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

REPORT NO. 25 - 2012 ACTIVITIES

Old Lyme, Connecticut
February 25-28, 2013

PREPARED FOR

U.S. SECTION TO NASCO

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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 939; this is the sum of documented returns to traps and returns estimated on selected Maine rivers, 77% less than observed in 2011 and 43% less than returned in 2010. Adult salmon returns to USA rivers with traps or weirs totaled 843 in 2012. Estimated return to Gulf of Maine coastal rivers was 115 adult salmon (90% CI = 76 – 167), the 14th highest for the 1991-2012 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 79% of the total return. Overall, 3% of the adult returns to the USA were 1SW salmon and 77% were MSW salmon. Most (74%) returns were of hatchery smolt origin and the balance (26%) originated from either natural reproduction or hatchery fry and eggs. A total of 6,936,800 juvenile salmon (fry, parr, and smolts), 5,097 adults, and 1,344,000 eggs were stocked, with 266,206 juveniles carrying a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 366 sea-run females, 2,410 captive/domestic and domestic females, and 6 female kelts. The number of females contributing was more than 2011 (2,030); however the total egg take 10,538,000 was lower than 2011 (11,594,000). Production of farmed salmon in Maine was not available, but was estimated at 5,397 metric tonnes (95% CI 2,381 to 8,413) using a regression of 2000 to 2009 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).

1.3 Adult Returns

Total return to USA rivers was 939; (Table 1.3.1), a 77% decrease from 2011 returns (Table 1.3.2). Returns are reported for three meta-population areas (Figure 1.3.1); Long Island Sound (LIS), Central New England (CNE), and Gulf of Maine (GOM). Changes from 2011 within areas were: LIS (-51%), CNE (-72%), GOM (-79%). For the larger rivers changes from 2011 were: Connecticut (-51%), Saco (-87%), Merrimack (-68%), Penobscot (-80%). In addition to catches at traps and weirs (843), the return of 115 (90% CI = 76 – 167) salmon was estimated for coastal populations within the Gulf of Maine area based on a linear regression [ln (returns) = 0.559 ln(redd count) + 1.289]. The ratio of sea ages for fish sampled at trap and weir 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 66% of the total return. Overall, 3% of the adult returns to the USA were 1SW salmon and 77% were MSW salmon. Most (74%) returns were of hatchery smolt origin and the balance (26%) 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 2010 was 0.22%, with the 2SW fish return rate 0.09% (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 2010 cohort of wild smolts on the Narraguagus was 0.42% (Figure 1.3.3).

In the USA, returns are well below conservation spawner requirements. Returns of 2SW fish from traps, weirs, and estimated returns were only 3 % of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 1.2 to 4.5 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2012 about 6,936,800 juvenile salmon (83% fry) were released into 13 river systems (Table 1.4.1). The number of juveniles released was less than that in 2011 (11,480,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and five coastal rivers within the GOM area Maine. The 419,000 parr released in 2012 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 (71,200), CNE Saco (11,900), and GOM Penobscot (555,000). In addition to juveniles, 5,097 adult salmon were released into USA rivers (Table 1.4.2). As in most previous years, more than half these adults were spent broodstock. On the Dennys River mature pre-spawn salmon stocking replaced annual fry stocking for the 2011 and 2012 spawning cohorts. In the fall of 2012 257gravid adult salmon were stocked into the Dennys River watershed; less than the 299 adults stocked in 2011. These pre-spawn adults and those released into three other coastal rivers in the GOM area produced redds. In the 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 and into the Merrimack were added to USA 2SW returns to calculate spawners. Thus, spawners exceeded returns in 2012 with USA spawners totaling 2,080. Escapement to natural spawning areas was 1,441 (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 271,116 salmon released into USA waters in 2012 was marked or tagged. Tags and marks for parr, smolts and adults included: Floy, PIT, radio, acoustical, and fin clips. There were no visual implant elastomer tagged smolts stocked in USA waters. About 24% of the marked fish were released into the CNE area and 49% 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 5,397 metric tonnes (95% CI 2,381 to 8,413) based on a regression of production and smolt moved to pens two years before. The estimate was approximately 49% of the 11,127 metric tonnes of production reported in 2010 (Table 1.6.1).

1.7 Potential Effects of Climate Change

The persistent range of Atlantic salmon in North America may be redefined by the dynamics of ocean and freshwater thermal conditions in combination with near-shore prevailing winds and riverine hydrology. These key ocean and freshwater salmon habitat conditions will change with climate and influence the viability of salmon populations (Todd et al. 2011). Three areas where climate change may affect salmon in North America are being investigated: the potential to exceed thermal thresholds in juvenile freshwater rearing areas, the phenology of smolt migrations (Todd et al. 2012), and thermally forced mortality in post-smolt marine nursery areas (Friedland et al. 2012). The likelihood of salmon freshwater habitats exceeding 23 and 27°C, physiologic thresholds of juvenile salmon growth and survival, has increased in mainstem rearing areas in New England salmon rivers. The phenology of smolt migrations in North America may be further unsynchronized by a differential shift in transitional temperatures in the juvenile rearing areas and the coastal ocean (Friedland et al. 2013). Increased sea surface temperatures, like that in 2012 that may reduce returns of 2SW in 2014, are expected to continue to erode marine survival for southern tier stocks (Friedland and Todd 2012).

Dr. B. Letcher and colleagues are developing a web site that links climate models with environmental models and fish models. Once complete, this modeling system will allow scenario testing of management alternatives under future climates in freshwater. The fish models, based on data from individually-tagged juvenile salmon, are being used to relate variation in stream flow (Steinschneider et al. 2012) and temperature to demographic process, including body growth and survival (Davidson et al. 2010). Integral projection models based on these relationships have shown that New England salmon population growth is declining and particularly sensitive to stream temperature in the fall. Forecasts of environmental conditions will result in faster rates of decline.

Collaborators at CONTE Laboratory are also developing models monitoring datasets of untagged fish to relate environmental conditions to occupancy and population growth.

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Table 1.3.1 Documented Atlantic salmon returns to USA by geographic area, 2012. "Natural" includes fish originating from natural spawning and hatchery fry.

Area	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	TOTAL
LIS	0	0	1	55	0	0	0	0	56
CNE	0	1	93	27	15	3	0	0	139
1 GOM	14	9	560	145	9	0	2	5	744

[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, 1967-2012. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

	Sea age					Origin	
Year	1SW	2SW	3SW	Repeat	Total	Hatchery	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1078	3	17	1,650	1,401	249
2011	1080	3045	26	16	4,167	3,465	702
2012	24	881	27	7	939	694	245

Table 1.3.3 Two sea winter (2SW) returns for 2012 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2012	Percentage of Requirement
Long Island Sound	LIS	10,094	120	1.2%
Central New England	CNE	3,435	56	1.6%
Gulf of Maine	GOM	15,670	705	4.5%
Total		29,199	881	3.0%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2012. 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	1,739,000	3,000	8,000	4,000	0	71,000	1,825,000
Central New England CNE	2: Merrimack, Saco	1,412,000	0	13,000	0	12,000	0	1,437,000
Gulf of Maine GOM	8: Androscoggin to Dennys	1,875,000	39,000	1,000	0	675,000	0	2,590,000
Outer Bay of Fundy OBF	1: Aroostook	731,000	0	0	0	0	0	731,000
Totals for USA	13	5,757,000	42,000	22,000	4,000	687,000	71,000	6,583,000

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2012 by geographic area. Egg numbers are rounded to 1,000.

			Captive Reared Domestic		Sea Run			Eggs
River		Purpose	Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	Total	Eyed
Central New England	CNE	Recreation	1,295				1,295	
Central New England	CNE	Restoration	640		20	107	767	
Gulf of Maine	GOM	Restoration	481	2,085		469	3,035	1,344,000
Total for USA							5,097	1,344,000

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2012. Includes hatchery and wild origin fish.

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Parr	34,800	68,707	3,905	107,412
AD	Smolt	27,905	59,123	71,018	158,046
FLOY	Adult	1,695			1,695
PING	Smolt		358		358
PIT	Adult		2,034		2,034
RAD	Adult	16	5	10	31
RAD	Adult	2			2
RAD	Smolt		388		388
Grand Total		64,418	130,615	74,933	269,966

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 2012. Production for 2012 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	6,031
2012	2,381 to 8,413

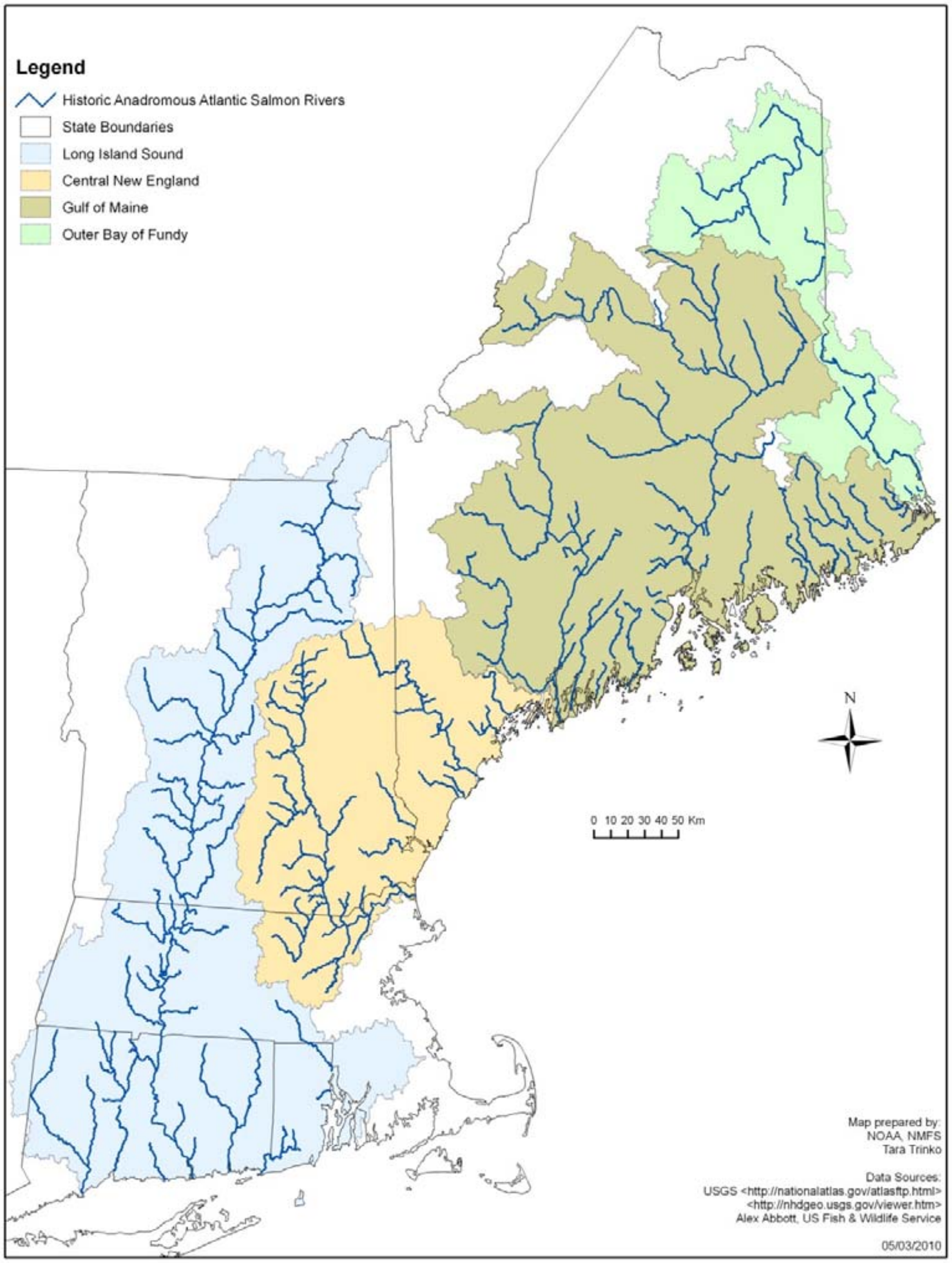


Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2012.

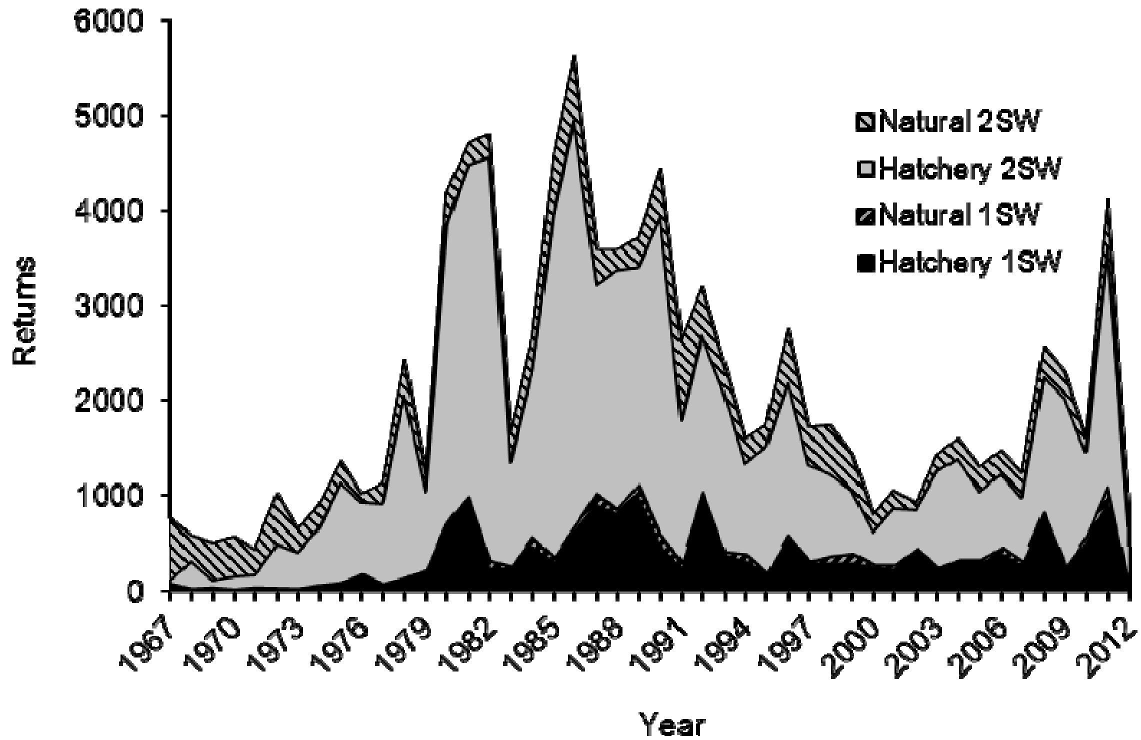


Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2012.

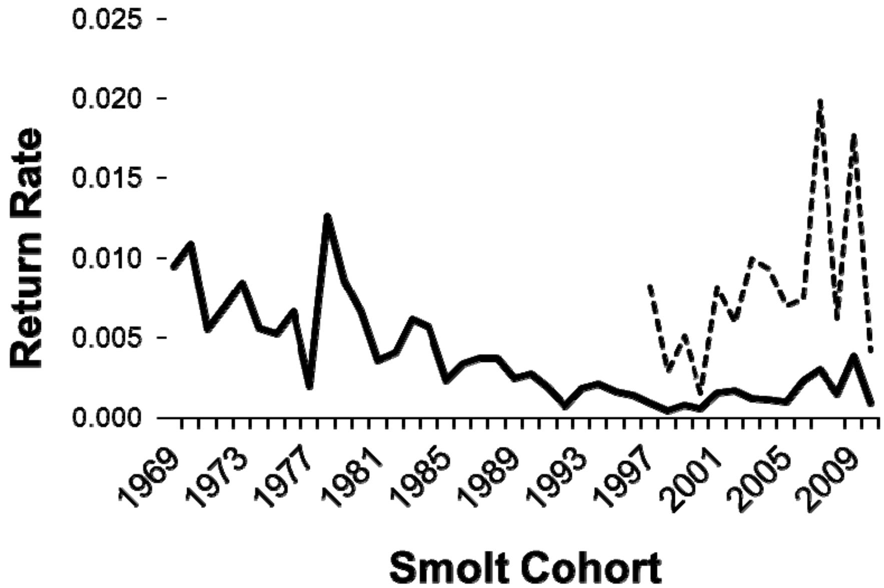
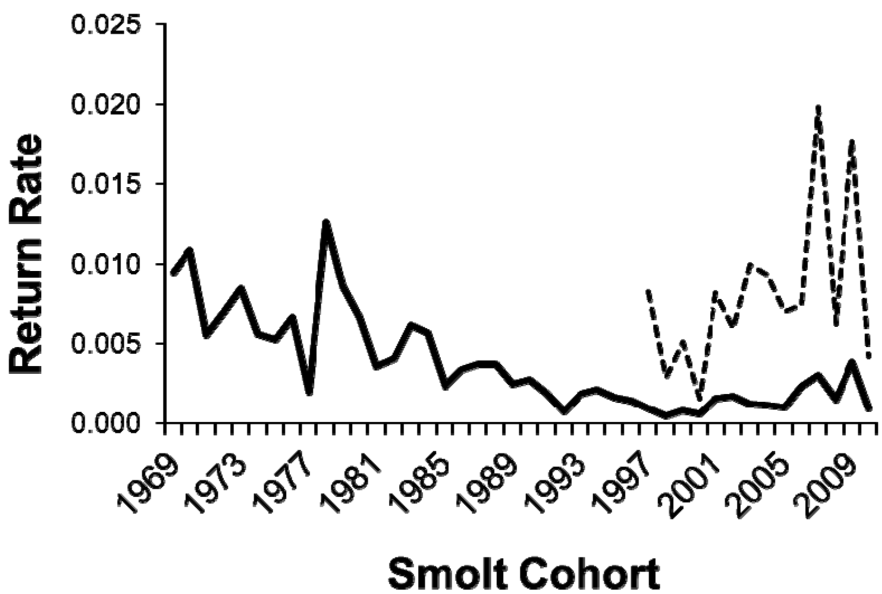


Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

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 could 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. Five Downeast Coastal stocks (Dennys, East Machias, Machias, Pleasant, Narraguagus), one Penobscot Bay stock (Penobscot), and one Merrymeeting Bay stock (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 conservation hatchery inputs to these systems, 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** DPS 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 stock. 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. Similar annual regulatory measures were adopted in 2004 and 2005. In 2006, multiannual regulatory measures covering the 2006-2008 fishing seasons were adopted assuming that the Framework of Indicators used in those interim years showed 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. Similar multiannual regulatory measures have been adopted to cover the 2009–2011 and the 2012-2014 fishing seasons.

2.3 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 and valued at $73.6M. With one company in production since 2011, confidentiality policies preclude detailed reporting. The Industry projects that with new practices of fallowing production areas and rotations, 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.

2.4 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.

2.5 Stock Assessment

2.6 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 5.7 million juvenile salmon were stocked in 2012 across 16 river systems, a reduction of about 50% from the median for the decade. Fry stocking dominates numerically, with 10.2 million stocked; fry were planted in all 16 systems. Six river systems were stocked with parr and six with smolts. Managers stocked around 800,000 smolts in US waters, with 554,000 stocked in the Penobscot River. This smolt 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.

2.7 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). From 1967 to the present, the median annual Atlantic salmon return to US Rivers was about 1,670. The time-series of data clearly shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (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. Smolt stocking drives much of the overall total adult returns and in 1977, smolt stocking exceeded a half million and has stayed above that level since then. From 1977 to 1990, the median US returns was 3,824 and recovery and restoration appeared within reach. Unfortunately, the trajectory of this recovery did not continue due to a phase shift circa 1991 in marine survival, and an overall reduction in marine survival occurred in most southern North American populations (Chaput et al. 2005). Median annual Atlantic salmon returns to US rivers from 1991 to the present is

1,717 fish, less than 45% of the1977-1990 time-series median. 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.

Median returns since 2008 have averaged 2,359 fish suggesting a modest increase in marine survival may be occurring. However, returns to US waters in 2012 were only 939 fish, which ranks 38th in the 46 year time-series. Relative to the median during the current marine phase (1991–present), returns were the second lowest in 22 years. This is in stark contrast to 2011 returns that were the highest in the modern period.

Overall stock health can be measured by comparing abundance relative to 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 2012 was 3.0% 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 2012 were typical, in that the Penobscot River population and hatchery smolt accounted for the largest percentage (75%) of the total return.

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. Median 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 (23.3) and decreased southward for the Central New England (11.1) and Long Island Sound (1.8) stock indices.

Maine return-rate assessments provide both an index 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 (SAR) for the last five years was 7.1 for 1SW salmon and 23.2 for 2SW fish. The total cohort SAR averaged 31.2. Starting in 1997, NOAA began a program to estimate production of naturally-reared smolts in the Narraguagus River, Maine. The average cohort SAR for naturally reared Narraguagus River smolt for the past five years was 144.5. That rate was 4.6 times higher than the Penobscot 2SW hatchery cohort average for the same time-period.

In 2012, the SAR for 2SW hatchery smolts released in the Penobscot River was 9.4, ranking 35th in the 42-year record, while the 2012 return rate for 1SW hatchery grilse was 0.1 ranking 42nd in the 43-year record. The 2SW return rate in the Narraguagus River in 2012 was 23.1, more than 2.5 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.

2.8 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 km^2), with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people, with salmon habitat in cities and remote wilderness. However, taken over a long time–series, this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

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 trends was a graphical comparison of large parr densities throughout the region. Densities were calculated for sites with at least 10 years of 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). For the Gulf of Maine DPS, data included density estimates from CPUE estimates as well as depletion-sampled estimates. The predicted year effects were then back-transformed to density units (Figure 2.4.3.1).

An examination of average densities (# per 100 m^2 habitat units) from 2008 to present shows generally higher densities in Gulf of Maine DPS (3.7) estimates, relative to the Central New England (1.7) and Long Island Sound (1.6) but with substantial inter-annual variability. However, densities in the Gulf of Maine, while still variable, are higher in the past five years and may be trending upward. 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 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. The Connecticut River estimate was discontinued in 2012 due to changing management practices. 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.

2.9 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.

2.10 Summary

Historic Atlantic salmon abundance in New England exceeded 100,000 returns annually (National Research Council 2004). Habitat changes 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 1991. Since 1991, median US salmon returns were 1,717 fish, and returns in 2012 were only 939 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 since have been low, compromising the long-term prospects of even hatchery-supplemented populations. Returns since 2008 suggest a potential shift to higher ocean productivity. Additionally, mariculture is increasing worldwide, and New England production should be around 6,000 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 2011-2012 no reported harvest but estimated to be in range of 6,000 mt from industry projections.

Category	1993-2002 Average	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
U.S. Recreational (#) *	16.0	-	-	-	-	-	-	-	-	-	-
US Aquaculture	10.8	6.0	8.5	5.3	4.7	2.7	9.0	6.0	11.1	**	**
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	10.8	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).

