2.3 but the last 5 years rising to 3.0. While insightful, a more thorough examination of these data relative to other factors, such as elevation, temperature, and stocking practices, may provide additional insights into best management practices and environmental factors.

Another juvenile metric that provides a composite view of freshwater rearing is indices of smolt production. These estimates are relatively limited in New England, but two longer time-series of data are available and provide a good contrast: the Connecticut River basinwide estimate and the Narraguagus River smolt assessment (Figure 2.4.3.2). The Narraguagus metric is a mark-recapture estimate using rotary-screw traps that monitor production of fry-stocked fish and naturally spawned fish. The Connecticut estimate is a composite estimate of late-summer, electrofishing-density data weighted geographically with an assumed overwinter survival rate. Further analysis of smolt population dynamics is done periodically to examine other abundance indices, age distribution, and run timing. Because both these indices track natural production of smolts, the general coherency in trends indicated that similar factors may be controlling smolt recruitment on a regional basis in many years. Identification of these factors and when smaller scale differences occur would enhance ability to predict smolt production.

2.5 Biological Reference Points

Biological reference points for Atlantic salmon vary from other managed species in the region because they are managed in numbers, not biomass, and also because they are a protected species with limited fisheries targets. Fisheries targets (MSY , B_{MSY} , F_{MSY} , F_{TARGET}) have not been developed because current populations are so low relative even to sustainable conservation levels. A proxy for minimum biomass threshold for US Atlantic salmon would be conservation spawning escapement (CSE), because this provides the minimum population number needed to fully utilize available freshwater nursery habitat. This number is based on a single spawning cohort (2SW adults), not the standing stock of all age groups. As defined above, the CSE for New England is set at 29,199. The strongest populations in the Gulf of Maine are at less than 20% of their target of 15,670 and almost all these fish are hatchery origin while recovery goals target wild spawners. Natural survival of Atlantic salmon in the marine environment is estimated to be 0.03 per month, resulting in an annual natural mortality rate (M) of 0.36.

2.6 Summary

Historic Atlantic salmon abundance in New England probably exceeded 100,000 returns annually (National Research Council 2004). Habitat destruction and overfishing resulted in a severely depressed US population that, by 1950, was restricted to Maine, with adult returns of just a few hundred fish in a handful of rivers. Hatchery-based stock rebuilding occurred from 1970 to 1990, reaching a peak of nearly 6,000 fish in 1986. A North American collapse of Atlantic salmon abundance started around 1990. In the past decade, US salmon returns have averaged 1,888 fish, and returns in 2011 were 4,167 fish. All stocks are at very low levels; only the Penobscot River population has been near 10% of its conservation spawning escapement and only because of an intensive smolt stocking program. Naturally-reared returns in the Penobscot are proportionally low. Most populations are still dependent on hatchery production and marine survival regimes from 1991-2007 were low, compromising the long-term prospects of even hatchery-supplemented populations. Returns since 2008 suggest a potential shift to higher ocean productivity of salmon may be starting. Additionally, mariculture is increasing worldwide, and New England production should be around 8,000 mt in the next decade.

Table 2.2.1 Recreational (reported in numbers), aquaculture production (thousand metric tons), and commercial (no fishery) landings of Atlantic salmon from Maine. (* Recreational catch is 0 from 1995 forward). **With only one company in 2011- no reported harvest but estimated to be in range of 5.5 to 8.5.

Category	1992-	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	2001 Average										
U.S. Recreational (#) *	35	-	-	-	-	-	-	-	-	-	-
US Aquaculture	10.7	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0	11.1	**
Commercial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	10.7	6.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0	11.1	**

Table 2.4.2.1. Most current two-sea winter (2SW) conservation spawning escapement requirements for US river populations and 2SW returns (with % of CSE).

<u>Stock Complex</u>	<u>CSE</u>	<u>2011</u>	<u>%CSE</u>
Long Island Sound Complex	10,094	82	0.8%
Central New England Complex	3,435	298	8.7%
Gulf of Maine DPS	15,670	2,665	17.0%
Subtotals	29,199	3,045	10.4%

For further information

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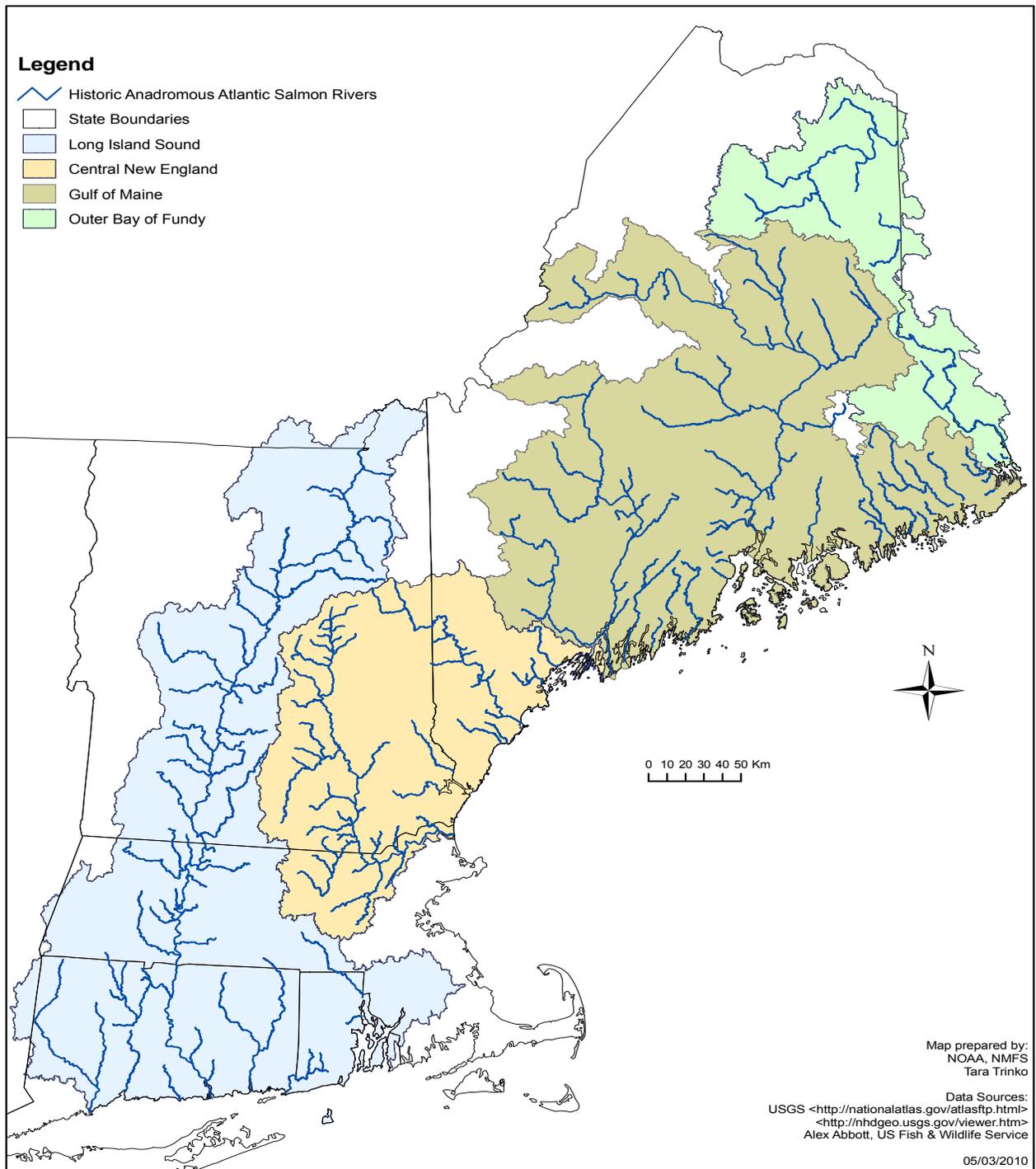
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2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

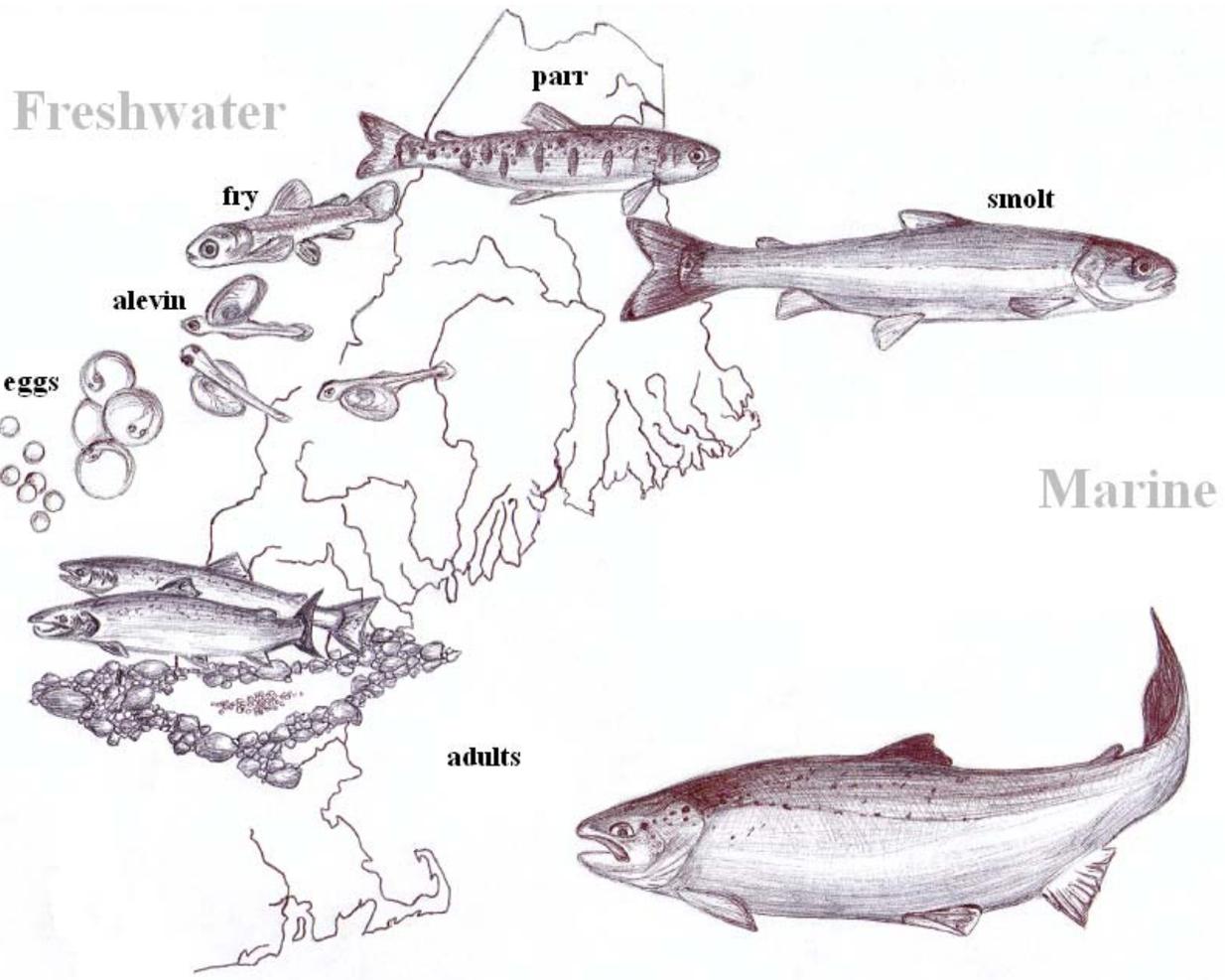


Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

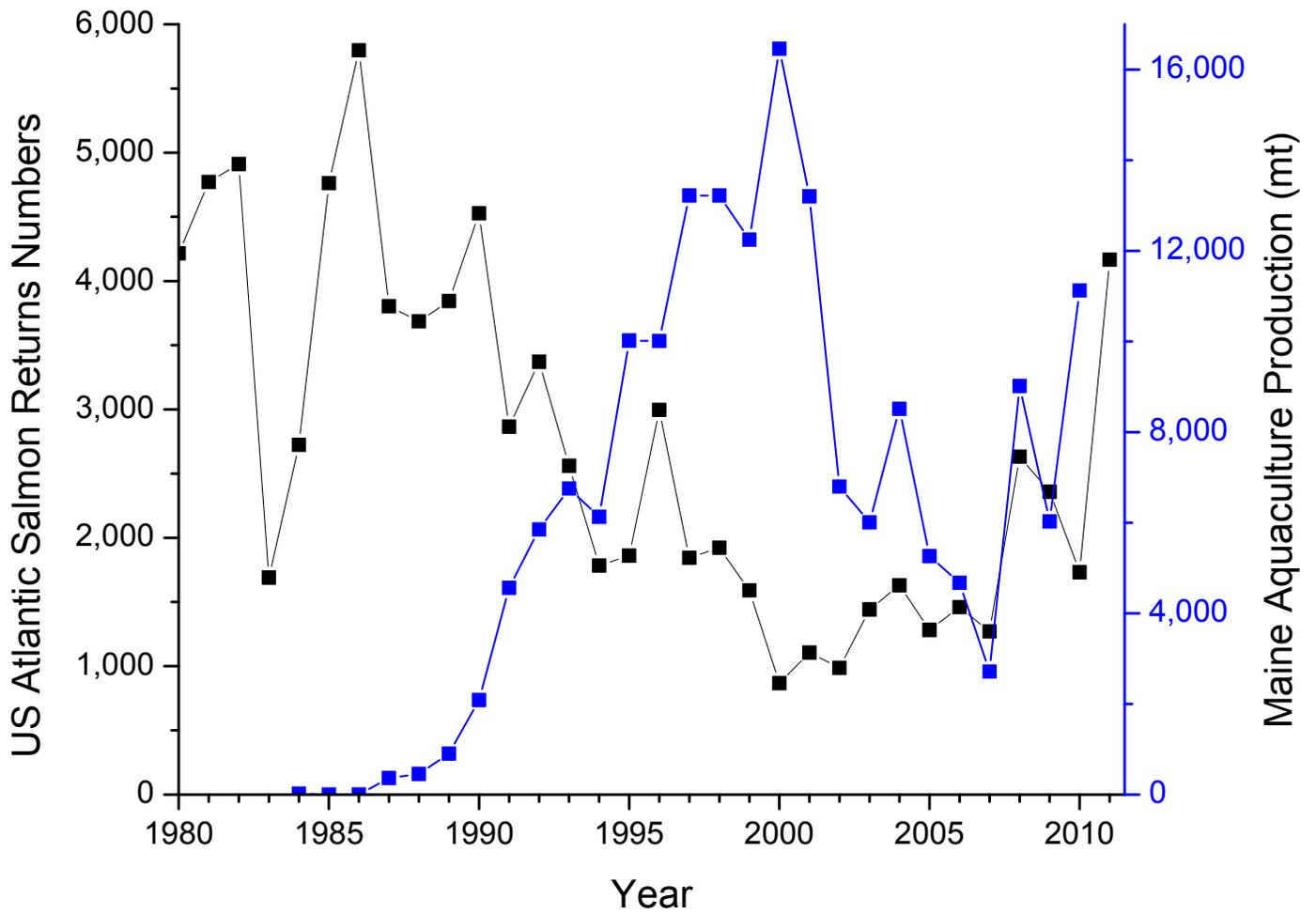


Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons).

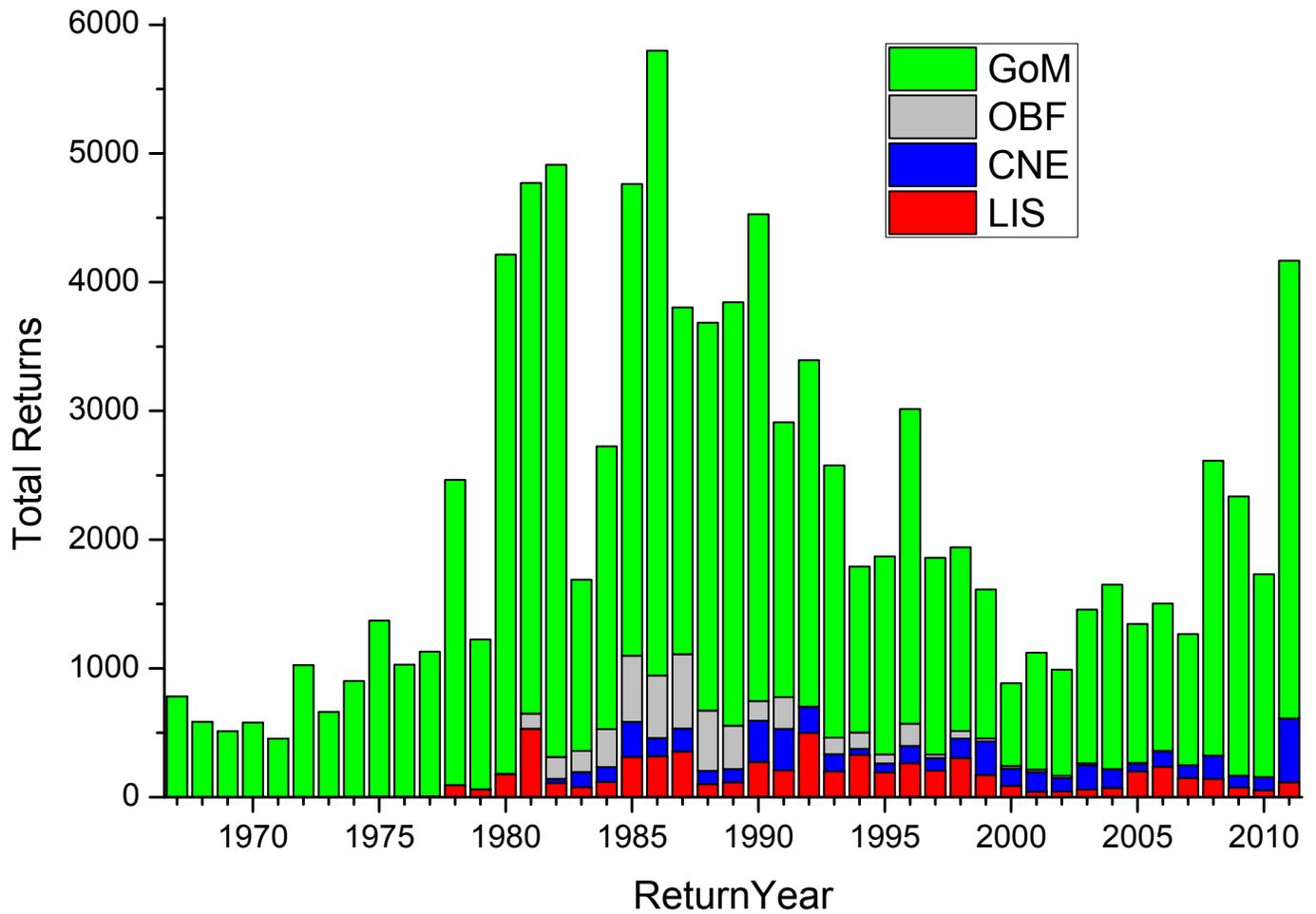


Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex.

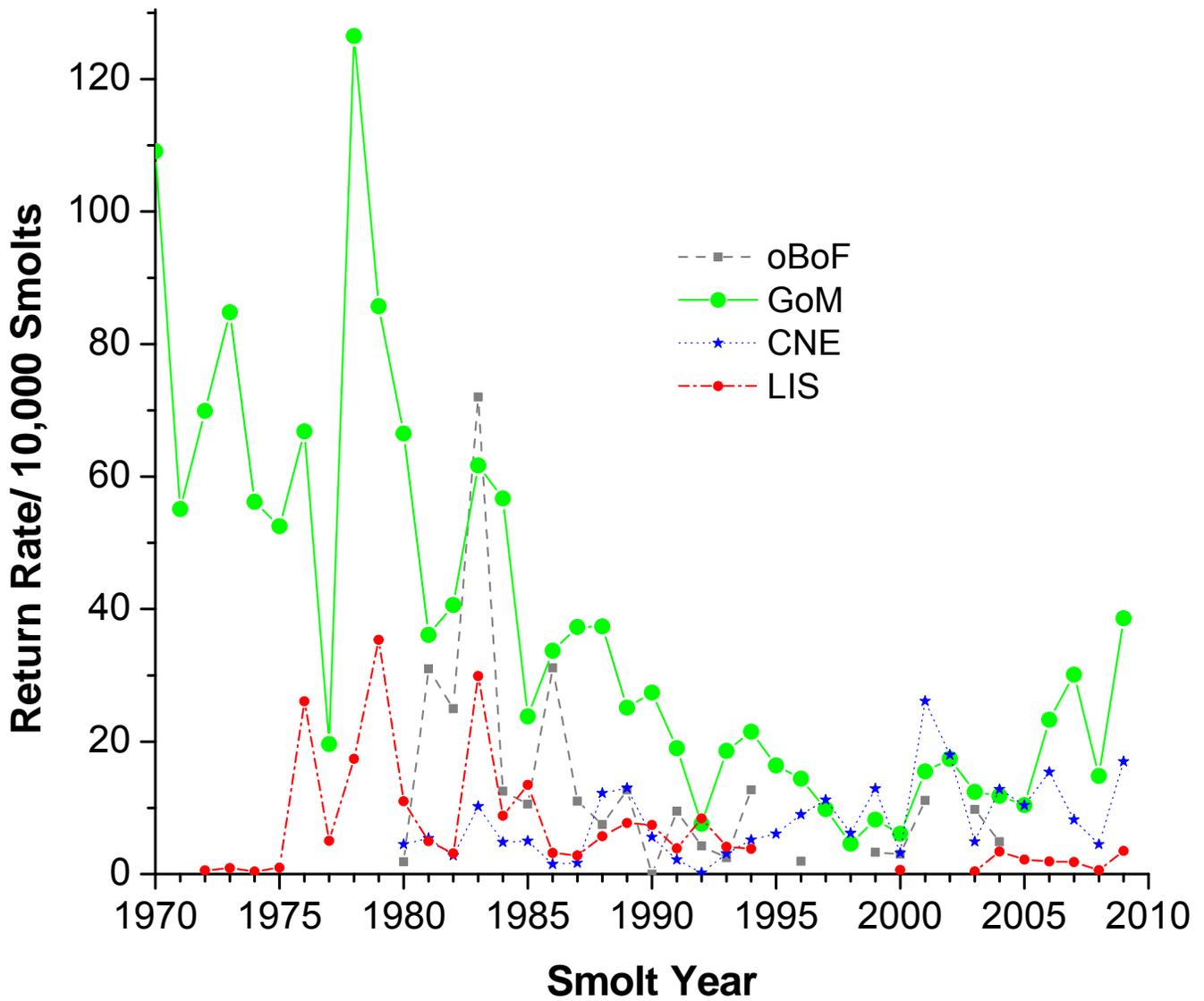


Figure 2.4.2.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

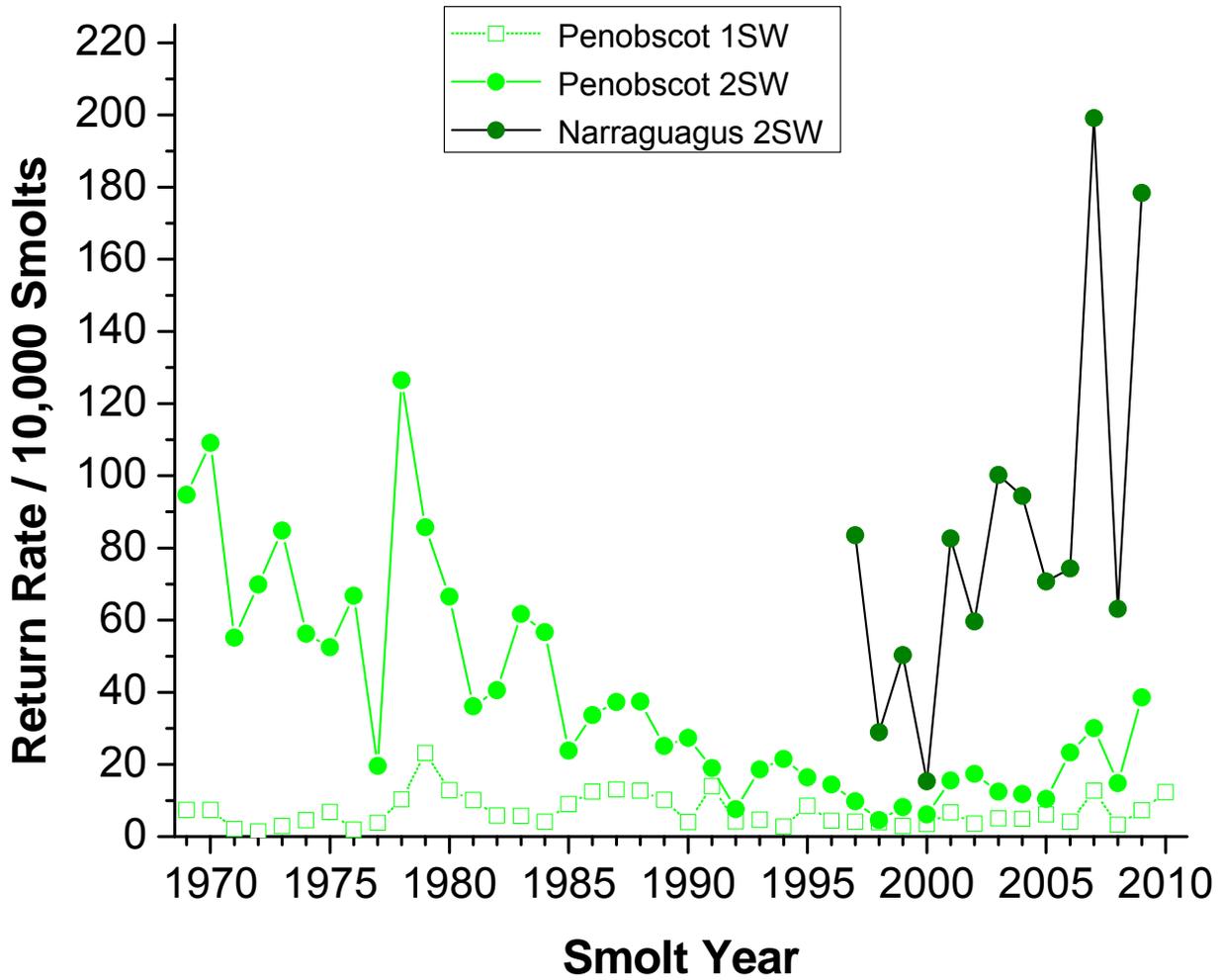


Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

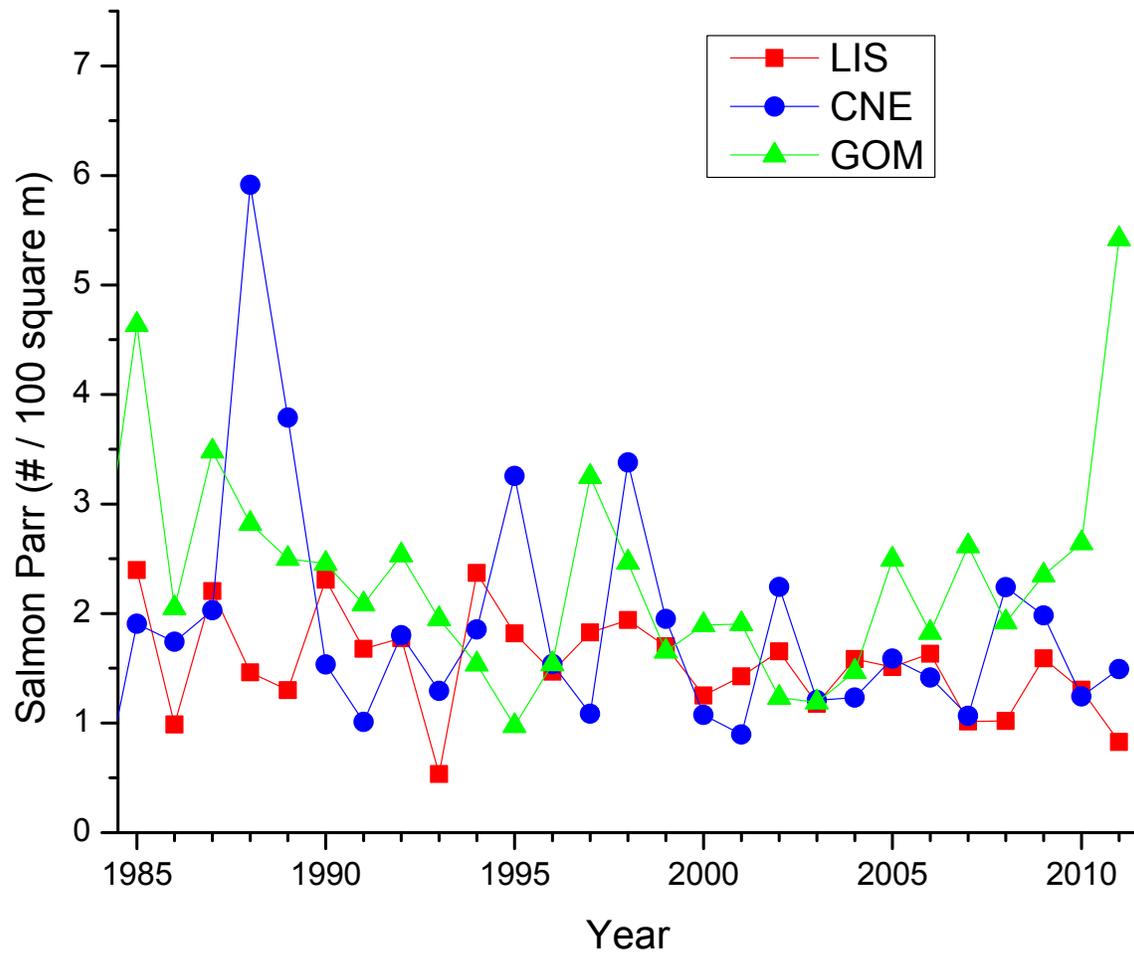


Figure 2.4.3.1 Index of large parr density from a mixed random effects model using electrofishing data from sites with > 10 years of data from 1984 through present from USASAC databases for three stock complexes: Long Island Sound, Central New England, and in the Gulf of Maine DPS.