Stock Complex	CSE	2012	%CSE
Long Island Sound Complex	10,094	56	0.6%
Central New England Complex	3,435	120	3.5%
Gulf of Maine DPS	15,670	705	4.5%
Subtotals	**29,199**	**881**	**3.0%**

For further information

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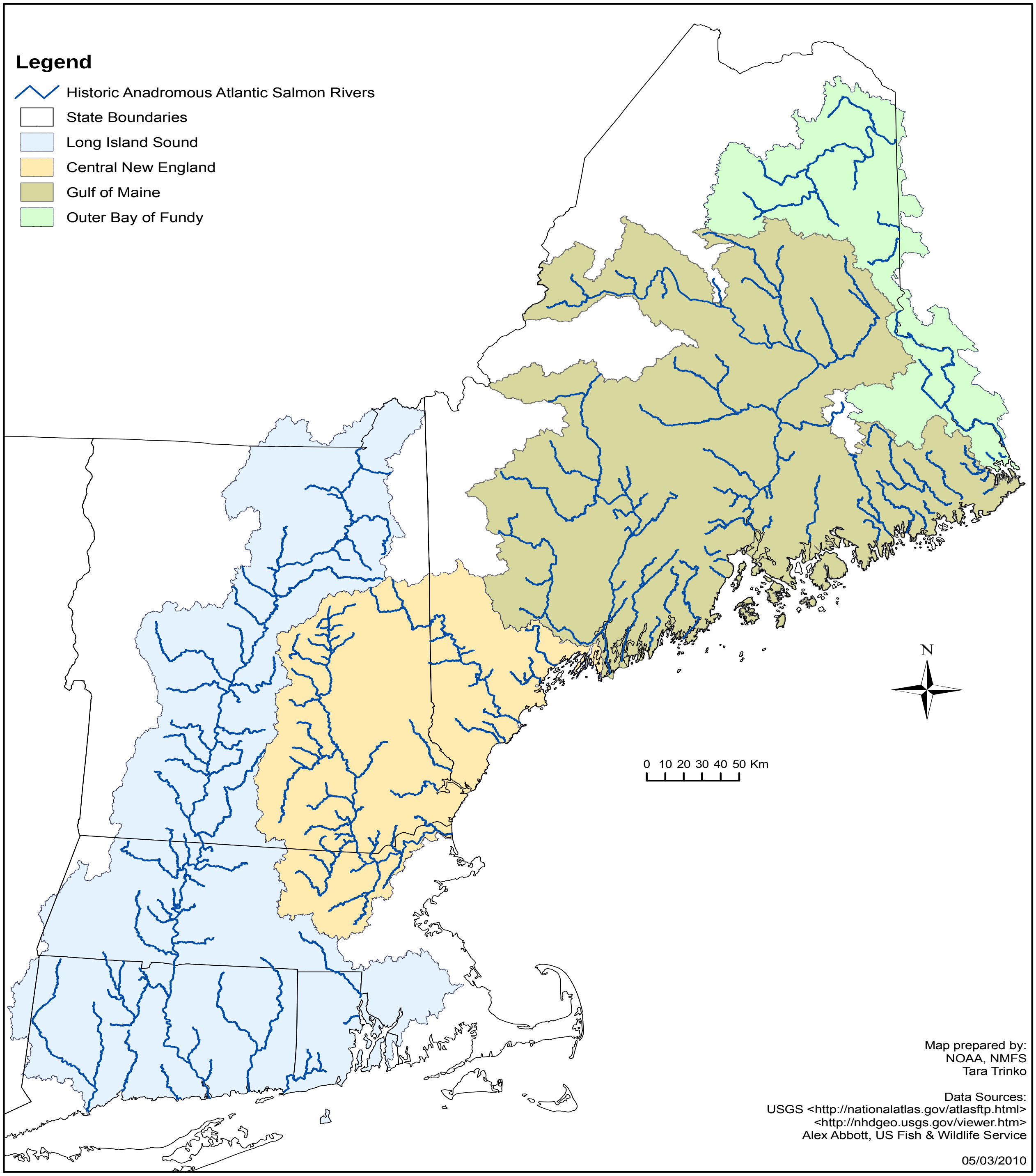


2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

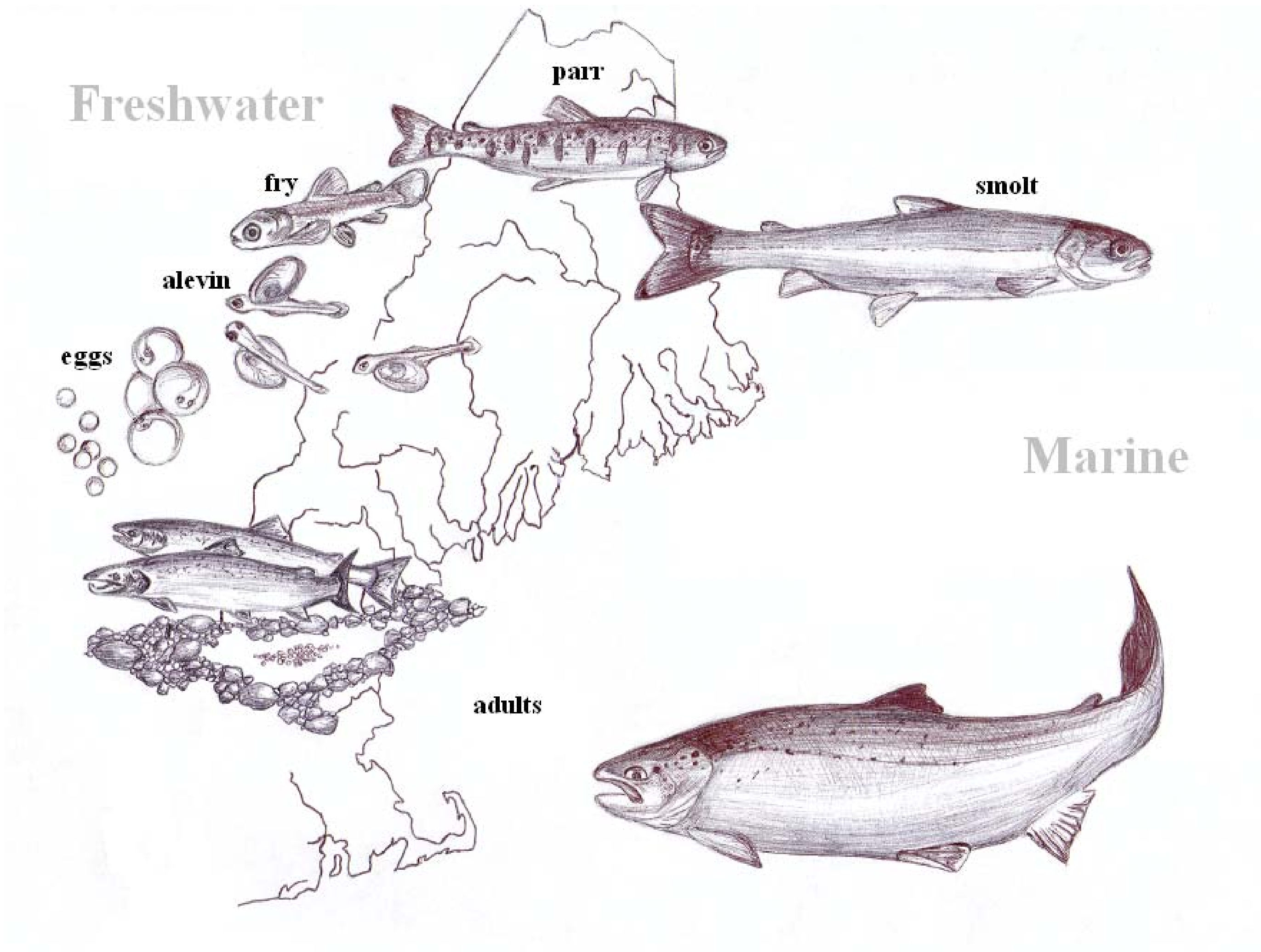


Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

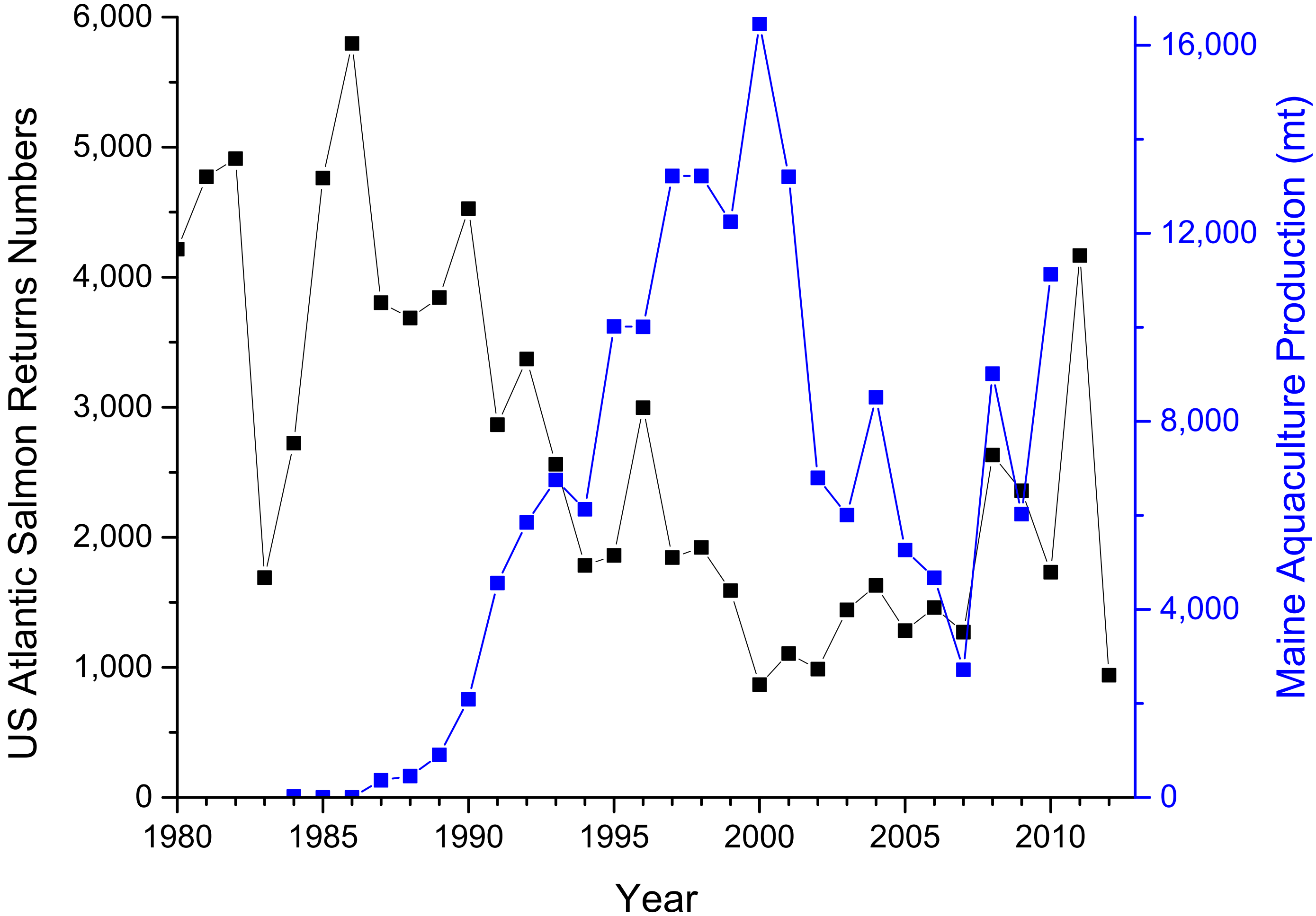


Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons).

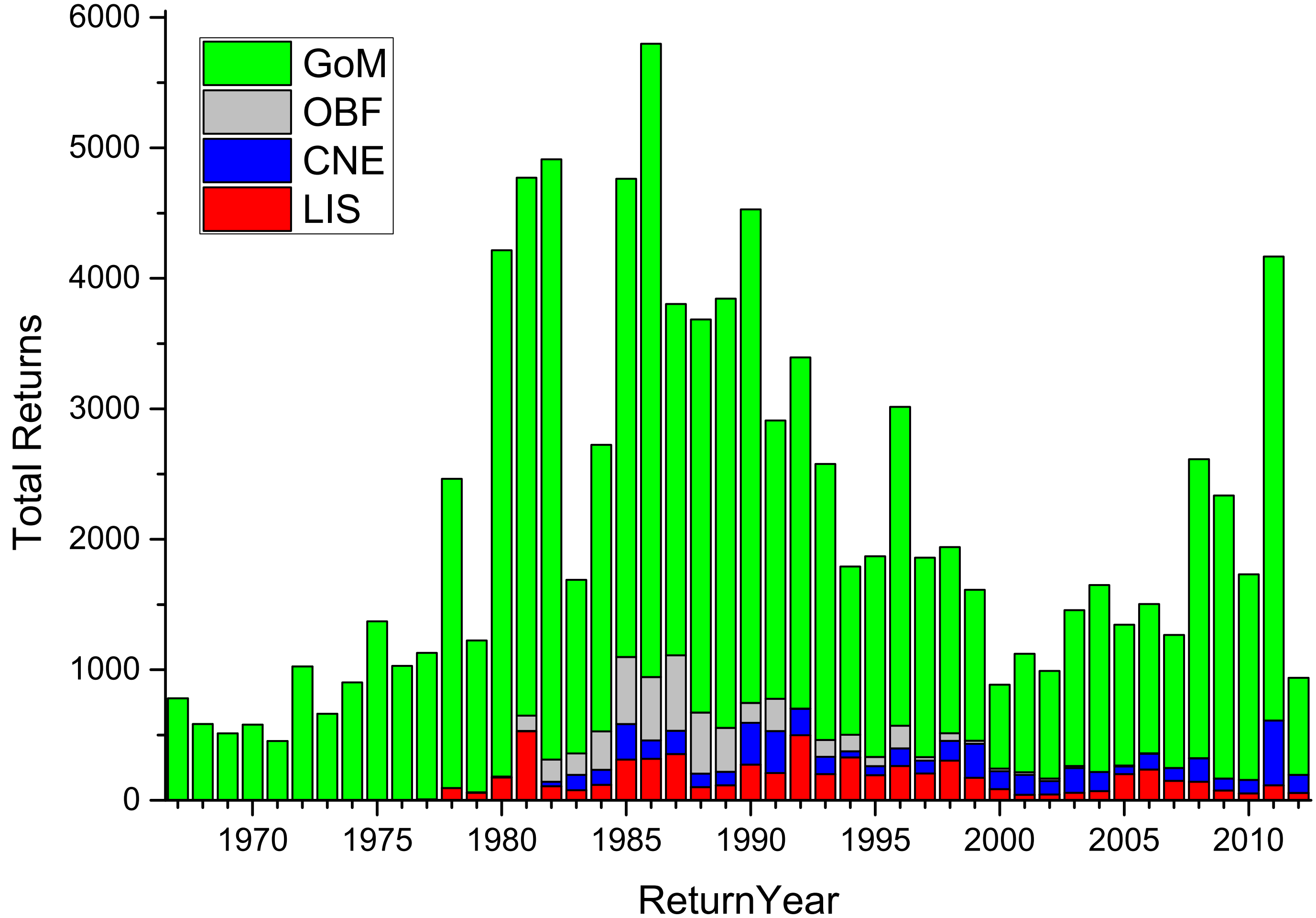


Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex.

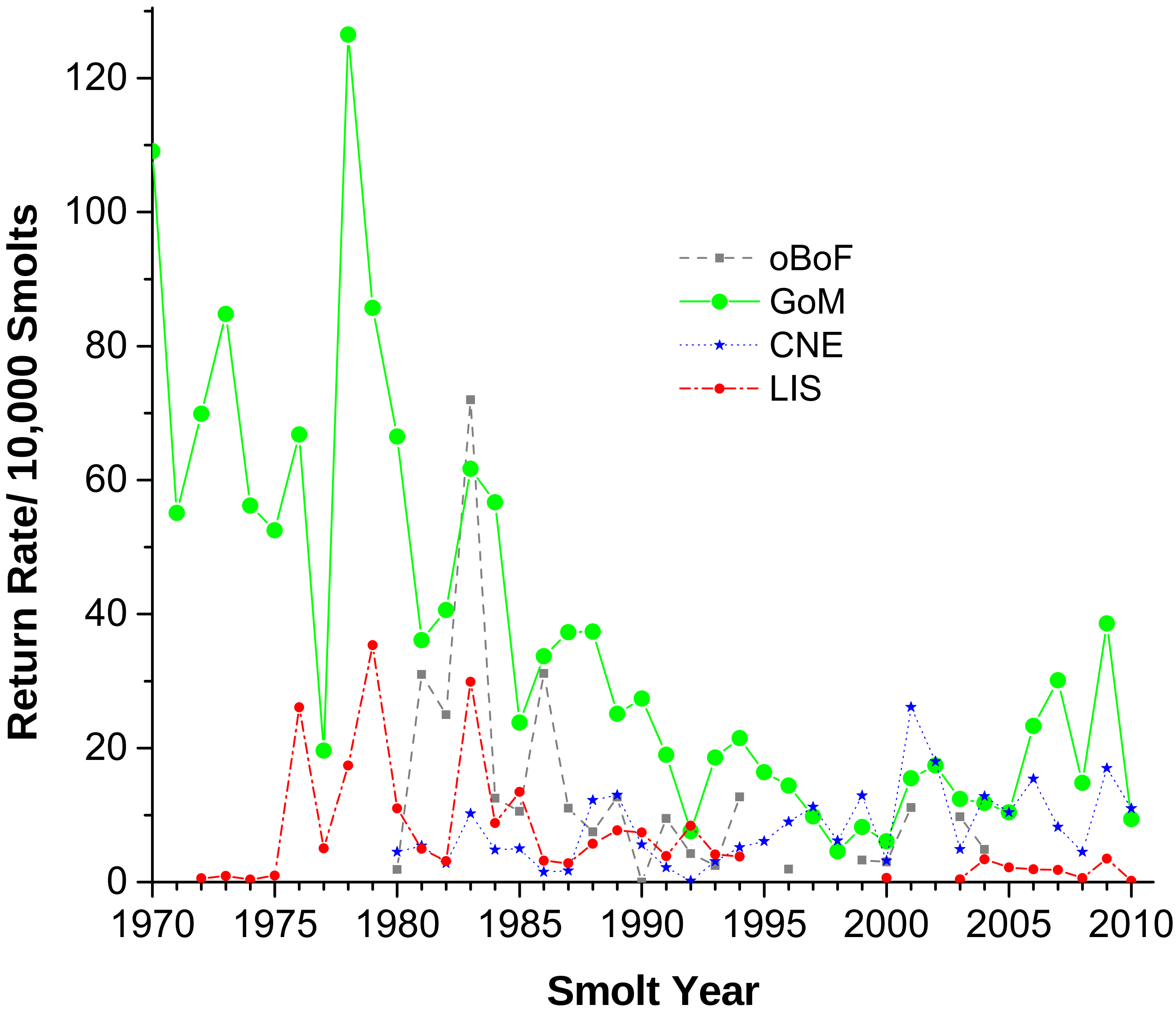


Figure 2.4.2.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

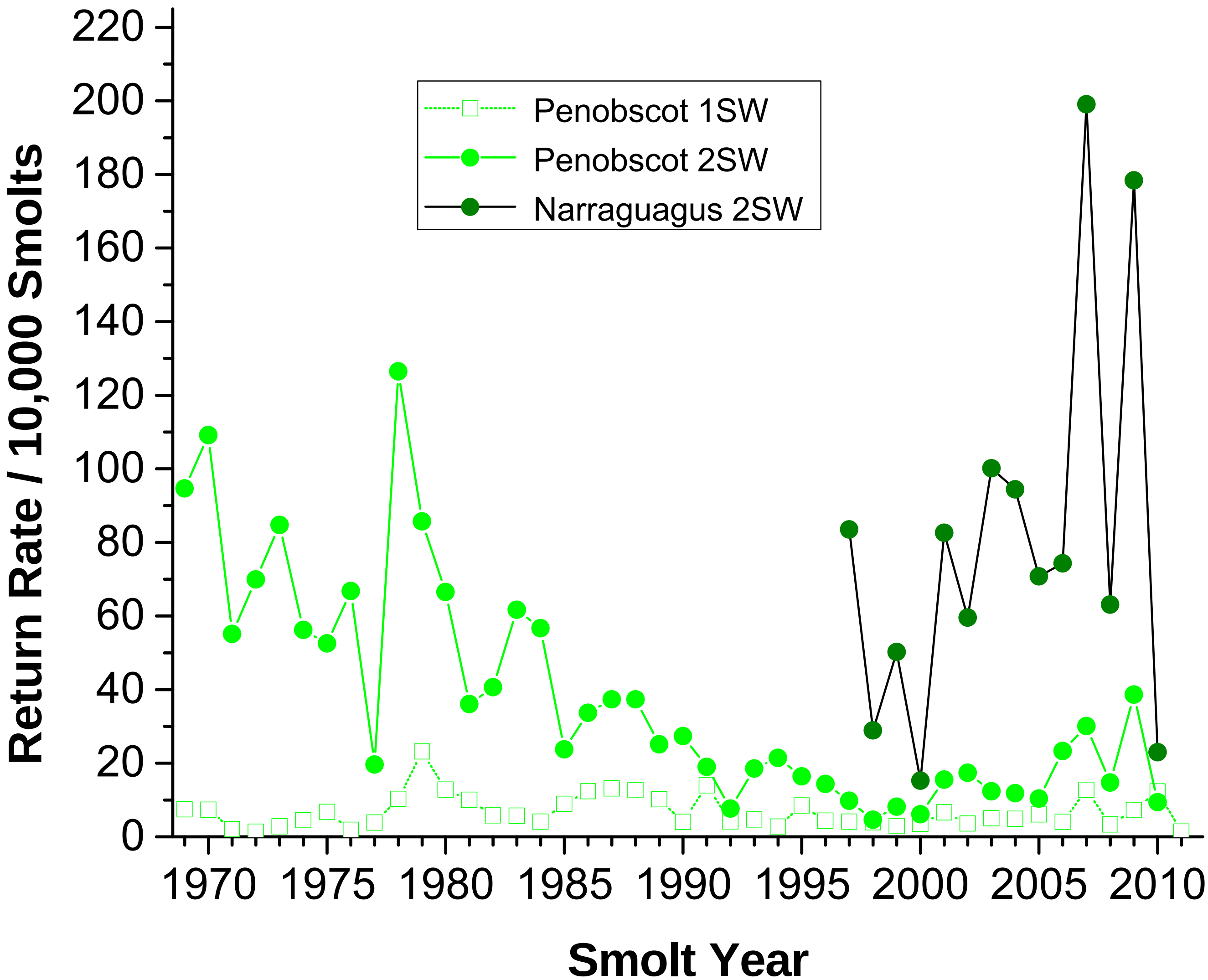


Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

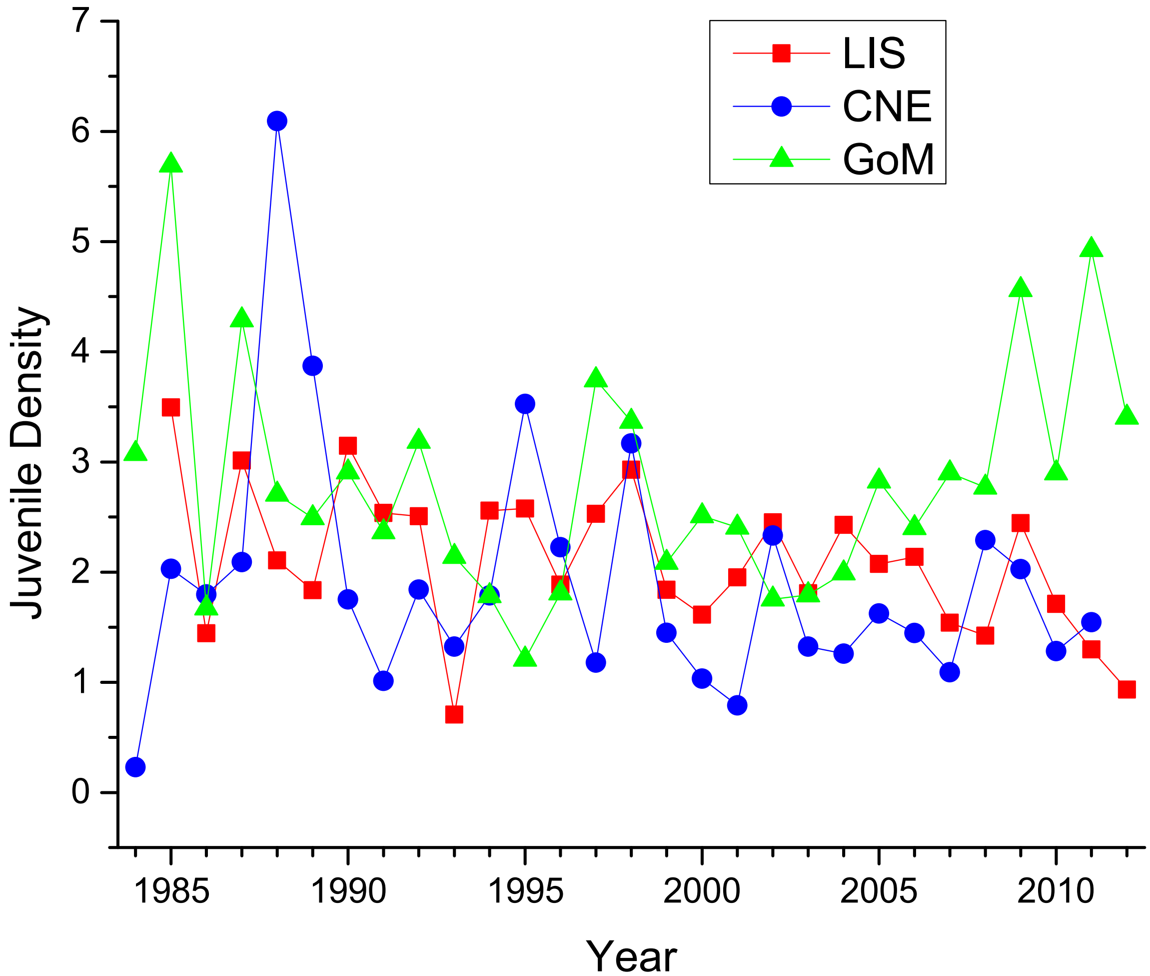


Figure 2.4.3.1 Index of large parr density from a mixed random effects model using electrofishing data from sites with > 10 years of data from 1984 through present from USASAC databases for three stock complexes: Long Island Sound, Central New England, and in the Gulf of Maine DPS.

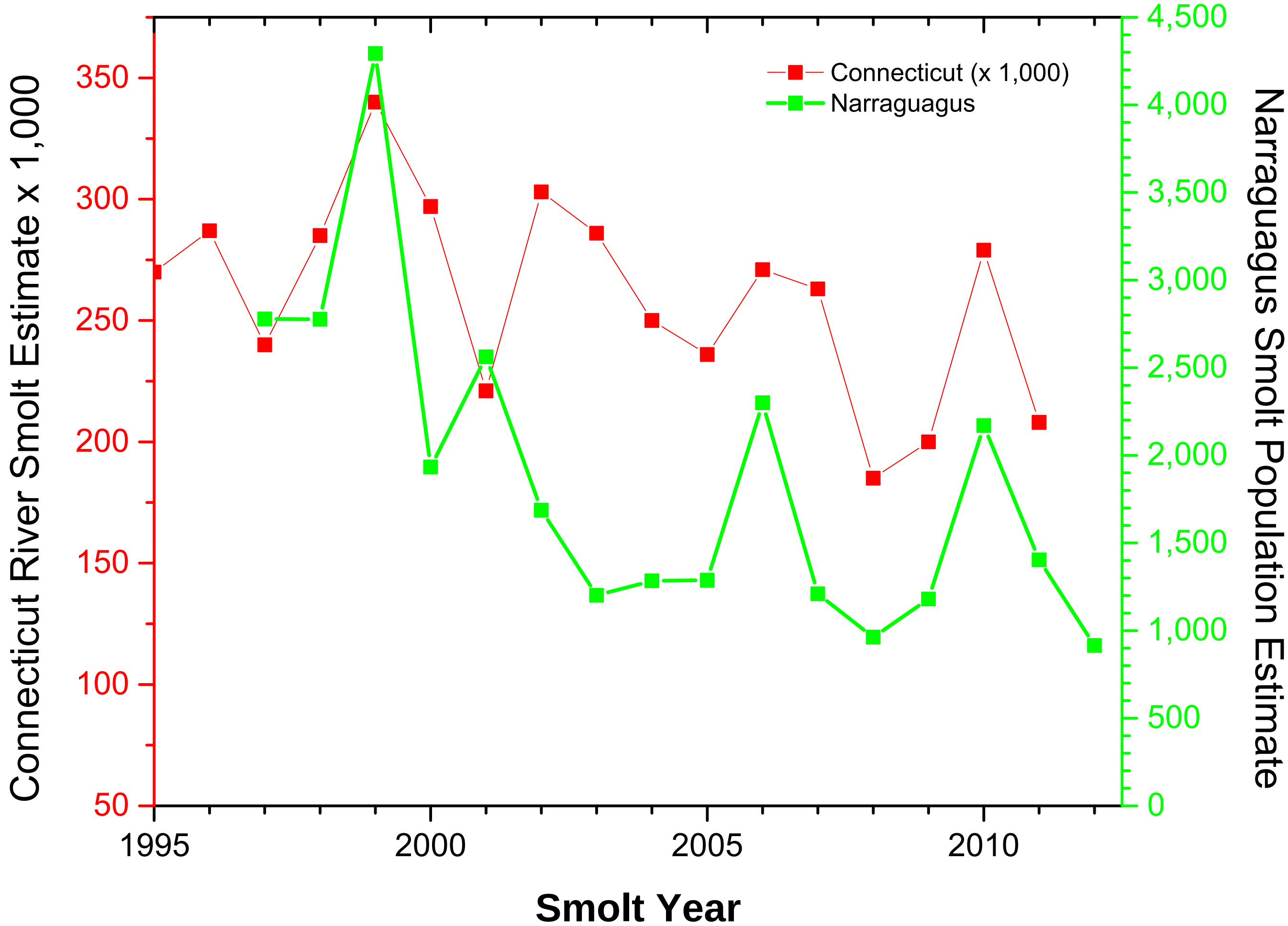


Figure 2.4.3.2 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine and the Connecticut River Basin in total. See text for details of estimation methods.

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 2012. The following is a summary of work on Atlantic salmon.

3.1.1 Adult Returns

A total of 54 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 29 on the Connecticut River mainstem, 5 in the Farmington River, 14 in the Salmon River and 6in the Westfield River. A total of 45 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS).

Ten salmon were trapped at the Holyoke Dam, radio-tagged and released upstream, one was subsequently recaptured and retained at the RCNSS, leaving a total of nine fish released. One tagged adult entered the Deerfield River briefly before moving into the Millers River, five (including Millers River fish) passed the fishways at Turners Falls, four passed the Vernon Dam Fishway, two passed passed Bellows Falls fishway and continued upriver, both fish passing at Wilder Dam fishway.

One (2%) salmon was of hatchery (smolt-stocked) origin. The remaining 53 (98%) were of wild (fry-stocked) origin. No grilse were documented in 2012; all returns were determined to be two sea-winter age fish. Freshwater age distribution of wild salmon was 1^{+} (6%), 2^{+} (92%) and 3^{+} (2%).

3.1.2. Hatchery Operations

In 2012, the program achieved 32% of egg production goals (4.8 million eggs produced, 15 million goal), 17% of fry stocking goals (1.7 million fry stocked, 10 million goal), and 71% of smolt stocking goals (71,000 viable smolts stocked, 100,000 goal).

As noted in last year's report, the damage and ultimate closure of the White River National Fish Hatchery (WRNFH) resulted in a substantial decrease in the green egg take, which translated to a very low fry stock-out in 2012. In addition, poor eye-up rates were observed at State-operated facilities, further exacerbating this situation. As of this report, WRNFH remains closed. At the July 2012, CRASC meeting, the USFWS announced its decision to no longer support fish culture of Connecticut River Atlantic salmon. The Dwight D. Eisenhower National Fish Hatchery and Berkshire National Trout Hatchery will stock the last Connecticut River salmon on their stations as age 2 smolts in 2013. RCNSS is being considered for other USFWS uses at this time.

The USFWS decision in July resulted in a re-assessment of restoration program fish culture capacity among the State partners, under a charge given by the CRASC. A report was provided back to CRASC in October that addressed the charges and future options to the extent possible. Ultimately in November 2012, the Massachusetts Division of Fisheries and Wildlife (MADFW) determined it would no longer operate the Roger Reed State Fish Hatchery (RRSFH) in support of the restoration program, as a result of the USFWS decision. Domestic Atlantic salmon broodstock retained at RRSFH were spawned in the fall of 2012 and all Connecticut River salmon were subsequently stocked out to support an established broodstock ice fishery program. RRSFH will stock out their last Connecticut River Atlantic salmon fry in 2013. The Connecticut Department of Energy and Environmental Protection (CTDEEP) determined that it would continue to produce a reduced number of salmon broodstock and fry at its Kensington State Fish Hatchery. The Vermont Department of Fish and Wildlife (VTFW) determined that it would accept eggs from other partners to incubate for fry stocking at its Roxbury State Hatchery. Decisions by MADFW and CTDEEP will preclude this after 2013. More information is included in the Program Update section on this matter.

Egg Collection

A total of 4.835 million green eggs was produced at the two state and one federal hatchery in 2012. Sea-run broodstock produced 234,200 eggs from 33 females and 37,116 eggs from six kelts held at RCNSS. Domestic broodstock produced 4.56 million eggs from 721 females held at KSSH and RRSFH.

3.1.2 Stocking

Juvenile Atlantic Salmon Releases

A total of 1.82 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2012. Totals of 509,107 fed fry and 1.22 million unfed fry were stocked into tributary systems with the assistance of hundreds of volunteers. Totals of 71,018 (2smolts), 3,963 (2parr), 7,499 (1parr) and 3,105 (0parr) were released into lower sections of larger tributaries from Connecticut upriver into Vermont. Numbers of fry stocked was greatly reduced from the previous ten-year average which had been approximately 6 million, for reasons noted in the Hatchery Section.

Egg Plants

The fall of 2012 spawning, with reduced facility operation capacity and an improved status of domestic broodstock, resulted in an egg take beyond the available incubation capacity at KSFH. The CTDEEP, using Maine Department of Marine Resources back-pack egg planting pump, planted 306,306 green eggs in the West Branch of the Farmington River and in one of its tributaries.

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).

3.1.3 Juvenile Population Status

Smolt Monitoring

Monitoring of smolts at the Turners Falls Dam was conducted on a reduced scale in 2012. No mark-recapture smolt study (FirstLight Power, Holyoke Gas and Electric, USFWS) was conducted in 2012. Limited data were obtained from monitoring at the Cabot Station bypass sampler, at the Turners Falls Dam, by FirstLight Power staff. A total of 235 smolts was sampled April 27 - June 11 at the Cabot Station sampler. Smolts were also collected at Moore Dam, at the 15 Miles Project Area, in the upper basin by TransCanada hired biologists and released downstream of their Vernon Dam. Up to this year, these smolts had been released downstream of McIndoes Dam, but the power company in 2012 offered to move smolts further downstream. A total of 1,367 smolts was collected April 17 - June 18, with over 80% of the catch occurring between May 5 and June 6. This sample size is consistent with past years' data at this site. The CTDEEP monitored the smolt run at the Rainbow Dam Bypass using real-time direct counts and digital videography. A total of 504 smolts (233 from the fishway window and 271 from the bypass) was observed.

Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at index stations throughout the watershed. Sampling was conducted by CTDEEP, MADFW, NHFG, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production.

3.1.4 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. The CRASC Fish Passage Subcommittee worked to develop a standardized fishway inspection form, with the USFWS Fish Engineering as the lead. In 2012, main stem dam (upstream) fishways of Vernon, Turners Falls, and Holyoke were inspected, prior to opening. The State of Connecticut conducted inspections within their state and the USGS Conte Lab provided additional professional input. Additional in-season and post season inspections are also identified as desirable and are both long-term monitoring goals.

The licenses of five large hydropower projects (four main stem dams) will expire in 2018. These projects are Turners Falls, Vernon, Bellows Falls, and Wilder dams as well as the Northfield Mountain Pumped Storage facility, a project area (affected) spanning 175 river miles. State and Federal resource agencies have had pre-application discussions on this topic, worked with NGOs, participated in scoping and facility tour meetings, and reviewed Preliminary Application Documents over the past year. At this time, a total of 44 Study Requests has been developed and will be submitted among the resource agency participants. The requests broadly address issues of fish passage, habitat, and aquatic (dependent) organism populations. The FERC deadline for receiving these requests and comment is March 1, 2013.

Vernon Dam – The Vernon Dam fish ladder was inspected by the USFWS Fish Engineer Section and USGS Conte Lab in the spring of 2012, prior to watering, which resulted in the identification of several issues, which were promptly addressed. The result was a dramatic increase in American shad passage rates not observed in seven years.

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 to address downstream passage concerns for shortnose sturgeon and American eel.

Vermont Yankee Nuclear Power Plant- The State of Vermont is in the process of a legal hearing on one of the permits (certificates) required for the plant's operation. In addition, the administratively expired State NPDES permit is slated for reissuance in 2013. The State has recently demanded study plans to examine whether there are effects to the American shad population following a seven year-old increase to effluent temperature rates permitted by the state.

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.

Gilman Dam- A downstream fish bypass was in operation for spring 2012.

Manhan River Dam- Denil ladder construction was delayed due to construction problems and required additional funding for completion, which was secured. USFWS must complete some final steps internally in Contracting Office for the Town to be able to proceed as of the time of this report.

Fiske Mill Dam- The fish lift at the first dam on the Ashuelot River was completed and operational in the spring of 2012.

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.

3.1.5 Genetics

Tissue samples were taken from all 2012 sea-run broodstock for genetic monitoring. Microsatellite analysis for broodstock management was completed by the USFWS Northeast Fishery Center (NEFC). The sea-run broodstock were PIT tagged to ensure individual identification at spawning. This information is necessary to develop the mating scheme linking individual broodstock to their genetic information, in a deliberate effort to mate salmon that are not closely related. Monitoring indicates that gene diversity and allelic richness remains high across multiple generations. There is annual fluctuation in allele diversity but alleles are being maintained in the population.

Mature male parr, collected from the Sawmill River, supplemented sea-run males. Mating of sea-run females utilized a 3 male: 1 female breeding matrix. A 1:1 spawning ratio was observed for domestic brood stock spawned at the KSSH and RRSFH.

Sea-run origin fry were stocked in Bronson Brook and Sawmill rivers in the spring of 2012 for mature parr production to supplement future male spawners.

A multi-year effort to process genetic samples from the Atlantic Salmon Marking Study was initiated in 2011 and continued in 2012 with funding from VTDFW, NMFS, USFWS and implemented by the USFWS-NEFC. As of October 2012, a total of 6,459 samples was extracted for analyses, with genotyping of 3,925 samples (ranging from 1998 adult grandparents through 2010 smolts). Data have been sent to USGS Conte Lab for further analyses. Ten marked year classes (starting in 2002) were created and will continue to provide opportunities for sampling through the 2015 adult runs. As a priority, tissue sampling from adults are expected to continue, while sampling of smolts may no longer be possible or will be reduced to the Farmington River into the future.

3.1.6 General Program Information

As noted in the Hatchery Section, the USFWS decided it will no longer operate fish culture facilities to support the Connecticut River Atlantic Salmon Restoration Program and made that publically known at the July 2012 CRASC meeting. The USFWS has noted the many important contributions from the salmon restoration effort (passage, habitat, management coordination, education) since the late1960s, but continued low return rates of adult salmon, budget concerns, and competing regional priorities prompted this agency's decision. Following a charge given to the CRASC Technical Committee by the Commission, to determine what culture facility resources remain, options, and future outlook, a report was developed for the Commission. In October 2012, the Commission discussed this report and several options including the need for more internal, within agency, deliberations. The USFWS noted that in the absence of having another priority use for RCNSS, it would consider a state request to utilize the facility in this transitional period, if asked.

The CTDEEP provided a request in December 2012, for the use of RCNSS in 2013 for holding sea-run returns through spawning in the fall. The USFWS has subsequently decided it will operate RCNSS in a reduced capacity for up to 100 sea-run returns through spawning, when eggs will be taken by CTDEEP for incubation at the KSFH. The future use of RCNSS remains undecided at this time. The USFWS will provide technical assistance for all partners relative to fish health, genetics, assessment and evaluation. These decisions have significant ramifications for the future of the program and partners are in the process of planning for the future. Details of the modified program, termed the Legacy Program and focused in Connecticut, will be provided in next year's report.

The use of salmon egg incubators in schools as a tool to teach about salmon, watersheds and conservation continued, but was impacted by the closure of WRNFH. As a result, the NHFG opted to switch its educational program to brook trout. The Connecticut River Salmon Association, in cooperation with CTDEEP, conducted its Salmon-in-the-Classroom program at 73 schools in Connecticut. MADFW and USFWS continued their Atlantic Salmon Egg Rearing Program in Massachusetts at over 40 schools or organizations.

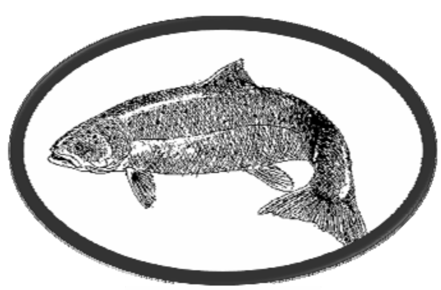
3.1.7 Migratory Fish Habitat Enhancement and Conservation

CTDEEP cooperated with partners on two fish passage projects: the installation of a Denil fish ladder on the first dam (StanChem) of the Mattabesset River (Berlin, CT; sponsor- The Nature Conservancy) and the complete removal of the breached Spoonville Dam (Farmington River, East Granby, CT; sponsor- Farmington River Watershed Association). The Spoonville Dam was a velocity barrier to shad and river herring at many spring flow levels. Both the CTDEEP and USFWS among the partners supporting the planned 2013 removal of the Ed Bill's Pond Dam (Eightmile River, Lyme, CT). The USFWS is assisting in the completion of the Manhan River fish ladder (Easthampton, MA) that if paperwork is completed soon will permit final work to begin in 2013. The Green River (Greenfield, MA) has its first upstream dam in planning for removal and the next second dam being examined for an appropriate fishway design, with many partners (CT River Watershed Council lead). On Amethyst Brook (Pelham, MA) a tributary to the Fort River, an old mill dam was successfully removed by MA Department of Ecological Restoration with many partners who are also looking to remove the first barrier on the Fall River (Gill, MA) as well.

In Vermont, the USFS completed the following projects within the White River Watershed:

- Marsh Brook - Aquatic Organism Passage (AOP), North Hollow Rd crossing in town of Rochester. Post-Irene culvert replacement. Installed a buried pipe with width equal to 1.2 bankfull width.
- Marsh Brook AOP, Marsh Brook Rd crossing in town of Rochester. Post-Irene culvert replacement. Installed bottomless arch with width equal to 1.2 bankfull width.
- Perkins Brook AOP, Flanders Rd crossing in Town of Rochester, Post-Irene culvert replacement. Installed bottomless arch with width equal to 1.2 bankfull width.
- Bingo Brook AOP, Forest Rd 42, GMNF, replaced perched culvert with bottomless arch.
- Corporation Brook Road Restoration, GMNF. Post-Irene removal of damaged culvert replaced with hardened ford.

In the Deerfield River Watershed the USFS completed the Reservoir Brook AOP, Forest Rd 73, GMNF. The USFS Replaced perched double culvert with pre-fabricated concrete arch and natural stream bottom.



3.2 Long Island Sound: Pawcatuck River

3.2.1 Adult Returns

Two Atlantic salmon adults were captured at the Potter Hill Fishway in 2012. The fish are female of wild (fry stocked) origin.

3.2.2 Hatchery Operations

Egg Collection

Sea-Run Broodstock

The sea-run fish were spawned this year, which resulted in approximately 5,000 eggs.

Captive/Domestic Broodstock

At the Perryville hatchery, we currently have approximately 550 adult salmon broodstock that were acquired from Connecticut Hatcheries in 2011. Some of these fish were spawned, from which there were 2,000 viable eggs. We have an additional 200 adult salmon, which were not spawned.

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 2012. No smolts were stocked in the Pawcatuck River in 2012.

Adult Salmon Releases

No adult Atlantic salmon were stocked in five Rhode Island lakes in 2012.

3.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were not conducted in 2012 due to lack of personnel.

3.2.5 Smolt Monitoring

No work was conducted on this topic during 2012.

3.2.6 Tagging

In Rhode Island, all smolts are released with adipose fin clips, however, no smolts were released in 2012.

3.2.7 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. A third successive permit was denied by FERC. A new initiative to assess fish passage needs at the three lower Pawcatuck River dams is currently underway by the Army Corps of Engineers.

The denil fishway construction at the Horseshoe Falls Dam has been completed. This is the fourth obstruction on the river.

3.2.8 Genetics

No genetics samples were collected in 2012.

3.2.9 General Program Information

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

3.2.10 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2012.

4 Central New England

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

One hundred and thirty-seven (137) Atlantic salmon were captured in the Merrimack River at the Essex Dam, Lawrence, MA. Nine fish with an adipose fin clip were released immediately [two (2) radio tagged] to swim the river; three (3) fish escaped into the forebay. One hundred and twenty-five (125) captured salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Thirteen of the fish had an adipose fin clip indicating they were previously released into the Souhegan River as smolts; two died at the hatchery and eleven were released [eight (8) radio-tagged] in the Souhegan River before spawning season. In addition to the two adipose fin-clipped mortalities, an additional five fish died, three prior to spawning and two after spawning. Four fish were non-spawners. One hundred and five (105) salmon were spawned which included 33 (31%) males and 72 (69%) females. One hundred and seven (107) fish were released back to the Merrimack River downstream of the Essex Dam after spawning.

Morphometric data and scale samples were taken from the 125 salmon transported to the hatchery; nine fish were measured for length and released, as noted, to swim the river. Of the 125 fish transported to the hatchery, the age and origin of 119 was determined using scale samples. Five of the 125 fish were non sea-run fish with a broodstock scale signature indicating a H1.0 origin/age. One fish had unreadable scale samples and no age and origin was determined. Of the nine released fish, all had adipose fin clips indicating that they had been released into the Souhegan River as one year old hatchery smolts (H1). Based on length it was estimated that one of the nine fish was a H1.0, seven fish were H1.2, and one fish was H1.3.

4.1.2 Hatchery Operations

North Attleboro National Fish Hatchery (NANFH) incubated and shipped 430,455 eyed eggs to the Saco River Salmon Club Hatchery, ME (SRSCH) on February 3 and 4, 2012. A total of 175,350 eyed eggs were shipped to Warren State Fish Hatchery, NH (WSFH) on February 29. Approximately 80,000 eyed eggs were retained for parr and smolt production in the Merrimack, Souhegan, and Saco rivers for 2013. Green eggs were received from NNFH in the fall of 2011.

The Merrimack River Kelt Program was discontinued in 2011, and no Merrimack River kelts were transferred or reconditioned. The remaining kelts on station are used for display purposes.

NANFH released 11,905 one-year old smolts into the Saco River watershed on April 17 and 18. On November 29, 14,130 fall parr were transferred to the Saco River Salmon Cub Hatchery for grow out and subsequent release into the Saco River. The Merrimack River was stocked with 17,783 one-year old smolts downstream of the Essex Dam in Lawrence, MA between April 12 and 19.

4.1.3 Egg Collection

Sea-Run Broodstock

One hundred and five sea-run salmon were spawned at NNFH. Fish were spawned during the period 19 October - 27 November, and produced 509,762 green eggs that resulted in 432,484 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 85% eye-up in its fifth year of sea-run egg incubation. The 72 females produced an average of 7,080 eggs each. The hatchery retained 7,000 sea-run eggs for F1 captive broodstock production.

Domestic Broodstock

A total of 231 female and over 240 male captive (F1 from sea-runs) broodstock spawned at NNFH; 490 fish were non-spawners. Spawners provided an estimated 745,652 green eggs. All eggs were retained at NNFH for incubation/fry production and subsequent release to the upper Merrimack River watershed, the Saco River watershed, and the Adopt-A-Salmon educational programs. Of the 231 females, 65 were four years old and 166 were three years old. The domestic broodstock spawning season began on 8 November ended 31 January, and included 18 spawning events.

4.1.4 Stocking

In 2012, 1,016,000 Atlantic salmon fry were released into the Merrimack River watershed in April and May. Salmon eggs were hatched at NNFH and WSFH. NNFH reared 436,000 unfed fry, and WSFH reared 580,000 unfed fry. Only tributaries and the main stem Pemigewasset River upstream of Ayers Island Dam were stocked with fry.

An estimated 22,000 adipose clipped 0+ parr were released in the Souhegan River in Fall 2012. This was the third year that efforts were made to increase stocking of fall parr as part of focused restoration effort on newly accessible habitat in the Souhegan River.

An estimated 33,783 smolts were released into the watershed with approximately 17,783 one-year-old smolts reared by the NANFH released into the lower Merrimack River downstream of Essex Dam in early April. An additional 16,000 one-year-old smolts with an adipose clip were released into the Souhegan River. All smolts were F1 or F2 progeny of Merrimack River lineage salmon.

This was the fifth 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 2012, 20 adult sea-run salmon and 640 domestic salmon were release in the Merrimack River watershed. Nine adipose fin-clipped fish [two (2) radio tagged] were released at the dam to swim the river; these fish with a fin clip were known Souhegan River smolt origin returns. In addition, eleven fish with a clip captured at Essex Dam were transported and held at the NNFH until fall when released [eight (8) radio-tagged] in the Souhegan River.

Pre-spawn domestic broodstock (240, age 3+; three (3) radio-tagged were released in the Souhegan River, and 400 (age 3+) were released in the Baker River. Fish were released in the Souhegan River on 5 November at a single location. In the Baker River, fish were released on 26 October in two separate groups of 180 and 220 each at release sites in Warren and Wentworth, NH, respectively. Fish were released as gravid, ripe and running, to allow for natural spawning. Redd counts were conducted multiple times to assess spawning.

Adult returns with adipose fins, assumed to be destine for the Souhegan Riverwere released in two locations. Of the two (2) fish released with radio tags released upstream of the Essex Dam fishway, one fish was successful recorded entering the Souhegan River. This potentially represents the first documented the sea-run fish have access to suitable spawning habitat in decades. The remaining fish were released in the fall, once fish appeared to be ready to spawn, upstream of the McClane and Goldman dams. One radio tagged sea-run fish (female) was recovered dead a few days after release. The tag was recovered, disinfected and used to radio tag one of the three domestic fish released with the other 200+ domestic fish on November 5th. In general, fish tagged in 2012 had less downstream movement than those released in 2011. This may be due to fish being placed on the spawning grounds when fish appeared ripe and running or due to lower flows. Canoe based redd surveys were hindered because of flow. However, redds were found throughout the upper River area via walking surveys alone the shoreline. These surveys were done in a haphazard manor only accessing the river where possible.

4.1.5 Juvenile Population Status

Yearling Fry / Parr Assessment

In 2012, the historic index sites were not surveyed for parr with the exception of the Souhegan River standard sampling site. However, changes made to stocking practices (changed from fry stocking to fall parr stocking) made the Souhegan River standard sampling site data unavailable for comparison to past years. Through agency consensus it was determined that there would be greater value in evaluating natural spawning studies being conducted on the Souhegan and Baker Rivers, than standard parr surveying effort.

Depletion and CPUE methodologies were employed to estimate success of adult spawning, both sea-run and broodstock. These surveys were conducted in both the Souhegan and Baker rivers in areas where redds were observed. The Souhegan had additional areas surveyed where no redds were observed. Fine scale habitat surveys do not exist in these watersheds so these surveys are not designed to estimate watershed wide populations of juveniles, but instead as an index of production from natural spawning activities. The Souhegan River had two depletion surveys with an additional 13 CPUE effort surveys of 26,520 seconds. The Baker River had two depletion sites with an additional 3 CPUE effort surveys of 16,468 seconds.

4.1.6 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 Green Power - 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 pother migratory fish including 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 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.

Negotiations are underway involving, Enel, the Department of Interior [(National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS)], and a number of NGOs to reach agreement regarding installation of an inflatable crest gate at the Lowell Hydroelectric Facility, Pawtucket Dam, Lowell, MA. The NPS has raised objections regarding potential impacts to historical aspects of the dam, whereas the FWS fully supports crest gate installation given the success of improved facility operations and fish passage at both Essex Dam and Amoskeag Dam. It is expected that FERC will make a determination regarding crest gate installation at Pawtucket Dam in the next year.

4.1.7 Genetics

Juvenile salmon resulting from paired matings are no longer be tracked/catalogued through genetic analyses for Merrimack River hatchery production programs. Funding was secured in 2002 for genetic analyses of sea-run salmon, domestic broodstock, and kelts used in the 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. Paired matings 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. The regions were partitioned into lower (sea-run parentage fry), middle (kelt parentage fry), and upper watershed (F1/domestic parentage fry).

From 2004 to 2009 fish stocked downstream from Ayers Island Dam (Bristol, NH) located on the Pemigewasset River were composed of fry from sea-run and kelt parentage and had a genetic signature, whereas those stocked upstream of Ayers Island Dam were not marked. Fin clips were obtained from salmon captured at Essex Dam and the genetic information was used to determine paired matings and also to determine fry stocking location (tributary, river reach/location).

A primary point of interest was whether fry-origin adult returns were 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) were 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 was based on groups (sea-run, kelt and domestic). Sea-run adults historically spawned and matured earlier than their domestic equivalents coinciding with more favorable stocking conditions in southern tributaries. Later maturing domestic origin fry were stocked into the upper tributaries of the Pemigewasset River. Kelts were 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.

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. Return rates of fry origin adults remain well below replacement levels and have not met program expectations.

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.

Management and restoration goals for the Merrimack River program have included river specific stock development, an adaptive fry production/stocking program, and a proposed production of 200,000 smolts. Eyed eggs from the Merrimack River program were shipped to NANFH for smolt production and subsequent release in the Merrimack River in Spring 2012. 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 has been reliant on both the NNFH and NANFH for smolt production. Whereas a minimum of 50,000 smolts were produced in previous years at GLNFH, an anticipated production level of approximately 40,000 smolts is expected for the Merrimack River in year 2013 due to limited space at the hatcheries. Eggs for smolt production are selected at random from parentage categories including sea-run and domestic fish to obtain the greatest genetic diversity.

4.1.8 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 past years, rule changes 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 2012, 695 (age 3) domestic broodstock were released for the fishery. In fall 2012, an additional 600 (age 2) and 400 (age 3) broodstock were released for a combined total release of 1,695 fish that were available for the fishery. Of the 1,000 fish released in fall, 400 age 3 fish were pre-spawn and gravid; these fish were released in late October 2012 in the Baker River on or near spawning habitat. It was expected that these fish would spawn and those that survived through winter could be available for angling in spring.

For many years anglers had submitted catch and harvest reporting diaries on a voluntary basis. In 2006 and 2007, participation in the volunteer reporting program fell below 10% of the total number of anglers that purchased Atlantic salmon broodstock permits. 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 2011, 1,302 anglers purchased a permit to fish for broodstock salmon. Data for the 2012 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 2012 school year marked the twentieth anniversary of the Adopt-A-Salmon Family Program in central New England. In January and February, 9,655 salmon eggs were distributed from the NNFH to thirty-three (33) participating schools in New Hampshire and Massachusetts. These schools then incubated eggs in the classroom and released fry into tributaries in late spring and early summer. Eighteen of the schools that received eggs also participated in a 1.5 hour educational program at the Piscataquog River Park in west Manchester, NH. The program culminated with 1,259 students releasing fry into the Piscataquog River. The program was conducted by seven dedicated volunteers with assistance from FWS staff.