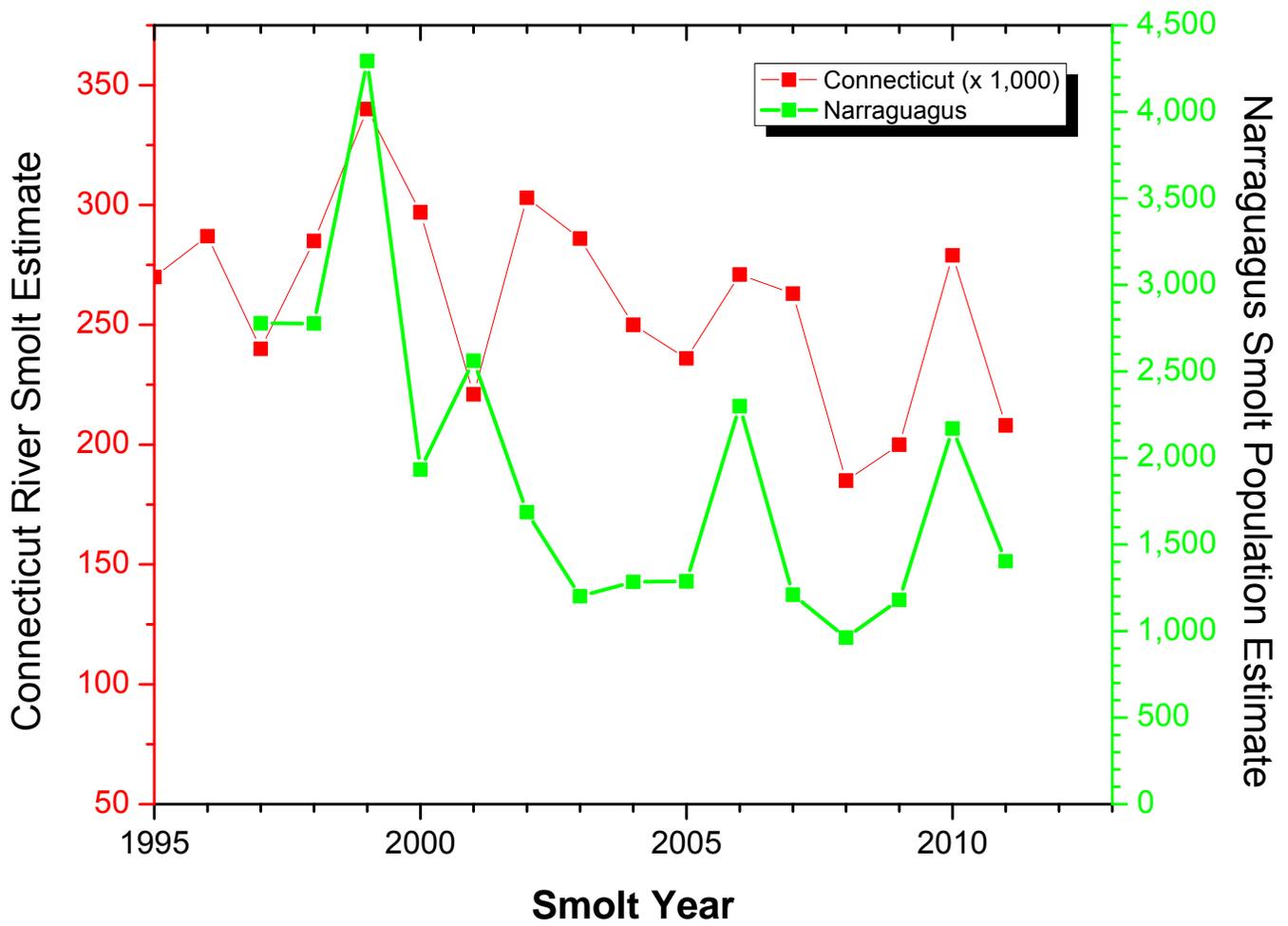


Figure 2.4.3.2 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basin in total. See text for details of estimation methods.

3 Long Island Sound

3.1 Long Island Sound: Connecticut River

Connecticut River Atlantic Salmon Commission (CRASC) partner agencies continued their varied work on diadromous fish restoration in 2011. Below is a summary of work on Atlantic salmon.

3.1.1 Adult Returns

A total of 111 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed; 73 on the Connecticut River mainstem, 16 in the Farmington River, 13 in the Salmon River and nine in the Westfield River. A total of 94 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS).

Three of the Salmon River fish were observed but not captured at the fishway at Leesville Dam. One Farmington River fish was observed but not captured at Rainbow Dam fishway. One dead fish was documented at the river mouth in Old Lyme, CT. Three fish were passed without handling at Holyoke Dam, two of which were documented passing Vernon Dam fishway, and one of those was subsequently captured at the Townshend Dam trap on the West River, VT. Ten salmon were trapped at the Holyoke Dam, radio-tagged and released upstream. Of those: one entered the Deerfield River and seven passed the fishways at Turners Falls Dam and Vernon Dam. Of those passing Vernon dam: six passed Bellows Falls Dam fishway (two of which were detected in the White River) and three passed Wilder Dam fishway.

Nineteen (17%) of the salmon observed were of hatchery (smolt-stocked) origin. The remaining 92 (83%) were of wild (fry-stocked) origin. Total number of grilse (both origins) was 33 (30%) of total returns, a notably high proportion relative to program history, with 31 of those being wild origin. Two sea winter wild salmon totaled 61 fish (55%). Freshwater age distribution of wild salmon was 1⁺ (4%), 2⁺ (92%) and 3⁺ (4%).

3.1.2 Hatchery Operations

The program achieved 33% of egg production goals (4.9 million eggs produced, 15 million goal), 60% of fry stocking goals (6.0 million fry stocked, 10 million goal), and 80% of smolt stocking goals (80,100 viable smolts stocked, 100,000 goal).

Tropical Storm Irene in August produced severe floods that damaged the White River National Fish Hatchery (WRNFH) and resulted in immediate high losses of domestic broodstock in the outside ponds. The USFWS determined that the hatchery had to be de-populated and shutdown by December, which created huge operational challenges for the Program. The Technical Committee quickly modified previous plans to deal with spawning plans, incubation space options, chiller status, fish health testing and transfer of eggs. A brief but intensive spawning effort at WRNFH salvaged 1.2M eggs, which were taken to state facilities for incubation. It was decided to not stock any of the older broodstock (ages 1-4) anywhere in the basin due to the possible exposure of the WRNFH water system to the nuisance diatom *Didymosphenia geminate* along with other management and fish health concerns. Age-0 parr from inside tanks were stocked in the adjacent White River. The remaining broodstock were provided to Northeast Indian Tribes for their ceremonial purposes (food), in December and early January.

Biosecurity measures undertaken at RCNSS in 2007 in response to detection of infectious pancreatic necrosis (IPNV) continued. Spawning at RCNSS required a crew of approximately 12 staff supplied by CRASC cooperators to meet biosecurity requirements. Fish health testing was done on ovarian fluid on all females broodstock sampling and by lethal sampling on all males, including mature parr. All 2011 sea-run returns tested negative for IPNV. Kelt eggs were taken from NANFH kelts and fertilized at RCNSS with parr. Sea-run and kelt eggs were transferred from RCNSS to Kensington State Salmon Hatchery (KSSH) and Roger Reed State Fish Hatchery (RRSFH) after disease testing. RCNSS retained approximately 125K eyed eggs to produce 100K fry to stock two tributaries used for mature male parr collections in subsequent years for spawning at RCNSS. Those fry are currently on feed and scheduled for stocking in early April.

A fin condition survey was conducted in February at Dwight D. Eisenhower National Fish Hatchery (DDENFH) and Berkshire National Fish Hatchery (BKNFH) to evaluate smolts prior to stocking in 2011. Based on this evaluation and length measurements, DDENFH produced 2,037 parr (2% of total), 11,339 smolts with fatal fin condition (13%), and 77,596 viable smolts (85%). The assessment at BKNFH determined 1,309 parr (27%), 909 smolts with fatal fin condition (19%), and 2,582 (54%) viable smolts were produced. Parr are 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 73,000 1+ presmolts is in production at DDENFH for stocking in 2012. They were marked with an adipose fin clip and vaccinated with a multivalent vaccine for *Vibrio* and *Aeromonas salmonicida* (furunculosis) in October. Parr (9,500) were graded out and stocked in suitable habitat at the time of vaccination. This reduces densities in the hatchery pools for the remaining presmolts and allows the parr to potentially grow for another year in the stream and smoltify in 2013. The presmolts will be evaluated for size and fin condition prior to stocking in 2012.

Egg Collection

A total of 4.94 million green eggs was produced at five state and federal hatcheries within the program. Sea-run broodstock produced 376,000 eggs from 47 females held at RCNSS. Domestic broodstock produced 4.38 million eggs from 707 females held at WRNFH, KSSH, and RRSFH. Kelt broodstock produced 176,000 eggs from 24 females held at NANFH. Egg production remained below the prior ten year average of 11.0 million and the program goal of 15 million.

3.1.3 Stocking

Juvenile Atlantic Salmon Releases

A total of 6.1 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2011. Totals of 499,500 fed fry and 5.5 million unfed fry were stocked into 39 tributary systems with the assistance of hundreds of volunteers. Totals of 80,100 2smolts, 9,900 2parr, 9,500 1+parr and 5,200 0parr were released into the lower Connecticut River mainstem, the White River, the Westfield River, and the Farmington

River. Numbers of fry stocked are fairly consistent with past 5 years 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 in the states of Connecticut (rivers and streams) and Massachusetts (lakes and ponds).

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 2011. This was the nineteenth 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. Due to periods of repeated and sustained high river flows in April and May, a statistically reliable estimate was not possible due too few captures of wild smolts at Cabot (139 total, 130 marked) and low recaptures of marked smolts at Holyoke (3 marked recaps from 936 total wild smolt sample) because of extensive spill at the mainstem dams.

Electrofishing effort from index stations was dramatically reduced In 2011, due to sustained higher than normal stream flows and Tropical Storm Irene impacts, which affected much of the river basin. Although a number of smaller sites were sampled, larger sites were generally not sampled in many systems. As a result, no basin-wide smolt estimate was possible for 2012.

3.1.5 Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at 91 index stations throughout the watershed (less than half the number sampled last year). Sampling was conducted by CTDEEP, 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 at juvenile index sites was 42.9 /100m² unit and the mean 0+ parr density was 6.1/unit with a mean first summer survival of 17%. The mean density of 1+ parr was 2.9/unit with a mean survival from stocked fry of 2.8%. Mean total lengths at capture of 0+ and 1+ parr were 83 and 152 mm, respectively. Densities of 0+ and 1+ parr are similar to last year although the timing of sampling was largely before the large scale flood event. It is unclear how parr survival was impacted in reaches of flood altered habitat in addition to emergency road, bridge, culvert repair work which further damaged large quantities of habitat.

3.1.6 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.

Five large hydropower projects, operated by international owners, will have their Federal Energy Regulatory Commission (FERC) licenses expire in 2018. These projects are located on the mainstem river include Turners Falls, Vernon, Bellows Falls, and Wilder dams as well as the Northfield Mountain Pumped Storage Facility. Agencies have started pre-application discussions on this topic.

Holyoke Dam- Plans for development of a new downstream passage screen and bypass system for the main Holyoke generating station (Hadley Falls) were again re-designed. Some additional details are being developed to address agency concerns following owner design retraction. This downstream passage need is to address shortnose sturgeon and American eel passage issues.

Vermont Yankee Nuclear Power Plant- Entergy obtained a 20 year extension to their operating license (was to expire in 2012). This federal license was challenged by the State of Vermont which lost in a federal court decision in January 2012. Studies to evaluate the impact of the plant's thermal discharge on smolt migration were delayed again in 2011. The existing NPDES permit is expired and the VT ANR will be moving to address necessary permit needs for this plant.

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 dams. A total of 1,471 wild smolts was captured in 2011 (3,214 in 2010) and trucked below McIndoes Dam for release. Flow inducers were operational in 2011 to improve guidance.

Gilman Dam- A downstream fish bypass was completed in 2011 and will be in operation for spring 2012.

Woronoco Dam- A new full depth trash rack with $\frac{3}{4}$ inch spacing was installed in 2010 and evaluated by releasing radio tagged smolts again in 2011. The final report has not been reviewed.

Manhan River Dam- Denil ladder construction was delayed due to construction problems and required additional funding for completion. The project is on hold.

Deerfield River- Construction of downstream passage modifications at Deerfield 3 project has been completed and will be operational for spring 2012.

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

Fiske Mill Dam- The fish lift at the first dam on the Ashuelot River is completed and will be operational for the first time in the spring of 2012.

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

Bethel Mills- Interim spill was in place for the 2011 smolt run but construction of a permanent downstream facility was delayed at this dam on the Third Branch of the White River by T.S. Irene flood. Construction is now anticipated to occur in 2012.

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

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

3.1.7 Genetics

Tissue samples were taken from all 2011 sea-run broodstock for genetic monitoring. Microsatellite analysis for broodstock management was completed by the NEFC. The sea-run broodstock were PIT tagged to ensure individual identification at spawning. This information is necessary to develop the mating scheme linking individual broodstock to their genetic information, in a deliberate effort to mate salmon that are not closely related. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

Mature male parr, collected from the Sawmill River, supplemented sea-run males, although the high proportion of grilse led to a near 1:1 ratio in 2011 of adult returns. Mating of sea-run females utilized a 3 male: 1 female breeding matrix in which one cross was used for future broodstock production and two crosses were incubated to produce fry for stocking and future broodstock for KSSH and RRSFH. A 1:1 spawning ratio was observed for domestic brood stock spawned at the WRNFH, KSSH, and RRSFH.

Sea-run origin fry were stocked in Bronson Brook (27,000) and Sawmill rivers (65,000) in spring of 2011 for mature parr production to supplement future male spawners.

Beginning in 1998, genetically identifiable domestic broodstock had been maintained at the WRNFH. By tracking the individual matings, individual families and therefore stocked fry can be genetically “marked” for post stocking evaluation. Starting in 2001, these fish were spawned and families of domestic eggs were produced with known genetic marks that are stocked in specific tributaries or groups of tributaries (regions) for later identification. The resultant fry were stocked starting in 2002 to expand the marking and program evaluation efforts. This effort has continued annually. Smolts were sampled for biological and run timing data in downstream bypasses at Cabot Station at Turners Falls Dam (139), Holyoke Dam (936 total wild smolts sampled), and Rainbow Dam (905) in 2011. A subsample from these smolts had tissue samples taken for genetic analysis as part of the marking program study.

A multi-year effort to process genetic samples from the Atlantic Salmon Marking Study was initiated in 2011 with funding from VTDFW, NMFS, USFWS and implemented by the USFWS Lamar Genetics Unit. A total of 4,334 samples were extracted for analyses, with genotyping expected to be completed at the time of this report (fry, smolts, adult returns, and parent assignments QA/QC). Data from this first year step will be sent to USGS Conte Lab for additional analyses in the spring of 2012. Samples analyzed in to date include all samples collected during 2011 and several other past years. Another VTDFW grant will be used next year for to analyze additional archived samples, further reducing or eliminating the backlog of samples. Ten marked year classes (starting in 2002) were created and will continue to provide opportunities for sampling through the 2013 smolt and 2015 adult runs. Fry stocked in 2011 were the last group of genetically marked fry. As in past years, the genetically-marked fry was only a portion (typically 30-45%) of total fry stocked.

3.1.8 General Program Information

Flood damage from Tropical Storm Irene to WRNFH was severe and required fish depopulation and closure of the facility. Infrastructure impacts included extensive damage to electrical systems, motor controls, wells, adjacent river bank, settlement pond, well pumps, and facility structures. The estimated cost of rebuilding and repairs is \$5.0 million dollars. The loss of the WRNFH for the program will have important impacts due to its recent annual contributions of approximately 65% of the fry stocked primarily in the upper basin. In addition, this facility served as the Program egg bank, had important chiller capacity, and received surplus eggs from state facilities beyond their incubation capacity. Funding options to address a sequenced approach to repairs are being developed but remain uncertain at the time of this report as is when the facility will become operational again.

In addition, the USFWS has decided NANFH will no longer retain kelts for the Program following the 2011 season.

Some of the best salmon habitat in the basin, found in northwestern Massachusetts and Vermont, was severely damaged by the Irene flood. Extreme, channel forming flows severely altered instream and riparian habitat features in 2-4th order streams. Systems particularly hard hit include the tributary watersheds of the Westfield, Deerfield, West, Saxtons, Black, and White. The habitat has been further degraded in some areas by the massive road, bridge, and embankment repair activities which has included instream operation of large earthmoving equipment, riverbank armoring, and changes to stream grades and riparian zones. It is expected that much of the habitat may experience reduced production of juvenile salmon.

The Connecticut DEP changed its name in July 2011 to the Department of Energy and Environmental Protection (DEEP) and the use of DEEP is slowly being incorporated into this and other reports.

The use of salmon egg incubators in schools as a tool to teach about salmon, watersheds and conservation continued in the basin, but was impacted by the closure of WRNFH. As a result, the NHFG opted to switch to brook trout. The Southern Vermont Natural History Museum working with VTDFW, provided eggs for eight schools in Vermont. The CRSA, in cooperation with CTDEEP, conducted their Fish Friends program at 73 schools in Connecticut. Trout Unlimited in cooperation with MADFW and USFWS continued its Atlantic Salmon Egg Rearing Program in Massachusetts at 46 schools or organizations. For the 2011-2012 school year, 127 schools participated in this type of salmon education in Connecticut, Massachusetts, and Vermont.

3.1.9 Migratory Fish Habitat Enhancement and Conservation

In cooperation with several partners, NHFG continued habitat restoration work (design and evaluation) on Warren Brook, a Cold River tributary. NHFG continues to address habitat restoration in Nash Stream (Upper Ammonoosuc). New USFWS grant awards in 2011 were given to help fund the planned Ed Bill's Pond Dam removal in 2012 (Eightmile River) and to assist with remaining funding needed to complete the partially built Manhan River fish ladder.

A small mill dam on Amethyst Brook (Fort River, MA) is scheduled for removal in 2012. Another unutilized dam on the Fall River (MA) is proceeding with plans for removal that was initiated in 2011.

In Vermont, the USFS completed the following projects in the Green Mountain National Forest. (1) Jenny Coolidge Culvert Replacement, Weston, VT; replaced aquatic organism barrier with bottomless arch structure using "Stream Simulation" design principles. The road crossing is no longer a barrier to fish and other aquatic organisms and reconnects approximately two miles of headwater stream habitat to the mainstem West River. (2) Bingo Brook Culvert Replacement, Rochester, VT; began construction on a bottomless arch culvert to replace a structure that was barrier to aquatic organisms. The road crossing is no longer a barrier to fish and other aquatic organisms and reconnects approximately 1.5 mile of headwater stream habitat to the mainstem White River. (3) Perkins Brook Culvert Replacement, Rochester, VT; began construction on a bottomless arch culvert to replace a structure that was barrier to aquatic organisms. The road crossing is no longer a barrier to fish and other aquatic organisms and reconnects approximately one mile of headwater stream habitat to the

mainstem White River. (4) White River Headwaters Large Wood Restoration, Granville, VT; placed large woody debris into approximately a half mile of Clark Brook and Patterson Brook. Salmon fry are stocked annually in the mainstem and have direct access to these headwater tributaries.

3.2 Long Island Sound: Pawcatuck River

3.2.1 Adult Returns

Four Atlantic salmon adults were captured at the Potter Hill Fishway in 2011. The fish are female of wild (fry stocked) origin.

3.2.2 Hatchery Operations

Egg Collection

Sea-Run Broodstock

The sea-run fish were not spawned this year.

Captive/Domestic Broodstock

We currently have five captive fish of sea-run origin at the Perryville Hatchery. They were not spawned in 2011 because of lack of personnel.

A number of fish were acquired from Connecticut hatcheries to retain as broodstock are currently located at the Perryville Hatchery. These fish included: 800 fish that were 340g and 207 that were 113 g.

3.2.3 Stocking

Juvenile Atlantic Salmon Releases

The *Salmon in the Classroom* program was responsible for stocking approximately 6,000 fry into the Pawcatuck River and its tributaries. No other Atlantic salmon fry were stocked into the Pawcatuck River in 2011. No smolts were stocked in the Pawcatuck River in 2011.

Adult Salmon Releases

Approximately 150 adult Atlantic salmon were acquired from the Nashua National Fish Hatchery in January 2011 and stocked in five Rhode Island ponds for ice fishing. In December 2011, an additional 200 Atlantic salmon, raised at the Perryville Hatchery were distributed into four Rhode Island ponds for ice fishing.

3.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were not conducted in 2011 due to lack of personnel.

Smolt Monitoring

No work was conducted on this topic during 2011.

Tagging

All smolts are generally released with adipose fin clips, however, no smolts were released in 2011.

3.2.5 Fish Passage

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

Additionally, the lower Shannock Dam, which was the third obstruction on the Pawcatuck River was removed and a naturalized streambed was created. The next dam upstream is Horseshoe Falls. This dam is currently under construction for the installation of a Denil fishway and is projected to be completed in 2012.

3.2.6 Genetics

No genetics samples were collected in 2011.

3.2.7 General Program Information

Lack of personnel is currently the primary issue in Rhode Island's Atlantic salmon restoration program.

3.2.8 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2011.



4 Central New England

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

Four hundred and two sea-run Atlantic salmon returned to the Merrimack River at Essex Dam, Lawrence, MA. Three hundred and ninety-four captured salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Sixty-two were adipose fin-clipped fish previously released into the Souhegan as smolts; four died at the hatchery and fifty-eight were released in the Souhegan River (20 of the salmon were radio-tagged) before spawning season. Additionally, eight fish were released prior to spawning into the Souhegan River after a genetic parentage analysis determined their prior release as fry in the river. Forty-seven fish were released into the Pemigewasset River (10 females were radio tagged) after a parentage analysis determined their prior release as fry upstream of Ayers Island Dam.

In addition to the four mortalities of fish that were to be stocked in the Souhegan River, an additional 14 fish died prior to spawning, and three were non-spawners. Two hundred and sixty salmon were spawned which included 153 (59%) males and 107 (41%) females. Ninety-three fish were dispatched after spawning for fish health testing to ensure the absence of pathogens that potentially could be passed to offspring. One hundred and sixty post spawned fish were released in the Merrimack River below Essex Dam after spawning.

A total of 402 sea-run Atlantic salmon returned to the Essex Dam Fish Lift in 2011. Seven fish either escaped or died at the dam without measurements or scale samples being taken. Of the remaining fish, morphometric data was taken from 395 fish and 392 of these had scale samples taken that were analyzed for origin and age. Of the 392 sea-run salmon analyzed, 289 (73.7%) were hatchery smolt origin and 103 (26.3%) were fry origin. Of the 289 hatchery smolt origin salmon, 126 (43.6%) were grilse (1 SW) and 163 (56.4%) were multi sea-winter fish (2-4 SW). Of the 103 fry origin salmon, eleven (11.7%) were grilse, 92 (89.3%) were multi sea-winter fish. In 2011, adult

salmon that returned represented four fry cohorts: 2005 - 2008. The rate of return for the fry stocked in 2007 was 0.833, per 10,000 fry stocked. This return rate is 7.19 times higher than the average return rate of 0.158 from 1994-2006. Smolt origin adult returns in 2011 represented four cohorts: 2007 – 2010. The return rate for 2009 was 2.02 per 1,000 smolts stocked. This return rate is somewhat higher than the average return rate of 1.45 from 1996-2008. The current return rate for 2010 is 1.76 from grilse alone. This high grilse return rate might indicate a strong 2 SW return in 2012 from this year class.