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 totaled 20,819 in 2012, including 10,805 students and 9,163 adults. Since its inception Fishways has documented greater than one-half-million visitors, and about 8,314 school programs have been delivered to date. The total number of outreach and partly at Visitor Center programs offered in 2012 approached 350 with an estimated 9,000 students and 6,000 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). The agreement provides that NNFH and NANFH will produce and release 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 were provided in Year 2011 and 400,000 eyed eggs will be provided thereafter in Years 2012 -2015, the period of the agreement. An estimated 400,000 eyed eggs were shipped from NNFH to the Club hatchery in February/March. NANFH produced 11,905 one-year-old smolts for release to the river in April, and produced 14,130 parr that were transported to the Club hatchery in November 2012.

There have been changes in salmon management in the Merrimack River watershed in recent years. Changes have included a reduction in smolt production from an estimated 50,000 to at a minimum 25,000 due to production limitations at NNFH and NANFH, and a reduction in watershed wide fry releases commensurate with an increase in adult pre-spawn releases in select tributaries. Fry production/release decreased from a target of 1.4 million to about 1.0 million in 2012, with a focus on stocking fry only in areas upstream of Ayers Island Dam. In addition, a pilot program has been initiated to test the efficacy of allowing sea-run fish to run the river in lieu of spawning fish at NNFH. These sea-run fish are a small subset of all returning fish, identified via adipose fin clips, stocked as smolts in the Souhegan River. Some Souhegan River smolt origin adult salmon were released at Essex Dam to swim the river in 2012 with the expectation that they would enter that river and spawn. Others were captured and held at the NNFH until fall when they were released in the Souhegan River with pre-spawn domestic adult salmon.

Merrimack River –Policy Committee 2012

In spring 2012 the Policy Committee for Anadromous Fishery Management of the Merrimack River Basin supported a plan to reevaluate the Atlantic Salmon program. For over 30 years the Merrimack River Atlantic salmon Restoration Program has implemented management measures to establish a self-sustaining salmon population, but with limited success. Improved marine survival rates and record number of adult sea-run returns in year 2011, both within the watershed and within other Gulf of Maine populations, has increased optimism for achieving success. A potential increase in marine survival, changes in hatchery supplementation, and an increase in accessible spawning habitat has made assessing the Program, over a short horizon of three (3) years, warranted. Specifically, continued improved marine survival similar to that observed in year 2011, and a level of successful spawning in the Souhegan River will increase the possibility of success for the Program.

Specific objectives are as follows:

1. Reevaluate program in the near term (Year 2015), focusing on the measures of marine survival in the Merrimack River population and other Gulf of Maine populations.
2. Natural spawning of salmon in the Souhegan River and other tributaries where spawning habitat is accessible.
3. Increase smolt production through hatchery efficiencies.
4. Assess benefits/costs of releasing all smolts in Souhegan River.
5. Maintain juvenile salmon in the watershed and focus on the progeny of sea-run returns.
6. Implement optimal fish passage (upstream and downstream) measures at dams, water development projects, and impediments to migration in the main stem and major tributaries in the watershed.

Multiple restoration strategies have been implemented and are referred to in this report including, small scale tracking studies to monitor adult success on the Souhegan River, redd surveys, wild fry monitoring, etc. The plan also develops evaluation metrics based on modeled versus observed adult sea-run returns, return rates from smolt stocked fish and return rates from fry stocked fish. With these changes there are concomitant shifts in production/releases of hatchery products. There are potential and likely effects of these changes may include: 1) lower sea-run returns, 2) an increase in need for F1 hatchery broodstock and 3) need to closely monitor increase potential for genetic bottle necks.

4.1.9 Migratory Fish Habitat Enhancement and Conservation

Habitat Restoration

Shawsheen River

There continues to be studies and assessments 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 have been approved for removal and the third dam will either be removed or fish passage facilities will be constructed.

Souhegan River

In 2012, 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 continuing to undergo feasibility studies to be considered for removal. Efforts continue to stock parr, smolt and gravid adults in the Souhegan River to facilitate restoration efforts.

4.2 Central New England: Saco River

4.2.1 Adult Returns

NextEra Energy operated three fish passage-monitoring facilities on the Saco River. The Cataract fish lift located on the east channel in Saco and the Denil fishway-sorting facility located on the west channel in Saco and Biddeford were operational from 1 May to 29 October, 2012. Twelve salmon were observed moving upriver through these facilities; however, the count could exceed 12 due to the possibility of adults ascending Cataract without passing through one of the counting facilities. The proportions of wild and hatchery origin salmon, determined from scale samples taken at the Skelton and Cataract facilities, were used to prorate the age and origin for the total run. Of the twelve sea-run Atlantic salmon counted at Cataract, all were of hatchery origin.

4.2.2 Hatchery Operations

Egg Collection

In 2012, 430,455 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 release as fry.

4.2.3 Stocking

Juvenile Atlantic Salmon Releases

In April 2012, a total of 12,000 smolts were transported from North Attleboro National Fish Hatchery (NANFH) and released to the river. In addition 13,000 age 1 parr were transferred from NANFH to the Saco River Salmon Club Hatchery in 2011, held overwinter and stocked in the mainstem Saco in 2012. Approximately 396,000 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 2012.

Smolt Monitoring

Tagging

All smolts (12,000) transported from NANFH to the Saco River for release received an adipose fin clip along with 13,000 parr.

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 partially funded the 2012 smolt, fry and parr stockings.

4.2.6 Genetics

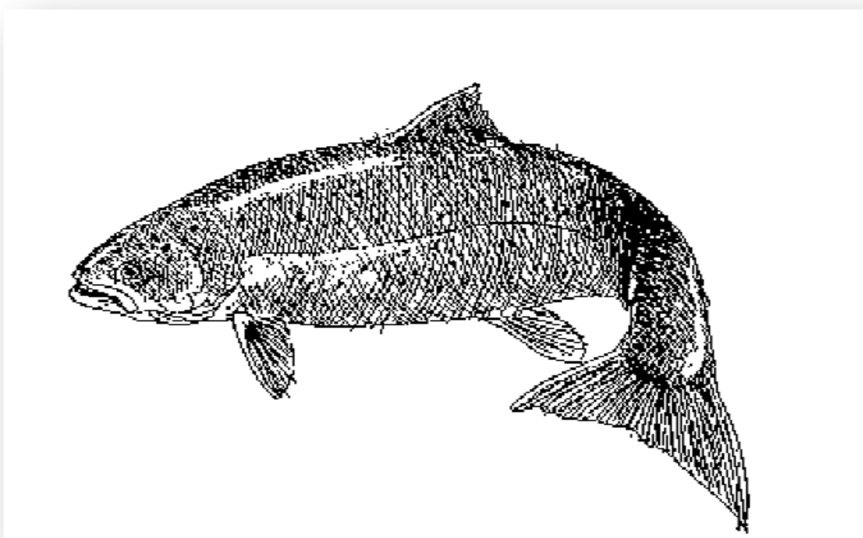
No genetic samples were collected in 2012.

4.2.7 General Program Information

The US Fish and Wildlife Service and the Maine 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 2012.



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 2012 were 741. Returns are the sum of counts at fishways and weirs (648) and estimates from redd surveys (98). 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 2012 was 1,224. 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 2012, 481 pre-spawn captive broodstock were stocked in the Dennys, Sheepscot, East Machias, Machias, and Union rivers.

Estimated replacement (adult to adult) of naturally reared returns to the DPS has varied since 1990 although the rate has been somewhat consistent since 1997 at or below 1 (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). Despite an apparent increase in replacement rate since 2008, naturally reared returns are still well below 500 (Fig. 5.1.2).

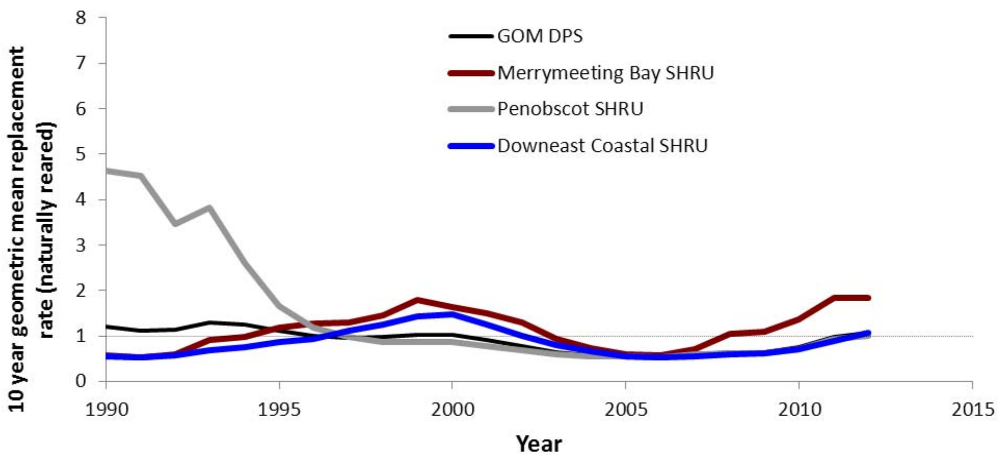


Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and the three Salmon Habitat Recovery Units (SHRU).

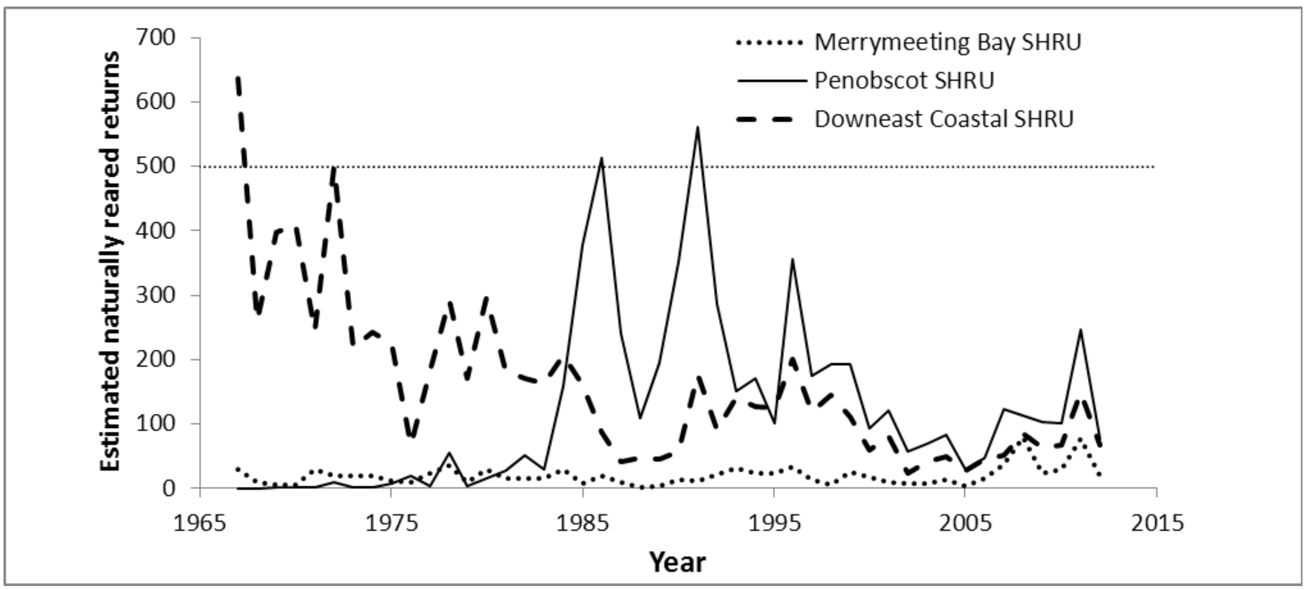


Figure 5.1.2 Estimated Naturally Reared Returns to the GOM

Small Coastal Rivers

Downeast Coastal SHRU

Dennys River

The Dennys weir was not intended to be fished in 2012 because of low returns and reduction in staffing resources. However, due to an escape of Atlantic salmon raised in aquaculture reported by the Atlantic Salmon Federation (New Brunswick), the weir in Dennysville was installed to restrict access to the Dennys River. Because of the short notice and available staffing, a trap net was first installed at the site to restrict access until a larger crew could be assembled to install the weir components. The actual weir was installed on 14 August and fished until 4 October. No salmon of either conservation or aquaculture origin were captured.

On 4 October, 2012, 257 captive reared gravid adult salmon (124 female and 133 male) were stocked into the “Community Pool” on the Dennys River. These fish were from the captive reared line. Fourteen (14) redds were counted during the 2012 redd surveys on the Dennys River that included approximately 97% of known spawning habitat area.

East Machias River

Six (6) redds attributed to wild returns were counted during the 2012 redd surveys in the East Machias River that included approximately 96% of known spawning habitat area. An additional 36 redds were located in Northern Stream where 52 pre-spawn captive reared adults from CBNFH were stocked.

Machias River

We counted a total of 73 redds, covering approximately 58% of the spawning habitat area in the Machias drainage. Pre-spawn adult captive broodstock (81) were stocked in the West Branch of the Machias watershed, and 49 redds were documented in the sub-watershed. The count could include redds produced by wild returns.

Pleasant River

To evaluate adult returns to the Pleasant River above Saco Falls, DMR staff operated the Saco Falls fishway trap on the Pleasant River from 5 June, 2012 to 19 October, 2012. The trapping facility allows staff to intercept returns resulting from natural reproduction and recent smolt stocking of 50,000 smolts annually (2011-2015) at Crebo Crossing (rkm 42.47). The first 1SW returns from the 2011 stocked cohort were expected, as well as 1SW and MSW returns from fry stocking and natural reproduction. Staff captured two (2) adults (1 female; 1 male) in the fishway trap in 2012. Both adults were 2SW salmon of river-origin. Sea-age and origin were determined based on scale reading, marks and tags. Nine (9) redds of sea-run origin were found in the Pleasant

River in 2012 during surveys of about 84% of spawning habitat area. Fifty-six (56) pre-spawn adults were released into the Pleasant River below Saco Falls. Four (4) redds were attributed to these fish.

Narraguagus River

Maine Department of Marine Resources (DMR), Sea Run Fisheries and Habitat staff operated the Cherryfield fishway trap on the Narraguagus River in Cherryfield, Maine from 27 April, 2012 to 30 October, 2012. Staff documented 18 sea-run salmon ascending the dam and fishway. Staff captured 16 adults (8 female; 8 males) in the fishway trap. Captures were predominately multi sea-winter (MSW) size-class salmon; five (5) river-origin and nine (9) hatchery-origin MSW returns. Of hatchery-origin returns, seven (7) were attributed to smolt stocking and two (2) were attributed to 0+ parr stocking. Only one (1) 1SW salmon was captured in 2012. Sea-age and origin were determined based on scale reading, marks and tags. In addition, staff captured one (1) Craig Brook National Fish Hatchery (CBNFH) captive-reared adult that was released post-spawn on 17 November, 2011. Two (2) adult salmon of unknown sex and origin were observed on video ascending the spillway. Returns in 2012 (18) were down 91% from last season’s 20-year high (196) and were less than half the previous 10-year average (38 returns). In 2012, 75 redds were counted during surveys by canoe and foot covering approximately 76% of spawning habitat area.

Penobscot SHRU

Ducktrap River

No redds were observed during surveys in late November that encompassed 70% 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 2012 that included 100% of identified Atlantic salmon spawning habitat in the system. No Atlantic salmon spawning activity has been detected for 14 years (1999 to 2012), despite repeated and extensive searches annually.

Union River

Three (3) Atlantic salmon were captured at the fishway trap operated by Black Bear Hydro Partners, LLC on the Union River in Ellsworth below Graham Lake. All were aquaculture escapees based on analysis of scale samples and fin deformities. This year the fishway was operated daily from 5 May to 15 June after which it was checked three or more days per week until 13 November.

Merrymeeting Bay SHRU

Sheepscot River

The river was surveyed, focusing on spawning habitat in the upper portion of the mainstem and West Branch. Twelve redds were attributed to the 35 stocked pre-spawn adults from CBNFH. Surveys encompassed 77% 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 (returns) = 0.559 ln (redd count) + 1.289] based on redd and adult counts from 1991-2009 on the Narraguagus River, Dennys River and Pleasant River (USASAC 2010). Total estimated return based on redd counts for the small coastal rivers was 115 (90% CI = 44 - 309) (Table 5.1.1). Estimates include returns to the Union River

Table 5.1.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2012. 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
2012	44	115	309

Large Rivers

Penobscot River

The Veazie Dam fishway trap was operated daily from 30 April through 25 October, 2012. We captured 624 sea-run Atlantic salmon during 2012, releasing 150 salmon back to the Penobscot River upstream of the Veazie Trap. An additional 131 salmon were trucked upstream to a boat launch in Costigan for release. A total of 474 salmon were transported to CBNFH. Thus, total escapement to the Penobscot River above the Veazie Dam in 2012 was 150 Atlantic salmon. Three aquaculture suspect salmon were captured during a five day period in early October. All three fish were determined to be escapes from aquaculture facilities based on fin condition and scale analysis, and were sacrificed.

Androscoggin River

The Brunswick fishway trap was operated from 7 May to 29 October, 2012. The fishway was closed 4 June through 12 June due to the flooding of the control room. The fishway was closed 9 August through 9 September for maintenance and high water temperatures. There was one Atlantic salmon captured at the Brunswick fishway this year. The Atlantic salmon was passed upstream into the head pond and biological data and tissue were taken in accordance with DMR protocols. Later scale pattern analysis identified this salmon as a suspect aquaculture (AQS) escape. The tissue sample (adipose punch) taken from this Atlantic salmon was sent to the USFWS Northeast Fishery Center in Lamar, PA for genetic analysis.

Kennebec River

The Lockwood fish lift was operated by NextEra Energy staff from 1 May to 26 October, 2012. The trap was shut down from 15 August to 29 August for repairs and maintenance. The total trap catch for 2012 was five adult sea-run Atlantic salmon. Biological data and tissue were taken from each individual fish in accordance with DMR protocols and existing marks and tags recorded. Of the five returning sea-run Atlantic salmon one was a two-sea winter (2SW) hatchery origin fish and four were naturally reared two-sea winter (2SW) fish. DMR staff tagged all five salmon with radio telemetry tags provided by NextEra in support of the company's downstream kelt passage study. All adult Atlantic salmon were trucked and released in the Sandy River.

Sebasticook River

The Fort Halifax dam was removed in the summer of 2008 opening up 7.33 river kilometers of habitat and allowing all species of diadromous fishes to reach the Benton Falls fish lift. The Benton Falls fish lift was operated from 4 May to 23 July, 2012. The trap was shut down from 4 June through 6 June due to high river discharge. No Atlantic salmon were captured at the Benton Falls fish lift this year.

Survival Estimates

Atlantic salmon survival rates were calculated for marked hatchery stocks and naturally reared stocks for the Narraguagus and Penobscot Rivers (Table 5.1.2). Calculations were based on known numbers of stocked salmon, smolt estimates, and adult returns. Smolt-to-adult (SAR) survival rates varied by origin; naturally reared smolts on the Narraguagus River had the highest average SAR survival (1.05%).

Table 5.1.2. Summary table of Atlantic salmon survival rates. All rates for hatchery origin stocks were based on marked groups. Data represent cohorts were 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	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	512,500	1,005	0.196
2009	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	559,828	2,585	0.462
2010	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	567,086	1,227	0.216
2010	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	2,372	25	1.05
2010	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	62,400	76	0.12

Dennys River Smolt and Parr Stocking

Smolt and parr by-product reared at Green Lake NFH were stocked in the Dennys River from 2000 to 2007. Parr by-product from the 1-smolt program were released in the fall from 2000-2006 (Table 5.1.3). Age 1-smolt were released in the spring from 2001-2007. Additionally, a small number of age 2-smolt reared at Craig Brook NFH were stocked in the spring of 2008 and 2009. Smolt stocking nearly 381,000 individuals over a 9-year period resulted in just 19 adult returns. Parr stocking nearly 208,000 individuals resulted in only one adult return. Smolt-to-adult return rates (SAR) of age 1-smolt ranged from 0.0 – 0.000141; a maximum of just 1.41 adults/10,000 smolt stocked (Table 5.1.4). Parr-to-adult return rates (PAR) ranged from 0.0 – 0.000056; a maximum of 0.56 adults/10,000 parr stocked (Table 5.1.4). Limited stocking of age 2-smolt in 2008 and 2009 produced one adult return.

Stocking Numbers				
Drainage	Year	LifeStage		
		Parr	1-Smolt	2-Smolt
Dennys	2000	30,500	-	-
Dennys	2001	17,900	49,800	-
Dennys	2002	34,900	49,000	-
Dennys	2003	31,000	55,200	-
Dennys	2004	44,000	56,300	-
Dennys	2005	21,700	56,700	-
Dennys	2006	27,600	56,500	-
Dennys	2007	-	56,500	-
Dennys	2008	-	-	200
Dennys	2009	-	-	600
Dennys	**2000-2009**	**207,600**	**380,000**	**800**

Parr - GLNFH; age 1-smolt program fall by-product

1 Smolt - GLNFH

2 Smolt - CBNFH

Table 5.1.3 Numbers of fall Parr and 1-Smolts outplanted into the Dennys River 2000-2007. Parr were released in the fall.

Smolt Return Rates			
Smolt Cohort	Returns	SAR	n/10k
2001	7	0.000141	1.41
2002	4	0.000082	0.82
2003*	0	0.000000	0.00
2004**	2	0.000036	0.36
2005	3	0.000053	0.53
2006	2	0.000035	0.35
2007	0	0.000000	0.00
2008[A]	1	0.005000	50.00
2009[A]	0	0.000000	0.00

* 1SW only; No Trap 2SW

** 2SW only; No Trap 1SW

[A] 2 Smolt

Parr Return Rates			
Smolt Cohort	Returns	PAR	n/10k
2000	0	0	0.00
2001	1	0.000056	0.56
2002	0	0	0.00
2003	0	0	0.00
2004	0	0	0.00
2005	0	0	0.00
2006	0	0	0.00

Table 5.1.4 Return rates to the Dennys River for outplanted Parr and Smolt cohorts 2000-2009

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 4,440,883 million eggs for the Maine program in 2012: 1,950,000 million eggs from Penobscot sea-run broodstock; 1,233,883 million eggs from two domestic broodstock populations; 1,257,000 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 259 Penobscot origin females, 68 domestic females, and 467 captive females were spawned at CBNFH. At GLNFH, 352 age four and 21 age three domestic females were spawned to provide eggs for in-stream egg planting in the Sandy River, a tributary to the Kennebec River.

In 2012 the spawning protocol for the Pleasant River was altered slightly due to a large population of domestic broodstock as well as an increase in age three maturation. In order to ensure all broodstock were represented in the egg take, but limit egg production to a manageable level, only a small aliquot (approximately 1500 eggs) of each female's eggs were retained and fertilized. Remaining unfertilized eggs were discarded.

Egg Transfers

CBNFH transferred 1.1M eyed eggs to GLNFH for parr and age 1 smolt production (Penobscot, Machias and Pleasant strains), 130K eyed eggs to two facilities operated by the Downeast Salmon Federation for private rearing (Pleasant and East Machias strains), 353K eyed Penobscot eggs to DMR for egg planting in Cove Brook and the West Branch Pleasant River, and 126K eyed Sheepscot eggs to DMR for egg planting in the Sheepscot River.

GLNFH transferred 911K 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 2012.

Wild Broodstock Collection and Domestic Broodstock Production

In 2012, 1,195 wild parr (135, Dennys; 160, East Machias; 258, Machias; 211, Pleasant; 261, Narraguagus; 170, Sheepscot) were collected by Maine Fishery Resources Office (MEFRO) and DMR personnel 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 2011 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 624 fish in 2012. 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 2012. Incoming adults were isolated in the screening facility to undergo sampling procedures and await the results of PCR testing. Only one adult was identified as ‘suspect’, due to inconclusive and inconsistent test results, in 2012.

Stocking Activities

Stocking activities in Maine resulted in the release of over 4.77 million Atlantic salmon in 2012. These releases included Atlantic salmon from all lifestages and were initiated by Federal and State agencies, NGO’s, researchers and educational programs.

Juvenile Stocking

Age-1 smolts reared at GLNFH were stocked into the Penobscot Basin (555K), Narraguagus (59K), and Pleasant (60K). Narraguagus smolts were marked with an adipose clip.

Temperature advanced age 0 parr reared at GLNFH released into the Penobscot Basin totaled 326K. Ambient age 0 parr reared at CBNFH released into the Sheepscot River totaled 16K; all CBNFH origin parr were marked with adipose fin clips. The Downeast Salmon Federation released 53K ambient age 0 parr reared by the East Machias Atlantic Salmon Resource Center; East Machias parr were adipose fin clipped.

CBNFH produced approximately 1.83 million fry [Penobscot, 1.07M; East Machias, 88K; Machias, 231K; Narraguagus, 389K; Sheepscot, 50K] primarily unfed, for release by the DMR throughout the Distinct Population Segment (DPS). In order 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 86.8% to 101%; fry released in the Penobscot Basin had DIs ranging from 92.7% to 112%. Additional fry, reared by the Downeast Salmon Federation, were released into the Pleasant [40K].

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 2012, gravid excess broodstock were released to the Dennys River (257), East Machias River [Northern Stream] (52), Machias River [West Branch Machias River] (81), Pleasant (56) and Sheepscot (35). All East Machias adults released to Northern Stream were tagged with 134.2 kHz PIT tags to facilitate tracking.

Following spawning, 469 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2012. 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 (80); Machias (141), Narraguagus (297); Pleasant (256); Sheepscot (161).

The number of spent broodstock released increased in 2012 as part of a strategy to reduce the number of gravid broodstock produced in older year classes which often confounds other stocking strategies. However, some age three broodstock were retained to be used again if necessary in 2014.

GLNFH released 1,150 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River.