4.1.2 Hatchery Operations

North Attleboro National Fish Hatchery (NANFH) produced and shipped a total of 479,762 eyed kelt eggs to Warren State Fish Hatchery, NH (WSFH) in two shipments on 2 March 2 and 16 March. These eggs were from the last Merrimack River kelts on station (2008 and 2009 sea-run returns). Resulting fry were released in the upper Merrimack River watershed. The Merrimack River Kelt Program has been discontinued. No Merrimack River kelts were transferred or reconditioned. All but a few kelts were sacrificed and sampled for disease. The remaining kelts are on display to the public.

NANFH released a total of 17,211 one-year old smolts into Merrimack River, downstream of Essex Dam in Lawrence, MA. The majority of these smolts were released between 5 April and 22 April. A final group of smolts was released on 5 May to support a smoltification study.

NANFH received 1.1 million domestic green eggs from NNFH. And 17,178 parr were transported to NNFH (20 and 22 December) for smolt production for the Souhegan River.

Egg Collection

Sea-Run Broodstock

Three hundred and ninety-four sea-run salmon were held at NNFH. Fish were spawned during the period 20 October - 21 November, and produced 934,633 green eggs that resulted in 831,532 eyed eggs. All sea-run eggs were held and incubated at NNFH to avoid exposing other hatcheries to eggs that could hold infectious pathogens. NNFH achieved 89% eye-up in its fourth year of increased number of sea-run egg incubation. The 107 females produced an average of 8,734 eggs each. The hatchery retained 6,000 sea-run eggs for F1 captive broodstock production.

Domestic Broodstock

A total of 387 female and over 400 male captive (F1 from sea-runs) broodstock spawned at NNFH, and there were 309 non-spawners. The spawners provided an estimated 1,530,124 green eggs. Approximately 1,121,968 (73.3%) were shipped to NANFH and 408,156 (26.7%) were retained at NNFH for incubation/fry production and subsequent release to the upper Merrimack River watershed, the Saco River watershed, or the Adopt-A-Salmon educational programs. Of the 387 females, 181 were four years old and 206 were three years old. The domestic broodstock spawning season began on 26 October, ended 28 December, and included 10 spawning events.

4.1.3 Stocking

In 2011, 892,000 Atlantic salmon fry were released into the Merrimack River watershed in April and May. Salmon fry were propagated at NNFH and WSFH. NNFH reared 342,000 unfed fry, and WSFH reared 550,000 unfed fry. Only tributaries above Ayers Island were stocked with fry with the exception of the Souhegan River. An estimated 93,771 0+ parr were released into the river in the fall of 2011. This is the second year efforts have been made to increase stocking of fall parr as part of focused restoration efforts on newly accessible habitat in the Souhegan River.

An estimated 34,510 smolts were released into the watershed with approximately 17,211 one-year-old smolts reared by the NANFH released into the lower Merrimack River downstream of Essex Dam in early April. An additional 17,299 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 fourth year that all smolts were derived from adults of Merrimack River origin. Smolts produced at NANFH were not marked, 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.

In 2011, 112 adult sea-run salmon and 500 domestic salmon were released in the Merrimack River watershed. Sea-run fish were stocked based on where they were imprinted. Released Souhegan River sea-run fish were either 1) adipose fin clips indicating stocking of smolts into the Souhegan River (58) and 2) genetic determination and scale analysis indicating fry stocked in the Souhegan River or other lower river tributaries (8). An additional 46 sea-run adults with genetic and scale analysis indicating upper basin fry stocking locations (above Ayers Island Dam) were stocked into the Pemigewasset River. The 500 domestic salmon were released in the Baker River.

In the Souhegan River adult fish were released in two locations on separate days representing a summer release and a pre spawn fall release. The summer release consisted of 10 fish released on 17 June and nine 30 June. Of the ten fish release on the 17 June, all fish had gastrically inserted radio transmitters. Five were stocked upstream and five were stocked downstream the McLane and Goldman dams. One tag was recovered a few days later after a fish was recorded as being caught and killed by an angler. That tag was subsequently used to tag a single fish released upstream of the dams on 30 June, in addition four fish were released upstream and four fish were released downstream of the dams. The pre spawn fall release on 11

October consisted of 46 total sea-run adult fish, of those ten female fish had gastrically inserted radio transmitters. All of those fish were released upstream of the two dams, where most of the quality spawning habitat is suspected to occur. Redd counts of the upstream area was hindered by high flows.

The Pemigewasset River had 47 wild sea-run returns stocked on 17 October. All fish had genetic determination of being stocked as fry above Ayers Island Dam except one fish that was suspected to be unintentionally stocked. Ten of those fish had gastrically implanted radio transmitters to evaluate movement and habitat utilization.

The Baker River had 500 domestic adult salmon stocked in two separate groups of 250 each; one group in Warren and one in Wentworth. These fish were able to be released as the large sea-run component filled most of the required eggs need for hatchery production. These fish were stocked as gravid, ripe and running fish to allow for natural spawning. Redd counts were conducted multiple times to assess spawning.

4.1.4 Juvenile Population Status

Yearling Fry / Parr Assessment

In 2003, the number of fall parr sample sites was reduced from a high of 28 to seven traditional (historic) index sites. In 2011, the number of sampling sites was reduced again to four sites. The remaining sites are located on the Pemigewasset, Mad, Baker and Souhegan rivers. This reduction reflected the cessation of stocking at the three eliminated sites. The sampling protocol uses a depletion method to estimate the abundance of yearling parr at sites. Sampling occurs during the late summer and early fall. Sampling at sites is a cooperative effort involving staff from the NHFG, USFS, USFWS, USACOE and volunteers. The effectiveness of this year's sampling was hindered by the high waters caused by Hurricane Irene in late August. It was not possible to use block seines at any of the four sampling sites.

4.1.5 Fish Passage

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

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

Studies and evaluations of salmon smolt 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.

As of 2011 all returning adult salmon were 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 for most of the river system. One tributary with increase restoration focus is the Souhegan River (See 4.1.8). 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.

As a result of recent floods and problems with the fish lift, Enel chose to make improvements to Essex dam and fish lift. In late 2009 the company replaced wooden flashboards on the crest of the dam with a multiple-operating-zone inflatable system anchored into the present dam crest. Replacement of the existing flashboard system with an inflatable crest gate system has provided a number of operational and environmental benefits including: elimination of impoundment drawdown for flashboard replacement; improved control of upstream water levels in both high and low-flow situations; more effective fish passage as flashboard damage and leakage periods, which provide “false fish attraction” to the dam, have been minimized in extent and duration; and enhanced aesthetics associated with advanced water-control technology and decreased trash loading at the dam. The company also developed and installed a gate structure that when deployed protects the entrance gallery of the fish lift from debris loading and damage during periods of high water.

A similar inflatable crest gate system 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.

4.1.6 Genetics

Funding was secured in 2002 for genetic analyses of sea-run salmon, domestic broodstock, and kelts used in Merrimack River hatchery production programs. Fin-clip samples from all sea-run fish and kelts and a sub-sample of domestic broodstock were obtained and archived for analysis by the USFWS, Northeast Fishery Technology Center. As in previous years, paired matings in the fall of 2010 were tracked by tissue samples with eggs/fry segregated in hatcheries to enable the identification of parent origin and point of initial stocking in defined geographic regions. These regions are primarily partitioned into lower (sea-run parentage fry), middle (kelt parentage fry), and upper watershed (F1/domestic parentage fry).

From 2004 to 2010 fish stocked downstream from Ayers Island Dam (Bristol, NH) located on the Pemigewasset River are composed of fry from sea-run and kelt parentage and have a genetic signature, whereas those stocked upstream of Ayers Island Dam are not marked. Fin clips are obtained from salmon captured at Essex Dam and the genetic information is used to determine paired matings and also to determine fry stocking location (tributary, river reach/location).

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

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

In 2008, the Merrimack River program began releasing smolts from Merrimack River sea-run return parentage at the traditional site upriver from tidewater. Based on work conducted by the Northeast Fishery Technology Center and Conte Anadromous Fish Lab and as reported by the Center and Lab, genetic relationships among populations of Merrimack, Connecticut, Penobscot, and Maine Distinct Population Segment (DPS) salmon populations were determined using microsatellite loci to quantify estimates of genetic diversity within and between populations. Results indicate a lower amount of genetic differentiation among the Penobscot, Connecticut, and Merrimack River

populations compared to the differences observed among the DPS populations. Slight, but significant genetic differences were observed between the Connecticut and Penobscot River populations, however significant differences were generally not observed between the Merrimack and Penobscot populations. Accordingly, following the establishment of a river-specific broodstock and discontinuation of stocking Penobscot River juveniles, the Connecticut River population has become slightly genetically divergent from the Penobscot stock, although there is a clear indication of recent shared lineage.

Management and restoration goals for the Merrimack River program have included river specific stock development, an adaptive fry production/stocking program, and the production of 200,000 smolts. Accordingly, eyed eggs from the Merrimack River program were shipped to NANFH for smolt production and subsequent release in the Merrimack River in Spring 2010. In past years eggs were shipped to GLNFH for parr/smolt grow-out, however with the expanded ESA listing of salmon in Maine, GLNFH is no longer accepting eggs outside of the Maine DPS. The Merrimack River is now reliant on both the NNFH and NANFH for smolt production. Whereas a minimum of 50,000 smolts were produced in previous years at GLNFH, anticipated production level of approximately 25,000 smolts is expected for the Merrimack River in year 2012 due to limited space at the hatcheries. Eggs for smolt production were selected at random from nearly all parentage categories including sea-run, kelt, and domestic fish to obtain the greatest genetic diversity.

4.1.7 General Program

Atlantic Salmon Broodstock Sport Fishery

The NHFG via a permit system manages an Atlantic salmon broodstock fishery in the mainstem Merrimack River (NH) and lower portion of the Pemigewasset River. Whereas angled Atlantic salmon required the presence of a floy tag on captured fish as well as an angler tag for harvest in previous years, rule changes have now eliminated the angler tagging requirement. Creel limits are one fish per day, five fish per season, a minimum fish length of 15 inches, and the presence of a floy tag. The season is open all year for taking salmon with a catch and release season from 1 October to 31 March. In spring 2011, 400 (age 3 and 4) domestic broodstock were released for the fishery. In fall 2011, an additional 780 (age 2) broodstock were released for a combined total release of 1,180 fish to support the fishery.

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

The decline in volunteer angler reporting does not appear to indicate a decline in the popularity of the broodstock fishery. Permit sales have remained steady in recent years, with approximately 1,400 permits sold each year since 2006. In 2010, 1,439 anglers purchased a permit to fish for broodstock salmon. Data for the 2011 season is not yet available. Permit sales suggest that anglers continue to value this unique opportunity to fish for Atlantic salmon in northern New England.

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

Adopt-A-Salmon Family

The 2011 school year marked a shift in the Adopt-A-Salmon Program. The program continued to distribute salmon eggs to schools for incubation in their classroom but has discontinued providing an educational hatchery tour program. In January and February 2011, 41 schools received 11,710 eggs to be reared in their classrooms. Throughout the late winter and spring, students monitored and cared for the egg through the fry stage and then released them into selected sites in the Merrimack River watershed.

The Amoskeag Fishways Partnership

The Merrimack River Anadromous Fish Restoration Program continued to be represented in The Amoskeag Fishways Partnership [Partnership (www.amoskeagfishways.org)]. Partners that include PSNH, Audubon Society of New Hampshire, NHFG, and 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 offers educational outreach programming to school groups, teachers, 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, program participants, and meeting/outreach participants in 2011 were 23,438, including 14,040 students and 9,398 adults. Since its inception Fishways has documented greater than one-half-million visitors, and about 8,000 school programs have been delivered to date. The total number of outreach and partly at Visitor Center programs offered in 2011 was 441 with 11,732 students and 6,343 adults participating. Fishways continues to be an exciting place to attend educational programs, to see wildlife and fish up-close, and to carry out environmental education and conservation programs. All agencies continue to participate as active members of the Management and Program committees that provide oversight for the Partnership.

The Partnership was formed to create, manage, and oversee educational activities at the Fishways. The four-way collaboration among partners was formed in 1995 to increase visitation to the Fishways by creating new and improved educational programs, expanded year-round hours of operation, and an innovative, hands-on exhibit hall; by strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire; and by broadening the educational focus of the visitor center to encompass more than just the fish passage facility.

Central New England - Integrated ME/NH Hatchery Production

The FWS, Eastern New England Fishery Resources Complex has developed an agreement with MDMR to engage in planning and implementing an Atlantic salmon restoration and enhancement project in the Saco River watershed (see section 4.2.3). In 2009, NANFH produced and released one-year-old smolts and yearling parr. The agreement has now been revised, and NNFH and NANFH will produce and stock in aggregate, 10,000 one-year-old smolt annually in the Saco River in Spring; produce and provide at a minimum 5,000 parr for continued Saco River Salmon Club (Club) “grow-out” or release to the Saco River; and produce and provide to the Club, Atlantic salmon eyed eggs from Merrimack River domestic strain. A minimum of 250,000 eyed eggs provided in Year 2011 and 400,000 eyed eggs will be provided thereafter in Years 2012 -2015, the period of the agreement. An estimated 153,791 eyed eggs were shipped from NNFH to the Club hatchery in February/March 2011. NANFH produced 12,220 one-year-old smolts for release to the river in April, and produced 16,420 parr for shipment to the hatchery in December 2011.

Based on shifts in availability of smolts from GLNFH, results from genetic analysis and changes to freshwater habitat availability, there have been changes to salmon management in the Merrimack River watershed. Changes include reduction in smolt production to approximately 25,000 due to limitations of NNFH and NANFH and reduced fry production because of a lack of notable differential success of lower river tributaries. Fry production would decrease from a target of 1.4 million to 1.0 million, with a focus on stocking of fry only in areas above Ayers Island Dam and within the Souhegan River

watershed. In addition, a pilot program would be initiated to test the efficacy of allowing sea-run fish to run the river in lieu of spawning the fish at NNFH. These sea-run fish would be a small subset of all returning fish, identified via adipose fin clips, that were stocked as smolts in the Souhegan River. These fish would be the first salmon in the Merrimack River allowed the opportunity to naturally return and spawn. Potential and likely effects of these changes would be 1) lower sea-run returns, 2) increase need for F1 hatchery broodstock and 3) need to closely monitor increase potential for genetic bottle necks. In addition, benchmarks based on new management initiatives will be developed and included in a revised framework document expected to be developed with partners in 2012.

4.1.8 Migratory Fish Habitat Enhancement and Conservation

Habitat Restoration

Shawsheen River

Feasibility studies continue to determine the scope of work for ecosystem restoration on the Shawsheen River, Lawrence/North Andover, MA. The river enters the Merrimack River approximately 1.0 rkm downstream of Essex Dam and river herring and salmon have been observed in the lower reaches of the river. Anglers have been observing salmon at the confluence with the Merrimack River in mid-February and early March in recent years. While habitat in the upper reaches of the Shawsheen River is better suited to river herring, aquatic habitat in the lower reaches of the river may improve for salmon with proposed restoration measures. The Shawsheen River Restoration Project is led by the non-profit Center for Ecological Restoration in collaboration with the Town of Andover. Partners include Atria Senior Living, Inc. (owner of Marland Place Dam); NOAA Fisheries; US Fish and Wildlife Service; American Rivers; Mass. Environmental Trust; Shawsheen River Watershed Association; and others. The Massachusetts Division of Ecological Restoration (formerly Riverways Program) has awarded Priority

Project status to the project. The goals of the project are to restore fish passage and riverine ecological functions to the lower Shawsheen River. The Shawsheen River is a tributary of the Merrimack River that generally flows northeast along a 40.2 rkm course, entering the Merrimack River in Lawrence, MA. Three dams, Balmoral, Marland Place, and Ballardvale, block upstream passage of migratory and resident aquatic species. The first two dams are proposed for removal and the third dam will either be removed or fish passage facilities would be constructed.

Souhegan River

In 2011, 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. With the removal of Merrimack Village Dam on the Souhegan River, migratory and resident fish were provided access to 23.2 rkm of main stem river habitat and 8.0 rkm of tributary habitat. Two additional dams, McClane and Goldman Dams in Milford NH, on the Souhegan River are currently undergoing feasibility studies to be considered for removal. Efforts continue to stock fry, parr and smolt in the Souhegan to help facilitate restoration efforts.

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 2011 was 94 adult Atlantic salmon. However, the count could exceed 94 due to the possibility of adults ascending Cataract without passing through one of the counting facilities and not being captured at the Skelton trap. Ninety four 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 9 May to 31 October, 2011. Forty-five adult sea-run Atlantic salmon were captured at Skelton Dam in Dayton and Buxton and transported by FPLE to the Ossipee River and released. Sixty six (66) were of hatchery origin (36-2SW, 30-1SW) and 28 were naturally reared (17-2SW, 11-1SW).

4.2.2 Hatchery Operations

Egg Collection

In 2011, 300,000 eyed eggs from Merrimack River origin broodstock were transferred from the Nashua National Fish Hatchery to the Saco River Salmon Hatchery. A portion of these were distributed to school programs (Fish Friends) and the remaining reared at the hatchery for stocking as fry.

4.2.3 Stocking

Juvenile Atlantic Salmon Releases

In April 2011, a total of 12,000 smolts were transported from North Attleboro National Fish Hatchery (NANFH) and released to the river. In addition 14,000 of the 16,000 age 0 parr transferred from NANFH to the Saco River Salmon Club Hatchery in 2010 were held overwinter and stocked in the mainstem Saco in 2011. Approximately 237,000 fry, reared at the Saco River Salmon Club Hatchery, were released into one mainstem reach and 28 tributaries of the Saco River.

Adult Salmon Releases

No adult Atlantic salmon were stocked into the Saco River.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

No electrofishing surveys directed at assessing juvenile Atlantic salmon populations were conducted in the Saco River watershed in 2011.

Smolt Monitoring

Tagging

All smolts (12,000) transported from NANFH to the Saco River for release received an adipose fin clip.

4.2.5 Fish Passage

The license issued to Florida Power and Light Energy (FPLE) for the Bar Mill hydro project located on the Saco River on 26 August, 2008 by Federal Energy Regulatory Commission established a fund to enhance Atlantic salmon adult returns to the Saco River. This fund financed the 2011 smolt stockings.

4.2.6 Genetics

Forty five genetic samples were collected in 2011. The samples were taken from sea-run adult returns captured at the Skelton Dam passage facility. All tissue samples were preserved in 95% ethanol and have been archived.

4.2.7 General Program Information

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

4.2.8 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2011.

5 Gulf of Maine

5.1 Adult Returns

Documented adult Atlantic salmon returns to rivers in the geographic area of the Gulf of Maine DPS (73 FR 51415-51436) in 2011 were 3,556. Returns are the sum of counts at fishways and weirs (3,438) and estimates from redd surveys. No fish returned “to the rod”, because angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Narraguagus, Penobscot, Kennebec, and Union rivers, and at a semi-permanent weir on the Dennys River. Fall conditions were suitable for adult dispersal throughout the rivers, and conditions allowed redd counting.

Escapement to these same rivers in 2011 was 3,836. Because there was no rod catch, the escapement to the GOM DPS area was assumed to equal returns (estimated or released after capture) plus released pre-spawn captive broodstock (adults used as hatchery broodstock are not included). In 2011, 827 pre-spawn captive broodstock were stocked in the Dennys, Sheepscot, East Machias, Machias, and Union rivers.

Estimate replacement (adult to adult) of naturally reared returns to the DPS has not exceeded one since the mid 1990's (Figure 5.1.1). Most of these were 2SW salmon that emigrated as 2 year old smolt, thus, cohort replacement rates were calculated assuming a five year lag. These were used to calculate the geometric mean replacement rate for the previous ten years (e.g. for 2000: 1991 to 2000) for the naturally reared component of the DPS overall and in each of three Salmon Habitat Recovery Units (SHRU).

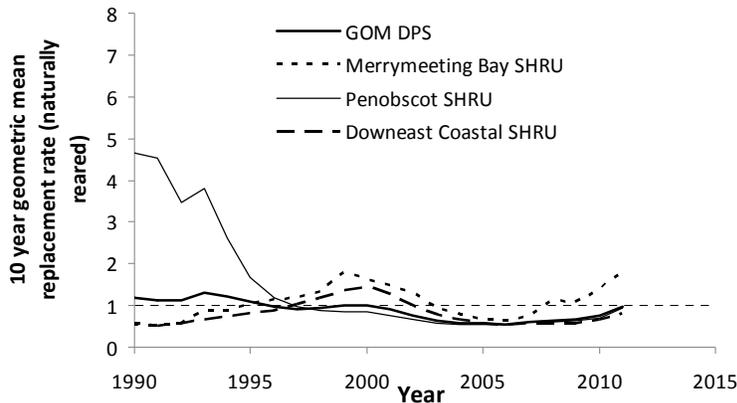


Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and in the three Salmon Habitat Recovery Units (SHRU).

Small Coastal Rivers

Downeast Coastal SHRU

Dennys River. The Dennys weir trap was operated from 1 June to 17 October, 2011. Staff captured a total of nine sea-run salmon: two (2) river-origin grilse, four (4) female and one (1) male river-origin two sea-winter fish, one (1) female river-origin three sea-winter fish, and one (1) male hatchery smolt-origin two sea-winter adult stocked as a smolt in the Narraguagus River in 2009. In addition, staff captured six (6) male captive reared adults that were released in October 2011 as part of the Dennys River pre-spawn adult release experiment. These stocked fish and the three aquaculture escapes are not included in the season total. The first captured aquaculture adult was inadvertently released to the river on 5 September. Two subsequent captures on 6 September and 12 September were lethally sampled.

On 3 and 4 October, 2011, 299 captive reared gravid adult salmon (96 female and 203 male) were stocked into the “Community Pool” on the Dennys River. These fish were from both the captive reared and domestic Dennys lines. One hundred and three (103) redds were counted during the 2011 redd surveys on the Dennys River that included approximately 89% of known spawning habitat area. Although there is no way to identify redds produced by wild returns, it is likely 10 were produced by the documented returns.

East Machias River. Twenty six (26) redds attributed to wild returns were counted during the 2011 redd surveys in the East Machias River that included approximately 98 % of known spawning habitat area. An additional 54 redds were located in Northern Stream where 41 pre-spawn captive reared adults from CBNFH were stocked.

Machias River. We counted a total of 188 redds, covering approximately 87% of the spawning habitat area in the Machias drainage. Pre-spawn adult captive broodstock (109) were stocked in the West Branch of the Machias watershed, and 91 redds were documented in the sub-watershed. The count could include redds produced by wild returns.

Pleasant River. Twenty three (23) redds were found in the Pleasant River in 2011 during surveys of about 85% of spawning habitat area.

Narraguagus River. Maine Department of Marine Resources staff operated the Cherryfield fishway trap from 2 May, 2011 to 26 October, 2011. Staff documented 196 sea-run salmon in the Narraguagus River ascending the Stillwater Dam in Cherryfield, Maine. Staff captured 179 adults in the fishway trap; the highest daily catch (17) and median capture date was on 29 June. Seventeen adult salmon were observed ascending the spillway on video. The 2011 run was 79% (154/196) hatchery origin returns. However, river-origin returns (42) were higher than any year since 1996. The 75 grilse captured were 38% of the returns. Sea-age and origin were determined based on scale reading and marks. Sea-age and origin of those individuals counted on video tape were prorated based on sampled returns. Total return was more than 2.5 times greater than 2010. In 2011, 265 redds were counted during surveys by canoe and foot covering approximately 91% of spawning habitat area.

Ducktrap River. No redds were observed during surveys in late November that encompassed 73% of the spawning habitat area in the Ducktrap River watershed.

Cove Brook. No spawning activity was found in Cove Brook during redd surveys conducted in November 2011 that included 100% of identified Atlantic salmon spawning habitat in the system. No Atlantic salmon spawning activity has been detected for 13 years (1999 to 2011), despite repeated and extensive searches annually.

Union River. No Atlantic salmon were captured at the fishway trap operated by Black Bear Hydro Partners, LLC on the Union River in Ellsworth below Graham Lake. This year the fishway was operated daily from 1 May to 30 June after which it was checked three or more days per week until 1 November.

Merrymeeting Bay SHRU

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

Redd Based Returns to Small Coastal Rivers

Scientists estimate the total number of returning salmon to small coastal rivers using capture data on rivers with trapping facilities (Dennys, Pleasant, Narraguagus and Union rivers) combined with redd count data from five additional rivers. Estimated returns are extrapolated from redd count data using a return-redd regression [$\ln(\text{returns}) = 0.559 \ln(\text{redd count}) + 1.289$] based on redd and adult counts from 1991-2009 on the Narraguagus River, Dennys River and Pleasant River (USASAC 2010). Total estimated return based on redd counts for the small coastal rivers was 323 (90% CI = 248 - 551) (Table 5.1.1). Estimates include returns to the Union River.

Table 5.1.2 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2010. Estimates include the Union River.

Year	LCI	Mean	UCI
1991	243	302	374
1992	204	251	311
1993	222	261	315
1994	154	192	239
1995	131	162	200
1996	298	353	417
1997	139	172	215
1998	167	213	272
1999	147	184	231
2000	81	109	129
2001	90	103	120
2002	33	42	53
2003	63	77	97
2004	62	84	115
2005	44	71	111
2006	49	79	122
2007	39	59	72
2008	106	138	178
2009	114	160	217
2010	118	164	329
2011	248	323	551

Large Rivers

Penobscot River. The Veazie Dam fishway trap was operated daily from 2 May through 31 October, 2011. We captured 3,125 sea-run Atlantic salmon during 2011, releasing 855 salmon back to the Penobscot River upstream of the Veazie Trap. Four of those fish were observed and escaped through the trap entrance cone prior to handling. An additional 1,537 salmon were trucked upstream to boat launches in Costigan and Old Town for release. A total of 736 salmon were transported to CBNFH, however 166 salmon (109 females, 57 males) of these were subsequently released on 5 October prior to spawning habitat in the Piscataquis River. Thus, total escapement to the Penobscot River above the Veazie Dam in 2011 was 2,558 Atlantic salmon. Based on trap counts at Weldon Dam 194 of these entered the East Branch.

Androscoggin River. The Brunswick fishway trap was operated from 5 May to 19 October, 2011. The fishway was closed 25 July through 12 September for maintenance and high water temperatures. The total trap catch for 2011 was 44 adult sea-run Atlantic salmon (15 naturally reared 14 2SW and 1 1SW; 29 hatchery origin 27 2SW and 2 1SW). Two salmon radio tagged and released into the Androscoggin River were captured in the Kennebec later in the season (see General Program Information).

Kennebec River. The Lockwood fish lift was operated by NextEra Energy staff from 1 May to 28 October, 2011. The trap was shut down from 22 August to 2 September for scheduled maintenance. The total trap catch for 2011 was 64 adult sea-run Atlantic salmon; 21 were of hatchery origin two-sea winter (2SW), and 43 were naturally reared (41-2SW, 2-1SW). All 64 adult Atlantic salmon were trucked and released to 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. The Benton Falls fish lift was operated from 3 May to 7 July, 2011. No adult Atlantic salmon were captured or observed at the facility during that period.

Survival Estimates

Atlantic salmon survival rates were calculated for marked hatchery stocks and naturally reared stocks for the Narraguagus, Penobscot, and Sheepscot rivers (Table 5.1.1). Calculations were based on known numbers of stocked salmon, smolt estimates, and adult returns. Smolt-to-adult (SAR) survival rates varied by origin. Hatchery parr stocked on the Narraguagus River had the highest average SAR survival, followed by naturally reared salmon and hatchery smolts, respectively. Parr-to-adult survival (PAR) was similar between the Narraguagus hatchery parr and the accelerated growth parr stocked in the Penobscot River.



Table 5.1.3. Summary table of Atlantic salmon survival rates. All rates for hatchery origin stocks were based on marked groups. Data represent cohorts where all 2 sea-winter adult returns have been accounted for. Therefore, in some cases some 3 sea-winter adults may still be at large.

Cohort Year	Salmon Habitat Recovery Unit	Drainage	Source	Survival From	Survival To	Number Stocked or Estimated	Number of survivors	Survival
2008	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	54116	21	0.0388%
2009	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	52829	88	0.1666%
2010	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	61928	35	0.0565%
2006	Downeast Coastal	Narraguagus	Hatchery Parr	Parr	Adult	17476	5	0.0286%
2007	Downeast Coastal	Narraguagus	Hatchery Parr	Parr	Adult	15687	9	0.0574%
2008	Downeast Coastal	Narraguagus	Hatchery Parr	Smolt	Adult	414	5	1.2077%
2009	Downeast Coastal	Narraguagus	Hatchery Parr	Smolt	Adult	231	9	3.8961%
2006	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	2300	19	0.8261%
2007	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1210	9	0.7438%
2008	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	962	7	0.7277%
2009	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1180	24	2.0339%
2006	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	169066	409	0.2419%
2007	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	147619	529	0.3584%

2008	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	147789	241	0.1631%
2009	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	178034	673	0.3780%
2002	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	50249	27	0.0537%
2003	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	72835	26	0.0357%
2004	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	69719	34	0.0488%
2005	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	96320	41	0.0426%
2006	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	100541	54	0.0537%
2007	Penobscot Bay	Penobscot	Hatchery Accelerated Parr	Parr	Adult	105577	23	0.0218%

5.2 Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock reared at Craig Brook National Fish Hatchery (CBNFH) and Green Lake National Fish Hatchery (GLNFH) produced 5.34 million eggs for the Maine program in 2011: 2.63 million eggs from Penobscot sea-run broodstock; 1.25 million eggs from two domestic broodstock populations; 1.46 million eggs from five captive broodstock populations. No eggs were taken from Dennys strain broodstock as all gravid adults were released into the Dennys River to spawn naturally.

Spawning protocols for domestic and captive broodstock at CBNFH and GLNFH give priority to first time spawners and utilize 1:1 paired matings. Spawning protocols for Penobscot sea run broodstock also utilize 1:1 paired matings. A total of 313 Penobscot origin females, 4 domestic females, and 374 captive females were spawned at CBNFH. At GLNFH, 351 age four domestic females were spawned to provide eggs for in-stream egg planting in the Sandy River, a tributary to the Kennebec River.

Egg Transfers

CBNFH transferred 1.1M sea-run, captive and domestic eyed eggs to GLNFH for parr and age 1 smolt production (Penobscot, Narraguagus and Pleasant strains), 180K to two facilities operated by the Downeast Salmon Federation for private rearing (Pleasant and East Machias strains), and 83K eyed Sheepscot strain eggs to DMR implantation in artificial redds in the Sheepscot River.

GLNFH transferred 776K eyed, Penobscot domestic origin eggs to Department of Marine Resources (DMR) for implantation in artificial redds in the Sandy River, a tributary to the Kennebec River.

In addition, all three egg sources (sea-run, captive, and domestic) from the two federal hatcheries were used to support the USFWS' Salmon-in- Schools and Atlantic Salmon Federation Fish Friends programs in 2011.

Wild Broodstock Collection and Domestic Broodstock Production

In 2011, 1,212 wild parr (161, Dennys; 152, East Machias; 266, Machias; 210, Pleasant; 262, Narraguagus; 161, Sheepscot) were collected by DMR and transported to CBNFH for captive rearing. The Dennys domestic broodstock program, developed to address an accidental release of aquaculture adults in 2006, has been discontinued. In addition, no new domestic lines of pedigreed broodstock for the Pleasant will be developed. In lieu of domestic lines, additional captive parr were captured to ensure sufficient genetic diversity.

GLNFH retained approximately 1,200 fish from the 2010 year class of sea run Penobscot-strain Atlantic salmon. These fish will be used for F2 domestic egg production at GLNFH for 2-3 years.

The total adult sea-run broodstock collection from the Penobscot River (Veazie dam) was 739 fish in 2011. All adults captured were marked with PIT tags and sampled for genetic characterization at Veazie dam.

Disease Monitoring and Control

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

All Penobscot sea run broodstock retained at CBNFH were tested for Infectious Salmonid Anemia (ISA) as they were brought to the station in 2011. Incoming adults were isolated in a newly constructed screening facility to undergo sampling procedures and await the results of PCR testing. No adults were identified as 'suspect' in 2011 as compared to 10 suspects in 2010.

5.3 Stocking

Stocking activities in Maine resulted in the release of over 4.56 million Atlantic salmon in 2011. Progeny produced from sea-run, captive, and domestic broodstock were released as eggs, fry, parr, and smolts. In addition, spent and surplus pre-spawn adult broodstock were returned rivers within the geographic range of the Gulf of Maine Distinct Population Segment.

Juvenile Stocking

Age-1 smolts reared at GLNFH were stocked into the Penobscot Basin (554K), Narraguagus (64K), and Pleasant (61K). A by-product of Pleasant domestic broodstock production at CBNFH resulted in 95 age-2 smolts being released to the Pleasant River. This year (2011) was the third and final year of a three year direct estuary release study in the Penobscot Basin. Approximately 33,000 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.

Temperature advanced age 0 parr reared at GLNFH released into the Penobscot Basin totaled 298 thousand; all GLNFH origin parr were marked with adipose fin clips in 2011. Approximately 15.5 thousand age 0 parr reared at CBNFH in close to natural thermal conditions were released into the Sheepscot River. All CBNFH origin parr were marked with adipose fin clips.

CBNFH produced approximately 2.69 million fry, primarily unfed, for release by the DMR throughout the Distinct Population Segment (DPS). To have fry in the rivers at the appropriate developmental stage, as measured by the developmental index (DI), releases from CBNFH were coordinated with DIs as practical. Downeast fry were released at DIs ranging from 88.7% to 100%; fry released in the Penobscot Basin had DIs ranging from 106% to 119%.

GLNFH produced 17.3 thousand unfed domestic fry for an outreach effort in cooperation with the Union River Salmon Association; all fry were released into the Union River. Two private hatcheries operated by the Downeast Salmon Federation on the Pleasant and East Machias rivers released a total 174,000 fry.

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 2011, gravid excess broodstock were released to the Dennys River (299), East Machias River [Northern Stream] (41), Machias River [West Branch Machias River] (109) and Togus Stream (90 Sheepscot strain). Of the 41 adults released to Northern Stream, 20 females were tagged with 134.2 kHz PIT tags to facilitate tracking. Additional releases of gravid excess broodstock, of mixed origins, occurred in the Union River: East Machias (22), Machias (39), Narraguagus (108), and Pleasant (119).

This year (2011) was the final year of a three year adult translocation study that used Penobscot sea-run adults. The aim of the study is to increase the likelihood of successful natural reproduction by transporting adults captured and brought to CBNFH into high quality spawning habitat in the upper Piscataquis River. A total of 167 adults were released in early October; 42 of the females were tagged with radio tags for tracking movements during the spawning season.

Following spawning, 556 Penobscot sea-run broodstock were released from CBNFH into the Penobscot River in 2011. 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 captive broodstock from CBNFH were released into their natal rivers: East Machias (123); Machias (222), Narraguagus (285); Pleasant (58); Sheepscot (142). The number of spent broodstock released increased in 2011 as part of a strategy to reduce the number of gravid broodstock produced in older year classes which often confounds other stocking strategies. GLNFH released 1,166 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River.

Dennys River Adult Stocking Plan

The plan calls for a minimum of 218 gravid adult salmon (sex ratio of 1:1) stocked into the Dennys River watershed beginning in the fall of 2011 and for four subsequent years (to 2015) to assess the strategy over variable environmental conditions. This stocking strategy eliminates fry stocking and the need to spawn adults at Craig Brook National Fish Hatchery each year. Monitoring will include: spawner surveys each fall following stocking and juvenile abundance and distribution surveys for offspring (0+ and older parr). If possible emergence and smolt assessments will be conducted. During the five year period large parr will be collected and taken to Craig Brook National Fish Hatchery to maintain the brood line. All parr collected for broodstock will be genotyped. Tissue samples from juveniles collected during assessment will be available for parentage analyses to assess genetic diversity of the river population, which could differ from that of the broodstock. Juvenile relative abundance and genetic diversity will be used as measures of success and for management decisions. If large parr abundances and or genetic diversity of the population decline below those produced by the fry program, fry stocking will be resumed.

5.4 Juvenile Population Status

A Generalized Random - Tessellated Stratified (GRTS) design (Stevens and Olsen 2004) was implemented for the 2011 sampling season. A total of 259 sites were developed for the Downeast SHRU, the Penobscot Bay SHRU, and the Merymeeting Bay SHRU. Selection criteria included stream width and drainage. The sampling frame was selected using either the NHD Flow line feature from USGS or the Habitat Model developed by Wright et al. (2011) (Figure 5.4.1). These selected sites have provided a clearer picture of relative distribution and abundance within the GOM-DPS. Analyses based on this sampling design are in progress.

BSRFH conducted electrofishing surveys to monitor spatial and temporal abundance of Atlantic salmon juveniles at 346 sites in 2011. Two hundred and thirty five (235) of the sites were randomly selected (GRTS). The other sites were selected to document juvenile production from adult stocking and egg planting. Two sampling methods were

used; the first estimated total abundance at sites on each river (Table 5.4.1) with data presented as fish/unit, where one unit equals 100 m². The second method was based on standardized wand sweeping protocols for 300 seconds of wand time (catch per unit effort (CPUE) and produced relative abundance in fish/minute (Table 5.4.2). At 24 (10.2 %) of the randomly selected sites, CPUE sampling was done inside a total abundance site. These randomly chosen “double method” sites are done to maintain a record of catchability for gear and methods and to calibrate CPUE data among years. Data aggregated by Salmon Habitat Recovery Unit (Table 5.4.3) document the relative low juvenile Atlantic salmon populations throughout the geographic range of the Gulf of Maine DPS in the last six years.

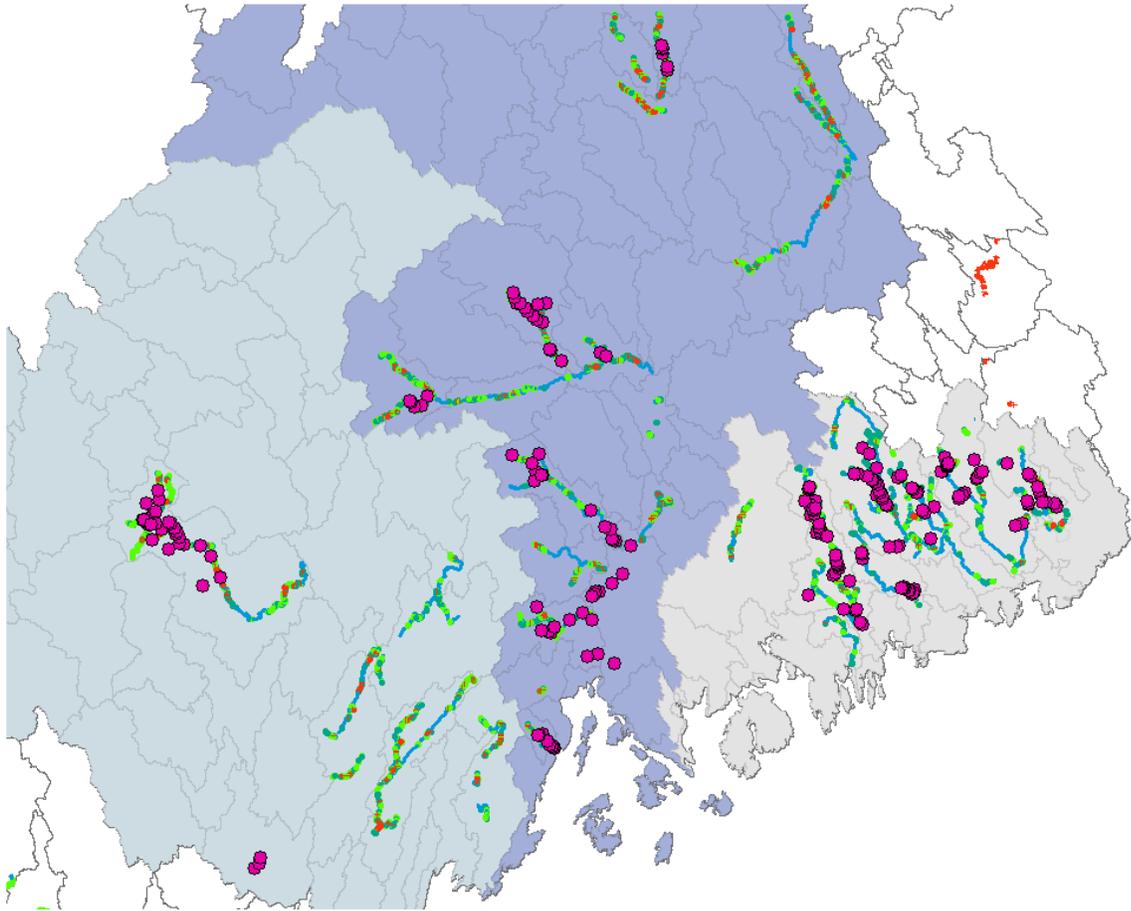


Figure 5.4.1. Locations of sites selected for juvenile salmon assessments in 2011 based on the GRTS design.

An index of juvenile abundance calculated using annual densities ($\log + 0.01$ transformed) at sites with more than ten years of data confirms the relative low densities (Figure 5.4.2). A mixed random effects general linear model was used to analyze the data, with years specified as fixed effects; sites within 10 digit HUCs and 10 digit HUCs within years considered random effects. A "no intercept" model was specified. The index is the estimated annual least square means (and 95 % CI) back transformed from logarithms to density. A similar index will be produced for relative abundances, when more years of data are available.

Table 5.4.1. Minimum (min), median, and maximum (max) juvenile Atlantic salmon population densities (fish/100m2) based on multiple pass electrofishing estimates in selected Maine Rivers,

Drainage	Year	Density fish / unit							
		Parr				YOY			
		N	Min	Median	Max	N	Min	Median	Max
Dennys	2011	3	2.45	2.83	12.65	3	2.67	5.95	10.91
East Machias	2011	4	2.14	5.37	19.35	4	0.48	11.82	44.76
Machias	2011	4	0.00	0.74	7.61	4	0.00	1.26	2.67
Narraguagus	2011	4	0.68	1.56	9.72	4	2.47	9.84	21.89
Pleasant	2011	4	2.31	12.26	94.58	4	0	8.25	65.74
Ducktrap	2011	1	14.90	14.90	14.9	1	4.06	4.06	4.06
Penobscot	2011	4	0.00	4.94	12.23	4	0.00	15.39	49.80
Kennebec	2011	6	1.37	6.92	31.06	6	0.00	0.00	7.12
Sheepscoot	2011	11	0.00	10.25	44.45	11	0.00	9.47	43.26

2011. Drainages are grouped by Salmon Habitat Recovery Unit (double line).

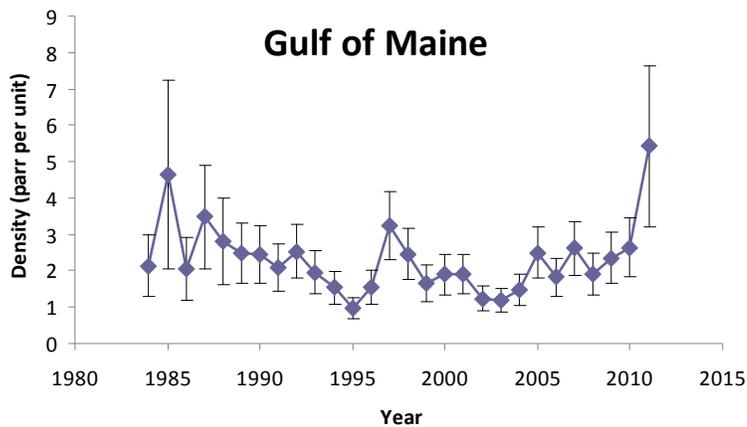


Figure 5.4.2. Index of parr abundance in the Gulf of Maine DPS, based on juvenile salmon assessments conducted from 1984 to 2011.

Table 5.4.2. Minimum (min), median, and maximum (max) relative abundance of juvenile Atlantic salmon population (fish/minute) based on timed single pass catch per unit effort (CPUE) sampling in selected Maine Rivers, 2011. Drainages are grouped by Salmon Habitat Recovery Unit (double line).

Drainage	Year	CPUE fish / minute									
		Parr					YOY				
		N	Min	Median	Max	N	Min	Median	Max		
Hobart	2011	13	0.00	0.20	2.00	13	0.00	0.40	1.80		
Dennys	2011	15	0.00	1.00	1.80	15	0.00	1.60	4.58		
East Machias	2011	40	0.00	0.90	4.00	40	0.00	0.20	5.31		
Machias	2011	35	0.00	0.57	3.97	35	0.00	0.40	5.00		
Narraguagus	2011	43	0.00	0.79	5.11	43	0.00	1.18	6.32		
Pleasant	2011	16	0.00	0.89	8.74	16	0.00	0.99	4.40		
Cove Brook	2011	4	0.00	0.00	0.00	4	0.00	0.00	0.00		
Ducktrap	2011	10	0.00	1.09	1.73	10	0.00	0.20	2.12		
Penobscot	2011	73	0.00	0.00	3.82	73	0.00	0.00	5.72		
Androscoggin	2011	3	0.00	0.20	0.20	3	0.00	0.20	0.20		
Kennebec	2011	42	0.00	0.30	4.37	42	0.00	0.30	9.80		
Sheepscoot	2011	11	0.00	0.20	2.40	11	0.00	0.40	4.00		

Table 5.4.3. Minimum (min), median, and maximum (max) density (fish/100m2) and relative abundance (fish/minute) of Atlantic salmon juveniles. Data from sampled rivers were aggregated by Salmon Habitat Recovery Unit (SHRU), 2006 to 2011.

SHRU	Year	Density fish / unit								CPUE fish / minute							
		Parr				YOY				Parr				YOY			
		N	Min	Median	Max	N	Min	Median	Max	N	Min	Median	Max	N	Min	Median	Max
Downeast Coastal	2006	76	0.00	2.85	35.21	73	0.00	2.84	51.53	139	0.00	1.01	3.46	155	0.00	1.40	4.33
	2007	55	0.00	2.88	22.32	53	0.42	7.33	58.85	133	0.00	0.56	5.05	141	0.00	1.58	15.31
	2008	43	0.00	3.55	20.15	43	0.00	7.02	73.83	18	0.00	0.00	1.00	18	0.00	0.35	8.75
	2009	56	0.00	3.75	32.53	56	0.00	7.66	36.54	49	0.00	0.79	20.39	54	0.00	1.59	15.37
	2010	29	0.54	5.17	28.00	29	0.00	8.03	89.09	91	0.00	1.00	8.84	96	0.00	1.40	15.54
2011	19	0.00	2.83	94.58	19	0.00	3.41	65.74	173	0.00	0.80	8.74	173	0.00	0.60	6.32	
Penobscot Bay	2006	74	0.00	0.19	26.88	48	0.00	0.00	67.16	24	0.00	0.00	1.60	34	0.00	0.00	2.20
	2007	49	0.00	0.00	33.73	25	0.00	0.00	66.78	41	0.00	0.00	2.51	53	0.00	0.00	1.80
	2008	11	0.00	6.69	17.75	11	0.00	19.94	47.08	82	0.00	0.00	1.49	88	0.00	0.00	6.75
	2009	10	0.00	7.89	20.39	10	4.07	29.80	39.74	161	0.00	0.00	2.93	163	0.00	0.00	4.48
	2010	7	0.00	17.03	22.07	8	0.00	0.74	29.54	86	0.00	0.00	3.91	95	0.00	0.75	15.95
2011	5	0.00	6.99	14.90	5	0.00	4.06	49.80	87	0.00	0.00	3.82	87	0.00	0.00	5.72	
Merrymeeting Bay	2006	42	0.00	1.34	23.38	41	0.00	0.28	25.28	12	0.00	0.00	0.63	11	0.00	0.00	3.95
	2007	33	0.00	0.28	50.27	33	0.00	4.03	69.76	37	0.00	0.00	2.60	33	0.00	0.20	5.03
	2008	26	0.00	1.65	21.65	27	0.00	2.17	38.85	38	0.00	0.00	0.77	39	0.00	0.00	1.40
	2009	17	0.00	6.01	21.74	17	0.00	3.12	28.07	46	0.00	0.00	3.27	48	0.00	0.20	9.35
	2010	22	0.00	2.14	16.57	21	0.00	3.03	109.94	110	0.00	0.00	2.94	112	0.00	0.80	29.40
2011	17	0.00	8.65	44.45	17	0.00	1.89	43.26	45	0.00	0.20	4.37	45	0.00	0.20	9.80	

Smolt Abundance

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

Narraguagus River

We handled 4,044 smolts, 131(3.2%) of which were recaptures. A subset of smolts was scale sampled (n= 133) and tissue sampled for genetics (n=223). The observed age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) was: 1.2% age 1+, 91.6 % age 2+, and 7.2 % age 3+ (Table 5.4.5). Age 2+ smolts averaged 165 ± 15 mm fork length (n=76) and 44.6 ± 13.8 g live weight (n = 72) (Tables 5.4.6 and 5.4.7 and Figures 5.4.1 and 5.4.2). During the first week of May, ~ 63,000 age 1+ salmon smolts were stocked, and therefore most (93%) of the smolts collected were of hatchery origin.

The total estimate of smolts (naturally reared, fall parr and hatchery stocked smolts) exiting the Narraguagus system was $27,737 \pm 2,508$. Similar to 2010, the overall estimate was much lower than the known number of 1+ hatchery smolts that were stocked into the system (>50,000). The population estimate for naturally-reared smolts was $1,404 \pm 381$ smolts (Figure 5.4.3). The population estimate on the Narraguagus River for naturally-reared smolts in 2011 of $1,404 \pm 381$ was considerably less than that of the previous year ($2,170 \pm 228$) and slightly higher than the estimates from 2007-2009.

Sheepscot River

We captured 462 smolts at the Sheepscot River site, 206 of which were found to be marked with an adipose clip, indicating they were stocked as 0+ parr in 2009 or 2010. A subsample of scales (n=387) and tissue samples (n=242) were collected from smolts. We analyzed scale samples to determine age and origin distributions ages and to generate mean fork length and weight (Tables 5.4.6 and 5.4.7, Figures 5.4.1 and 5.4.2). This year, the Sheepscot River's naturally reared smolt component was composed of 1.2% age 1+, 94.7% age 2+, 3.5% age 3+, and 0.6% age 4+ (Table 5.4.5). Age 2+ naturally-reared smolts averaged 183 ± 19 mm fork length (n = 161) and 63.0 ± 19.2 g live weight (n = 155) (Tables 5.4.6 and 5.4.7, Figures 5.4.1 and 5.4.2). The population estimate of naturally-reared smolts was $1,702 \pm 370$ (1.1 smolts/habitat unit) and about 40% of the 2010 estimate ($3,936 \pm 370$). The estimate of hatchery origin smolts (stocked as fall parr in 2009 and 2010) in 2011 was $1,720 \pm 399$.

Piscataquis River

We collected 573 smolts in the Piscataquis River RSTs, 393 of which were marked and released 3.2 km upstream. Of these marked smolts, 64 were recaptured (16.4%).

The age composition of naturally-reared smolts was: 83.1% age 2+, 16.9% age 3, and no age 4, based on scale reading (n=444). Age 2+ naturally-reared smolts averaged 140.2 mm (± 0.46 SE) fork length (n = 368) and 26.1g (± 0.27 SE, n =367) (Tables 5.4.6 and 5.4.7, Figures 5.4.1 and 5.4.2).. Age 3+ naturally-reared smolts were larger and averaged 156.3 mm (± 1.31 SE) fork length (n = 75) and 36.5g (± 0.95 SE, n =75). The population estimate of migrating smolts was $5,209 \pm 1,312$.

Hobart Stream

We captured 20 naturally reared smolts in the alternative smolt trap. Age 2+ naturally-reared smolts averaged 158 ± 2 mm fork length (n = 20) and 39.5 ± 1.6 g wet weight (n = 20) (Tables 5.4.4 and 5.4.5, Figures 5.4.2 and 5.4.3). Low capture and recapture numbers precluded calculating a population estimate.

Smolt Run Timing

In 2011, the median capture date of smolts on the Narraguagus, Sheepscot, and Piscataquis Rivers was later than in 2009 and 2010, while they were all similar to the median capture dates observed in 2007 and 2008 (Figures 5.4.4. and 5.4.5.)