5.3 Juvenile Population Status

A Generalized Random - Tessellated Stratified (GRTS) design (Stevens and Olsen 2004) was again implemented for the 2012 sampling season. A total of 140 sites were developed for the Downeast SHRU, the Penobscot Bay SHRU, and the Merrymeeting 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 5.3.1). These selected sites have provided a clearer picture of relative distribution and abundance with in 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 295 sites in 2012. Two hundred and thirty five (140) 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 5.3.1) with data presented as fish/unit, where one unit equals 100 m^2. 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 5.3.2). At 15 (10.7 %) of the randomly selected sites and at an additional 20 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 5.3.3) document the relative low juvenile Atlantic salmon populations throughout the geographic range of the Gulf of Maine DPS in the last six year

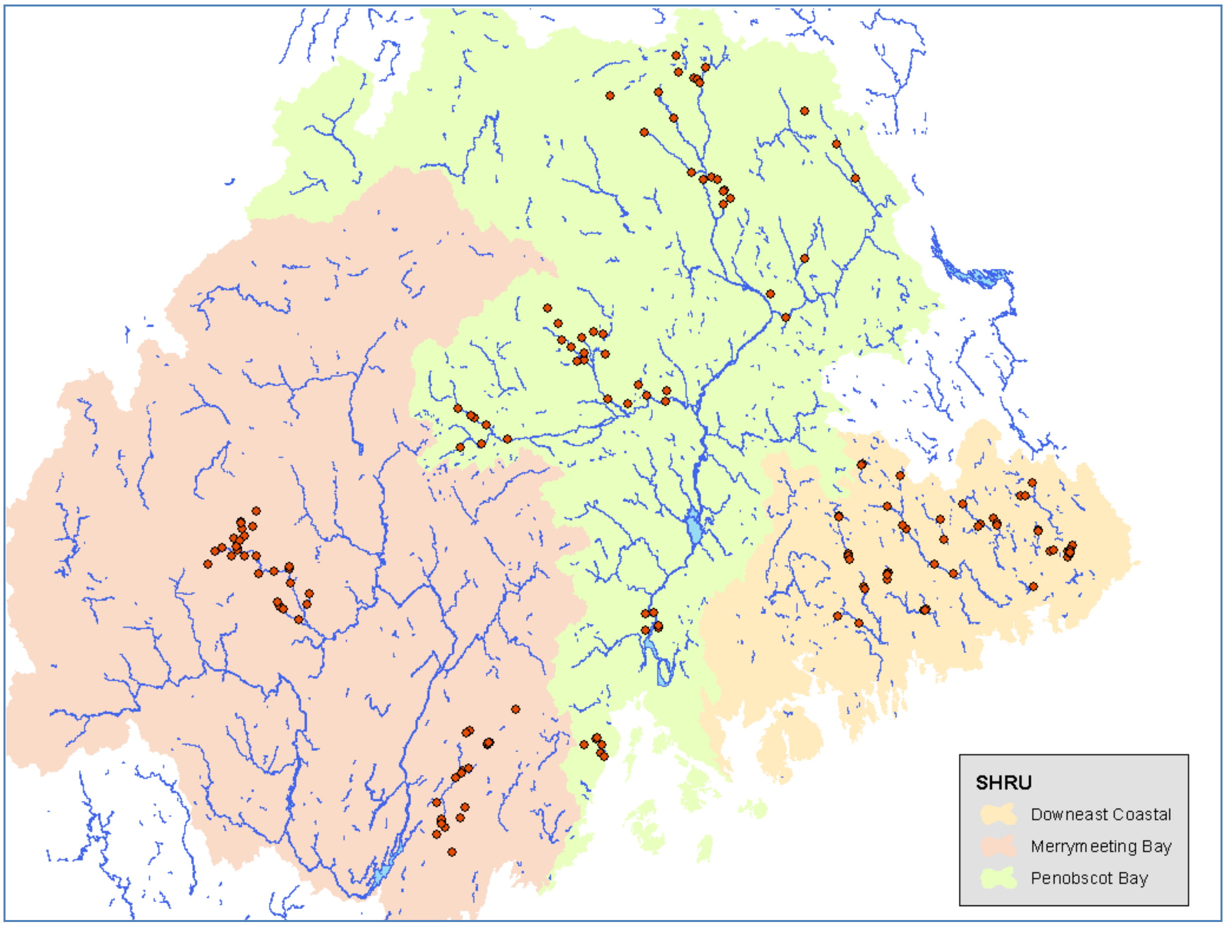


Figure 5.3.1. Locations of sites selected for juvenile salmon assessments in 2012 based on the GRTS design.

Table 5.3.1. Minimum (min), median, and maximum (max) juvenile Atlantic salmon population densities (fish/100m^2) based on multiple pass electrofishing estimates in selected Maine Rivers, 2012. Drainages are grouped by Salmon Habitat Recovery Unit (double line).

Denisty fish / unit									
Drainage	Year	Parr				YOY			
		N	Min	Median	Max	N	Min	Median	Max
Dennys	2012	2	1.3	4.7	8.1	2	0.0	0.0	0.0
East Machias	2012	2	2.8	3.3	3.9	2	0.6	4.4	8.3
Machias	2012	3	0.7	3.2	11.4	3	0.7	2.2	19.9
Pleasant	2012	2	0.6	1.5	2.4	2	0.0	2.9	5.9
Cove	2012	3	0.0	0.0	0.0	3	17.3	21.9	69.9
Ducktrap	2012	1	9.5	9.5	9.5	1	0.0	0.0	0.0
Penobscot	2012	9	0.4	4.3	13.0	9	0.4	28.7	67.9
Kennebec	2012	9	0.0	2.7	13.6	9	0.7	19.7	77.5
Sheepscot	2012	11	0.0	1.9	16.0	11	0.0	0.4	8.3

Table 5.3.2. 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, 2012. Drainages are grouped by Salmon Habitat Recovery Unit (double line).

CPUE fish / minute									
Drainage	Year	Parr				YOY			
		N	Min	Median	Max	N	Min	Median	Max
Dennys	2012	10	0.00	**1.51**	3.19	10	0.0	**0.0**	1.0
East Machias	2012	20	0.00	**1.00**	3.14	20	0.0	**0.6**	4.8
Machias	2012	17	0.00	**0.39**	3.07	17	0.0	**0.2**	5.4
Narraguagus	2012	11	0.00	**0.76**	1.92	11	0.0	**1.1**	4.2
Pleasant	2012	10	0.00	**0.30**	0.79	10	0.0	**0.1**	2.8
Cove Brook	2012	15	0.00	**0.00**	0.00	15	0.4	**4.1**	14.0
Ducktrap	2012	7	0.00	**0.74**	3.05	7	0.0	**0.0**	0.0
Penobscot	2012	63	0.00	**0.00**	1.87	63	0.0	**0.4**	11.1
Union	2012	5	0.00	**0.00**	0.00	5	0.9	**2.6**	4.8
Androscoggin	2012	4	0.00	**0.20**	0.34	4	0.0	**0.0**	0.6
Kennebec	2012	75	0.00	**0.20**	4.92	75	0.0	**0.4**	13.0
Sheepscot	2012	29	0.00	**0.20**	2.80	29	0.0	**0.2**	4.2

Table 5.3.3. Minimum (min), median, and maximum (max) density (fish/100m^2) and relative abundance (fish/minute) of Atlantic salmon juveniles. Data from sampled rivers were aggregated by Salmon Habitat Recovery Unit (SHRU), 2006 to 2012.

		Density fish / unit								CPUE fish / minute							
SHRU	Year	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	**2.8**	35.2	73	0.0	**2.8**	51.5	139	0.00	**1.01**	3.46	155	0.00	**1.40**	4.33
	2007	55	0.00	**2.9**	22.3	53	0.4	**7.3**	58.9	133	0.00	**0.56**	5.05	141	0.00	**1.58**	15.31
	2008	43	0.00	**3.6**	20.2	43	0.0	**7.0**	73.8	18	0.00	**0.00**	1.00	18	0.00	**0.35**	8.75
	2009	56	0.00	**3.7**	32.5	56	0.0	**7.7**	36.5	49	0.00	**0.79**	20.39	54	0.00	**1.59**	15.37
	2010	29	0.54	**5.2**	28.0	29	0.0	**8.0**	89.1	91	0.00	**1.00**	8.84	96	0.00	**1.40**	15.54
	2011	19	0.00	**2.8**	94.6	19	0.0	**3.4**	65.7	173	0.00	**0.80**	8.74	173	0.00	**0.60**	6.32
	2012	9	0.6	2.8	11.4	9.0	0.0	0.7	19.9	68	0.00	**0.55**	3.19	69	0.00	**0.20**	5.4
Penobscot Bay	2006	74	0.00	**0.2**	26.9	48	0.0	**0.0**	67.2	24	0.00	**0.00**	1.60	34	0.00	**0.00**	2.20
	2007	49	0.00	**0.0**	33.7	25	0.0	**0.0**	66.8	41	0.00	**0.00**	2.51	53	0.00	**0.00**	1.80
	2008	11	0.00	**6.7**	17.8	11	0.0	**19.9**	47.1	82	0.00	**0.00**	1.49	88	0.00	**0.00**	6.75
	2009	10	0.00	**7.9**	20.4	10	4.1	**29.8**	39.7	161	0.00	**0.00**	2.93	163	0.00	**0.00**	4.48
	2010	7	0.00	**17.0**	22.1	8	0.0	**0.7**	29.5	86	0.00	**0.00**	3.91	95	0.00	**0.75**	15.95
	2011	5	0.00	**7.0**	14.9	5	0.0	**4.1**	49.8	87	0.00	**0.00**	3.82	87	0.00	**0.00**	5.72
	2012	13	0.0	1.5	13.0	13.0	0.0	21.9	69.9	90	0.00	**0.00**	3.05	90	0.00	**0.79**	13.96
Merrymeeting Bay	2006	42	0.00	**1.3**	23.4	41	0.0	**0.3**	25.3	12	0.00	**0.00**	0.63	11	0.00	**0.00**	3.95
	2007	33	0.00	**0.3**	50.3	33	0.0	**4.0**	69.8	37	0.00	**0.00**	2.60	33	0.00	**0.20**	5.03
	2008	26	0.00	**1.6**	21.7	27	0.0	**2.2**	38.9	38	0.00	**0.00**	0.77	39	0.00	**0.00**	1.40
	2009	17	0.00	**6.0**	21.7	17	0.0	**3.1**	28.1	46	0.00	**0.00**	3.27	48	0.00	**0.20**	9.35
	2010	22	0.00	**2.1**	16.6	21	0.0	**3.0**	109.9	110	0.00	**0.00**	2.94	112	0.00	**0.80**	29.40
	2011	17	0.00	**8.7**	44.5	17	0.0	**1.9**	43.3	45	0.00	**0.20**	4.37	45	0.00	**0.20**	9.80
	2012	20	0.0	2.3	16.0	20.0	0.0	6.6	77.5	108	0.00	**0.20**	4.92	107	0.00	**0.40**	12.97

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 5,669 smolts, 120 (2.1%) of which were recaptures. A subset of smolts was scale sampled (n= 107) and tissue sampled for genetics (n=203). The observed age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) was: 94.4% age 2+ and 5.6% age 3+ (Table 5.3.4). Age 2+ smolts averaged 172 ±14 mm fork length (n=68) and 52.0 ± 13.0 g live weight (n = 68) (Tables

5.3.5 and 5.3.6 and Figures 5.3.1 and 5.3.2). During the first week of May, ~ 59,000 age 1+ salmon smolts were stocked, and therefore most (94.6%) of the smolts collected were of hatchery origin. The population estimate for naturally-reared smolts was 915 ± 232 smolts (Figure 5.3.3). The total estimate of smolts (naturally reared, fall parr and hatchery stocked smolts) exiting the Narraguagus system was 42,261 ± 4,348.

Sheepscot River

We captured 375 smolts at the Sheepscot River site, 240 of which were found to be marked with an adipose clip, indicating they were stocked as 0+ parr in 2010 or 2011. A subsample of scales (n=351) and tissue samples (n=164) were collected from smolts. We analyzed scale samples to determine age and origin distributions ages and to generate mean fork length and weight (Tables 5.3.6 and 5.3.7, Figures 5.3.1 and 5.3.2). This year, the Sheepscot River's naturally reared smolt component was composed of 1.6% age 1+, 82.4% age 2+, and 16.0% age 3+ (Table 5.3.5). Age 2+ naturally-reared smolts averaged 180 ± 20 mm fork length (n = 103) and 61.5 ± 21.8 g live weight (n = 103) (Tables 5.4.6 and 5.4.7, Figures 5.4.1 and 5.4.2). The population estimate of naturally-reared smolts was 1,101± 252. The estimate of smolts of hatchery origin (stocked as fall parr in 2009 and 2010) was 2,102± 429.

Piscataquis River

We collected 455 smolts (all naturally reared) in the Piscataquis River RSTs, 220 of which were marked and released 3.2 km upstream. Of these marked smolts, 61 (27.7%) were recaptured. The age composition was: 48.8% age 2+, 50.2% age 3+, and 3.0% age 4+ based on scale reading (n=290, Table 5.3.5). Age 2+ smolts averaged 160 ± 12 mm fork length (n = 123) and 40.4 ± 8.8 g live weight (n = 123) (Tables 5.3.6 and 5.3.7, Figures 5.3.1 and 5.3.2). The population estimate of emigrating smolts was 2,013 ± 353.

Smolt Run Timing

In 2012, the median capture date of smolts on the Narraguagus, Sheepscot, and Piscataquis Rivers was earlier than in 2011 (Figures 5.3.4. and 5.3.5.).

Table 5.3.4. Freshwater age of naturally-reared smolts collected in smolt traps on selected Maine rivers.

	2012				5 year average (2007-2011)			
River	1+	2+	3+	4+	1+	2+	3+	4+
Narraguagus	0%	94.4%	5.6%	0%	0.5%	85.9%	13.5%	0.2%
Piscataquis	0%	46.8%	50.2%	3.0%	0.3%	66.3%	33.1%	0.3%
Sheepscot	1.6%	82.4%	16.0%	0%	2.2%	93.6%	4.1%	0.1%

Table 5.3.5. Mean fork length (mm) by origin of smolts captured in smolt traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2012	n	5 year average ('07-'11)	n	2012	n	5 year average ('07-'11)
Narraguagus	108	185±17	1080	169±17	68	172±14	536	169±16
Piscataquis	0	N/A	0	N/A	123	160±12	1765	142±11
Sheepscot	171	161±10	370	154±12	103	180±20	730	187±18

Table 5.3.6. Mean smolt live weight (g) by origin of smolts captured in smolt traps in Maine.

	Age 1+ hatchery-origin				Age 2+ naturally-reared			
River	n	2012	n	5 year average ('07-'11)	n	2012	n	5 year average ('07-'11)
Narraguagus	108	64.5±18.5	1076	48.7±15.8	68	52.0± 13.0	532	48.9± 15.2
Piscataquis	0	N/A	0	N/A	123	40.4±8.8	1740	27.5±6.6
Sheepscot	171	46.1±8.8	343	39.6±9.9	103	61.5±21.8	724	68.2±20.1

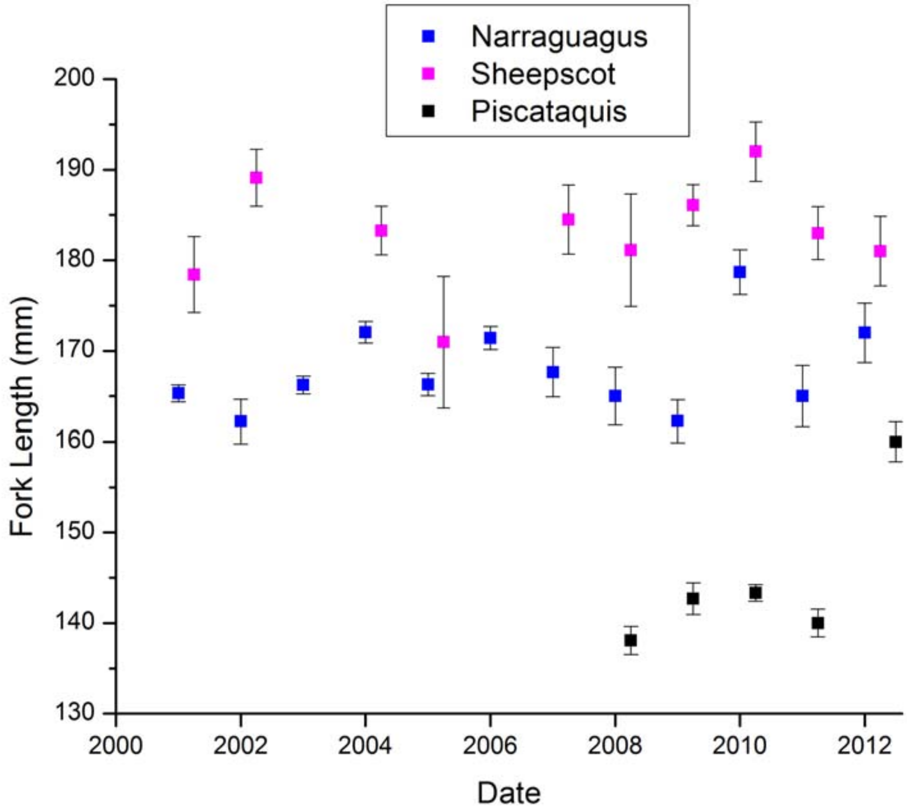


Figure 5.3.1. Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2001-2012.

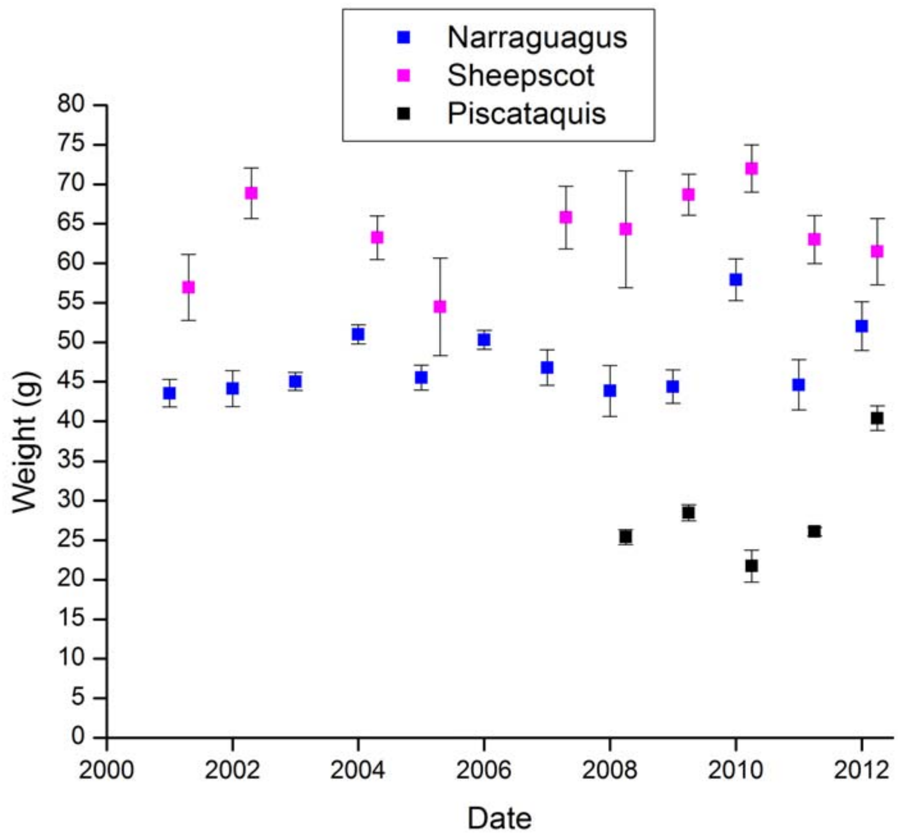


Figure 5.3.2. Mean live weight (g) ± 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2001-2012.

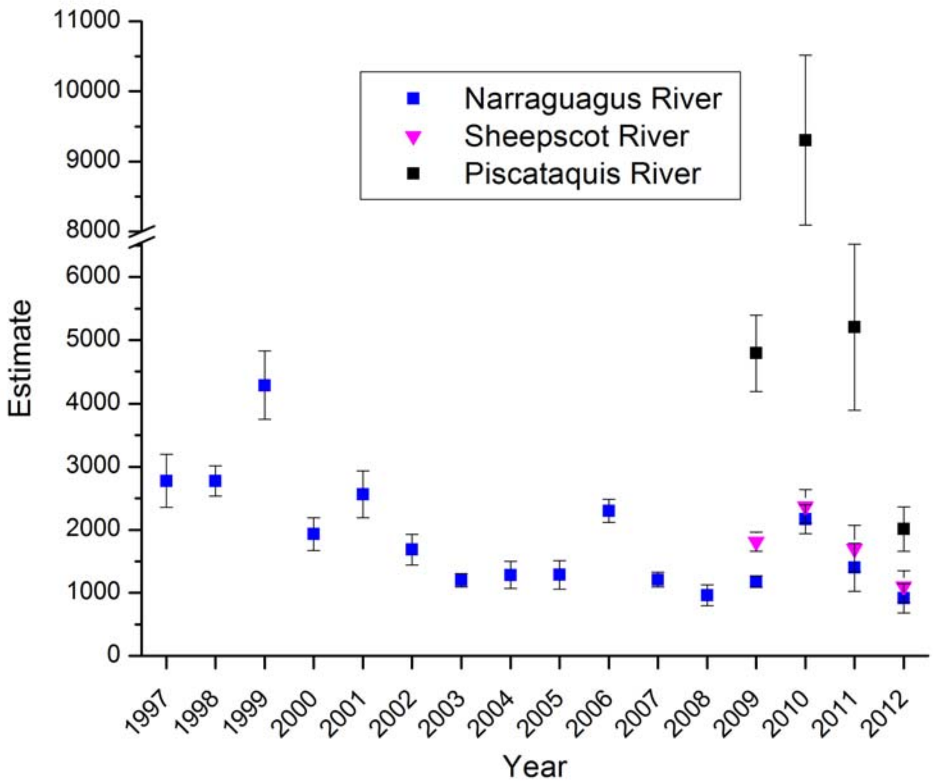


Figure 5.3.3. Population Estimates (± Std. Error) of emigrating naturally reared smolts in the Narraguagus River, Sheepscot River, and Piscataquis River, Maine from 1997 to 2012 using DARR 2.0.2.

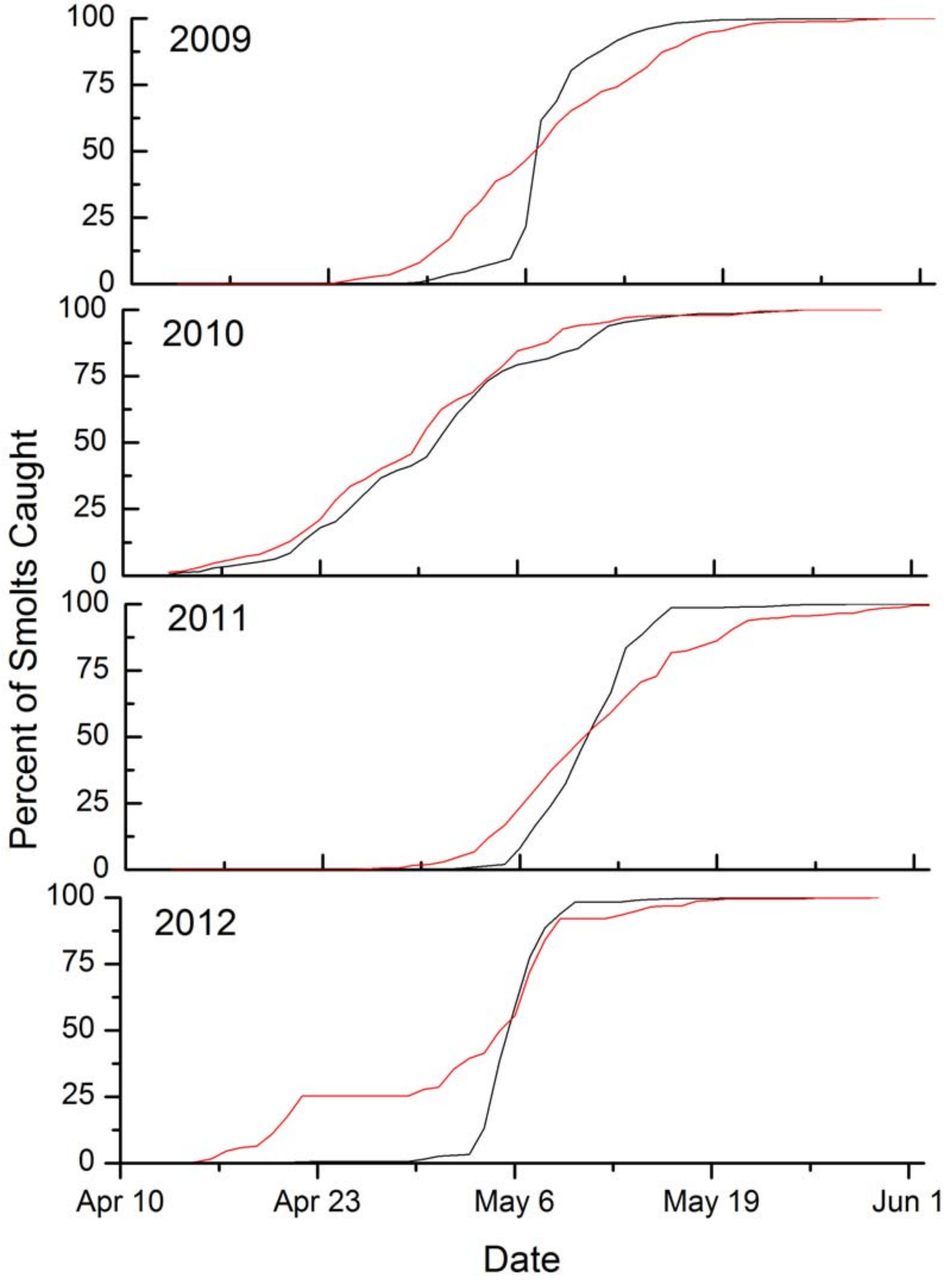


Figure 5.3.4. Cumulative percentage smolt catch for smolts of all origins in rotary screw traps by date (run timing) on the Narraguagus and Sheepscot Rivers, Maine, for years 2009 to 2012.