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

River	2011				5 year average (2006-2010)			
	1+	2+	3+	4+	1+	2+	3+	4+
Hobart	0%	100%	0%	0%	N/A	N/A	N/A	N/A
Narraguagus	1.2%	91.6%	7.2%	0%	0.5%	86.4%	12.9%	0.1%
Piscataquis	0%	83.1%	16.9%	0%	0.4%	63.0%	36.3%	0.4%
Sheepscot	1.2%	94.7%	3.5%	0.6%	3.6%	92.4%	4.0%	0%

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

River	Age 1+ hatchery-origin				Age 2+ naturally-reared			
	n	2011	n	5 year	n	2011	n	5 year
				average (‘06-‘10)				average (‘06-‘10)
Hobart	0	N/A	0	N/A	20	158±9	N/A	N/A
Narraguagus	350	176±14	750	166±17	76	165±15	651	170±15
Piscataquis	0	N/A	0	N/A	368	140±15	1397	143±11
Sheepscot	92	158±10	296	153±13	161	183±19	618	187±18

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

River	Age 1+ hatchery-origin				Age 2+ naturally-reared			
	n	2011	n	5 year	n	2011	n	5 year
				average (‘06-‘10)				average (‘06-‘10)
Hobart	0	N/A	N/A	N/A	20	39.5 ± 7.4	N/A	N/A
Narraguagus	347	53.1±13.3	749	46.3±16.0	72	44.6± 13.8	651	49.2± 14.7
Piscataquis	0	N/A	0	N/A	367	26.1±5.2	1373	27.9±6.9
Sheepscot	65	43.2±8.9	296	38.3±9.9	155	63.0±19.2	618	67.7±20.5

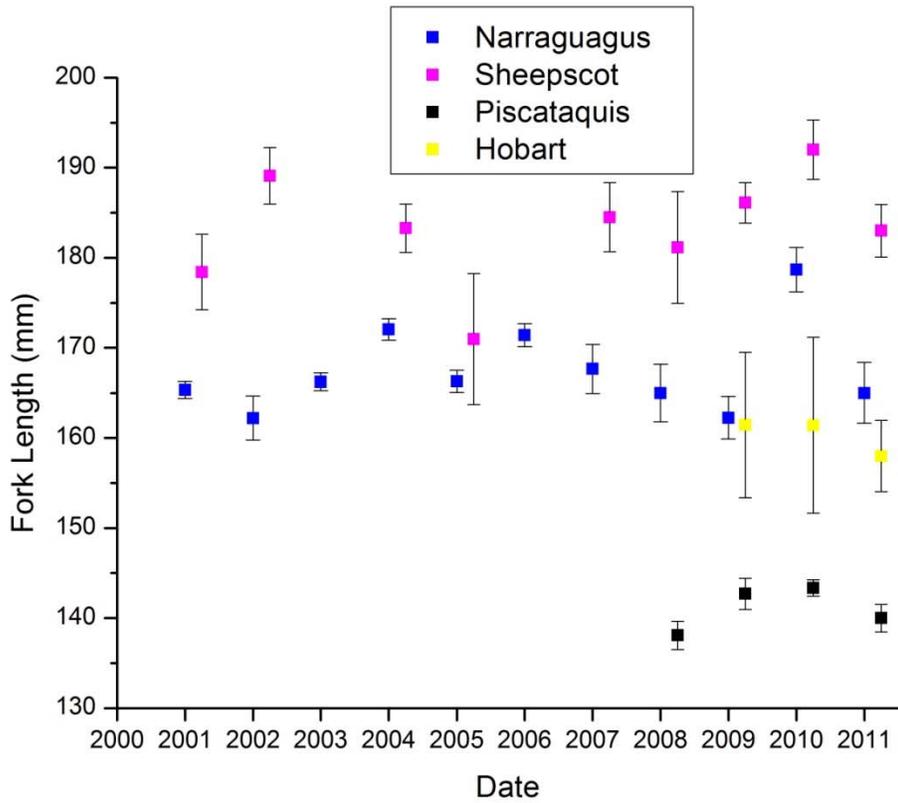


Figure 5.4.2 Mean fork length (mm) \pm 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2000-2010.

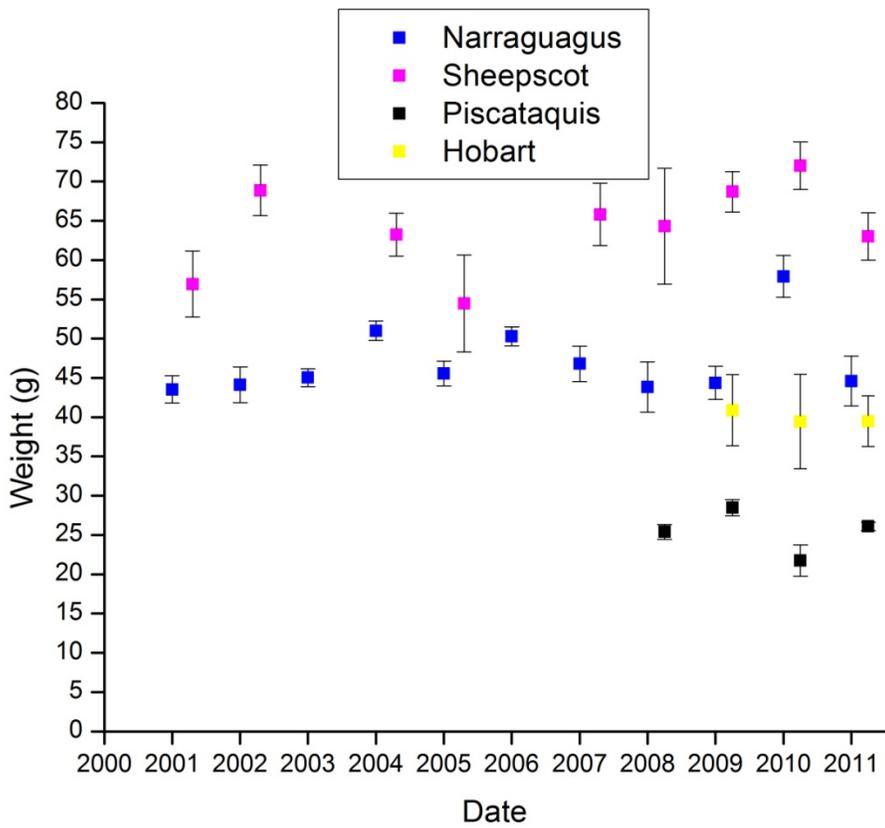


Figure 5.4.3 Mean wet weight (g) ± 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2000-2010.

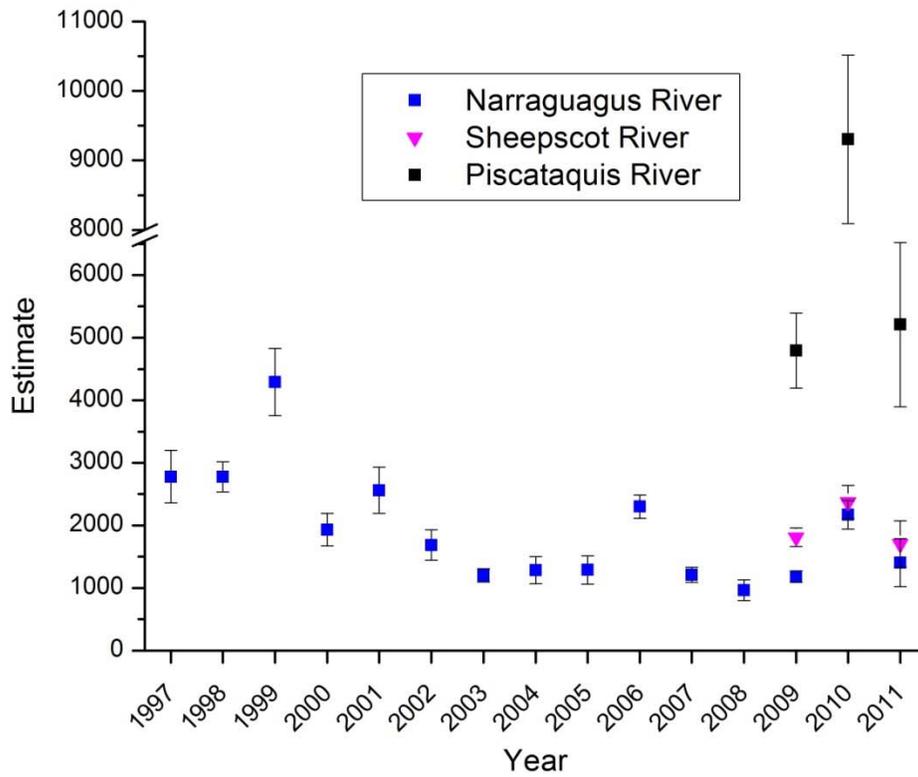


Figure 5.4.4 Population Estimates (\pm Std. Error) of emigrating smolts in the Narraguagus, Sheepscot and Piscataquis rivers, Maine from 1997 to 2010 using DARR 2.0.2.

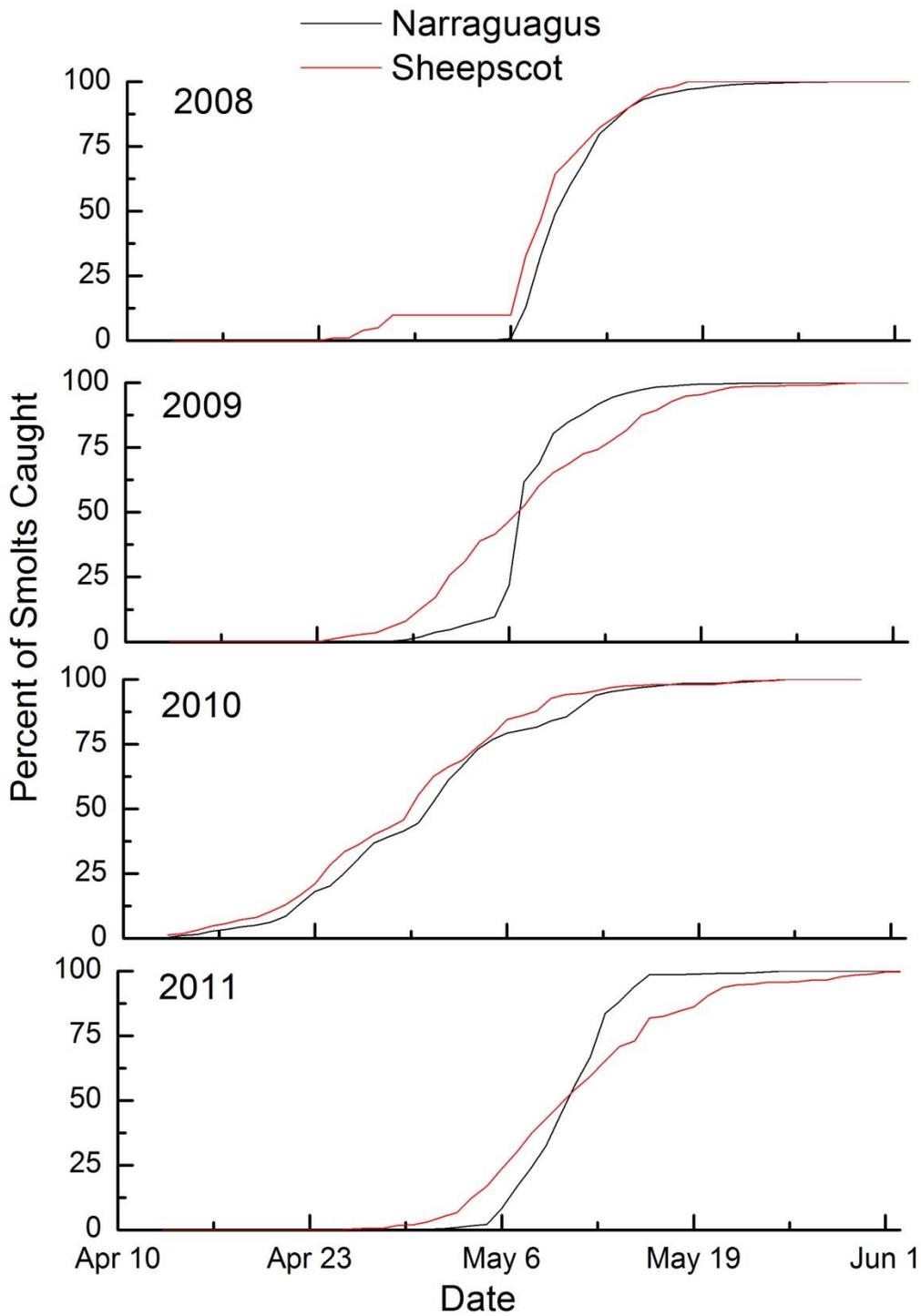


Figure 5.4.5 Cumulative percentage smolt catch for smolts of all origins in Rotary Screw Traps by date (run timing) on the Narraguagus and Sheepscot Rivers, Maine, for years 2007 to 2010.

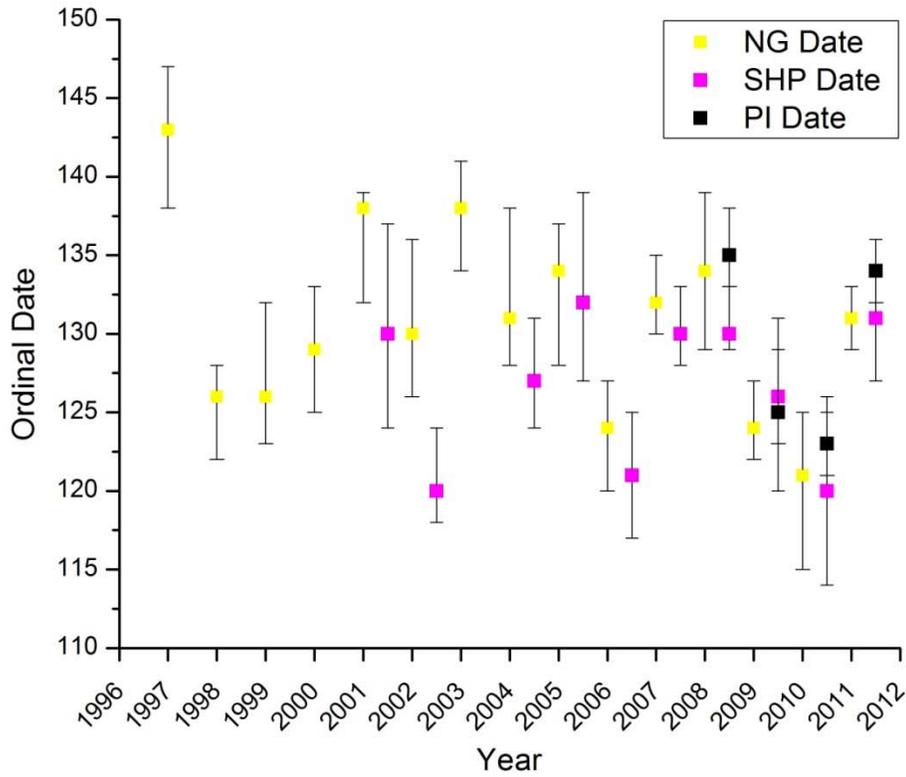


Figure 5.4.6 Ordinal day (days from January) of median smolt catch of naturally-reared smolts in rotary screw traps on the Narraguagus and Sheepscot Rivers, 1997-2010. Error bars represent 25th and 75th percentiles of median run dates.

5.5 Fish Passage

Downstream Smolt Passage Studies at Lockwood and Hydro-Kennebec Projects, Kennebec River, Maine

Smolt passage studies were conducted at the Lockwood and Hydro-Kennebec Projects on the Kennebec River during the spring of 2011. At Lockwood, five groups of radio-tagged smolts were released either directly into the Lockwood forebay canal or upstream of the Project and their passage routes and bypass use under varying degrees of spill were recorded. Additional data on smolt passage routes and bypass use were collected from five groups of radio-tagged smolts released for the Hydro-Kennebec Project one mile upstream from Lockwood. Of the 210 smolts passing Lockwood (117 released at Lockwood 93 at Hydro-Kennebec), 55 were released directly into the Lockwood forebay canal and the remaining 155 had the option to pass the Project via spill, downstream bypass or turbine routes. Of the 155 smolts approaching Lockwood from upstream, 76.8% (119 of 155) passed the Project via spill and 20.6% (32 of 155) entered the forebay canal. Passage routes for the remaining 2.6% (4 of 155) were unknown. Downstream bypass use was based on 64 smolts present within the forebay canal. Of these, 81.3% (52 of 64) of those smolts passed through the turbines and the remaining 18.7% (12 of 64) used the downstream bypass. Downstream bypass attraction and effectiveness increased from 23.8% attracted and 14.3% passed when 4% of station capacity was released through the downstream bypass to 62.8% attracted and 20.9% of smolts passed when it was at 6% of station capacity.

The downstream bypass at the Brookfield Power Hydro-Kennebec facility on the Kennebec River was evaluated during spring 2011 using 98 radio tagged smolt released upstream of the Project the evenings of 19, 22, and 25 May, and 2 and 3 June. Overall, a total of 95 of the 98 Atlantic salmon smolts released upstream of Hydro-Kennebec passed the Project. Of the individuals that moved downstream, 67.4% passed on spill, 16.8% passed via the turbine units, and 14.7% used the downstream bypass. Among five releases the percentage of smolts that used the bypass ranged from 0.0% to 42.3%. At the same time as this study downstream bypass efficiency was also investigated at the Lockwood Project located one mile downstream. Radio-transmitter frequencies were the same for the two studies, thus, smolts released at Hydro-Kennebec were also detected passing the Lockwood Project. Of the 95 smolts that passed Hydro-Kennebec, only two individuals did not pass Lockwood, remaining in the reach between the two projects.

Fishway Repaired at Cherryfield Ice Control Dam, Narraguagus River Watershed

Due to extensive rot on the wood that frames in the fishway at the Cherryfield dam, work was done during the fall of 2011 to rebuild the interior of the fishway. This work included: removal of the baffles, sides, and floor of the fishway; rebuilding the gate at the exit of the fishway; and replacing the baffles, walls and floors with new hemlock. The expected lifespan on this maintenance is 20 to 30 years.

PIT Antennae Installed at Fishways on Penobscot River

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

Data collected in 2011 allowed near real time assessment of upstream passage and the assessment of different management actions. For example, preliminary analyses of the effect of transporting fish above Milford dam from the trap at Veazie Dam demonstrated that transported fish have a higher probability of successfully migrating to the upstream dams than fish that were released above Veazie Dam. In addition, transported fish reached the upper dams in a shorter amount of time than run of the river fish. A second application was in assessing the effect of a pike jump at West Enfield Dam. This pike jump was installed in the middle of the fishway to deter northern pike from migrating upstream. Using data collected from the antennas, it was apparent that there was a discrepancy in the number of fish that reached Weldon Dam and the number of fish that successfully ascended the fishway in June. Upon reducing the height of the pike jump there was a sharp increase in the percentage of fish ascending to the top of the fishway.

5.6 Genetics

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

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

To reduce handling stress, tag loss, and tagging-related mortality, juvenile broodstock are currently tagged one year post-capture at CBNFH. This allows the fish to reach an appropriate size to allow for intramuscular insertion of PIT tags. In October 2010, DPS broodstock (collected in 2008) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.7 General Program Information

Atlantic Salmon Smolt Telemetry Studies

In 2011, NOAA Fisheries Service tagged and released naturally reared (n = 49) and age 1 hatchery smolts (n = 154) into the Penobscot River estuary on eight dates in May. Movements were passively monitored with moored ultrasonic receivers through the estuarine and near-shore marine environment. Naturally-reared smolts were smaller than hatchery stocked smolts (168 vs. 194 mm FL; Kruskal-Wallis: $P < 0.05$). The preliminary estimates of smolt survival to the outer Penobscot marine array were 0.29 (95% CL 0.15-0.44) for naturally reared and 0.63 (95% CL 0.40-0.77) for hatchery smolts. In previous years, both groups partitioned habitat use in the bay similarly. However in 2011, mid-bay behavior varied with origin; less than half (47%) of naturally-reared smolts traveled to the east of Islesboro (Dice Head), while 68% of hatchery smolts traveled east of Islesboro. At the outer array, the majority of smolts exited through the western (Owls Head) passage (naturally reared 78 % and hatchery 87%) following the pattern of smolt movement in previous years. The time from release to passing the outer array was similar for naturally-reared (5.16 days) and hatchery smolts (4.33 days).

Adults Tracking, Androscoggin River

Twenty-one of the adult Atlantic salmon that returned to the Androscoggin were tagged with radio transmitters. One tag was recovered (illegally angled) and reapplied to another returning Atlantic salmon later in the season. Two tagged Atlantic salmon, which were of naturally reared origin (2SW) dropped out of the Androscoggin and migrated up the Kennebec River to the Lockwood fish lift facility. These ATS were captured at the Lockwood facility, transported to the Sandy River where they remained throughout the spawning season, and were counted as returns to the Kennebec River.

Marine Ecology of Gulf Of Maine Atlantic Salmon

Because low marine survival has been identified as a barrier to Atlantic salmon recovery throughout the Northwest Atlantic, NOAA Fisheries and Maine Sea Grant hosted a series of workshops between 2008 and 2010 focused on the migratory and saltwater phases of Gulf of Maine Atlantic salmon populations. The goal of the workshops was to explore changes in marine survival of Gulf of Maine Atlantic salmon, and to generate an interdisciplinary synthesis of the universe in which salmon exist and factors affecting their marine survival. There was a strong effort to get scientists from other disciplines to contribute their expertise to understanding the estuary and marine ecosystems that Maine Atlantic salmon encounter. The workshops focused on the marine ecology of emigrating postsmolts from coastal Maine to Greenland, and on the return migration of adults.

The workshops and final report built upon foundation of Cairns (2001). He reported four leading hypotheses of declining abundance of Atlantic salmon in estuarine-marine environments:

- 1) Post-fishery marine mortality is higher than presumed by fishery models.
- 2) Smolt survival is reduced due to fish predation in estuaries.
- 3) Bird and mammal predation reduces survival at sea.
- 4) Salmon have changed migration routes due to altered oceanographic conditions.

The 2008-2010 NOAA Fisheries Workshops were designed to reframe these existing North American Atlantic salmon mortality hypotheses and gain new perspectives. The deliberations focused on the migration of US and Gulf of Maine Atlantic salmon and did not address the freshwater life stages, except where effects may have affected marine phases. We placed emphasis on identifying parameters that could be managed at local or regional scales, and those with particular relevance to Gulf of Maine Atlantic salmon. Rather than a single, high-profile species approach, our interdisciplinary group felt that integration of climate, environmental, fisheries, and community ecology studies will foster an approach aimed at understanding and managing for the functional aspects and flexibility of the salmonid ecosystem. Six hypotheses emerged from the workshops as priority areas for research and eventually management:

1. Climate change and variability have altered oceanic salmon habitat (temperature, productivity, physical oceanography), affecting marine survival of Gulf of Maine Atlantic salmon.
2. Altered oceanographic conditions [meteorologically-driven shifts in current velocity and direction] have led to changes in migration routes/behavior resulting in reduced marine survival of Gulf of Maine Atlantic salmon.
3. Changes in Northeast Shelf marine communities have altered Atlantic salmon food webs, resulting in reduced marine survival of Gulf of Maine Atlantic salmon (see Cairns et al. 2001, V.7.b).
4. Populations of other diadromous species in the Gulf of Maine have declined, resulting in reduced marine survival of Gulf of Maine Atlantic salmon.
5. Climate change has disrupted the correspondence between freshwater and saltwater conditions, leading to greater mortality rates of smolts and affecting marine survival of Gulf of Maine Atlantic salmon.
6. A loss of genetic diversity has reduced life history diversity, including adult run timing and variability in marine migration routes, affecting marine survival of Gulf of Maine Atlantic salmon.

The full citation to this document and link to project website are:

Schmitt, Catherine, and Paul Anderson, editors. 2012. Marine Ecology of Gulf of Maine Atlantic Salmon: Summary Document from a 2008-2010 Series of Workshops. Submitted to the Northeast Fisheries Science Center, MSG-TR-12-01. Orono, ME: Maine Sea Grant College Program.

<http://www.seagrant.umaine.edu/extension/nmfs-salmon-ecology>

U. S. Fish & Wildlife Service Schools Programs

2011 marked the seventeenth year of FWS' outreach and education program, which focuses on endangered Atlantic salmon populations and habitats in Maine rivers. Student participants are provided the opportunity to raise river-specific Atlantic salmon eggs and fry in classrooms and release the fry into their natal river in early May. Classroom instruction involves the life cycle of Atlantic salmon and other diadromous fish, habitat requirements and human impacts which can affect their survival. The Salmon-in-Schools program contributes fry to the Dennys, Machias, East Machias, Pleasant, Narraguagus, Sheepscot, Union and Penobscot rivers. In addition to educational facilities, a business is annually invited to participate in the program to broaden exposure to the general public.

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

Egg Take at CBNFH

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

The photoperiod treatment is designed to re-set the biological clock in the sea-run broodstock, delaying maturation and the onset of spawning, using artificial light. Filtered ambient light is still available; extra light was administered via overhead lighting using a predetermined schedule and time clocks. The 2010 treatment extended the light available during the summer solstice [June 21] for two weeks following the solstice, which resulted in a delay in spawning by ten days over the ten year average. In an attempt to balance rearing requirements for unfed fry at CBNFH and the advanced smolt program at GLNFH the 2011 photoperiod treatment was reduced to a ten day extension of solstice-level light. However, the spawning pattern observed in 2010 was repeated indicating the reduction had little effect. A further reduction in the treatment is planned for 2012.

Survey of Dams

In 2010 and 2011 the National Marine Fisheries Service conducted a comprehensive survey of all non-FERC licensed dams within the freshwater range of the Gulf of Maine Distinct Population Segment (GOM DPS). The purpose of the survey was to gather site-specific information on the dam, identify future ambitions and goals for the dam, and whether or not dam owners would consider opportunities for dam removal or fish passage improvements.

Physical surveys were completed on three hundred seventy seven dams. Forty-five dams had fish passage while 332 dams did not have fish passage. One hundred forty of 284 dam owners agreed to complete the dam owner survey. Forty-four percent of respondents expressed interest in options for fish passage; 27 percent expressed interest in selling their dam; and nine percent expressed interest in dam removal.

Recovery Plan being Drafted

Based on the 2006 Status Review (Fay et al. 2006) and an independent peer review, the USFWS and NOAA listed an expanded Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon as endangered on June 19, 2009 (74 FR 29344). The geographic range of the expanded GOM DPS includes all the watersheds from the Androscoggin River, northward along the Maine coast to the Dennys River. Concurrent with the new listing, Critical Habitat was designated within three salmon habitat recovery units (SHRU) for the GOM DPS of Atlantic salmon (74 FR 29300). Since that time the federal fisheries agencies have been drafting a Recovery Plan for the GOM DPS that addresses the significant threats identified in the listing (74 FR 29344): passage and habitat losses dams and culverts, inadequate existing regulatory mechanisms for dams and culverts, and continued low marine survival rates for U.S. stocks of Atlantic salmon.

A draft version of the Atlantic salmon Recovery Plan has been approved by USFWS and NOAA. The recovery plan provides a set of achievable objectives for down- and de-listing based on abundance, population growth rate, likelihood of extinction, and the distribution of accessible habitat and populations among the three SHRU. The plan takes a stepwise approach to building critically low numbers of adult Atlantic salmon and increasing habitat connectivity. It focuses on increasing access within freshwater migration corridors and into suitable spawning and rearing habitat, and on understanding the factors driving marine mortality. The premise of the approach is that actions to improve freshwater productivity will improve the likelihood of survival in the marine environment until we can evaluate our ability to influence marine survival. A publically available draft of the Atlantic salmon Recovery Plan is expected to be available for comment during the summer of 2012.