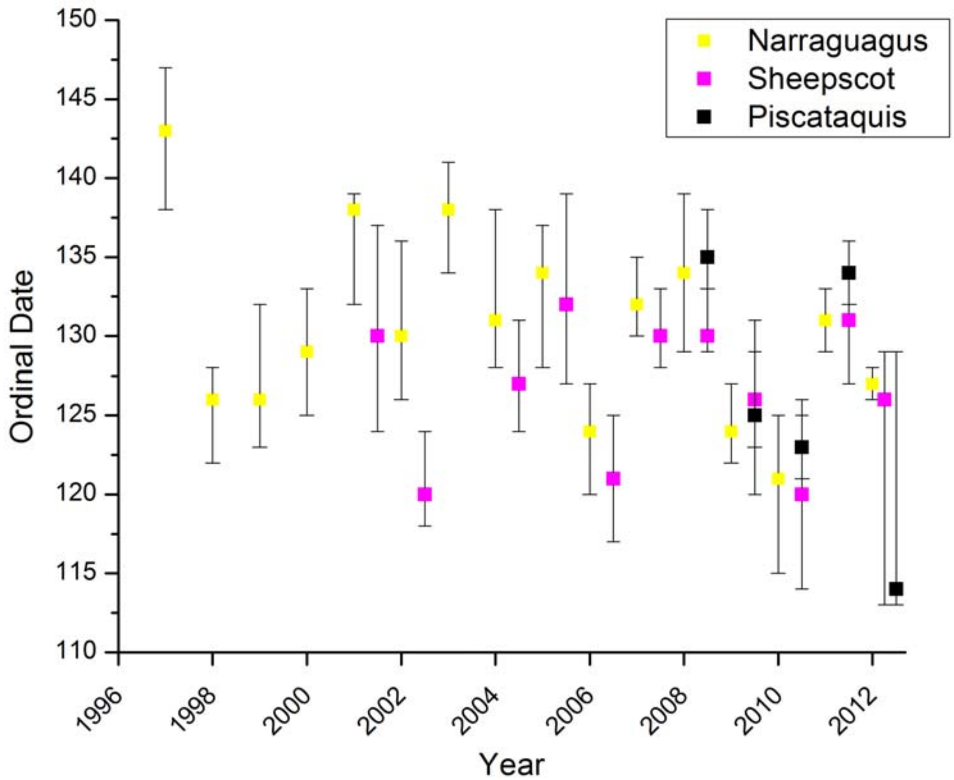


Figure 5.3.5. Ordinal day (days from January) of median smolt catch of naturally-reared smolts in rotary screw traps on the Narraguagus, Sheepscot, and Piscataquis Rivers, 1997-2012. Error bars represent 25th and 75th percentiles of median run dates.

5.4 Fish Passage

Penobscot River Restoration Project

The Great Works Dam was located on the Penobscot River in Old Town and Bradley, Maine, and the property is owned by the Penobscot River Restoration Trust. Removal work on the dam began in early June 2012 and was largely complete by the end of November. Contractor R.F. Jordan and Sons of Ellsworth, Maine removed approximately 10,000 cubic yards of material from the river, including concrete, timber, and rockfill. Veazie Dam removal is scheduled to begin in 2013, and Howland Dam bypass construction is planned to follow.

Figure 5.7.2 Aerial view of the Great Works Dam on the Penobscot River before and after removal.

PIT Antennae Installed at Fishways on Penobscot River

In 2012, the Maine Department of Marine Resources, the University of Maine and the USGS Maine Cooperative Fish and Wildlife Research Unit cooperated to install antenna arrays at nine dams along the Penobscot River and its tributaries in order to monitor the upstream migration of returning sea-run Atlantic salmon using PIT (passive integrated transponder) technology. At each dam a minimum of two antennas were installed at the bottom and top of the fishway to assess passage success at dams, transit time among dams, and the effect of size on passage at dams.

This year 154 tagged salmon were released to the river, including 82 females, 67 males (multi sea-winter fish), and 5 grilse (1 sea-winter fish). Due to the pending removal of the Great Works Dam in Old Town, the majority of the salmon were trucked from the Veazie Dam upriver approximately 10 kilometers and released at the boat launch in Costigan. Most adults took approximately 12 days to travel from Costigan to the dams in either West Enfield or Howland. Actual transit time for many adults may have been lower as some fish may approach a dam and fail to be detected by the antenna array. Using information on detection efficiency the passage rate at West Enfield was estimated at 81% and a higher passage rate of 92% was estimated at Howland.

In 2012, DMR made a concerted effort to release returning adults with marks or tags indicating they were stocked as 0+ hatchery parr in the Pleasant River. Passage results indicated the majority of these fish passed the Howland fishway and appeared to be migrating up the Piscataquis River and potentially back to the Pleasant River. Similarly, the passage data suggest that wild reared fish exhibited a tendency to migrate up the Piscataquis River.

Penobscot Species Protection Plan

In 2012, Blackbear Hydro prepared a Species Protection Plan to protect that listed Atlantic salmon, short nose sturgeon, and Atlantic sturgeon at their projects in the Penobscot River. The Plan become part of the FERC licenses for their projects on the Penobscot River and includes numerous measures to protect listed fish species in the river including installation of a new upstream fish lift at the Milford Dam and new downstream fishways at Milford, Orono, and Stillwater Dam. The projects, when operated pursuant to the SPP, will significantly reduce current impacts to listed Atlantic salmon and sturgeon. As part of the Species Protection Plans, upstream and downstream passage survival of Atlantic salmon at Blackbear's hydroelectric projects on the Penobscot River must meet 95% and 96%, respectively.

Brookfield Power also prepared an Interim Species Protection Plan for the Hydro Kennebec Project on the Kennebec River in Maine in 2012. As part of the plan, Brookfield Power will construct a new upstream fishway at the project in 2015. Upstream and downstream passage studies will also be conducted at the project to assess Atlantic salmon survival.

5.5 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick (1), the Lockwood fish lift on the Kennebec River (5), the Narraguagus River (15), and the Penobscot River (624). In total 645 genetic samples were collected in 2012 from adult trapping facilities. All tissue samples were preserved in 95% ethanol.

Since 1999, all broodstock at CBNFH have been PIT tagged and sampled for genetic characterization via fin clips. This activity allows 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, 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 2012, DPS broodstock (collected in 2011) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.6 General Program Information

Atlantic Salmon Smolt Telemetry Studies

Acoustic telemetry is a useful tool to assess Atlantic salmon smolt migration paths and survival through estuary and costal habitats. In 2012, we tagged and released naturally reared (n = 81) and age 1 hatchery smolts (n = 121) into the Penobscot River estuary on four dates in April and May. Movements were passively monitored via moored acoustic receivers through the estuarine and near-shore marine environment. Naturally reared smolts were significantly smaller than hatchery stocked smolts (166 vs. 200 mm FL; Kruskal-Wallis: $P < 0.05$). Preliminary estimates of smolt survival to the outer Penobscot Marine Array was estimated to be 0.52 (95% CL 0.29-0.69) for naturally reared and 0.57(95% CL 0.32-0.74) for hatchery smolts. In most years, both groups partition the bay similarly, in 2012, mid-bay behavior was again similar with little more than half (55%) of naturally reared smolts traveling on the eastern side of Islesboro (Dice Head) as compared to hatchery smolts, of which 63% used this route. Through the outer array, the majority of smolts exited via the western (Owls Head) passage (naturally reared 89% and hatchery 88%) following the pattern of previous years. Naturally reared smolts took less time to exit the array compared to hatchery reared smolts (release to outer array; 5.03 versus 7.43 days).

U. S. Fish & Wildlife Service Schools Programs

2012 marked the eighteenth 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 is 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 2012 photoperiod treatment mimicked the 2011 treatment, a reduction to a ten day extension of solstice-level light. However, the spawning pattern observed in 2012 was repeated indicating the reduction had little effect; in fact spawning was delayed an additional week for reasons unknown. A similar delay in spawning was observed in both captive populations at CBNFH and the domestic broodstock at GLNFH, neither of which were exposed to photoperiod manipulations.

GOM DPS Recovery Plan

A draft of the First Revision to the Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon has been completed by the U.S. Fish and Wildlife Service (Service) and National Oceanographic and Atmospheric Administration - National Marine Fisheries Service (NMFS), in close collaboration with Maine Department of Marine Resources and the Penobscot Indian Nation. The draft was reviewed by the Department of Interior Office of the Regional Solicitor in late fall of 2012. Revisions are nearly complete to the draft plan in response to issues raised by the Regional Solicitor's Office. The Service and NMFS target date for publishing a notice of availability for public review in the Federal Register, in late spring of 2013. Once the document is under public review, the agencies will convene several public meetings across the DPS to allow direct discussions between stakeholders and the agencies; formal comments will be accepted through electronic means and via surface mail.

Pleasant River Trap at Saco Falls

As part of an effort to improve adult returns and population size in the Pleasant River 55,000 smolts were stocked during the spring of 2012. 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, DMR, and USGS 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 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. DMR staff operated the Saco Falls fishway trap on the Pleasant River from 5 June, 2012 to 19 October, 2012. Two 2SW salmon; one male and one female were captured. See Section 5.1 Adult Returns, Pleasant River for capture data.

5.7 Migratory Fish Habitat Enhancement and Conservation

Habitat Protection

The pace of habitat protection activities has slowed considerably since 2006 when the Maine Atlantic Salmon Conservation Fund (NFWF) ended. In 2012 a large tract of land was protected in the Dennys River watershed adjacent to Cathance Lake by the Downeast Rivers Land Trust.

Habitat Connectivity

Numerous studies have identified how stream barriers can disrupt ecological processes, including hydrology, passage of large woody debris and movement of organisms (Jones et al. 2000, Poff and Hart 2002, Trombulak and Frissell 2000, and Warren and Pardew 1998). Thousands of barriers exist in Maine streams that block the movement of diadromous fish, other aquatic and terrestrial species, sediment, nutrients and woody debris. These barriers include dams and road-stream crossings. All dams interrupt stream systems, but are highly variable in their effects on the physical, biological, and chemical characteristics of rivers. Improperly sized and placed culverts can drastically alter physical and ecological stream conditions. Undersized culverts can restrict stream flows, cause scouring and erosion and restrict animal passage. Perched culverts usually scour the stream bottom at the downstream end and can eliminate or restrict animal passage. Culverts that are too small, or have been difficult to maintain or install are also at increased risk of catastrophic failure during larger than average storm events. Emergency replacements are more dangerous, more costly economically and more environmentally damaging than replacements planned ahead of disaster.

A coordinated effort is underway in Maine to identify aquatic connectivity issues across the state. Since 2006, state and federal agencies and non-governmental organizations have been working together to inventory and assess fish passage barriers in Maine and to develop barrier removal priorities. Partners include the Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Department of Marine Resources (MDMR), Maine Forest Service, Maine Department of Transportation, Maine Natural Areas Program, Maine Coastal Program, Maine Audubon, The Nature Conservancy, Trout Unlimited, Atlantic Salmon Federation, Maine Rivers, National Oceanic and Atmospheric Agency, USDA Natural Resources Conservation Service, US Fish and Wildlife Service, Androscoggin Soil and Water Conservation District, and local land trusts.

After 7 years of fieldwork, nearly half of the state has been surveyed (see Fig 5.7.1). Over 6,000 road-stream crossings have been assessed within the Gulf of Maine DPS. A wide variety of private owners, municipalities, and agencies are using survey information to prioritize road-stream crossing improvement projects. Many local, state, and private road managers have requested data showing where problems are so they can include them in long-term budget and repair schedules.

In 2013, stream barrier surveys will be completed in the Upper Androscoggin River, Upper Kennebec River, West Branch of the Penobscot, and Aroostook River Watersheds in western and northern Maine, including areas that have been designated as high priority for expanding access for Atlantic salmon by Maine Department of Marine Resources.

Maine Barrier Survey Status Map

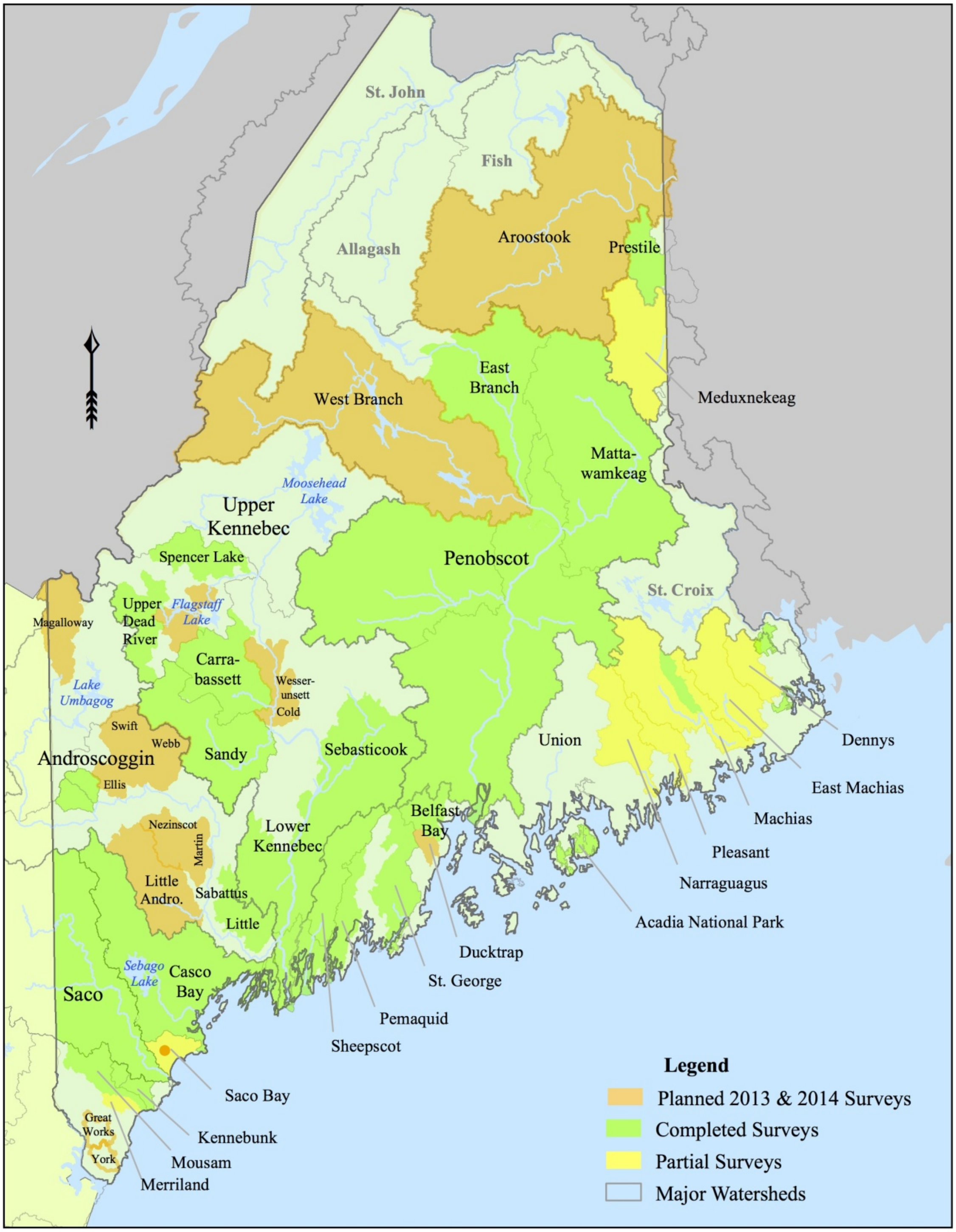


Figure 5.7.1 Extent of Maine Barrier Assessment Survey

Stream Smart Training – Maine Audubon has led a statewide partnership to educate professionals responsible for road-stream crossings on how to improve stream habitat by creating better crossings. The 4 workshops held in 2012 covered road-stream crossing projects from site assessment to permitting and installation. The partnership hosted Stream-Smart Road Crossing Workshops in four regions of the state to inform public and private road owners about opportunities to replace aging and undersized culverts with designs that last longer, improve stream habitat, save money on maintenance, and can reduce flooding. Participants in the workshops included town road commissioners, public works directors, contractors, forest landowners, foresters, loggers, engineers, conservation commissions, watershed groups and land trusts.

Additional project partners include the Maine Coastal Program, Maine Department of Environmental Protection, NOAA, US Fish & Wildlife Service, USDA NRCS, Maine Forest Service, Maine Rivers, Casco Bay Estuary Partnership, Project Share, Sustainable Forestry Initiative, and US Army Corps. An additional 4 workshops are being planned for 2013 along with a 3-day Stream Simulation course to train project managers in assessment and design techniques.

Online Data Viewer – An online data viewer that provides easy access to habitat and barrier datasets is in development and will be available in 2013. The viewer is hosted by the Maine Office of GIS and will contain Atlantic salmon spawning and rearing habitat, HUC12 focus areas and modeled rearing datasets along with dams and public-road stream crossings. The viewer is expected to assist with coordination of stream connectivity projects.

Habitat Restoration and Enhancement Projects in the East Machias River

Various NGO's and State and Federal agencies teamed up implement habitat enhancement projects within the East Machias Drainage. In 2012 coarse wood was added to Northern Stream. The USFWS deployed 50 thermographs throughout the drainage to illustrate spatial temperatures. MEDEP placed clamshells in small tributaries as part of a stream water buffering project. Ground work has been completed to for a 2013 installation of and arch culvert across Richardson Brook a cold tributary to Northern Stream.

Flanders Stream

Figure 5.7.3 Before and after photos of Flanders Stream, Sullivan, ME. Photo on left shows Denil fishway and culvert combination. Photo on right shows functioning rock/weir pool.

Project Description:

The Town of Sullivan is a small coastal town located in the Downeast region of Maine. Flanders Stream watershed supports native sea-run fish, including alewife, blueback herring, American eel, sea lamprey and sea run brook trout. The watershed is located within the Gulf of Maine Atlantic salmon Downeast coastal SHRU (salmon habitat recovery unit). Recovery of native forage and buffer species such those found in Flanders Stream has been identified as an integral part of the Atlantic salmon recovery effort.

This project restored river connectivity in Flanders Stream by removing the one barrier that exists in the watershed between Flanders Pond and coastal Flanders Bay. The barrier is stream channel ledge that was modified to accommodate a road crossing, perched culvert and deteriorated 1960's fish ladder. Since the stream channel consists of blasted ledge, access to upstream spawning habitat was accomplished by installing an arch bottomless culvert (required for the road crossing) with a nature-like fish passage structure on the downstream end of the culvert to allow for upstream and downstream passage through the culvert.

The passage project restored access to 535 acres of lake and 3 miles of riverine habitat for native amphibians and reptiles, as well as sea-run alewives, American eel, brook trout and sea lamprey. It also improved overall river connectivity, ecological function, and productivity in the watershed, and downstream to the coastal habitats of Flanders Bay, Frenchman's Bay and the Gulf of Maine through the increased exchange of biota, nutrients, and sediment. The watershed is located within the Downeast area where Atlantic salmon distinct segment populations occur and increased populations of alewife may provide prey and buffering benefits to ongoing salmon recovery efforts.

The culvert road crossing and rock ramp will be maintained by the Town of Sullivan and Maine Department of Marine Resources. The road crossing is the only access road to landowners and residents on Thorne Road which the Town of Sullivan has always and will continue to maintain. DMR-Bureau of Sea-Run Fisheries and Habitat, headquartered in Hallowell Maine, has staff in nearby Jonesboro to oversee the care and maintenance of fishways in Downeast Maine. Local supporters of alewife restoration will also assist in the maintenance of the fish passage structure.

This project supports and compliments many ongoing efforts by USFWS, DMR, NOAA and other partners in the Downeast region to restore the listed Atlantic salmon. Additionally, sea-run alewife and American eel are two species in decline throughout their range that are currently under consideration for ESA listing. Shortnose sturgeon, striped bass, mackerel, bluefish, and several ground fish species may benefit as a result of increased productivity of forage fish and invertebrate species in Flanders-French Bay and the Gulf of Maine. Other species that will benefit from the project include inland and coastal species including amphibians and reptiles, birds of prey, marine birds and mammals, and groundfish. Restoring access to Flanders Stream watershed spawning and nursery habitat will benefit these species and improve the health of the Gulf of Maine coastal ecosystem.

Other Projects

In 2012, 26 aquatic connectivity projects were completed across the Gulf of Maine DPS (Table 5.7.1) with the primary goal of restoring aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment). A total of over 240 kilometers of stream was made accessible as a result of these projects. These efforts were made possible due to strong partnerships including Project SHARE, Maine Dept. Inland Fisheries and Wildlife, Maine Dept. of Marine Resources, Maine Dept. of Conservation, Maine Forest Service, NOAA Fisheries, Atlantic Salmon Federation, U.S. Fish and Wildlife Service, The Nature Conservancy, Downeast Lakes Land Trust, municipalities, lake associations, and many large and small private landowners..

Stream	Site	Primary Watershed HUC 10	Sub basin HUC 12	Opened Est. miles	Area (miles2)	Opened Est. Km.	Area (sq. Km)	Structure
Northern Stream	Northern Bridge	East Machias River		24.8	24.4	39.9	63.2	Bridge
Nash Stream	Ridge Road	Harrington	Harrington	3.6	3.5	5.8	9.1	Open Arch
Middle Brook	Moosehorn Impoundment	Hobart		0.1	0.2	0.1	0.4	Decommission
Maple	Moosehorn Impoundment	Hobart		0.1	0.2	0.1	0.4	Decommission
Old Stream	Canaan Dam	Machias River	Old Stream	23.0	21.0	37.0	54.4	Remnant Dam
Old Stream	Groves Mills	Machias River	Old Stream	23.8	22.2	38.3	57.5	Remnant Dam
WB Machias	Hydraulic check above 39 road	Machias River	WB Machias River	34.5	35.0	55.5	90.6	Remnant Dam
4th Machias Lake Trib.		Machias River	Fourth Machias Lake	0.3	0.3	0.4	0.8	Open Arch
29-15 DELLT		Machias River	Fourth Machias Lake	0.3	0.2	0.4	0.5	Open Arch
Pembroke	Below Rt 9	Machias River		7.5	8.1	12.1	21.0	Remnant Dam
Marshall Brook		MDI		1.0	0.6	1.6	1.6	Box Culvert
Ash Bog Stream Trib	127	Narraguagus	WB Narraguagus	0.3	0.3	0.4	0.6	Bridge
Ash Bog Stream Trib	133	Narraguagus	WB Narraguagus	0.1	0.2	0.2	0.4	Bridge
Barrel Brook		Narraguagus	Beddington Lake	4.3	2.0	6.9	5.1	Remnant Dam
Barrel Brook		Narraguagus	Beddington Lake	4.0	2.0	6.5	5.1	Open Arch
Barrel Brook		Narraguagus	Beddington Lake	3.7	1.7	6.0	4.3	Bridge
Barrel Brook		Narraguagus	Beddington Lake	0.7	0.6	1.0	1.5	Bridge
Pike Brook	Partners 12k	Pleasant River		0.3	0.5	0.4	1.3	Open Arch
Unnamed Tributary	Site 7418	East Branch Penobscot	Lower East Branch Penobscot River	0.7	0.2	1.1	0.5	Bridge
Unnamed Tributary	Site 7398	East Branch Penobscot	Lower Seboeis River	0.3	0.2	0.4	0.6	Decommission
Unnamed Tributary	Site 7402	East Branch Penobscot	Lower Seboeis River	1.0	0.7	1.6	1.8	Bridge
Unnamed Tributary	Site 7588	East Branch Penobscot	Lower Seboeis River	0.9	0.5	1.4	1.2	Bridge
Roaring Brook	Remnant Dam	Pleasant River	Lower West Branch Pleasant River	8.9	12.0	14.3	31.1	Remnant Dam
Pushaw Lake	Pushaw Lake Outlet	Stillwater River	Pushaw Lake			0.0	0.0	Fishway
Flanders Stream	Flanders Stream	Frenchman Bay	Flanders Stream	5.3		8.5	0.0	Open Arch
Mattamiscontis Stream	Mattamiscontis Stream Outlet	Mattamiscontis Stream-Piscataquis	Upper Mattamiscontis Stream			0.0	0.0	Rock ramp

Table 5.7.1 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.

Pleasant River Focus Area Initiative

USDA, USFWSand 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.

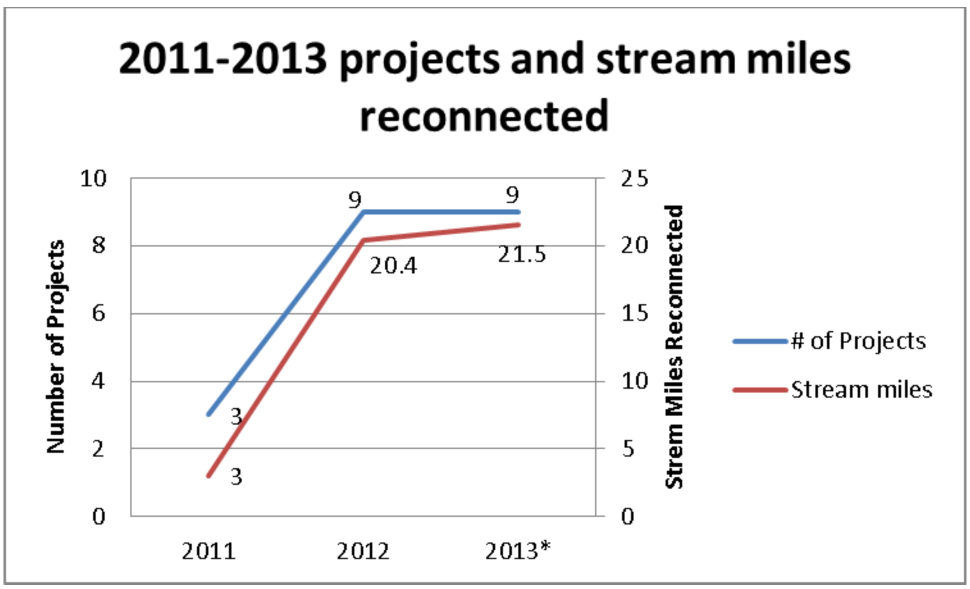


Figure 5.7.5 Connectivity projects completed 2011 – 2013 with stream miles reconnected.