Pleasant River Trap at Saco Falls

As part of an effort to improve adult returns and population size in the Pleasant River 50,000 smolts were stocked during the spring of 2011. These smolts were placed at a location known as Crebo Flats with the goal of stocking the reaches upstream of Saco Fall at a rate that might return CSE. To evaluate this effort, collaboration between the USFWS and DMR resulted in fabricating a trap to be inserted into the fishway located at Saco Falls. This trap will intercept sea-run adults resulting from smolt stocking and

natural reproduction. This adult counting facility will ensure there are adult assessments on two rivers where salmon are actively managed in the Downeast Coastal Salmon Habitat Recovery Unit (SHRU). Annual concurrent adult census and redd counts will be used to revise the regression predicting returns for rivers where only redds are counted. The trap was installed briefly during October of 2011 to ensure it would fit and work out any kinks prior to being deployed during 2012.

The trap was designed and built by Alex Haro at the Conte Laboratory in Turners Falls, MA. The trap is constructed of aluminum recycled from other trapping projects. It is designed to be disassembled into components that one or two people can carry and assembled in place.

5.8 Migratory Fish Habitat Enhancement and Conservation

Habitat Connectivity

In 2011, 18 aquatic connectivity projects were completed in four Downeast Maine rivers (Union=1, Narraguagus=2, Machias=11, East Machias=4) with the primary goal of restoring aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment). These projects were possible because of collaborations among Project SHARE, Maine Dept. Inland Fisheries and Wildlife, Maine Dept. of Marine Resources, Maine Dept. of Conservation, Maine Forest Service, NOAA Fisheries, U.S. Fish and Wildlife Service, The Nature Conservancy, American Forestry Management, Malcolm French (private land owner), Downeast Lakes Land Trust, and Wagner Forest Management. Eleven stream-road crossings were retrofitted with bankfull spanning open arch structures, one project used an elliptical structure salvaged from a previous culvert replacement, three sites were road decommissions, three crossings were replaced with wooden bridges, and one remnant log drive dam was removed. The estimated fish bearing stream habitat above these (18) connectivity projects was Km (Table 5.8.1). Annual monitoring determines if the projects withstand natural flood and beaver activity. Of the 138 restoration sites completed in Downeast Maine salmon rivers since 2005, none have failed during high flow events or because of beaver activity. In 2011, one project required minor maintenance to cover a footer exposed during the 60-100 year flood event in December 2010 and beaver debris was removed from several open arch structures.

Pleasant River Focus Area Initiative

USDA, and Maine DMR and DIF&W began a cooperative aquatic stream restoration/enhancement initiative in 2011, focused in getting stream restoration projects on the ground in the Penobscot River watershed. The primary goal is to: restore geomorphic characteristics and function of Maine's lotic systems; enhancing in-stream habitat complexity and connectivity to benefit diadromous fishes, including Atlantic salmon, and brook trout and resident fish species at a landscape scale. Because there are large numbers of problem culverts in the Penobscot watershed NRCS and partners are using the Pleasant River sub-watershed as the "focus area" for their restoration efforts. The focus area was chosen based on the amount and quality of brook trout and Atlantic salmon habitat, along with availability of eligible NRCS clients, including the Penobscot Nation, and several land owners.

By creating working relationships with private land owners, three road stream decommission projects were completed on private forest land in 2011. These projects allowed native brook trout to access an additional three miles (4.8 km) of habitat. The projects scheduled for 2012 on private land include: three road decommission projects reconnecting 10 miles (16.1 km) of brook trout habitat and the removal of a remnant log drive dam for alewife passage. A series of workshops on stream survey and design of fish friendly stream crossings are scheduled for 2012 in the Pleasant River Drainage.

Habitat Complexity

A large wood (LW) habitat improvement project was initiated by BSRFH staff in 2006 to improve habitat complexity and suitability by placing trees into the river at a rate of one tree per ten meters of river length. A combination of "cut and drop" trees and trees with root balls were added to 14 treatment sites between 2006 and 2010. Nine (9) more sites were treated with large wood in 2011 to complete 23 of the planned 24 treatment sites for the Large Woody Debris project. Assessments at the nine sites included: pre-treatment shelter availability and longitudinal profile at both treatment and control sites and post-treatment wood loading was assessed, Atlantic salmon fry stocked, and autumn salmon populations were assessed using electrofishing. Observations at previously treated sites indicate the treatments have created habitat complexity; with small shallow pools, riffles, and over head cover associated with the added wood pieces. Trees with attached root balls have not moved, and geomorphologic changes seem to be occurring more quickly than with the dropped trees. Fish community data, collected annually at selected sites and five years after treatment at others, will be analyzed in the near future.

Trees were added to river reaches at 12 sites not part of the initial project and are being used as tests of operational scale additions. Four of the sites were on Old Stream, within the Machias River drainage, seven were on the West Branch of the Machias River, and one site was on the mainstem of the Narraguagus River below U.S. Rt. 9 in Beddington. These sites were not as long as the study sites (50 to 100 m compared to 125 to 200m), but maintained a similar wood loading rate of about one tree per 10 meters of stream and will provide data on tree movement and channel responses in wider river reaches where discharge exceeds that of the original 24 study sites.

Penobscot River Restoration Project

Progress towards the first dam removal continued in 2011 and final design plans were completed for Great Works Dam removal. Great Works Dam removal is scheduled to begin in June 2012 and to be completed in 2012. Veazie Dam removal is scheduled to begin in 2013, and Howland Dam bypass construction is planned to follow.

Fundraising was successful in 2011 with total remaining funding needed to complete the project reduced from \$18 to \$10 million. Ongoing funding and support has continued from National Oceanic and Atmospheric Administration Fisheries and from the U.S. Fish and Wildlife Service, in addition to private donors and Trust partners. For more and more current information see <http://www.penobscotriver.org/>

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

River	Stream	Habitat Access		Project / New Structure		
		Stream (Km)	Watershed (ha)	Length (m)	Width (m)	Description
East Machias	Barrows Stream	1.1	194.2	13.4	3.0	Open Arch
East Machias	Dead Stream	0.4	111.4	13.4	2.7	Open Arch
East Machias	Joe Brook	1.5	414.4	14.2	3.0	Elliptical Culvert
East Machias	Northern Stream	37.0	5,413.1			Decommission
Machias	Crooked River	6.4	1,043.8			Decommission
Machias	Dead Stream	1.5	316.0	13.4	3.0	Open Arch
Machias	Dead Stream	9.3	1,618.7	18.3	6.1	Open Arch
Machias	Hayes Brook	1.0	124.3			Decommission
Machias	Kerwin Brook	0.8	199.4	13.4	2.4	Open Arch
Machias	Knox Lake Outlet	2.3	388.5	15.2	3.0	Open Arch
Machias	5th Lake Stream	0.6	292.7	15.8	1.8	Open Arch
Machias	Thompson Brook	1.4	152.8	13.4	2.4	Open Arch
Machias	Unnamed Stream	0.2	23.3		4.6	Bridge
Machias	Unnamed Stream	0.8	90.6		4.6	Bridge
Machias	West Branch	69.5	10,826.1			Remnant Dam
Narraguagus	Ash Bog Stream	5.6	828.8	15.8	4.4	Open Arch
Narraguagus	Ash Bog Stream	1.2	147.6	13.7	2.7	Open Arch
Union River Bay	Dean Brook	1.3	155.4		3.7	Bridge

Literature Cited

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6 Outer Bay of Fundy

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

6.1 Adult Returns

Aroostook River

Tinker Dam fish lift was from 30 June to 10 November, 2011 (see fish passage section for closure dates); with a 2011 trap catch of 51 salmon, only 30 of which were sea-run fish. Thus, sea-run returns were similar to 2010 (33). The remaining 21 (all adipose fin clipped and 16 carried floy tags) were captured in the Beechwood Dam gatewell as out-migrating smolts in 2009, reared for two years until sexually mature at the Mactaquac Biodiversity Facility (MBF). Scale samples are not collected from salmon at the Tinker trap to determine age to minimize handling stress. Instead fish captured at Tinker are assigned to sea-age class (grilse or salmon) based on observed fork lengths or tags if present. Of the 30 sea-run fish captured in 2011 there were 14 grilse (≤ 63 cm), 16 multi-sea-winter salmon (> 63 cm). The relationship between fish length and sea-age for St. John River salmon was developed from known age (scales) and length data collected by DFO scientists at the Mactaquac Dam.

St. Croix River

The fishway trap at Milltown on the St. Croix was operated 9 May to 11 July, 2011. No salmon were documented during that time period. After July, the trap was opened for free passage.

6.2 Hatchery Operations

Aroostook River

Atlantic Salmon for Northern Maine, Inc. (ASNM) owns and operates the Dug Brook Hatchery in Sheridan, Maine to produce Atlantic salmon fry for the Aroostook River. The hatchery relies on eyed salmon eggs from “St. John River strain” salmon spawned at the Mactaquac Biodiversity Facility. The eggs are tested in compliance with U.S. Title 50 fish health criteria and then imported to Dug Brook Hatchery for hatching. Transfers in 2011 totaled 417,859 eyed eggs, all from captive reared broodstock held at the Mactaquac Biodiversity Facility in Frenchville, NB.

St. Croix River

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

6.3 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 508,602 non-feeding fry soon after hatching into the Aroostook River in accordance with BSRFH recommendations.

St. Croix River

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

Adult Salmon Releases

Aroostook River

Although there were no adult releases into the Aroostook River, Department of Fisheries and Oceans has an adult release program for the St. John River that results in spawners entering the Aroostook River. In 2011, the 21 captive-reared adult that passed the Tinker fishway were probably collected as a smolt in the gatewells at Beechwood Dam and reared to maturity at the Mactaquac facility. There were 111 (57 female 54 males) with that capture history released to 'free-swim' to their tributary of origin (i.e. Aroostook R., Salmon R., Tobique R.) on the following dates: 14 July, 22 July, 6 October, and 19 October. The fish were adipose clip and had either a red or blue Floy tag.

St. Croix River

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

6.4 Juvenile Population Status

Electrofishing Surveys

High river flows during the fall precluded follow-up population assessments to evaluate the performance of fry stocked in the Aroostook River.

Smolt Monitoring

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

Tagging

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

6.5 Fish Passage

Aroostook River

Unlike 2010, the Beechwood Dam fish lift (located downstream of the Tobique Narrows and Aroostook River) was operated for a full migration season. The Tinker fish lift was shut down for 22 days from 24 September to 06 October and 29 October to 06 November for annual turbine maintenance. DMR staff continue to work with DFO staff and Algonquin Power Company (operators of the Tinker Dam) to find alternatives to prolonged annual closures of the Tinker fish lift during salmon migration.

St. Croix River

The International Joint Commission continues to explore options to re-open all of the St. Croix's boundary dam fishways to alewife passage under the terms of the 1909 Boundary Waters Treaty. Many of these options include implementing the 2010 Adaptive Management Plan for restoring alewives to the St. Croix drafted by an ad hoc group assembled by the inter-agency St. Croix Fisheries Steering Committee.

6.6 Genetics

No genetics samples were collected in 2010.

6.7 General Program Information

6.8 Migratory Fish Habitat Enhancement and Conservation

Connectivity

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

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

Sub-watershed (HUC 12)	Project (width m)	Long. DD	Lat. DD	Habitat Opened (km)
Clifford Stream	Open Arch (4.7)	603,931	4,991,479	4.8

7 Terms of Reference and Emerging Issues in New England Salmon

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

The focus topics identified at this meeting were limited and most time was spent on improved stock assessment work sessions and a theme session on fish health. This information is highlighted in the following three sections: 7.1) Fish Health Updates; 7.2) Regional Assessment Product Progress Update; and 7.3) draft terms of reference for next year's meeting are included.

7.1 US Fish Health Updates

The USASAC held a mini fish health and hatchery management session highlighting four papers. Listed below are short summaries of the presentations and discussions that are not already documented in the main report.

Aquaculture Activities & Sea Lice Update:

Aquaculture production levels for 2011 were below the 10 year average due to sea lice loads and issues with treatments. The therapeutic treatments currently being utilized are Slice and Hydrogen Peroxide bath treatments. Slice's lack of efficacy caused the industry to provide alternative Hydrogen Peroxide bath treatments to control sea lice loads. Currently, both Slice and Hydrogen Peroxide use is permitted through an FDA INAD (Investigational New Animal Drugs). While an INAD provides a mechanism to evaluate the efficacy and safety of new experimental drugs, the approval process is time consuming and costly. This limits the quick introduction of new drugs to the market, research and funding opportunities for new drugs, and timely operational adjustments

needed to address current and emerging diseases. In response to these limitations, the aquaculture industry established coordinated bay management which applies integrated approaches to disease management, improves treatment efficacy and breaks the pathogen cycle, reduces disease transfer between sites, and seeks to balance farming and environmental quality within each bay.

White River National Fish Hatchery Update following Hurricane Irene:

The White River National Fish Hatchery rears and maintains several year classes of Atlantic salmon totaling 15,000 fish. Egg production provides more than 6 million fry for stocking available habitat within the Connecticut River basin. Annually, approximately 4,000 excess Atlantic salmon broodstock are stocked for recreational fishing purposes within the Connecticut River Basin. In August of 2011, White River National Fish Hatchery incurred \$5.4 million in Hurricane Irene related damages. High flood waters entered outside wells potentially contaminating the facilities water supply with pathogens. In addition, outside pools were directly flooded with river water and large amounts of sediment causing direct mortality, escapement, fish movement amongst pools, and the introduction of river fish into them. As a result, the decision was made to depopulate the facility. Currently, \$600k of deferred maintenance dollars has been awarded to begin restoring the facility to 60% operational capacity. The USFWS's DRAFT FY 2013 construction plan includes \$2.1M for WRNFH repairs.

Disease Risk Matrix for Fish Culture Facilities:

A pathologist from Lamar Fish Health Center reviewed disease risk management involved in the restoration and recovery of Atlantic salmon in the Northeastern USA. Limited distribution endemic and listed pathogens of regulatory concern include viruses (ISAv, IPNV, VHSV, IHNV, OMSV), bacteria (*A. salmonicida*, *Y. ruckeri*, *R. salmoninarum*), and parasites (*M. cerebralis*, *C. Shasta*). Of additional concern are pathogens with an epizootiological link and emerging pathogens many which have caused sporadic problems in European aquaculture including viruses (Paramyxovirus, Alphavirus), bacteria (*Vibrio* species), and parasites (*Gyrodactylus salaris*, *Paranucleospora theridiana*, PKD). Due to the migratory behavior of Atlantic salmon, the occurrence and distribution of disease across the globe is of concern in risk management. Below is a projected disease risk matrix for Atlantic salmon in the Northeastern USA based on current USFWS risk classifications and fish health management protocols, FWS policy, and state regulations at federal fish culture facilities.

Likelihood	Consequence			
	Serious	Moderate	Minor	Negligible
Frequent	1	1	2	3
Likely	ISAv 1	1	2	3
Possible	VHSv OMVv 1	R.Sal IHNv A.Sal 2 IPNV Y.ruckeri	3	3
Unlikely	2	M. cerebraalis C.Shasta 2	3	3

7.2 USASAC Regional Assessment Product Progress Update

The USASAC moved forward on improving and enhancing assessment products. As noted last year, the USASAC felt that this large undertaking should be accomplished over the course of several intercession meetings. Intercession meetings were limited in 2011 but email information exchange and work at the meeting advanced progress on recovery metrics for Gulf of Maine DPS that can be used throughout New England. In addition, the structure of the 2012 meeting was such that it was a working meeting and some enhancements to regional assessment were done at the meeting. USASAC suggested that this annual meeting format continue and that the Chair should follow-up with leads of terms-of-reference during summer to encourage intercession meetings to accelerate this effort. Some considerations that the USASAC believed were essential moving forward were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New

England and NASCO managers for US data, 3) working towards providing data for the Gulf of Maine for each individual Salmon Habitat Recovery Unit with associated metrics of progress, and 4) 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).

7.3 USASAC Draft Terms of Reference 2012

The purpose of this section is to outline potential terms of reference identified at the USASAC annual meeting in March and to start an outline for refinement at our summer teleconference tentatively scheduled for mid-June 2012.

- 1) Anticipated ICES Requests (TOR document pending)
 - a. Marine Survival – return rates (rr), returns etc.
 - i. Redd-based coastal rivers estimate (Kocik-Lipsky)
 - ii. Smolt rr for NG, PN, CT, and MR (Kocik, Smithwood, Sprankle)
 1. age-structured adult return numbers (add 1SW and 3SW)
 - iii. Fry rr for LIS, CNE, GoM, BoF (Sweka, Trial, Smithwood) - continuing work on fry equivalents (FE) see below
- 2) Fry Equivalents - Return Rates for Atlantic salmon stocked as Fry – (**Sweka**, Trial, Smithwood, Bailey, Kocik) continue progress made at 2012 meeting and meet over summer to review draft approach
 - a. Need to develop a redd-based and escapement-based adjustment to account for wild contribution (based on redds and adult stocking) to supplement fry stocking – discount rate
 - b. Standardizing Return Rates - returns per 10K fry, standardize for various stocking stages and for areas with natural production (set discount/subsidy rates). Refine goal from USASAC perspective – a regional one compared to needs of USFWS Maine program.

- 3) Conservation Spawning Escapement Update – 2013 working paper (**Trial**, Kocik, Sweka, Trinko: Wright, regionally Atkinson (BoF, GoM, CNE); Bailey/Smithwood (CNE), Sprankle (LIS) Meeting by July 2012
 - a. revisit and update CSE estimated with revised habitat estimates and recovery regions
 - b. develop working paper to document current state of knowledge and document methods
 - c. Examine New England productivity and use Legault (2005) as background to determine equilibrium baselines

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

- 5) Redd-Based Estimate Benchmark 2012 Revision Working Paper in 2013 – (**Lipsky**, Kocik, Atkinson,
 - a. Goal written document outlining 2012 benchmark and interim improvements
 - b. Move Union River and other rivers to this metric to create Coastal River Estimate, separate by SHRU
 - c. Discuss in paper strategy to work on spatial scale for <100% survey given spawner distribution
 - d. Document fishway issues in the Narraguagus and role of high flows, next steps for moving forward. Next benchmark 2013 – move forward on spatial coverage adjustments and saturation index, scholarly paper looking at old data

- 6) New England Smolt Summary Benchmark Year 2013 Working Paper – (**Hawkes**, Lipsky, Sheehan (ICES), Sprankle, Smithwood)
 - a. Summarize population estimates, run timing, smolt age and other biocharacteristics
 - b. Build upon summary update presented at 2012 meeting
 - c. Add smolt tables into USASAC dbase and paper – Narraguagus, CT Farmington and Mainstem smolt estimate to USASC database

- 7) Emerging Issues Identified Intercession or at Annual Meeting

8 Appendices

8.1 List of Attendees

<u>First Name</u>	<u>Last Name</u>	<u>Primary Email</u>	<u>Agency</u>	<u>Location</u>
Ernie	Atkinson	Ernie.Atkinson@maine.gov	ME DMR	Jonesboro, ME
Patrisha	Barbash	Patrisha_Barbash@fws.gov	FWS	Lamar, PA
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Christina	Cappli	Christina_Cappli@fws.gov	FWS	Lamar, PA
Oliver	Cox	Oliver.N.Cox@maine.gov	ME DMR	Bangor, ME
Anitra	Firmenich	Anitra_Firmenich@fws.gov	FWS	Orland, ME
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT DEEP	Old Lyme, CT
Jim	Hawkes	James.Hawkes@noaa.gov	NOAA	Orono, ME
John	Kocik	John.Kocik@noaa.gov	NOAA	Orono, 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 DMR	Bangor, ME

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

Number	Authors	E-mail Address	Title
PS12-01	Veronica Masson	veronica.masson@dem.ri.gov	Pawcatuck River Update (WP)
PS12-02	Ken Sprankle	Ken_Sprankle@fws.gov	Connecticut River Update (WP/PPT)
PS12-03	Doug Smithwood	Doug_Smithwood@fws.gov	Merrimack River Update (WP/PPT)
PS12-04	Joan Trial	Joan.Trial@maine.gov	Maine Rivers Update (PPT)
WP12-01	Tim Sheehan	Tim.sheehan@noaa.gov	ICES Working Group on North Atlantic Salmon Summary 2011 (PPT)
WP12-02	Rory Saunders	Rory.Saunders@noaa.gov	NASCO: 2011 Highlights and 2012 Key Issues (PPT)
WP12-03	Dave Bean, John Lewis, Marcy Nelson	David.Bean@noaa.gov	Aquaculture Activities: 2011 (WP/PPT)
WP12-04	Wade Jodun	wade_jodun@fws.gov	Status of White River NFH (PPT)
WP12-05	Denise Buckley	Denise_Buckely@fws.gov	Fish Health Protocols and Maine Federal Hatcheries Update: 2011 (PPT)
WP12-06	Partrisha Barbash	Partrisha.Barbash@fws.gov	Disease Risk Matrix for Fish Culture Facilities (PPT)
WP12-07	John Sweeka	John_Sweeka@fws.gov	Alternative PVA Methods (PPT)
WP12-08	Ernie Atkinson	Ernie.Atkinson@maine.gov	Adult Trap Protocols for Endangered Salmon (WP)
WP12-09	James Hawkes	James.Hawkes@noaa.gov	New England Smolt Summary 2011 (PPT)
WP12-10	Ernie Atkinson	Ernie.Atkinson@maine.gov	Spatial sampling frame for juvenile salmon assessment using a GRTS design (PPT)
WP12-11	Christine Lipsky, James Hawkes, Ruth Haas-Castro, Randy Spencer, Colby Bruchs, and Ernie Atkinson	Christine.Lipsky@noaa.gov	Maine Smolts Update 2011 (WP)
WP12-12	James Hawkes, Graham Goulette, John Kocik	James.Hawkes@noaa.gov	Maine Telemetry Update 2011 (WP)
WP12-13	Oliver Cox, Colby Bruchs, Aaron Riddell	Oliver.N.Cox@maine.gov	Seal Bites and Other Injuries Observed on Atlantic salmon Returns to Maine (WP)
WP12-14	Paul Music, Graham Goulette, James Hawkes, John Kocik, Christine Lipsky and Justin Stevens	Paul.Music@noaa.gov	Smolt Injury Classification and Documentation (WP)
WP12-15	Paul Music, John Kocik, James Hawkes, Graham Goulette	Paul.Music@noaa.gov	NOAA Fisheries Northeast Fisheries Science Center Acoustic Telemetry Platforms of Opportunity Overview (WP)
WP12-16	Paul Music, Mike O'Malley, Justin Stevens and John Kocik	Paul.Music@noaa.gov	2011 Penobscot Estuary Avian and Marine Mammal Census Feasibility Results (WP)
WP12-17	John Kocik	John.Kocik@noaa.gov	Atlantic Salmon Bycatch: 2011
WP12-18	Joan Trial	Joan.Trial@maine.gov	Revising CSE for the USA (WP)

8.3 Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Bureau of Sea Run Fisheries and Habitat	BSRFH
Central New England Fisheries Resource Office	CNEFRO
Connecticut River Atlantic Salmon Association	CRASA
Connecticut Department of Environmental Protection	CTDEP
Connecticut Department of Energy and Environmental Protection	CTDEEP
Connecticut River Atlantic Salmon Commission	CRASC
Craig Brook National Fish Hatchery	CBNFH
Decorative Specialities International	DSI
Developmental Index	DI
Dwight D. Eisenhower National Fish Hatchery	DDENFH
Distinct Population Segment	DPS
Federal Energy Regulatory Commission	FERC
Geographic Information System	GIS
Greenfield Community College	GCC
Green Lake National Fish Hatchery	GLNFH
International Council for the Exploration of the Sea	ICES
Kensington State Salmon Hatchery	KSSH
Maine Aquaculture Association	MAA
Maine Atlantic Salmon Commission	MASC
Maine Department of Marine Resources	MDMR
Maine Department of Transportation	MDOT

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

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

8.4 Glossary of Definitions

GENERAL

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

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

LIFE HISTORY RELATED

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

Parr 20	Parr stocked at age 0 that migrate as 2 Smolts (20 months spent in freshwater).
Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
1 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	The period from July 1 to December 31 of the year the salmon became a smolt.
1SW Smolt	A salmon that survives past December 31 since becoming a smolt.
Grilse	A one-sea-winter (SW) salmon that returns to the river to spawn. These fish usually weigh less than five pounds.
Multi-Sea-Winter Salmon	All adult salmon, excluding grilse that return to the river to spawn. Includes terms such as two-sea-winter salmon, three-sea-winter salmon, and repeat spawners. May also be referred to as large salmon.
2SW Salmon	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31 four times since becoming a smolt.

Kelt	A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to homewaters to spawn again.
Reconditioned Kelt	A kelt that has been restored to a feeding condition in captivity.
Repeat Spawners	Salmon that return numerous times to the river for the purpose of reproducing. Previous spawner.

8.5 Abstracts

8.5.1 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. Because these abstracts are going to be published as a NOAA lab reference document and will be available electronically we are providing a link to this series and the 2012 report and all earlier reports will be available at this location. Please see: <http://www.nefsc.noaa.gov/publications/crd/>

8.6 List of Appendices

Appendix 1. Documented Atlantic salmon returns to the USA, 1967-2011. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1SW	2SW	3SW	Repeat	Total	Hatcher	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1078	3	17	1,650	1,401	249
2011	1080	3045	26	16	4,167	3,465	702

Appendix 2. Two sea winter (2SW) returns for 2011 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2011	Percentage of Requirement
Long Island Sound	LIS	10,094	82	0.8%
Central New England	CNE	3,435	298	8.7%
Gulf of Maine	GOM	15,670	2,665	17.0%
Total		29,199	3,045	10.4%

Appendix 3 Number of juvenile Atlantic salmon stocked in USA, 2011. 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	6,016,000	5200	9500	10000	0	81700	6,122,400
Central New England	CNE 2: Merrimack, Saco 10: Androscoggin to	1,130,000	109,800	0	0	46,900	0	1,286,700
Gulf of Maine	GOM Dennys	2,841,000	313,000	500	0	679,000	0	3,833,500
Outer Bay of Fundy	OBF 1: Aroostook	237,000	0	0	0	0	0	237,000
Totals for USA	15	10,224,000	428,000	10,000	10,000	725,900	81,700	11,479,600

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2011 by geographic area.

River	Purpose	Captive Reared Domestic		Sea Run		Total	Eggs	
		Pre-spawn	Post-spawn	Pre-spawn	Post-spawn		Eyed	
Central New England	CNE Restoration/Recreation	2,050		113		2,163		
Gulf of Maine	GOM Restoration	827	1,996	167	556	3,546	859,000	

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2010. Includes hatchery and wild origin fish.

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Adult	58			58
AD	Parr	63,000	15,500	19,481	97,981
AD	Smolt	17,299	307,687	81,681	406,667
FLOY	Adult	2,050			2,050
PING	Smolt		628		628
PIT	Adult	55	5,986		6,041
PIT	Smolt		95		95
RAD	Adult			10	10
Grand Total		82,462	329,896	101,172	513,530

RAD = radio tag

PIT = passive integrated transponder

PING = ultrasonic acoustic tag

Appendix 6. Aquaculture production (metric tonnes) in New England from 1997 to 2011. Production for 2011 was estimated, with 95% CI presented.

Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014
2009	6,028
2010	11,127
2011	2,100 to 8,100

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2011.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	6,010,000	5,200	9,500	10,000	0	81,700	6,116,400
Total for Connecticut Program							6,116,400
Androscoggin	1,000	0	0	0	0	0	1,000
Aroostook	237,000	0	0	0	0	0	237,000
Dennys	539,000	0	0	0	0	0	539,000
East Machias	180,000	0	0	0	0	0	180,000
Kennebec	85,000	0	0	0	0	0	85,000
Machias	347,000	0	500	0	0	0	347,500
Narraguagus	465,000	0	0	0	64,000	0	529,000
Penobscot	952,000	298,000	0	0	554,000	0	1,804,000
Pleasant	124,000	0	0	0	61,000	0	185,000
Saco	238,000	16,000	0	0	12,000	0	266,000
Sheepscot	129,000	15,000	0	0	0	0	144,000
Union	19,000	0	0	0	0	0	19,000
Total for Maine Program							4,336,500
Merrimack	892,000	93,800	0	0	34,900	0	1,020,700
Total for Merrimack Program							1,020,700
Pawcatuck	6,000	0	0	0	0	0	6,000
Total for Pawcatuck Program							6,000
Total for United States							11,479,600
Grand Total							11,479,600

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

Appendix 8. Number of adult Atlantic salmon stocked in New England rivers in 2011.

Drainage	Purpose	Captive/Domestic		Sea Run		Total
		Pre-Spawn	Post-Spawn	Pre-Spawn	Post-Spawn	
Dennys	Restoration	299	0	0	0	299
East Machias	Restoration	41	123	0	0	164
Kennebec	Restoration	90	0	0	0	90
Machias	Restoration	109	222	0	0	331
Merrimack	Restoration/Recreation	500	0	0	0	500
Merrimack	Restoration	0	0	113	0	113
Merrimack	Recreation	1,550	0	0	0	1,550
Narraguagus	Restoration	0	285	0	0	285
Penobscot	Restoration	0	1,166	167	556	1,889
Pleasant	Restoration	0	58	0	0	58
Sheepscot	Restoration	0	142	0	0	142
Union	Restoration	288	0	0	0	288
Total		2,877	1,996	280	556	5,709

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

***The 167 pre-spawn sea run fish stocked in the Penobscot River were sea run fish that were temporarily held in the hatchery prior to release to the river.*

Appendix 9.1. Atlantic salmon marking database for New England; marked fish released in 2011 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
Aquatic Scien2e		Smolt	H	Connecticut	RAD	60	AD	May	Connecticut
Aquatic Scien2e		Smolt	H	Connecticut	AD	70		May	Connecticut
NAI	4	Adult	W	Connecticut	RAD	10	PIT	May	Connecticut
NAI	2	Smolt	H	Connecticut	FLOY	879	AD	May	Connecticut
USFWS	1	Parr	H	Connecticut	AD	9,510		Oct	Connecticut
USFWS	2	Parr	H	Connecticut	AD	5,749		April	Connecticut
USFWS	2	Parr	H	Connecticut	AD	4,222		Dec	Connecticut
USFWS	2	Smolt	H	Connecticut	AD	80,672		April	Connecticut
USFWS	4	Adult	H	Dennys	PIT	111		Oct	Dennys
USFWS	5	Adult	H	Dennys	PIT	120		Oct	Dennys
USFWS	3	Adult	H	Dennys	PIT	68		Oct	Dennys
USFWS	5	Adult	H	East Machias	PIT	11		Oct	Union
USFWS	4	Adult	H	East Machias	PIT	66		Dec	East Machias
USFWS	4	Adult	H	East Machias	PIT	11		Oct	Union
USFWS	5	Adult	H	East Machias	PIT	25		Dec	East Machias
USFWS	5	Adult	H	East Machias	PIT	41	PIT	Oct	East Machias
USFWS	3	Adult	H	East Machias	PIT	32		Dec	East Machias
USFWS	5	Adult	H	Machias	PIT	26		Nov	Machias
USFWS	5	Adult	H	Machias	PIT	39		Oct	Union
USFWS	5	Adult	H	Machias	PIT	108		Oct	Machias
USFWS	4	Adult	H	Machias	PIT	1		Oct	Machias
USFWS	3	Adult	H	Machias	PIT	106		Nov	Machias
USFWS	4	Adult	H	Machias	PIT	90		Nov	Machias
NFGH	3	Adult	H	Merrimack	PIT	37		Oct	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	800		Oct	Merrimack

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
NHFG	3	Adult	H	Merrimack	FLOY	750		May	Merrimack
NHFG	3	Adult	H	Merrimack	FLOY	500		Oct	Merrimack
NHFG	3	Adult	H	Merrimack	PIT	10	RAD	Oct	Merrimack
USFWS	2,3,4	Adult	H	Merrimack	AD	19	PIT	June	Merrimack
USFWS	2,3,4	Adult	H	Merrimack	AD	39	PIT	Oct	Merrimack
USFWS	2,3,4	Adult	H	Merrimack	PIT	8	PIT	Oct	Merrimack
USFWS	0	Parr	H	Merrimack	AD	63,000		Oct	Merrimack
USFWS	1	Smolt	H	Merrimack	AD	17,299		April	Merrimack
NOAA	1	Smolt	H	Narraguagus	VIE	63,619	AC	May	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	170		Nov	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	6		Oct	Union
USFWS	5	Adult	H	Narraguagus	PIT	61		Nov	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	102		Oct	Union
USFWS	3	Adult	H	Narraguagus	PIT	54		Nov	Narraguagus
BSRFH		Adult	H	Penobscot	PIT	15	None	Oct	Penobscot
BSRFH		Adult	H	Penobscot	PIT	73	None	Sept	Penobscot
BSRFH		Adult	H	Penobscot	PIT	218	None	May	Penobscot
BSRFH		Adult	H	Penobscot	PIT	1,976	None	June	Penobscot
BSRFH		Adult	H	Penobscot	PIT	77	None	July	Penobscot
BSRFH		Adult	H	Penobscot	PIT	81	None	Aug	Penobscot
NOAA	1	Smolt	H	Penobscot	VIE	149,726	AC	April	Penobscot
NOAA	1	Smolt	H	Penobscot	VIE	32,952	AC	May	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	154	None	May	Penobscot
NOAA	2	Smolt	W	Penobscot	PING	49	None	May	Penobscot
UMO/USGS	1	Smolt	H	Penobscot	PING	200	None	April	Penobscot
UMO/USGS	1	Smolt	H	Penobscot	PING	90	VIE	May	Penobscot
UMO/USGS		Smolt	W	Penobscot	PING	135	None	May	Penobscot

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	3	Adult	H	Penobscot	PUNCH	501		Dec	Penobscot
USFWS	4	Adult	H	Penobscot	PUNCH	665		Dec	Penobscot
USFWS		Adult	W	Penobscot	PIT	556		Nov	Penobscot
USFWS		Adult	W	Penobscot	PIT	167	Radio	Oct	Penobscot
NOAA	1	Smolt	H	Pleasant	AC	61,390		April	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	16		Dec	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	82		Oct	Union
USFWS	5	Adult	H	Pleasant	PIT	20		Dec	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	37		Oct	Union
USFWS	3	Adult	H	Pleasant	PIT	22		Dec	Pleasant
USFWS	2	Smolt	H	Pleasant	PIT	95		June	Pleasant
USFWS	3	Adult	H	Sheepscot	PIT	49		Nov	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	77		Nov	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	16		Nov	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	90		Oct	Kennebec
USFWS	0	Parr	H	Sheepscot	AC	15,500		Sept	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

Appendix 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2011.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,108	58	7,426
Hatchery Juvenile	427,848	181,461	505,187
Wild Adult			733
Wild Juvenile			184
Total			513,530

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2011.

	1SW		2SW		3SW		Repeat		Total	2007-2011
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild		Average
Androscoggin	2	1	27	14	0	0	0	0	44	23
Connecticut	2	31	17	61	0	0	0	0	111	104
Dennys	0	2	1	5	0	1	0	0	9	7
Kennebec	0	2	21	41	0	0	0	0	64	28
Merrimack	128	11	155	90	12	5	1	0	402	151
Narraguagus	55	20	96	21	2	0	1	1	196	63
Pawcatuck	0	0	1	3	0	0	0	0	4	1
Penobscot	696	45	2167	201	3	1	12	0	3125	1,888
Saco	30	11	36	17	0	0	0	0	94	43
Total	913	123	2,521	453	17	7	14	1	4,049	2,307

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2011.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	707	4,389,000
Merrimack	Domestic	103	408,000
Penobscot	Domestic	351	1,216,000
East Machias	Captive	52	210,000
Machias	Captive	100	361,000
Narraguagus	Captive	124	485,000
Pleasant	Captive	26	124,000
Sheepscot	Captive	72	253,000
Total Captive/Domestic		1,535	7,446,000
Pleasant	Domestic	4	35,000
Total Domestic		4	35,000
Connecticut	Kelt	24	176,000
Total Kelt		24	176,000
Connecticut	Sea Run	47	376,000
Merrimack	Sea Run	107	935,000
Penobscot	Sea Run	313	2,626,000
Total Sea Run		467	3,937,000
Grand Total for Year 2011		2,030	11,594,000

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

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female												
Cocheco															
1993-2001	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															
1977-2001	1,379	16,146,000	8,000	15,748	106,470,000	6,000	0	0		1,747	22,286,000	10,200	18,874	144,902,000	6,600
2002	25	181,000	7,300	1,974	10,826,000	5,500	0	0		83	827,000	10,000	2,082	11,835,000	5,700
2003	34	245,000	7,200	2,152	11,600,000	5,400	0	0		67	660,000	9,800	2,253	12,505,000	5,600
2004	37	280,000	7,600	1,875	11,750,000	6,300	0	0		53	489,000	9,200	1,965	12,519,000	6,400
2005	102	758,000	7,400	1,382	9,050,000	6,500	0	0		37	384,000	10,400	1,521	10,192,000	6,700
2006	116	896,000	7,700	1,782	10,020,000	5,600	0	0		47	460,000	9,800	1,945	11,376,000	5,800
2007	95	723,000	7,600	1,598	9,390,000	5,900	0	0		113	1,190,000	10,500	1,806	11,303,000	6,300
2008	85	602,000	7,100	1,633	8,980,000	5,500	0	0		101	1,190,000	11,800	1,819	10,772,000	5,900
2009	46	317,000	6,900	1,975	9,906,000	5,000	0	0		62	642,000	10,400	2,083	10,865,000	5,200
2010	26	180,000	6,900	1,935	10,021,000	5,200	0	0		55	593,000	10,800	2,016	10,794,000	5,400
2011	47	376,000	8,000	707	4,389,000	6,200	0	0		24	176,000	7,300	778	4,941,000	6,400
Total Connecticut	1,992	20,704,000	7,400	32,761	202,402,000	5,700	0	0		2,389	28,897,000	10,000	37,142	252,004,000	6,000
Dennys															
1939-2001	26	214,000	7,600	0	0		633	2,382,000	3,800	40	330,000	7,700	699	2,926,000	5,000
2002	0	0		0	0		68	352,000	5,200	0	0		68	352,000	5,200
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500

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												
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300
2009	0	0		38	91,000	2,400	61	360,000	5,900	0	0		99	451,000	4,600
2010	0	0		87	596,000	6,900	25	105,000	4,200	0	0		112	701,000	6,300
2011	0	0		0	0		0	0		0	0		0	0	
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,324	5,678,000	4,700	40	330,000	7,700	1,515	6,909,000	4,900
East Machias															
1995-2001	0	0		0	0		567	2,211,000	4,100	0	0		567	2,211,000	4,100
2002	0	0		0	0		92	466,000	5,100	0	0		92	466,000	5,100
2003	0	0		0	0		93	456,000	4,900	0	0		93	456,000	4,900
2004	0	0		0	0		65	252,000	3,900	0	0		65	252,000	3,900
2005	0	0		0	0		88	281,000	3,200	0	0		88	281,000	3,200
2006	0	0		0	0		82	328,000	4,000	0	0		82	328,000	4,000
2007	0	0		0	0		78	456,000	5,800	0	0		78	456,000	5,800
2008	0	0		0	0		85	350,000	4,100	0	0		85	350,000	4,100
2009	0	0		0	0		81	311,000	3,800	0	0		81	311,000	3,800
2010	0	0		0	0		48	228,000	4,800	0	0		48	228,000	4,800
2011	0	0		0	0		52	210,000	4,000	0	0		52	210,000	4,000
Total East Machias	0	0		0	0	0	1,331	5,549,000	4,336	0	0		1,331	5,549,000	4,300
Kennebec															
1979-2001	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
Lamprey															

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												
1992-2001	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															
1941-2001	456	3,263,000	7,300	0	0		1,081	3,981,000	3,700	8	52,000	6,400	1,545	7,297,000	6,300
2002	0	0		0	0		111	533,000	4,800	0	0		111	533,000	4,800
2003	0	0		0	0		121	763,000	6,300	0	0		121	763,000	6,300
2004	0	0		0	0		120	613,000	5,100	0	0		120	613,000	5,100
2005	0	0		0	0		160	677,000	4,200	0	0		160	677,000	4,200
2006	0	0		0	0		160	720,000	4,500	0	0		160	720,000	4,500
2007	0	0		0	0		150	714,000	4,800	0	0		150	714,000	4,800
2008	0	0		0	0		141	650,000	4,600	0	0		141	650,000	4,600
2009	0	0		0	0		144	557,000	3,900	0	0		144	557,000	3,900
2010	0	0		0	0		108	480,000	4,400	0	0		108	480,000	4,400
2011	0	0		0	0		100	361,000	3,600	0	0		100	361,000	3,600
Total Machias	456	3,263,000	7,300	0	0	0	2,396	10,049,000	4,536	8	52,000	6,400	2,860	13,365,000	4,800
Merrimack															
1983-2001	1,031	7,710,000	7,500	7,906	42,820,000	5,200	0	0		139	1,646,000	12,300	9,076	52,177,000	6,400
2002	16	232,000	14,500	361	1,816,000	5,000	0	0		21	232,000	11,000	398	2,279,000	5,700
2003	60	499,000	8,300	489	1,914,000	3,900	0	0		20	236,000	11,800	569	2,649,000	4,700
2004	59	494,000	8,400	229	811,000	3,500	0	0		42	48,000	1,200	330	1,353,000	4,100
2005	13	111,000	8,500	191	691,000	3,600	0	0		65	697,000	10,700	269	1,499,000	5,600
2006	42	377,000	9,000	269	1,097,000	4,100	0	0		49	582,000	11,900	360	2,056,000	5,700
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

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
2009	48	369,000	7,700	516	2,380,000	4,600	0	0		55	577,000	10,500	619	3,326,000	5,400
2010	28	201,000	7,200	135	721,000	5,300	0	0		57	669,000	11,700	220	1,591,000	7,200
2011	107	935,000	8,700	103	408,000	4,000	0	0		0	0		210	1,343,000	6,400
Total Merrimack	1,505	11,760,000	8,800	11,161	56,263,000	4,200	0	0		540	5,709,000	10,300	13,206	73,733,000	5,500
Narraguagus															
1962-2001	0	1,303,000		0	0		1,013	3,359,000	3,300	0	0		1,013	4,662,000	3,300
2002	0	0		0	0		159	704,000	4,400	0	0		159	704,000	4,400
2003	0	0		0	0		120	624,000	5,200	0	0		120	624,000	5,200
2004	0	0		0	0		119	453,000	3,800	0	0		119	453,000	3,800
2005	0	0		0	0		146	449,000	3,100	0	0		146	449,000	3,100
2006	0	0		0	0		165	702,000	4,300	0	0		165	702,000	4,300
2007	0	0		0	0		186	854,000	4,600	0	0		186	854,000	4,600
2008	0	0		0	0		169	820,000	4,900	0	0		169	820,000	4,900
2009	0	0		0	0		178	848,000	4,800	0	0		178	848,000	4,800
2010	0	0		0	0		97	694,000	7,200	0	0		97	694,000	7,200
2011	0	0		0	0		124	485,000	3,900	0	0		124	485,000	3,900
Total Narraguagus	0	1,303,000		0	0	0	2,476	9,992,000	4,500	0	0		2,476	11,295,000	4,500
Orland															
1967-2001	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															
1992-2001	14	137,000	9,900	2	2,000	1,100	0	0		6	51,000	8,200	22	190,000	8,900
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

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
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	4,800	37	234,000	4,000
Penobscot															
1871-2001	17,349	148,461,000	7,800	4,708	12,143,000	2,600	0	0		0	0		22,057	160,604,000	7,500
2002	218	2,001,000	9,200	484	1,300,000	2,700	0	0		0	0		702	3,301,000	4,700
2003	362	3,194,000	8,800	0	0		0	0		0	0		362	3,194,000	8,800
2004	353	3,229,000	9,100	477	1,200,000	2,500	0	0		0	0		830	4,429,000	5,300
2005	296	2,458,000	8,300	359	1,314,000	3,700	0	0		0	0		655	3,772,000	5,800
2006	325	3,034,000	9,300	0	0		329	1,400,000	4,300	0	0		654	4,434,000	6,800
2007	315	2,697,000	8,600	394	1,595,000	4,000	0	0		0	0		709	4,292,000	6,100
2008	297	2,500,000	8,400	352	1,420,000	4,000	0	0		0	0		649	3,920,000	6,000
2009	283	2,433,000	8,600	312	1,040,000	3,300	0	0		0	0		595	3,473,000	5,800
2010	289	2,091,000	7,200	314	1,269,000	4,000	0	0		0	0		603	3,360,000	5,600
2011	313	2,626,000	8,400	351	1,216,000	3,500	0	0		0	0		664	3,842,000	5,800
Total Penobscot	20,400	174,724,000	8,500	7,751	22,497,000	3,400	329	1,400,000	4,300	0	0		28,480	198,621,000	6,200
Pleasant															
2001	0	0		0	0		13	46,000	3,500	0	0		13	46,000	3,500
2002	0	0		0	0		19	84,000	4,400	0	0		19	84,000	4,400
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

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												
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400
2010	0	0		30	186,000	6,200	12	42,000	3,500	0	0		42	228,000	5,400
2011	0	0		4	35,000	8,800	26	124,000	4,800	0	0		30	159,000	5,300
Total Pleasant	0	0		51	307,000	6,600	435	1,755,000	4,600	0	0		486	2,061,000	4,900
Sheepscot															
1995-2001	18	125,000	6,900	0	0		396	1,526,000	3,700	45	438,000	9,900	459	2,090,000	4,500
2002	0	0		0	0		100	455,000	4,600	0	0		100	455,000	4,600
2003	0	0		0	0		92	433,000	4,700	0	0		92	433,000	4,700
2004	0	0		0	0		78	308,000	3,900	0	0		78	308,000	3,900
2005	0	0		0	0		70	251,000	3,600	0	0		70	251,000	3,600
2006	0	0		0	0		83	277,000	3,300	0	0		83	277,000	3,300
2007	0	0		0	0		81	349,000	4,300	0	0		81	349,000	4,300
2008	0	0		0	0		75	340,000	4,500	0	0		75	340,000	4,500
2009	0	0		0	0		86	329,000	3,800	0	0		86	329,000	3,800
2010	0	0		0	0		68	264,000	3,900	0	0		68	264,000	3,900
2011	0	0		0	0		72	253,000	3,500	0	0		72	253,000	3,500
Total Sheepscot	18	125,000	6,900	0	0	0	1,201	4,785,000	3,982	45	438,000	9,900	1,264	5,349,000	4,100
St Croix															
1993-2001	36	271,000	7,500	0	0		0	0		0	0		36	271,000	7,500
2003	3	21,000	6,900	0	0		0	0		0	0		3	21,000	6,900
Total St Croix	39	292,000	7,200	0	0	0	0	0		0	0		39	292,000	7,200

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/female												
Union															
1974-2001	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.

Appendix 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	1,992	20,705,000	7,400	32,761	202,401,000	5,700	0	0		2,389	28,897,000	10,000	37,142	252,004,000	6,000
Dennys	26	214,000	7,600	125	687,000	4,600	1,324	5,678,000	4,700	40	330,000	7,700	1,515	6,909,000	4,900
East Machias	0	0		0	0		1,331	5,549,000	4,300	0	0		1,331	5,549,000	4,300
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		2,396	10,049,000	4,500	8	52,000	6,400	2,860	13,364,000	4,800
Merrimack	1,505	11,760,000	8,800	11,161	56,263,000	4,300	0	0		540	5,709,000	10,300	13,206	73,732,000	5,500
Narraguagus	0	1,303,000		0	0		2,476	9,992,000	4,500	0	0		2,476	11,295,000	4,500
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	18	152,000	5,800	6	6,000	1,100	0	0		13	76,000	4,700	37	234,000	4,000
Penobscot	20,400	174,724,000	8,500	7,751	22,496,000	3,400	329	1,400,000	4,300	0	0		28,480	198,621,000	6,200
Pleasant	0	0		51	306,000	6,500	435	1,754,000	4,600	0	0		486	2,061,000	4,900
Sheepscot	18	125,000	6,900	0	0		1,201	4,784,000	4,000	45	438,000	9,900	1,264	5,348,000	4,100
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	25,107	217,521,000	8,700	51,855	282,159,000	5,400	9,492	39,206,000	4,100	3,035	35,502,000	11,700	89,489	574,392,000	6,400

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.

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

<i>Number of fish stocked by life stage</i>							
	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin							
2001	3,000	0	0	0	0	0	3,000
2002	0	0	0	0	0	0	0
2003	1,000	0	0	0	0	0	1,000
2004	2,000	0	0	0	0	0	2,000
2005	0	0	0	0	0	0	0
2006	1,000	0	0	0	0	0	1,000
2007	1,000	0	0	0	0	0	1,000
2008	1,000	0	0	0	0	0	1,000
2009	2,000	0	0	0	0	0	2,000
2010	1,000	0	0	0	0	0	1,000
2011	1,000	0	0	0	0	0	1,000
Totals:Androscoggin	13,000	0	0	0	0	0	13,000
Aroostook							
1978-2001	1,693,000	317,400	38,600	0	32,600	29,800	2,111,400
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
2010	527,000	0	0	0	0	0	527,000
2011	237,000	0	0	0	0	0	237,000
Totals:Aroostook	5,020,000	317,400	38,600	0	32,600	29,800	5,438,400
Cocheco							
1988-2001	1,614,000	50,000	10,500	0	5,300	0	1,679,800
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							
1967-2001	78,398,000	2,826,800	1,810,300	0	3,769,200	1,011,400	87,815,700
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
2010	6,009,000	0	6,300	19,000	0	42,700	6,077,000
2011	6,010,000	5,200	9,500	10,000	0	81,700	6,116,400

Number of fish stocked by life stage

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Totals:Connecticut	144,936,000	2,843,400	1,829,200	60,700	3,771,300	1,657,600	155,098,200
Dennys							
1975-2001	1,183,000	68,700	4,800	0	202,500	29,200	1,488,200
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
2010	430,000	0	0	0	0	0	430,000
2011	539,000	0	0	0	0	0	539,000
Totals:Dennys	3,964,000	225,400	7,300	0	532,700	30,000	4,759,400
Ducktrap							
1986-2001	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	68,000	0	0	0	0	0	68,000
East Machias							
1973-2001	1,207,000	7,500	42,600	0	108,400	30,400	1,395,900
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
2010	266,000	0	0	0	0	0	266,000
2011	180,000	0	0	0	0	0	180,000
Totals:East Machias	3,629,000	7,500	42,600	0	108,400	30,400	3,817,900
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
2010	147,000	0	0	0	0	0	147,000
2011	85,000	0	0	0	0	0	85,000
Totals:Kennebec	399,000	0	0	0	200	0	399,200
Lamprey							

Number of fish stocked by life stage

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
1978-2001	1,383,000	427,700	58,800	0	141,400	32,800	2,043,700
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							
1970-2001	1,803,000	93,800	117,800	0	191,300	44,100	2,250,000
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
2010	510,000	0	0	0	0	0	510,000
2011	347,000	0	500	0	0	0	347,500
Totals:Machias	6,167,000	99,300	122,900	0	191,300	44,100	6,624,600
Merrimack							
1975-2001	28,040,000	227,500	594,900	0	1,319,400	635,900	30,817,700
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
2010	1,481,000	80,000	9,300	0	72,900	0	1,643,200
2011	892,000	93,800	0	0	34,900	0	1,020,700
Totals:Merrimack	40,648,000	409,800	617,000	0	1,906,800	638,100	44,219,700
Narraguagus							
1970-2001	1,618,000	62,900	14,600	0	107,800	84,000	1,887,300
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
2010	698,000	0	0	0	62,400	0	760,400
2011	465,000	0	0	0	64,000	0	529,000
Totals:Narraguagus	6,243,000	117,100	14,600	0	341,100	84,000	6,799,800
Pawcatuck							
1979-2001	4,109,000	1,209,200	263,200	0	65,100	500	5,647,000

Number of fish stocked by life stage

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
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
2010	290,000	0	0	0	3,900	0	293,900
2011	6,000	0	0	0	0	0	6,000
Totals:Pawcatuck	6,282,000	1,209,200	268,100	0	127,500	500	7,887,300
Penobscot							
1970-2001	12,448,000	3,186,200	1,390,500	0	11,064,400	2,508,200	30,597,300
2002	746,000	396,700	1,800	0	547,000	0	1,691,500
2003	741,000	320,700	2,100	0	547,100	0	1,610,900
2004	1,812,000	369,200	0	0	551,400	0	2,732,600
2005	1,899,000	295,400	0	0	555,500	0	2,749,900
2006	1,509,000	293,500	0	0	555,200	0	2,357,700
2007	1,606,000	337,800	0	0	559,900	0	2,503,700
2008	1,248,000	216,600	0	0	554,600	0	2,019,200
2009	1,023,000	172,200	0	0	561,100	0	1,756,300
2010	999,000	258,800	0	0	567,100	0	1,824,900
2011	952,000	298,000	0	0	554,000	0	1,804,000
Totals:Penobscot	24,983,000	6,145,100	1,394,400	0	16,617,300	2,508,200	51,648,000
Pleasant							
1975-2001	187,000	2,500	1,800	0	54,700	18,100	264,100
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
2010	142,000	0	0	0	0	0	142,000
2011	124,000	0	0	0	61,000	0	185,000
Totals:Pleasant	1,358,000	16,000	1,800	0	124,400	42,400	1,542,600
Saco							
1975-2001	3,337,000	418,700	201,200	0	331,400	9,500	4,297,800
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
2006	106,000	0	0	0	0	0	106,000
2007	576,000	0	0	0	0	0	576,000

Number of fish stocked by life stage

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
2008	358,000	9,100	0	0	0	0	367,100
2009	1,000	0	0	0	0	0	1,000
2010	302,000	0	0	0	26,500	0	328,500
2011	238,000	16,000	0	0	12,000	0	266,000
Totals:Saco	6,731,000	463,800	219,200	0	384,300	9,500	7,807,800
Sheepscot							
1971-2001	1,265,000	84,800	20,600	0	92,200	7,100	1,469,700
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
2010	114,000	14,500	0	0	0	0	128,500
2011	129,000	15,000	0	0	0	0	144,000
Totals:Sheepscot	3,254,000	193,300	20,600	0	92,200	7,100	3,567,200
St Croix							
1981-2001	1,266,000	435,400	158,300	0	796,600	20,100	2,676,400
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
2010	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							
1971-2001	425,000	371,400	0	0	379,700	251,000	1,427,100
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
2010	19,000	0	0	0	0	0	19,000
2011	19,000	0	0	0	0	0	19,000
Totals:Union	551,000	371,400	0	0	379,700	251,000	1,553,100
Upper StJohn							
1979-2001	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

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

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

	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin	12,000	0	0	0	0	0	12,200
Aroostook	5,020,000	317,400	38,600	0	32,600	29,800	5,438,200
Cochecho	1,958,000	50,000	10,500	0	5,300	0	2,024,200
Connecticut	144,935,000	2,843,400	1,829,200	60,800	3,771,300	1,657,600	155,036,600
Dennys	3,964,000	225,400	7,300	0	532,800	30,000	4,759,600
Ducktrap	68,000	0	0	0	0	0	68,000
East Machias	3,628,000	7,500	42,600	0	108,400	30,400	3,817,100
Kennebec	399,000	0	0	0	200	0	399,300
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	2,313,700
Machias	6,166,000	99,300	122,800	0	191,300	44,100	6,623,500
Merrimack	40,648,000	409,700	616,900	0	1,906,700	638,100	44,219,000
Narraguagus	6,244,000	117,100	14,600	0	341,100	84,000	6,801,000
Pawcatuck	6,281,000	1,209,200	268,100	0	127,500	500	7,886,500
Penobscot	24,982,000	6,145,100	1,394,400	0	16,617,300	2,508,200	51,647,200
Pleasant	1,358,000	16,000	1,800	0	124,400	42,400	1,543,000
Saco	6,730,000	463,800	219,200	0	384,300	9,500	7,806,900
Sheepscot	3,254,000	193,400	20,600	0	92,200	7,100	3,567,500
St Croix	1,269,000	470,400	158,300	0	808,000	20,100	2,726,300
Union	550,000	371,400	0	0	379,700	251,000	1,551,800
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
TOTALS	261,226,000	14,823,400	4,818,500	60,800	25,629,700	5,413,400	311,910,900

Summaries for each river vary by length of time series.