Table 5.7.2: Projected project list for 2013 upper Penobscot River restoration effort. Note: project and stream miles are projected based on current project planning.

Watershed	**Stream Name**	**Project Type**	**Target Species**	**Stream Miles**
West Branch Pleasant	Henderson Brook	Bridge	salmon & trout	1
West Branch Pleasant	Little Houston	Bridge	salmon & trout	1
West Branch Pleasant	Lucia Pond outlet	Bridge	salmon & trout	2.5
West Branch Pleasant	Unnamed Trib to Indian Pond #1	Bridge	trout	1
West Branch Pleasant	Unnamed Trib to Indian Pond #2	Bridge	trout	1
East Branch Pleasant	Babble Brook	Remnant Dam Removal	salmon & trout	3
Piscataquis	Blackstone	Bridge	salmon & trout	10
Sebec	Unnamed Trib to Long Pond	Culvert	trout	1
Sebec	Carabou Stream	Bridge	trout	1
			Total	21.5

uring 2012 Maine NRCS and partners completed five stream connectivity projects for the Pleasant River Initiative reconnecting twenty miles of stream habitat and a thousand acres of lake habitat. A variety of connectivity projects were implemented in 2012 that focus on the broader suite of diadromous species that are so closely connected to Atlantic salmon. Two of these are described in the following vignettes.

Figure 5.7.4 Mattamiscontis Lake - Man-made obstructions have confined alewives to a small percentage of their ancestral spawning area in the Penobscot River Basin. Mattamiscontis Lake which means a fishing place for alewives by the Penobscot people was experiencing a limited spawning alewife population due to a remnant log drive dam that has been in place prior to the 1880's. This 1,100 acre lake has an alewife carrying capacity of 240,000. This structure during low flows reduces the number of alewives able to gain access the lake to spawn and traps juvenile alewives during their downstream migration.

The remnant dam structure was removed and a series of rock weir step pools for resting places during migrations while maintaining the current lake level was installed. This project is not only important for Penobscot Nation traditional culture but the overall ecological health of the Penobscot River and was labeled by the DMR as a priority alewife restoration lake. Partners included the PIN, USFWS, and DMR.

Figure 5.7.5 Roaring Brook - The above remnant log drive dam on Roaring Brook in the Pleasant River drainage was identified in late June of this year by NRCS's Fisheries Biologist. The dam held back over a half mile of dead water habitat creating a thermal barrier for cold water fish species like brook trout and Atlantic salmon. The removal of the dam has reduced the half mile impoundment above the dam site and has connected an additional seven miles of stream. NRCS provided the coordination, land owner contacts and technical assistance for this project. Partners included Elliotsville Plantation Inc., USFWS, DMR, MDIFW and TU.

Pushaw Lake Fishway

A new fishway and water control structure were constructed at the outlet of Pushaw Lake in 2012 through a partnership that included NRCS, the Atlantic Salmon Federation, Maine Department of Marine Resources, USFWS, and Greater Pushaw Lake Association. The overall goal of this effort is to restore historic alewife runs in the Penobscot River drainage and Pushaw Lake is the second largest water body in the drainage (5,056 acres) with an estimated alewife production of over 1.1 million.

Habitat Complexity

A large wood (LW) habitat improvement project was initiated by MEDMR-DSRFH 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.

In 2012, 4 sites were treated with LW spanning 4 streams and 3 watersheds in Downeast Maine, enhancing about 830 meters of streams. Two sites were treated in the East Machias River drainage; one site on Northern Stream and one site on Richardson Brook. Dead Stream, in the Machias River drainage was also treated along with Eastern Little River on the Pleasant River drainage.

Habitat assessment work was completed on Holmes Brook in the Machias River drainage. Assessment included shelter availability using a technique developed by Finstad (2007) in which a PVC tube was used to quantify interstitial space used as shelter by fish species. A longitudinal profile, in which measurements were taken every 10m or at least three measurements within each habitat type, and at habitat breaks, was completed prior to treating. A large wood survey was completed for Holmes Brook as well, using the *TWF Monitoring Program methods manual for the large woody debris survey* (1999).

14 sites were stocked with Atlantic salmon fry at a rate of 100 per unit (1 unit = $100m^2$). This was done in collaboration with the United States Fish and Wildlife Service (USFWS), Craig Brook National Fish Hatchery (CBNFH), and the DMR BSRFH.

There were no LW sites sampled for juvenile abundance this year. Focus is on the long term effects (10 years or more) but interim sampling is planned at five year intervals. In 2013, four paired sites will be surveyed.

All sites completed in 2012 were treated using the grip hoist method. Trees with a DBH of 15cm or greater were selected for addition as LW. This method involved cutting key roots and pulling the tree into the stream. Enough of the root mass was cut as to allow the tree to not only be pulled over using the man-powered, simple machine, but to create as small of a hole as a result of the root mass being pulled up as possible to prevent further erosion and sedimentation in the stream (Fig 5.7.6).

Fig. 5.7.6 Illustration of coarse wood pulled into stream with roots attached. (Photo by Kyle Winslow, Project SHARE)

The remaining roots will help to anchor the LW in the stream and prevent emigration of LW due to high water events and ice flow.

This grip hoist method allows for a crew of at least three staff to fell from 10-20 trees in a day depending on a site. The equipment is mobile and there is no environmental impact other than the trees being felled as part of the study. The method is cost effective, and allowed us to be more flexible with scheduling as there is no need to contract a wood cutter to fell trees.

Follow up surveys will include longitudinal profiles of treatment and control sites, wood loading surveys of treatment sites, and shelter availability measurements for both treatment and control sites. Juvenile assessment will continue in 2013 with a focus on juvenile assessments in 2014. These follow up surveys are to begin in 2013 as described in Table 5.7.3.

The Sheepscot River was not treated in 2012 due to lack of landowner support, but it is anticipated that a treatment will occur in 2013. Four sites are anticipated to be treated in 2013 in the Downeast watersheds.

Table 5.7.3 List of streams treated with coarse wood.

Watershed	Tributary	Site Length (m)	Stocked Since	Treatment Date	Scheduled E-fish	Pre-Treatment Monitoring	LW Survey	Post Treatment Monitoring	Site Type Study (S) Production (P)
East Machias	Seavey Stream	200	2012	2011	2013	2010	2010	2013-2014	S
East Machias	Seavey Stream	200	2012	2011	2013	2010	2010	2013-2014	S
East Machias	Northern Stream (Lower)	200	Natural Recruitment	2011	2013	2011	2011	2013-2014	S
East Machias	Northern Stream (Upper)	200	Natural Recruitment	2011	2013	2011	2011	2013-2014	S
East Machias	Long lake Stream	200	2012	2011	2013	2010	2010	2013-2014	S
East Machias	Beaver Dam	175	2012	2011	2013	2011	2011	2013-2014	S
East Machias	Creamer (Upper)	200	2007	2007	Annual			2011	S
East Machias	Creamer (Lower)	200	2007	2007	Annual			2011	S
Narraguagus	Main Stem Below Rt. 9		2012	2011	2013	2011	2011	2011	P
Narraguagus	Main Stem below 31-00-0 Rd.	150		2011	2013	2011	2011	2013-2014	S
Narraguagus	Baker (Lower)	200	2009	2008	Annual			2011	S
Narraguagus	Baker (Mid)	200	2010	2011		2011	2011	2013-2014	S
Narraguagus	Baker (Upper)	150	2012	2008	2011	2011	2011	2011	S
Narraguagus	Shorey	200	2009	2009	2012	2009	2009	2011	S
Narraguagus	Sinclair (Upper)	200	2009	2009	2012	2009	2009	2011	S
Narraguagus	Sinclair (Lower)	200	2009	2009	2012	2009	2009	2011	S
Narraguagus	Rocky Brook	125	2009	2009	2012	2009	2009	2011	S
Narraguagus	Humpback (Upper)	150	2009	2009	2012	2009	2009	2011	S
Narraguagus	Humpback (Lower)	200	2009	2009	2012	2009	2009	2011	S
Narraguagus	35 Brook	125	2009	2009	2012	2009	2009	2011	S
Narraguagus	Gould	200	2007	2007	Annual			2011	S
Machias	Holmes Brook	200	2009	2008	2011			2011	S
Old Stream	New Stream	200	2009	2011	2013	2011	2011	2013-2014	S
Old Stream	Dead Stream	350		2007	Annual			2011	S
Sheepscot	WB Sheepscot	150		20??	2013				S
Old Stream	Old Stream			2011					P
Old Stream	Old Stream			2011					P
Old Stream	Old Stream			2011					P
Machias	West Branch			2011					P
Machias	West Branch			2011					P
Machias	West Branch			2011					P
Machias	West Branch			2011					P
Machias	West Branch			2011					P
Machias	West Branch			2011					P
East Machias	Northern Stream			2012					P
East Machias	Northern Stream		Proposed for 2013	2013					P
East Machias	Richardson Brook			2012					P
East Machias	Richardson Brook		Proposed for 2013	2013					P
East Machias	Richardson Brook		Proposed for 2013	2013					P
Machias	Dead Stream (Bowles Brook)			2012					P
Machias	Dead Stream		Proposed for 2013	2013					P

Figure 5.7.7 Northern Stream Treatment (2012) (photo by Jacob van de Sande, Downeast Salmon Federation).

Figure 5.7.8 Coarse wood on Northern Stream (Treated 2011) With an Atlantic salmon redd alongside LW. Picture taken by Kyle Winslow, Project SHARE

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Flanders Stream

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.

Adult Returns

Aroostook River

The 2012 Tinker Dam trap catch on the Aroostook River was 35 Atlantic salmon, compared to 51 in 2011 and 35 in 2010. Nearly half (16) of the 2012 catch were captive-reared fish previously released by the Department of Fisheries and Oceans (DFO). The 19 sea-run salmon were assigned a sea-age class (4 1SW, 15 MSW) based on observed fork length and the age/length relationship developed by the DFO for St. John salmon stocks (1SW ≤ 63 cm, MSW salmon > 63 cm). The Tinker trap was opened on 18 June following the first releases of salmon trapped downriver at the Mactaquac Dam, and closed on 05 November.

A temporary trap was installed in the Caribou Dam fishway on 6 May to monitor the fishway for the presence of smallmouth bass. The monitoring program was established in response to a reported sighting of a smallmouth bass by an angler fishing below the Caribou Dam in 2011. No bass were observed during fishway trapping, electrofishing, and angling surveys conducted in 2011 or 2012 and it was concluded that smallmouth bass are absent (or extremely rare) in the Aroostook River. All Atlantic salmon captured at the Caribou Dam in 2011 (24 total) were captured after 6 July as expected due to run timing at the Tinker trap. Numerous brook trout, landlocked Atlantic salmon, other resident species were captured in the trap during 2012 but no Atlantic salmon were observed prior to trap closure on 6 July. The Caribou trap was removed on 6 July 2012 and the fishway remained open for all of 2012.

6.1 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 stocking in the Aroostook River. The hatchery imports and incubates “St. John River strain” salmon eggs produced by captive-reared broodstock at the Mactaquac Biodiversity Facility. Broodstock and eggs are subject to U.S. Title 50 fish health certification. In 2012 the ASNM imported a record 1,265,000 eyed eggs and produced over 729,000 unfed fry.

6.2 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 729,000 non-feeding fry into the Aroostook River in under the supervision of DMR biologists.

Adult Salmon Releases

Aroostook River

Adult salmon are not stocked into the Aroostook River, but 16 of the captive-reared salmon stocked in the St. John River by the DFO entered the Aroostook River and passed the Tinker Dam. The captive-reared adults were reared (at the Mactaquac Biodiversity Facility) from wild smolts captured in the Beechwood Dam gatewells in 2010. After two years in captivity the sexually mature adults were floy tagged and released in the St. John River downstream of the Tobique and Aroostook Rivers. Presumably the 16 fish captured at Tinker originated as Aroostook River smolts.

6.3 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed in 2012.

Smolt Monitoring

No smolt monitoring was conducted for the Aroostook River program.

6.4 Tagging

No tagging occurred in the Aroostook River program.

6.5 Fish Passage

Aroostook River

The Tinker Dam fish lift and trap were not operated from 13 August to 18 August 2012 (6 days) due to routine 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.

6.6 Genetics

6.7 General Program Information

Canadian Species at Risk Act

Over the course of 2012, DFO drafted Recovery Potential documents for five significant population units in Atlantic Canada, including the Outer Bay of Fundy area (**http://www.registrelep.gc.ca/document/default_e.cfm?documentID=1944**). Four of the five meetings were held in 2012, the Outer Bay of Fundy meeting will be held in 2013. This is the only one of the areas being assessed that includes significant rearing area in the United States. DFO will be requesting comments from DMR on their draft documents, and it would be useful if we could address how a Canadian listing might affect protection of Atlantic salmon in the U.S. Further, it is unclear if the St. John River will continue to be the source of eggs for the Aroostook NGO hatchery.

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 marine and freshwater climate change models. This information is highlighted in the following four sections: 7.1) NASCO US Management Objectives Update; 7.2) U.S. Atlantic Salmon and Climate Change; 7.3 Interactive Web-Based Models to Link Climate and Fish in Streams; 7.4) USASAC Regional Assessment Product Progress Update. Finally, based on actions and discussions at the meeting draft terms of reference for next year's meeting were developed (7.5).

7.1 NASCO Management US Objectives Update and Program Classification Terminology

The existing NASCO management objective for considering a fishery at West Greenland includes an arbitrary criterion of a 25% increase in adult returns to the US from the average returns, 1992-1996. A working paper by Rory Saunders, Tim Sheehan, and Steve Gephard explained how this was established many years ago. The criterion was almost satisfied in 2011 when the Penobscot River experienced the best run in many years. However, this would have represented only 8.7% of the established Conservation Limit (CL) for the U.S. and could have allowed fishing of the GOM DPS (endangered) and would not have been consistent with the Precautionary Approach, ICES advice, and previous agreements of NASCO. There is a need to establish a more useful CL for the US. This need is amplified by the recent changes in the Connecticut River program.

Many alternative approaches to determining a new CL were considered. The paper recommended, and the USASAC concurred, that the US CL should be consistent with the draft recovery plan for the GOM DPS. This equates to roughly 6,000 MSW adults equally distributed across each of the three recovery units (see Figure 1) for a sustained period of time (at least 10 years).

Figure 7.1.1 Recovery units for the Gulf of Maine DPS.

Such a CL would not consider Conservation Spawning Escapement (CSE) needs for other river basins that are managed by programs of varying natures and would deflect any criticism from other Parties that the US was 'padding' realistic requirements. No one can deny the need for the CSEs for the GOM DPS. So instead of an arbitrary fraction of all habitat in all basins, including some with uncertain management objectives, the proposed CL will include 100% of all habitat in the basins included in the listed GOM DPS. This CL is higher and therefore more protective (in regards to a future potential fishery) to the fish in the basins that are not included than the current CL for which those basins were included. Moreover, since this CL would be used only for ICES catch advice to NASCO, it carries no constraints or mandates for local authorities managing programs in the basins that are not included. A more precise calculation of the CL will be provided by NOAA after further analyses.

The proposal for a new US CL prompted a new look at how the US categorizes its salmon programs. Traditionally, workers with Atlantic salmon have categorized rivers and the salmon programs operating within those rivers. Within the U.S., these categories initially were: Native/remnant (wild, native runs that avoided extirpation), Restoration (native runs were extirpated but salmon occur in the watershed due to restoration efforts), and Extirpated/extinct (native runs were extirpated and no salmon occur in the watershed due to the lack of any restoration efforts). With the listing of all native runs in the U.S. under the Endangered Species Act (Gulf of Maine DPS), the native/remnant category is now referred to as “Recovery”. NASCO has introduced additional categories for use in its Rivers Database, a map-based database on its website: 1) not threatened with loss, 2) threatened with loss, 3) lost, 4) restored, 5) maintained, 6) unknown, and 7) not present but potential. The NASCO categories, based on the experiences/needs of other nations, go further than the U.S. categories to create more distinctive subgroups. Changes in the salmon programs in southern New England watersheds during 2012-2013 will result in some of these programs no longer qualify as belonging to one of any of the existing categories.

Restoration programs can be viewed as efforts intended to establish a sustained population of anadromous salmon in rivers which have totally lost their native runs. Examples of U.S. restoration rivers/programs include the Connecticut, Pawcatuck, and Merrimack rivers. In 2012, the partners involved in the Connecticut River program decided to terminate the effort to restore a sustained population of salmon but continue to stock a very small number of hatchery-produced fry into small areas of the basin. The goals of this program are multiple and include genetic conservation, education, and research but do not include the long-term intent of restoring a run of sea-return adults that could be considered sustainable. In the future, the number of juveniles stocked and the number of adult returns will be reported into the U.S. database but it would be inappropriate to consider these data in the standard analyses along with true restoration or recovery programs.

In discussions, the USASAC endorsed the establishment of a new category for such programs termed “**reservation**”, incorporating the concept that the small salmon population is a biological reserve without any expectation of true restoration. A number of different programs/rivers could be categorized as “reservation” even though the exact natures of the programs differ. Any program that continues to maintain a wild population of salmon without any expectation of significant population growth or run restoration could be listed under the reservation category regardless of the numbers, age, or purpose of the fish stocked. It is expected that in 2013, the Connecticut River program will transition from a restoration program to a reservation program and decisions on re-categorization of other New England rivers could be made during the next one to three years.

7.2 US Atlantic Salmon and Climate Change

Kevin Friedland presented a concise synopsis of some of his recent research. The following is a synopsis of his presentation. Atlantic salmon populations have experienced a multi-decadal pattern of decline in recruitment that appears to be driven by climate factors that affect the survival of juveniles during their first year at sea. These retrospective patterns heighten concern over the impact of future changes in ocean climate on the viability of salmon populations, and though recent declines appear to be primarily due to effects in the marine environment, many freshwater habitats utilized by salmon may also be impacted by climate change making them uninhabitable during the salmon's freshwater phase. Three areas where climate change may impact salmon were considered: the potential to exceed thermal thresholds in juvenile freshwater rearing areas, the phenology of smolt migrations in North America, and the thermal forcing of mortality in post-smolt marine nursery areas. The likelihood of salmon freshwater habitats exceeding 23 and 27°C, taken as physiologic thresholds impacting juvenile salmon growth and survival, increased in the main rearing areas for Atlantic salmon in both Europe and North America, most intensely in a gradient from south to north. The phenology of smolt migrations in North America may be further unsynchronized by a differential shift in transitional temperatures in the juvenile rearing areas and the coastal ocean. Increased sea surface temperatures in key ocean regions are expected to continue to erode marine survival for southern tier stocks from both continental groups. The dramatic increase of sea temperatures in 2012 may impact the survival of 2SW salmon returning in 2014. The persistent range of Atlantic salmon in North America and Europe may be redefined by the dynamics of ocean and freshwater thermal conditions in combination with stressors associated with other segments of its life history. The following citations and hyperlinks should be consulted for further detail.

Friedland KD, Shank BV, Todd CD, McGinnity P, Nye JA (2013) Differential response of continental stock complexes of Atlantic salmon (Salmo salar) to the Atlantic Multidecadal Oscillation. Journal of Marine Systems In Press

Friedland KD, Manning JP, Link JS, Gilbert JR, Gilbert AT, O'Connell AF (2012) Variation in wind and piscivorous predator fields affecting the survival of Atlantic salmon, Salmo salar, in the Gulf of Maine. Fisheries Manag Ecol 19 (1):22-35. Link

7.3 Interactive Web-Based Models to Link Climate and Fish In Streams

Benjamin Letcher presented a synopsis of some of his recent research and demonstration of interactive web-based potential. The following is a synopsis of his presentation. Predicting species response to environmental change in streams requires models that include effects of variation in stream flow and temperature. Examples were presented with brook trout. Models that include data from individually tagged fish can relate variation in stream flow and temperature to demographic process, including body growth and survival. We have incorporated these relationships into a demographic model (Integral projection model) that allows estimation of population growth as a function of variation in stream flow and temperature. These models have shown that the population is slowly declining, that population growth is particularly sensitive to stream temperature in the fall, and that forecasts of environmental conditions will result in faster rates of decline. They are also developing models that take advantage of existing monitoring datasets of untagged fish. These models will not include demographic processes, but will relate environmental conditions to occupancy and population growth. To make these models more broadly accessible, they have developed a web site that links climate models with environmental models and fish models. Once complete, this modeling system will allow scenario testing of management alternatives under future climates.

7.4 USASAC Regional Assessment Product Progress Update

The USASC moved forward on improving and enhancing assessment products. As noted last year, the USASAC felt that this large undertaking should be accomplished over the course of several intercession meetings. Intercession meetings were limited in 2012 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 to be used 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). These needs are especially urgent as habitat connectivity and in-stream improvements are increasing regionally and the scope and impact of stocking programs is decreasing. Both are important tools and it would be unfortunate if new opportunities created to enhance fish habitat are not seeded with hatchery fish in an optimal manner.

7.5 USASAC Draft Terms of Reference 2014 Meeting

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, Bailey, 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 2013 meeting and meet over summer to continue progress
    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) Parr Marked Returns- Smolt Parr-Subsidy Issue- update on core study on accelerated growth fish in Penobscot – final update on analysis expected at 2014

meeting as all at-sea return data will be available (**Cox**, Firmenich, Flanery, Domina, Lipsky).

4) Redd-Based Estimate Benchmark 2012 Revision Working Paper in 2014 – (**Lipsky**, Trial, 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
    e. Re-development of model in R to facilitate broader use that @Risk Version

5) New England Smolt Summary Benchmark Year 2014 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 and 2013 meeting
    c. Add smolt tables into USASAC dbase and paper – Narraguagus, CT Farmington and Mainstem smolt estimate to USASC database
    d. Peer-reviewed ready working paper in 2014

6) Emerging Issues Identified Intercession or at Annual Meeting –

7) Potential Theme 2014– Diadromous fish timing and salmon to be investigated by incoming USASAC Chair at Summer Intercession Meeting
    a. Michael O'Malley - NOAA
    b. Patrick Erbland - UMaine
    c. Doppler Monitoring by USGS – Claire Enterline MDMR or Rob Lent USGC, in USGS monitoring – fish images are filtered out. Can that data be used for indices?

8 List of Attendees, Working Papers, and Glossaries

8.1 List of Attendees

First Name	Last Name	Primary Email	Agency	Location
Ernie	Atkinson	Ernie.Atkinson@maine.gov	ME DMR	Jonesboro, ME
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT DEEP	Old Lyme, CT
James	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
Mike	Bailey	Mike_Bailey@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
Tim	Wildman	Tim.Wildman@po.state.ct.us	CT DEEP	Old Lyme, CT
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Dave	Ellis	Dave.Ellis@po.state.ct.us	CT DEEP	Old Lyme, CT
Denise	Buckley	Denise_Buckley@fws.gov	FWS	Orland, ME
Peter	Lamothe	Peter_Lamothe@fws.gov	FWS	Orland, ME
Kevin	Friedland	Kevin.Friedland@noaa.gov	NOAA	Narragansett, RI
Ben	Letcher	Ben_Letcher@usgs.gov	USGS	Amhurst, MA

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

Number	Authors	E-mail Address	Title
PS13-01	Veronica Masson	veronica.masson@dem.ri.gov	Pawcatuck River Update (WP)
PS13-02	Ken Sprankle	Ken_Sprankle@fws.gov	Connecticut River Update (PPT)
PS13-03	Mike Bailey	Mike_Baily@fws.gov	Merrimack River Update (PPT)
PS13-04	Ernie Atkinson/Joan Trial	Ernie.Atkinson@maine.gov	Maine Rivers Update (PPT)
WP13-01	Tim Sheehan	Tim.sheehan@noaa.gov	ICES Working Group on North Atlantic Salmon Summary 2012 (PPT)
WP13-02	John Sweeka	John_Sweeka@fws.gov	2013 USASAC Database Summaries (PPT)
WP13-03	John Kocik, Susan Wigley, and Dan Kircheis	John.Kocik@noaa.gov	Annual Bycatch Update Atlantic Salmon 2012
WP13-04	Graham Goulette, James Hawkes and John Kocik	James.Hawkes@noaa.gov	Maine Telemetry Update 2012 (WP/PPT)
WP13-05	Christine Lipsky, James Hawkes, Ruth Haas-Castro and Mitch Simpson	Christine.Lipsky@noaa.gov	Maine Smolts Update 2012 (WP)
WP13-06	David Bean, Chris Vonderweidt, Jon Lewis, Marcy Nelson	David.Bean@noaa.gov	Maine and neighboring Canadian Commercial Aquaculture Activities and Production (WP)
WP13-07	Kevin Friedland	Kevin.Friedland@noaa.gov	Will Atlantic salmon persist in the Gulf of Maine in the face of changing climate conditions?
WP13-08	John Sweeka and Megan Kepler	John_Sweeka@fws.gov	A New Gulf of Maine Atlantic Salmon Population Viability Model: Narraguagus River Case Study (PPT)
WP13-09	James Hawkes, Michael O'Malley, Graham Goulette and Rory Saunders	James.Hawkes@noaa.gov	Investigating the influence of run timing, fish biomass and environmental conditions on smolt survival in the Penobscot Estuary (PPT)
WP13-10	Steve Gephard and Rory Saunders	Steve.Gephard@po.state.ct.us	Management Objectives for Atlantic Salmon in the United States (WP/PPT)

8.3 Glossary of Abbreviations

Glossary of Abbreviations

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Division of Sea Run Fisheries and Habitat	DSRFH
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.

8.5 LIFE HISTORY RELATED

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

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

2SW Salmon	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31four times since becoming a smolt.
Kelt	A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to homewaters to spawn again.
Reconditioned Kelt	A kelt that has been restored to a feeding condition in captivity.
Repeat Spawners	Salmon that return numerous times to the river for the purpose of reproducing. Previous spawner.