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

Documented returns include rod and trap caught fish. Returns are unknown where blanks occur.

Returns from juveniles of hatchery origin include age 0 and 1 parr, and age 1 and 2 smolt releases.

Returns of wild origin include adults produced from natural reproduction and adults produced from fry releases.

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
Androscoggin									
1983-2001	27	511	6	2	6	83	0	1	636
2002	0	2	0	0	0	0	0	0	2
2003	0	3	0	0	0	0	0	0	3
2004	3	7	0	0	0	1	0	0	11
2005	2	8	0	0	0	0	0	0	10
2006	5	1	0	0	0	0	0	0	6
2007	6	11	0	0	1	2	0	0	20
2008	8	5	0	0	2	1	0	0	16
2009	2	19	0	0	0	3	0	0	24
2010	2	5	0	0	0	2	0	0	9
2011	2	27	0	0	1	14	0	0	44
Total for Androscoggin	57	599	6	2	10	106	0	1	781
Cochecho									
1992-2001	0	0	1	1	5	7	0	0	14
2003	0	0	0	0	1	3	0	0	4
Total for Cochecho	0	0	1	1	6	10	0	0	18
Connecticut									
1974-2001	36	3,500	28	2	45	1,327	10	0	4,948
2002	0	3	0	0	2	38	1	0	44
2003	0	0	0	0	0	42	1	0	43
2004	0	0	0	0	5	64	0	0	69
2005	0	4	0	0	23	159	0	0	186
2006	13	33	0	0	20	147	0	1	214
2007	0	19	0	0	1	120	1	0	141
2008	7	10	0	0	3	118	1	2	141
2009	0	18	0	0	0	57	0	0	75
2010	0	3	0	0	1	47	0	0	51
2011	2	17	0	0	31	61	0	0	111
Total for Connecticut	58	3,607	28	2	131	2180	14	3	6,023
Dennys									
1967-2001	29	308	0	1	31	743	3	31	1,146
2002	2	0	0	0	0	0	0	0	2
2003	4	5	0	0	0	1	0	0	10

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
2004	0	1	0	0	0	0	0	0	1
2006	2	2	0	0	1	1	0	0	6
2007	1	1	0	0	0	1	0	0	3
2008	0	1	0	0	1	3	0	3	8
2009	0	0	0	0	0	6	1	1	8
2010	1	1	0	0	0	4	0	0	6
2011	0	1	0	0	2	5	1	0	9
Total for Dennys	39	320	0	1	35	764	5	35	1,199
Ducktrap									
1985-2001	0	0	0	0	3	30	0	0	33
Total for Ducktrap	0	0	0	0	3	30	0	0	33
East Machias									
1967-2001	21	250	1	2	12	329	1	10	626
Total for East Machias	21	250	1	2	12	329	1	10	626
Kennebec									
1975-2001	12	189	5	1	0	9	0	0	216
2006	4	6	0	0	3	2	0	0	15
2007	2	5	1	0	2	6	0	0	16
2008	6	15	0	0	0	0	0	0	21
2009	0	16	0	6	1	10	0	0	33
2010	0	2	0	0	1	2	0	0	5
2011	0	21	0	0	2	41	0	0	64
Total for Kennebec	24	254	6	7	9	70	0	0	370
Lamprey									
1979-2001	10	17	1	0	9	16	0	0	53
2003	0	0	0	0	2	0	0	0	2
2004	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	2	0	0	0	2
Total for Lamprey	10	17	1	0	13	16	0	0	57
Machias									
1967-2001	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									
1982-2001	247	973	19	8	118	964	26	0	2,355
2002	31	17	0	0	1	6	0	0	55
2003	12	129	0	0	0	4	0	0	145
2004	17	92	2	0	2	15	0	0	128

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
2005	8	25	0	0	0	1	0	0	34
2006	9	64	1	0	6	9	0	0	89
2007	8	52	0	0	1	12	1	0	74
2008	6	77	0	0	5	29	1	0	118
2009	4	41	2	0	1	28	2	0	78
2010	29	40	0	0	7	7	1	0	84
2011	128	155	12	1	11	90	5	0	402
Total for Merrimack	499	1,665	36	9	152	1165	36	0	3,562
Narraguagus									
1967-2001	92	650	19	53	84	2,364	70	154	3,486
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	8	1	1	11
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	18	1	1	24
2009	3	0	0	0	1	5	0	0	9
2010	30	33	1	1	3	6	0	2	76
2011	55	96	2	1	20	21	0	1	196
Total for Narraguagus	180	779	22	56	123	2479	72	159	3,870
Pawcatuck									
1982-2001	2	148	1	0	1	9	0	0	161
2003	0	0	0	0	0	5	1	0	6
2004	0	0	0	0	0	1	0	0	1
2005	0	0	0	0	0	2	0	0	2
2006	0	0	0	0	0	0	0	0	0
2007	0	2	0	0	0	0	0	0	2
2008	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	1	0	0	1
2011	0	1	0	0	0	3	0	0	4
Total for Pawcatuck	2	151	1	0	1	21	1	0	177
Penobscot									
1968-2001	9,628	40,364	276	662	645	3,543	31	91	55,240
2002	363	344	0	15	14	41	1	2	780
2003	196	847	1	4	6	56	0	2	1,112
2004	276	952	10	16	5	59	3	2	1,323
2005	269	678	0	8	6	22	0	2	985

	HATCHERY ORIGIN				WILD ORIGIN				Total
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
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
2010	410	819	0	11	23	53	0	0	1,316
2011	696	2,167	3	12	45	201	1	0	3,125
Total for Penobscot	13,300	50,377	293	738	829	4250	37	99	69,923
Pleasant									
1967-2001	5	12	0	0	13	226	3	2	261
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									
1985-2001	104	501	3	5	16	49	3	0	681
2002	3	37	0	2	3	2	0	0	47
2003	2	23	0	0	2	12	0	0	39
2004	3	10	0	0	2	4	0	0	19
2005	5	12	0	0	1	7	0	0	25
2006	8	15	0	0	4	3	0	0	30
2007	4	16	0	0	0	4	0	0	24
2008	11	26	2	0	8	12	3	0	62
2009	1	9	0	0	0	4	0	0	14
2010	8	5	0	0	3	4	0	0	20
2011	30	36	0	0	11	17	0	0	94
Total for Saco	179	690	5	7	50	118	6	0	1,055
Sheepscot									
1967-2001	6	38	0	0	30	358	10	0	442
Total for Sheepscot	6	38	0	0	30	358	10	0	442
Union									
1973-2001	302	1,815	9	28	1	15	0	0	2,170
2002	0	5	0	0	0	0	0	0	5
2003	1	0	0	0	0	0	0	0	1
2004	0	1	0	0	0	1	0	0	2
2005	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0

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

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

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

	Grand Total by River								Total
	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
Androscoggin	57	599	6	2	10	106	0	1	781
Cocheco	0	0	1	1	6	10	0	0	18
Connecticut	58	3,607	28	2	131	2,180	14	3	6,023
Dennys	39	320	0	1	35	764	5	35	1,199
Ducktrap	0	0	0	0	3	30	0	0	33
East Machias	21	250	1	2	12	329	1	10	626
Kennebec	24	254	6	7	9	70	0	0	370
Lamprey	10	17	1	0	13	16	0	0	57
Machias	32	329	9	2	33	1,592	41	131	2,169
Merrimack	499	1,665	36	9	152	1,165	36	0	3,562
Narraguagus	180	779	22	56	123	2,479	72	159	3,870
Pawcatuck	2	151	1	0	1	21	1	0	177
Penobscot	13,300	50,377	293	738	829	4,250	37	99	69,923
Pleasant	5	12	0	0	14	228	3	2	264
Saco	179	690	5	7	50	118	6	0	1,055
Sheepscot	6	38	0	0	30	358	10	0	442
Union	303	1,821	9	28	1	16	0	0	2,178

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

Year	Total 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	0	
1975	3	0	0.000	0	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	0	
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	
1979	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1980	9	18	2.022	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	
1981	15	19	1.261	0	0	0	11	89	0	0	0	0	0	0	0	0	11	89	0	0
1982	13	31	2.429	0	0	0	0	90	10	0	0	0	0	0	0	0	90	10	0	0
1983	7	1	0.143	0	100	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	46	1	0.022	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0
1985	29	35	1.224	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0	0
1986	10	27	2.791	0	0	0	4	96	0	0	0	0	0	0	0	0	4	96	0	0
1987	98	44	0.449	0	16	0	0	68	2	0	14	0	0	0	0	0	16	68	16	0
1988	93	92	0.992	0	0	0	0	97	1	0	2	0	0	0	0	0	0	97	3	0
1989	75	47	0.629	0	6	0	6	85	0	0	2	0	0	0	0	0	13	85	2	0
1990	76	53	0.693	0	13	0	0	87	0	0	0	0	0	0	0	0	13	87	0	0
1991	98	25	0.255	0	20	0	0	64	0	0	16	0	0	0	0	0	20	64	16	0
1992	93	84	0.904	0	1	0	0	85	1	0	13	0	0	0	0	0	1	85	14	0
1993	261	94	0.361	0	0	0	2	87	0	0	11	0	0	0	0	0	2	87	11	0
1994	393	197	0.502	0	0	0	1	93	0	0	6	0	0	0	0	0	1	93	6	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

1995	451	83	0.184	0	2	0	6	89	0	0	2	0	0	0	8	89	2	0
1996	478	55	0.115	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	0	0	1	9	86	3	0
2005	542	48	0.089	2	2	0	2	92	0	0	2	0	0	2	4	92	2	0
2006	397	37	0.093	0	0	0	0	97	0	0	3			0	0	97	3	
2007	455	43	0.095	0	2	0	2	93		2				0	5	95		
2008	424	17	0.040	0	18		82							0	100			
Total	8,676	1,570																
Mean			0.503	0	6	0	5	69	4	0	4	0	0	0	11	70	7	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	0
1975	3	0	0.000	0	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	0
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1979	5	3	0.561	0	100	0	0	0	0	0	0	0	0	0	0	0	100	0	0
1980	29	18	0.630	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1981	17	19	1.129	0	0	0	11	89	0	0	0	0	0	0	0	0	11	89	0
1982	29	46	1.565	0	0	0	0	89	11	0	0	0	0	0	0	0	89	11	0
1983	23	2	0.088	0	100	0	0	0	0	0	0	0	0	0	0	0	100	0	0
1984	58	3	0.051	0	0	0	0	33	33	0	33	0	0	0	0	0	0	33	67
1985	42	47	1.113	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0
1986	18	28	1.592	0	0	0	4	96	0	0	0	0	0	0	0	0	4	96	0
1987	117	51	0.436	0	18	0	0	67	2	0	14	0	0	0	0	0	18	67	16
1988	131	108	0.825	0	0	0	0	97	1	0	2	0	0	0	0	0	0	97	3
1989	124	67	0.539	0	22	0	7	69	0	0	1	0	0	0	0	0	30	69	1
1990	135	68	0.505	0	19	0	0	79	0	0	1	0	0	0	0	0	19	79	1
1991	221	35	0.159	0	17	0	0	63	0	0	20	0	0	0	0	0	17	63	20
1992	201	118	0.587	0	5	0	0	82	1	0	12	0	0	0	0	0	5	82	13
1993	415	185	0.446	0	4	0	3	87	0	0	6	0	0	0	0	0	6	87	6
1994	594	294	0.495	0	5	0	2	88	0	0	5	0	0	0	0	0	7	88	5

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

1995	678	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	0	0	1	11	86	2	0
2005	776	63	0.081	2	13	0	5	79	0	0	2	0	0	2	17	79	2	0
2006	581	50	0.086	0	8	0	0	88	0	0	4			0	8	88	4	
2007	631	61	0.097	0	3	0	2	92		3				0	5	95		
2008	601	32	0.053	0	9		91							0	100			
Total	12,580	2,324																
Mean			0.394	0	11	0	5	68	2	0	5	0	0	0	17	68	6	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	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	0	0
1981	2	0	0.000	0	0	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	0	87	13	0	0
1983	16	1	0.064	0	100	0	0	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	0	0	50	50	0
1985	14	12	0.881	0	0	0	0	100	0	0	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	0	0	100	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	0	80	20	0	0
1988	33	13	0.391	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0
1989	28	19	0.680	0	63	0	11	26	0	0	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	0	0	45	45	9	0
1991	37	2	0.054	0	50	0	0	0	0	0	50	0	0	0	0	0	50	0	50	0
1992	55	15	0.271	0	20	0	0	67	0	0	13	0	0	0	0	0	20	67	13	0
1993	77	52	0.673	0	13	0	6	77	0	0	4	0	0	0	0	0	19	77	4	0
1994	110	49	0.447	0	31	0	4	63	0	0	2	0	0	0	0	0	35	63	2	0
1995	115	42	0.367	2	38	0	5	52	0	0	2	0	0	0	0	2	43	52	2	0
1996	91	19	0.208	0	58	0	11	26	0	0	5	0	0	0	0	0	68	26	5	0
1997	148	4	0.027	0	0	0	0	100	0	0	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	0	0	100	0	0
1999	99	2	0.020	0	0	0	0	50	0	0	50	0	0	0	0	0	0	50	50	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

2000	125	9	0.072	0	0	0	0	89	0	0	11	0	0	0	0	89	11	0	
2001	125	12	0.096	0	8	0	17	75	0	0	0	0	0	0	0	25	75	0	0
2002	119	22	0.185	5	5	0	14	77	0	0	0	0	0	5	18	77	0	0	
2003	112	8	0.071	0	38	0	25	38	0	0	0	0	0	0	63	38	0	0	
2004	118	11	0.093	0	18	0	0	82	0	0	0	0	0	0	18	82	0	0	
2005	124	12	0.097	0	58	0	8	33	0	0	0	0	0	0	67	33	0	0	
2006	86	5	0.058	0	60	0	0	40	0	0	0			0	60	40	0		
2007	91	9	0.099	0	11	0	0	78		11				0	11	89			
2008	88	3	0.034	0	0		100							0	100				
Total	2,025	360																	
Mean			0.276	0	24	0	7	56	0	0	8	0	0	0	31	57	8	0	

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	0
1976	6	0	0.000	0	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	0
1978	11	18	1.698	0	0	0	0	11	33	22	28	6	0	0	0	33	61	6	0
1979	8	43	5.584	0	0	0	0	84	5	2	9	0	0	0	0	86	14	0	0
1980	13	42	3.333	0	0	0	0	19	5	19	52	5	0	0	0	38	57	5	0
1981	6	78	13.684	0	0	0	6	81	0	5	8	0	0	0	6	86	8	0	0
1982	5	48	9.600	0	0	2	2	77	8	0	10	0	0	0	2	79	19	0	0
1983	1	23	27.479	0	4	4	17	65	4	0	4	0	0	0	22	70	9	0	0
1984	53	47	0.894	0	13	0	4	77	2	0	4	0	0	0	17	77	6	0	0
1985	15	59	3.986	0	2	0	7	69	2	0	20	0	0	0	8	69	22	0	0
1986	53	111	2.114	0	11	0	0	77	1	0	9	0	2	0	11	77	10	2	0
1987	108	264	2.449	0	2	0	9	85	0	0	4	0	0	0	11	85	4	0	0
1988	172	93	0.541	1	5	0	0	90	0	0	3	0	0	1	5	90	3	0	0
1989	103	45	0.435	2	7	0	31	60	0	0	0	0	0	2	38	60	0	0	0
1990	98	21	0.215	5	0	0	10	81	0	0	5	0	0	5	10	81	5	0	0
1991	146	17	0.117	0	6	0	6	76	12	0	0	0	0	0	12	76	12	0	0
1992	112	15	0.134	0	0	0	0	93	7	0	0	0	0	0	0	93	7	0	0
1993	116	11	0.095	0	0	0	27	45	0	9	18	0	0	0	27	55	18	0	0
1994	282	53	0.188	0	0	0	13	85	0	0	2	0	0	0	13	85	2	0	0
1995	283	87	0.308	0	0	0	22	72	0	6	0	0	0	0	22	78	0	0	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

1996	180	27	0.150	0	0	0	15	85	0	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	0	25	75	0	0
1998	259	8	0.031	0	0	0	25	75	0	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	0	13	50	38	0
2000	222	12	0.054	0	0	0	0	100	0	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	0	40	20	40	0
2002	141	8	0.057	0	0	0	0	88	13	0	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	0	30	60	5	5
2004	156	35	0.225	0	0	0	3	83	3	6	6	0	0	0	0	3	89	9	0
2005	96	33	0.343	0	0	0	9	79	3	0	6	0	3	0	0	9	79	9	3
2006	101	15	0.148	0	0	0	7	27	33	0	33				0	7	27	67	
2007	114	95	0.833	0	1	0	7	88		3					0	8	92		
2008	177	7	0.040	0	0		100								0	100			
Total	3,722	1,352																	
Mean			2.205	0	1	0	13	63	4	2	9	0	0		0	14	65	14	1

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	0	0	100	0	0
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0	0
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	0	20	80	0	0	0
1996	29	0	0.000	0	0	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	0	0
1998	91	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	59	5	0.085	0	0	20	0	80	0	0	0	0	0	0	0	0	0	100	0	0
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	0	50	50	0	0	0
2001	42	2	0.047	0	0	0	0	100	0	0	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	0	0
2003	31	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	56	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	1	1	1.923	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	100	0
2006	8	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	12	2	0.173	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0	0
2008	31	1	0.032	0	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0
Total	574	23																		
Mean			0.161	0	9	1	1	41	0	0	7	0	0	0	0	11	42	7	0	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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 2006 - 2009 year class fish.

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

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

2000	51	63	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	0	0	28	64	8	0
2005	190	91	0.479	0	0	0	25	73	0	2	0	0	0	0	25	75	0	0
2006	151	78	0.517	0	0	0	13	68	1	4	14			0	13	72	15	
2007	161	211	1.314	0	0	0	9	90		0				0	9	91		
2008	125	44	0.353	0	0		100							0	100			
Total	2,188	4,944																
Mean			4.895	0	0	0	18	73	1	3	8	0	0	0	18	76	8	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	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	0	0
1990	4	0	0.000	0	0	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	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	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	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	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	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	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	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	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	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	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	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	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	0	0	8	46	46	0	0
2004	28	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	26	2	0.076	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0	0
2006	25	3	0.119	0	33	0	0	67	0	0	0					0	33	67	0	
2007	28	5	0.178	0	0	0	0	100		0						0	0	100		

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

2008	27	8	0.299	0	0	100								0	100
Total	432	100													
Mean			0.231	0	19	0	7	58	0	0	0	0	0	0	26 58 0 0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year	Total 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	0
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	63	0	0	13	0	0	0	0	25	63	13	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3	0	0	0	0	11	86	3	0
2005	84	1	0.012	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0
2006	73	5	0.069	0	0	0	0	80	0	0	20				0	0	80	20	
2007	57	4	0.070	0	0	0	0	100		0					0	0	100		
2008	63	4	0.064	0	0		100								0	100			

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Total	1,447	294																
Mean		0.194	0	4	0	13	76	0	0	6	0	0	0	17	76	6	0	0

Mean return rate computation includes incomplete return rates for 2006 - 2009 year class fish.

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

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

Year 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	0.343	1.923	0.081	0.089	0.076	0.097	0.012	0.479
2006	0.148	0.000	0.086	0.093	0.119	0.058	0.069	0.517
2007	0.833	0.173	0.097	0.095	0.178	0.099	0.070	1.314
2008	0.040	0.032	0.053	0.040	0.299	0.034	0.064	0.353

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	PW	CT	CTAH	SAL	FAR	WE	PN
Mean	2.205	0.161	0.394	0.503	0.231	0.276	0.194	4.895
StdDev	5.346	0.473	0.461	0.718	0.238	0.308	0.180	6.424

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

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

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

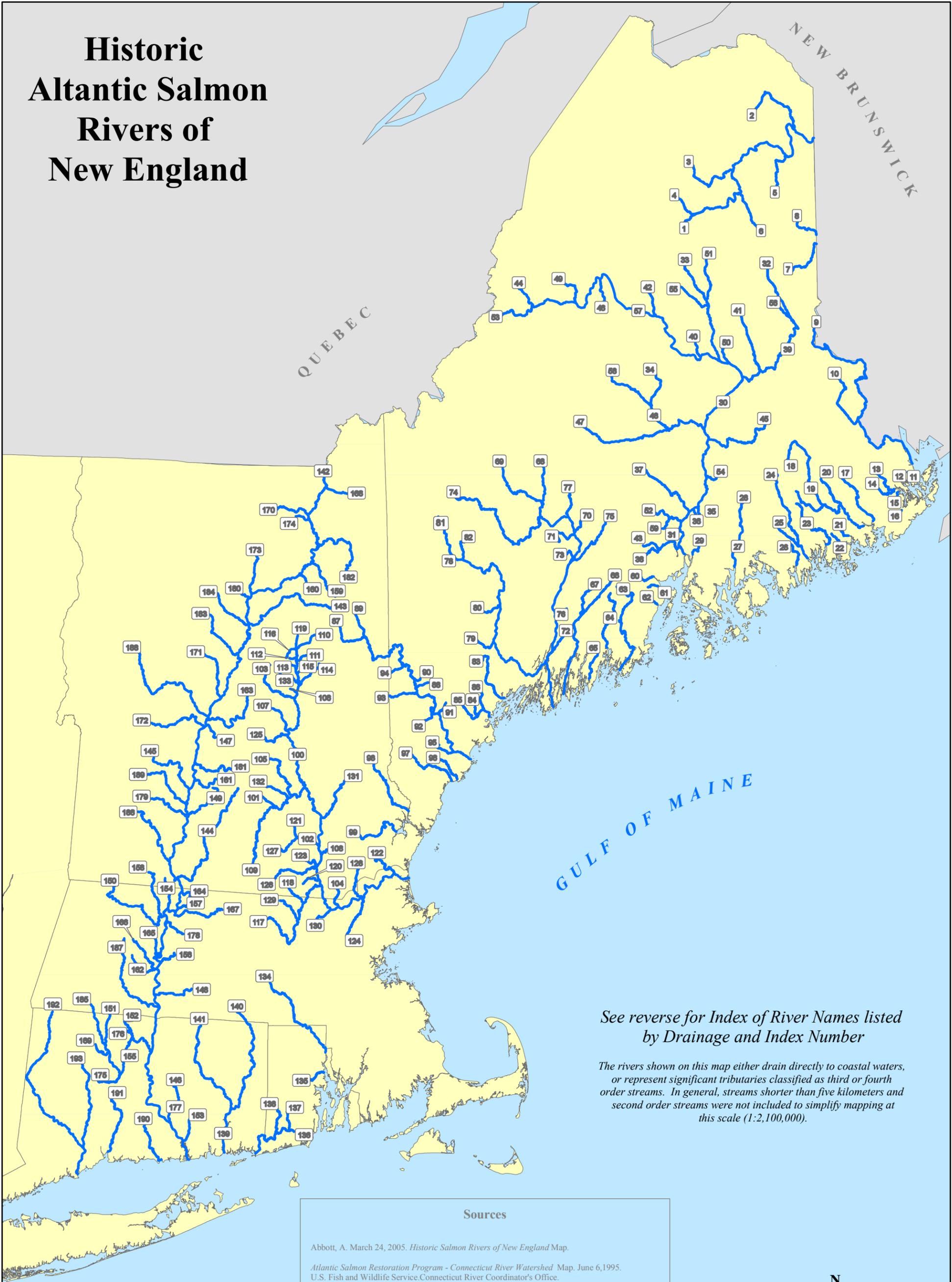
	Mean age class (smolt age. sea age) distribution (%)										Mean age (years) (%)				
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
Connecticut (above Holyoke)	0	4	0	4	86	1	0	5	0	0	0	8	86	6	0
Connecticut (basin)	0	8	0	5	81	1	0	5	0	0	0	13	81	5	0
Farmington	1	26	0	6	63	1	0	4	0	0	1	32	64	4	0
Salmon	1	20	0	19	60	0	0	0	0	0	1	39	60	0	0
Westfield	0	5	0	6	84	0	0	4	0	0	0	11	84	4	0
Penobscot	0	0	0	14	75	1	3	8	0	0	0	14	78	8	0
Merrimack	0	3	0	9	76	2	2	7	0	0	0	12	78	10	1
Pawcatuck	0	9	4	4	78	0	0	4	0	0	0	13	83	4	0
Overall Mean:	0	9	1	8	76	1	1	5	0	0	0	18	77	5	0

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

Historic Atlantic Salmon Rivers of New England – Index

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

Historic Atlantic 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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