8.6 Appendicies

Appendix 1. Documented Atlantic salmon returns to the USA, 1967-2012. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

	Sea age					Origin	
Year	1SW	2SW	3SW	Repeat	Total	Hatchery	Natural
1967	71	574	39	89	773	114	659
1968	17	498	12	55	582	314	268
1969	30	430	16	31	507	108	399
1970	9	539	15	16	579	162	417
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1025	495	530
1973	17	622	8	12	659	420	239
1974	52	791	35	25	903	639	264
1975	77	1,250	14	25	1,366	1,126	240
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	32	1,129	921	208
1978	132	2,254	17	35	2,438	2,060	378
1979	216	987	7	18	1,228	1,039	189
1980	705	3,420	12	51	4,188	3,842	346
1981	975	3,674	30	31	4,710	4,450	260
1982	310	4,439	25	44	4,818	4,474	344
1983	252	1,356	28	21	1,657	1,330	327
1984	551	2,058	19	50	2,678	2,207	471
1985	345	4,185	38	16	4,584	3,900	684
1986	658	4,906	49	11	5,624	4,893	731
1987	1,008	2,446	66	72	3,592	3,093	499
1988	846	2,672	10	70	3,598	3,337	261
1989	1,098	2,557	9	51	3,715	3,288	427
1990	586	3,798	19	41	4,444	3,812	632
1991	292	2,297	6	41	2,636	1,723	913
1992	1,022	2,149	6	14	3,191	2,617	574
1993	404	1,940	11	30	2,385	2,033	352
1994	380	1,212	2	18	1,612	1,260	352
1995	184	1,543	7	15	1,749	1,504	245
1996	572	2,146	11	33	2,762	2,134	628
1997	303	1,397	7	24	1,731	1,295	436
1998	358	1,361	3	23	1,745	1,159	586
1999	386	1,042	3	21	1,452	954	498
2000	270	515	0	18	803	578	225
2001	266	788	6	3	1,063	838	225
2002	436	504	2	20	962	845	117
2003	237	1,192	3	4	1,436	1,242	194
2004	319	1,283	15	18	1,635	1,391	244
2005	319	984	0	10	1,313	1,019	294
2006	450	1,023	2	5	1,480	1,161	319
2007	297	954	3	1	1,255	931	324
2008	814	1,764	11	24	2,613	2,188	425
2009	241	2,069	16	10	2,336	1,993	343
2010	552	1078	3	17	1,650	1,401	249
2011	1080	3045	26	16	4,167	3,465	702
2012	24	881	27	7	939	694	245

Appendix 2. Two sea winter (2SW) returns for 2012 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2012	Percentage of Requirement
Long Island Sound	LIS	10,094	56	0.6%
Central New England	CNE	3,435	120	3.5%
Gulf of Maine	GOM	15,670	705	4.5%
Total		29,199	881	3.0%

Appendix 3. Number of juvenile Atlantic salmon stocked in USA, 2012. 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	1,739,000	3,000	8,000	4,000	0	71,000	1,825,000
Central New England CNE	2: Merrimack, Saco	1,412,000	22,000	13,000	0	46,000	0	1,493,000
Gulf of Maine GOM	8: Androscoggin to Dennys	1,873,000	395,000	1,000	0	675,000	0	2,944,000
Outer Bay of Fundy OBF	1: Aroostook	731,000	0	0	0	0	0	731,000
Totals for USA	13	5,755,000	420,000	22,000	4,000	721,000	71,000	6,993,000

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2012 by geographic area. Egg numbers are rounded to 1,000.

			Captive Reared Domestic		Sea Run			Eggs
River		Purpose	Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	Total	Eyed
Central New England	CNE	Recreation	1,295				1,295	
Central New England	CNE	Restoration	640		20	107	767	
Gulf of Maine	GOM	Restoration	481	2,085		469	3,035	1,344,000
Total for USA							5,097	1,344,000

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2012. Includes hatchery and wild origin fish.

MarkCode	LifeHistory	CNE	GOM	LIS	Grand Total
AD	Parr	34,800	68,707	3,905	107,412
AD	Smolt	27,905	59,123	71,018	158,046
FLOY	Adult	1,695			1,695
PING	Smolt		358		358
PIT	Adult		2,034		2,034
RAD	Adult	16	5	10	31
RAD	Adult	2			2
RAD	Smolt		388		388
Grand Total		64,418	130,615	74,933	269,966

RAD = radio tag

PIT = passive integrated transponder

PING = ultrasonic acoustic tag

Appendix .6 Aquaculture production (metric tonnes) in New England from 1997 to 2012. Production for 2012 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	6,031
2012	2,381 to 8,413

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2012.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	1,733,000	3,100	7,500	4,000	0	71,000	1,818,600
Total for Connecticut Program							**1,818,600**
Aroostook	731,000	0	0	0	0	0	731,000
East Machias	88,000	53,200	0	0	0	0	141,200
Kennebec	2,000	0	0	0	0	0	2,000
Machias	231,000	0	1,400	0	0	0	232,400
Narraguagus	389,000	0	0	0	59,100	0	448,100
Penobscot	1,073,000	325,700	0	0	555,200	0	1,953,900
Pleasant	40,000	0	0	0	60,200	0	100,200
Saco	396,000	0	12,800	0	11,900	0	420,700
Sheepscot	50,000	15,700	0	0	0	0	65,700
Union	1,000	0	0	0	0	0	1,000
Total for Maine Program							**4,096,200**
Merrimack	1,016,000	22,000	0	0	33,800	0	1,071,800
Total for Merrimack Program							**1,071,800**
Pawcatuck	6,000	0	0	0	0	0	6,000
Total for Pawcatuck Program							**6,000**
Total for United States							**6,992,600**
Grand Total							**6,992,600**

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 2012.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	257	0	0	0	257
East Machias	Restoration	52	80	0	0	132
Machias	Restoration	81	141	0	0	222
Merrimack	Restoration/Recreation	640	0	0	0	640
Merrimack	Restoration	0	0	20	107	127
Merrimack	Recreation	1,295	0	0	0	1,295
Narraguagus	Restoration	0	297	0	0	297
Penobscot	Restoration	0	1,150	0	469	1,619
Pleasant	Restoration	56	256	0	0	312
Sheepscot	Restoration	35	161	0	0	196
Total		2,416	2,085	20	576	5,097

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 ***2012***.

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
SRSC	1		H		AD	12,800		April	Saco
USFWS	1	Smolt	H		AD	11,905		April	Saco
USFWS	4	Adult	H	Dennys	PIT	62	UCP	Oct	Dennys
USFWS	5	Adult	H	Dennys	PIT	73	UCP	Oct	Dennys
USFWS	3	Adult	H	Dennys	PIT	122	UCP	Oct	Dennys
EMARC	0		H	East Machias	AD	51,015		Nov	East Machias
EMARC	0		H	East Machias	AD	2,000		Oct	East Machias
USFWS	3	Adult	H	East Machias	PIT	19	UCP	Nov	East Machias
USFWS	4	Adult	H	East Machias	PIT	44	UCP	Nov	East Machias
USFWS	4	Adult	H	East Machias	PIT	15	UCP	Oct	East Machias
USFWS	5	Adult	H	East Machias	PIT	17	UCP	Nov	East Machias
USFWS	5	Adult	H	East Machias	PIT	37	UCP	Oct	East Machias
DMR		Adult	H	Kennebec	RAD	5		June	Kennebec
USFWS	5	Adult	H	Machias	PIT	43	UCP	Dec	Machias
USFWS	4	Adult	H	Machias	PIT	75	UCP	Dec	Machias
USFWS	3	Adult	H	Machias	PIT	23	UCP	Dec	Machias
USFWS	5	Adult	H	Machias	PIT	81	UCP	Oct	Machias
FPL		Adult	H	Merrimack	RAD	8		June	Saco
NHFG	2	Adult	H	Merrimack	FLOY	400		Oct	Merrimack
NHFG	2	Adult	H	Merrimack	FLOY	200		Sept	Merrimack
NHFG	3	Adult	H	Merrimack	FLOY	695		April	Merrimack
NHFG	3	Adult	H	Merrimack	FLOY	400		Oct	Merrimack
USFWS	3	Adult	H	Merrimack	RAD	8	AD	Oct	Merrimack
USFWS	0	Parr	H	Merrimack	AD	22,000		Oct	Merrimack
USFWS	3	Sea Run	H	Merrimack	RAD	2	AD	June	Merrimack

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	1	Smolt	H	Merrimack	AD	16,000		April	Merrimack
USFWS	4	Adult	H	Narraguagus	PIT	87	UCP	Nov	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	25	UCP	Dec	Narraguagus
USFWS	3	Adult	H	Narraguagus	PIT	59	UCP	Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	25	UCP	Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	11	UCP	Nov	Narraguagus
USFWS	3	Adult	H	Narraguagus	PIT	90	UCP	Nov	Narraguagus
USFWS	1	Smolt	H	Narraguagus	AD	59,123		May	Narraguagus
DMR		Adult	H	Penobscot	PIT	12		Sept	Penobscot
DMR		Adult	H	Penobscot	PIT	4		Oct	Penobscot
DMR		Adult	H	Penobscot	PIT	64		May	Penobscot
DMR		Adult	H	Penobscot	PIT	61		June	Penobscot
DMR		Adult	H	Penobscot	PIT	1		July	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	121		May	Penobscot
NOAA		Smolt	W	Penobscot	PING	81		May	Penobscot
Normandeau	1	Smolt	H	Penobscot	RAD	258		May	Kennebec
USFWS		Adult	H	Penobscot	PIT	469		Nov	Penobscot
USFWS	3	Adult	H	Penobscot	UCP	579		Dec	Penobscot
USFWS		Adult	H	Penobscot	PIT	7		June	Penobscot
USFWS	4	Adult	H	Penobscot	UCP	571		Dec	Penobscot
USGS/UMO	1	Smolt	H	Penobscot	PING	72		April	Piscataquis
USGS/UMO	1	Smolt	H	Penobscot	PING	84		April	Penobscot
USGS/UMO	1	Smolt	H	Penobscot	RAD	130		May	Penobscot
USFWS	3	Adult	H	Pleasant	PIT	172	UCP	Dec	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	22	UCP	Dec	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	56	UCP	Oct	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	22	UCP	Nov	Pleasant

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	5	Adult	H	Pleasant	PIT	40	UCP	Nov	Pleasant
USFWS	0		H	Sheepscot	AD	15,692		Sept	Sheepscot
USFWS	3	Adult	H	Sheepscot	PIT	81	UCP	Dec	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	68	UCP	Dec	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	12	UCP	Dec	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	35	UCP	Oct	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 ***2012****.*

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	1,703	8	4,900
Hatchery Juvenile	190,537	190,537	191,202
Wild Juvenile			81
Total			**196,183**

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2012.

	1SW		2SW		3SW		Repeat			2008-2012
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Connecticut	0	0	1	53	0	0	0	0	**54**	86
Kennebec	0	0	1	4	0	0	0	0	**5**	26
Merrimack	0	1	81	27	14	3	0	0	**127**	162
Narraguagus	2	0	9	5	1	0	0	0	**17**	64
Penobscot	8	5	531	69	6	0	2	3	**624**	1,828
Pleasant	0	0	0	2	0	0	0	0	**2**	2
Saco	0	0	12	0	0	0	0	0	**12**	40
Total	**10**	**6**	**635**	**160**	**21**	**3**	**2**	**3**	**841**	**2,208**

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2012.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	721	4,564,000
Merrimack	Domestic	231	746,000
Total	**Captive/Domestic**	**952**	**5,310,000**
Connecticut	Kelt	6	37,000
Total	**Kelt**	**6**	**37,000**
Connecticut	Sea Run	33	234,000
Merrimack	Sea Run	72	510,000
Total	**Sea Run**	**105**	**744,000**
Grand Total for Year	**2012**	**1,063**	**6,091,000**

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	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco															
1993-2002	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															
1977-2002	1,404	16,328,000	7,900	17,722	117,296,000	5,900	0	0		1,830	23,114,000	10,200	20,956	156,737,000	6,500
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
2012	33	234,000	7,100	721	4,564,000	6,300	0	0		6	37,000	6,200	760	4,835,000	6,400
Total Connecticut	2,025	20,939,000	7,400	33,482	206,966,000	5,800	0	0		2,395	28,935,000	9,700	37,902	256,839,000	6,100
Dennys															
1939-2002	26	214,000	7,600	0	0		701	2,734,000	4,000	40	330,000	7,700	767	3,278,000	5,100
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
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	4,667	40	330,000	7,700	1,515	6,909,000	4,900
East Machias															
1995-2002	0	0		0	0		659	2,677,000	4,200	0	0		659	2,677,000	4,200
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	4,270	0	0		1,331	5,549,000	4,300
Kennebec															
1979-2002	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															
1992-2002	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

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
Machias															
1941-2002	456	3,263,000	7,300	0	0		1,192	4,514,000	3,900	8	52,000	6,400	1,656	7,829,000	6,200
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	4,530	8	52,000	6,400	2,860	13,364,000	4,800
Merrimack															
1983-2002	1,047	7,942,000	7,900	8,267	44,636,000	5,200	0	0		160	1,877,000	12,000	9,474	54,456,000	6,300
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
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
2012	72	510,000	7,100	231	746,000	3,200	0	0		0	0		303	1,255,000	4,100

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.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Total Merrimack	1,577	12,270,000	8,100	11,392	57,009,000	4,100	0	0		540	5,708,000	10,200	13,509	74,988,000	5,400
Narraguagus															
1962-2002	0	1,303,000		0	0		1,172	4,063,000	3,500	0	0		1,172	5,366,000	3,500
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	4,530	0	0		2,476	11,295,000	4,500
Orland															
1967-2002	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															
1992-2002	14	137,000	9,900	2	2,000	1,100	0	0		9	61,000	6,600	25	200,000	8,300
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
2006	0	0		4	4,000	1,000	0	0		0	0		4	4,000	1,000
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
2008	0	0		0	0		0	0		2	10,000	5,000	2	10,000	5,000
2009	0	0		0	0		0	0		2	5,000	2,500	2	5,000	2,500
Total Pawcatuck	18	152,000	5,800	6	6,000	1,000	0	0		13	76,000	4,700	37	234,000	4,100

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
Penobscot															
1871-2002	17,567	150,462,000	7,900	5,192	13,443,000	2,600	0	0		0	0		22,759	163,905,000	7,500
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	6,400
Pleasant															
2001-2002	0	0		0	0		32	130,000	4,000	0	0		32	130,000	4,000
2003	0	0		0	0		11	92,000	8,300	0	0		11	92,000	8,300
2004	0	0		0	0		23	179,000	7,800	0	0		23	179,000	7,800
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400
2010	0	0		30	186,000	6,200	12	42,000	3,500	0	0		42	228,000	5,400
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	4,670	0	0		486	2,061,000	5,000

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Sheepscot															
1995-2002	18	125,000	6,900	0	0		496	1,981,000	3,800	45	438,000	9,900	559	2,545,000	4,500
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	3,930	45	438,000	9,900	1,264	5,349,000	4,000
St Croix															
1993-2002	36	271,000	7,500	0	0		0	0		0	0		36	271,000	7,500
2003	3	21,000	6,900	0	0		0	0		0	0		3	21,000	6,900
Total St Croix	39	292,000	7,200	0	0	0	0	0		0	0		39	292,000	7,200
Union															
1974-2002	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	2,025	20,939,000	7,400	33,482	206,965,000	5,800	0	0		2,395	28,935,000	9,700	37,902	256,839,000	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	1,577	12,270,000	8,100	11,392	57,009,000	4,100	0	0		540	5,709,000	10,200	13,509	74,988,000	5,400
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	4,100
Penobscot	20,400	174,724,000	8,500	7,751	22,496,000	3,500	329	1,400,000	4,300	0	0		28,480	198,621,000	6,300
Pleasant	0	0		51	306,000	6,500	435	1,754,000	4,700	0	0		486	2,061,000	5,000
Sheepscot	18	125,000	6,900	0	0		1,201	4,784,000	3,900	45	438,000	9,900	1,264	5,348,000	4,000
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	**25,212**	**218,265,000**	**8,700**	**52,807**	**287,469,000**	**5,400**	**9,492**	**39,206,000**	**4,100**	**3,041**	**35,540,000**	**11,700**	**90,552**	**580,483,000**	**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.

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin							
2001-2002	3,000	0	0	0	0	0	3,000
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							
1978-2002	1,815,000	317,400	38,600	0	32,600	29,800	2,233,400
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
2012	731,000	0	0	0	0	0	731,000
Totals:Aroostook	**5,751,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**6,169,400**
Cocheco							
1988-2002	1,795,000	50,000	10,500	0	5,300	0	1,860,800
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							
1967-2002	85,681,000	2,827,500	1,810,300	0	3,769,700	1,011,400	95,099,900
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
2012	1,733,000	3,100	7,500	4,000	0	71,000	1,818,600
Totals:Connecticut	**146,669,000**	**2,846,500**	**1,836,700**	**64,700**	**3,771,300**	**1,728,600**	**156,916,800**
Dennys							

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1975-2002	1,267,000	101,700	6,700	0	251,500	29,200	1,656,100
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							
1986-2002	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-2002	1,443,000	7,500	42,600	0	108,400	30,400	1,631,900
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
2012	88,000	53,200	0	0	0	0	141,200
Totals:East Machias	**3,717,000**	**60,700**	**42,600**	**0**	**108,400**	**30,400**	**3,959,100**
Kennebec							
2001-2002	10,000	0	0	0	0	0	10,000
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
2012	2,000	0	0	0	0	0	2,000
Totals:Kennebec	**401,000**	**0**	**0**	**0**	**200**	**0**	**401,200**
Lamprey							
1978-2002	1,486,000	427,700	58,800	0	201,400	32,800	2,206,700
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**

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Machias							
1970-2002	2,130,000	93,800	117,800	0	191,300	44,100	2,577,000
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
2012	231,000	0	1,400	0	0	0	232,400
Totals:Machias	**6,398,000**	**99,300**	**124,300**	**0**	**191,300**	**44,100**	**6,857,000**
Merrimack							
1975-2002	29,454,000	227,500	596,800	0	1,369,400	637,100	32,284,800
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
2012	1,016,000	22,000	0	0	33,800	0	1,071,800
Totals:Merrimack	**41,664,000**	**431,800**	**617,000**	**0**	**1,940,600**	**638,100**	**45,291,500**
Narraguagus							
1970-2002	1,879,000	62,900	14,600	0	107,800	84,000	2,148,300
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
2012	389,000	0	0	0	59,100	0	448,100
Totals:Narraguagus	**6,632,000**	**117,100**	**14,600**	**0**	**400,200**	**84,000**	**7,247,900**
Pawcatuck							
1979-2002	4,512,000	1,209,200	263,200	0	65,100	500	6,050,000
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

	Number of fish stocked by life stage						
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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
2012	6,000	0	0	0	0	0	6,000
Totals:Pawcatuck	**6,288,000**	**1,209,200**	**268,100**	**0**	**127,500**	**500**	**7,893,300**
Penobscot							
1970-2002	13,194,000	3,582,900	1,392,300	0	11,611,400	2,508,200	32,288,800
2003	741,000	320,700	2,100	0	547,100	0	1,610,900
2004	1,812,000	369,200	0	0	551,700	0	2,732,900
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
2012	1,073,000	325,700	0	0	555,200	0	1,953,900
Totals:Penobscot	**26,056,000**	**6,470,800**	**1,394,400**	**0**	**17,172,800**	**2,508,200**	**53,602,200**
Pleasant							
1975-2002	187,000	16,000	1,800	0	54,700	18,100	277,600
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
2012	40,000	0	0	0	60,200	0	100,200
Totals:Pleasant	**1,398,000**	**16,000**	**1,800**	**0**	**184,600**	**42,400**	**1,642,800**
Saco							
1975-2002	3,934,000	418,700	201,200	0	335,500	9,500	4,898,900
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
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
2012	396,000	0	12,800	0	11,900	0	420,700

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Saco	**7,127,000**	**463,800**	**232,000**	**0**	**396,200**	**9,500**	**8,228,500**
Sheepscot							
1971-2002	1,437,000	84,800	20,600	0	92,200	7,100	1,641,700
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
2012	50,000	15,700	0	0	0	0	65,700
Totals:Sheepscot	**3,304,000**	**209,000**	**20,600**	**0**	**92,200**	**7,100**	**3,632,900**
St Croix							
1981-2002	1,267,000	450,800	158,300	0	800,700	20,100	2,696,900
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	27,600	0	0	0	0	27,600
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**	**498,000**	**158,300**	**0**	**808,000**	**20,100**	**2,752,400**
Union							
1971-2002	430,000	371,400	0	0	379,700	251,000	1,432,100
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
2012	1,000	0	0	0	0	0	1,000
Totals:Union	**552,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,554,100**
Upper StJohn							
1979-2002	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	5,751,000	317,400	38,600	0	32,600	29,800	**6,169,400**
Cocheco	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	146,668,000	2,846,500	1,836,700	64,800	3,771,300	1,728,600	**156,851,200**
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	3,716,000	60,700	42,600	0	108,400	30,400	**3,958,000**
Kennebec	401,000	0	0	0	200	0	**401,100**
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	6,397,000	99,300	124,200	0	191,300	44,100	**6,856,400**
Merrimack	41,664,000	409,700	616,900	0	1,906,700	638,100	**45,235,000**
Narraguagus	6,633,000	117,100	14,600	0	400,300	84,000	**7,248,900**
Pawcatuck	6,281,000	1,209,200	268,100	0	127,500	500	**7,886,500**
Penobscot	26,055,000	6,470,800	1,394,400	0	17,172,500	2,508,200	**53,600,800**
Pleasant	1,398,000	16,000	1,800	0	184,700	42,400	**1,643,300**
Saco	7,127,000	463,800	232,000	0	396,200	9,500	**8,228,000**
Sheepscot	3,304,000	209,000	20,600	0	92,200	7,100	**3,632,800**
St Croix	1,269,000	470,400	158,300	0	808,000	20,100	**2,726,300**
Union	551,000	371,400	0	0	379,700	251,000	**1,553,000**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**266,976,000**	**15,221,000**	**4,840,200**	**64,800**	**26,316,200**	**5,484,400**	**318,837,400**

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				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin									
1983-2002	27	513	6	2	6	83	0	1	**638**
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**
Cocheco									
1992-2002	0	0	1	1	5	7	0	0	**14**
2003	0	0	0	0	1	3	0	0	**4**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2002	36	3,503	28	2	47	1,365	11	0	**4,992**
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**
2012	0	1	0	0	0	53	0	0	**54**
Total for Connecticut	58	3,608	28	2	131	2233	14	3	**6,077**
Dennys									
1967-2002	31	308	0	1	31	743	3	31	**1,148**
2003	4	5	0	0	0	1	0	0	**10**
2004	0	1	0	0	0	0	0	0	**1**
2006	2	2	0	0	1	1	0	0	**6**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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									
1985-2002	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2002	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2002	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**
2012	0	1	0	0	0	4	0	0	**5**
Total for Kennebec	24	255	6	7	9	74	0	0	**375**
Lamprey									
1979-2002	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									
1967-2002	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									
1982-2002	278	990	19	8	119	970	26	0	**2,410**
2003	12	129	0	0	0	4	0	0	**145**
2004	17	92	2	0	2	15	0	0	**128**
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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**
2012	0	81	14	0	1	27	3	0	**127**
Total for Merrimack	499	1,746	50	9	153	1192	39	0	**3,689**
Narraguagus									
1967-2002	92	650	19	54	88	2,367	70	154	**3,494**
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**
2012	2	9	1	0	0	5	0	0	**17**
Total for Narraguagus	182	788	23	56	123	2484	72	159	**3,887**
Pawcatuck									
1982-2002	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									
1968-2002	9,991	40,708	276	677	659	3,584	32	93	**56,020**
2003	196	847	1	4	6	56	0	2	**1,112**
2004	276	952	10	16	5	59	3	2	**1,323**
2005	269	678	0	8	6	22	0	2	**985**
2006	338	653	1	4	15	33	0	0	**1,044**
2007	226	575	0	1	35	88	0	0	**925**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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**
2012	8	531	6	2	5	69	0	3	**624**
Total for Penobscot	13,308	50,908	299	740	834	4319	37	102	**70,547**
Pleasant									
1967-2002	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**
2012	0	0	0	0	0	2	0	0	**2**
Total for Pleasant	5	12	0	0	14	230	3	2	**266**
Saco									
1985-2002	107	538	3	7	19	51	3	0	**728**
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**
2012	0	12	0	0	0	0	0	0	**12**
Total for Saco	179	702	5	7	50	118	6	0	**1,067**
Sheepscot									
1967-2002	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2002	302	1,820	9	28	1	15	0	0	**2,175**
2003	1	0	0	0	0	0	0	0	**1**
2004	0	1	0	0	0	1	0	0	**2**
2005	0	0	0	0	0	0	0	0	**0**
2006	0	0	0	0	0	0	0	0	**0**
2007	0	0	0	0	0	0	0	0	**0**
2008	0	0	0	0	0	0	0	0	**0**
2009	0	0	0	0	0	0	0	0	**0**
2010	0	0	0	0	0	0	0	0	**0**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Total 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

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	**2SW**	**3SW**	**Repeat**	**1SW**	**2SW**	**3SW**	**Repeat**	**Total**
Androscoggin	57	599	6	2	10	106	0	1	**781**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,608	28	2	131	2,233	14	3	**6,077**
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	255	6	7	9	74	0	0	**375**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	499	1,746	50	9	153	1,192	39	0	**3,689**
Narraguagus	182	788	23	56	123	2,484	72	159	**3,887**
Pawcatuck	2	151	1	0	1	21	1	0	**177**
Penobscot	13,308	50,908	299	740	834	4,319	37	102	**70,547**
Pleasant	5	12	0	0	14	230	3	2	**266**
Saco	179	702	5	7	50	118	6	0	**1,067**
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
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1979	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	9	18	2.022	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1981	15	19	1.261	0	0	0	11	89	0	0	0	0	0	0	11	89	0	0
1982	13	31	2.429	0	0	0	0	90	10	0	0	0	0	0	0	90	10	0
1983	7	1	0.143	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	46	1	0.022	0	0	0	0	0	100	0	0	0	0	0	0	0	100	0
1985	29	35	1.224	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	10	27	2.791	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	98	44	0.449	0	16	0	0	68	2	0	14	0	0	0	16	68	16	0
1988	93	92	0.992	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	75	47	0.629	0	6	0	6	85	0	0	2	0	0	0	12	85	2	0
1990	76	53	0.693	0	13	0	0	87	0	0	0	0	0	0	13	87	0	0
1991	98	25	0.255	0	20	0	0	64	0	0	16	0	0	0	20	64	16	0
1992	93	84	0.904	0	1	0	0	85	1	0	13	0	0	0	1	85	14	0
1993	261	94	0.361	0	0	0	2	87	0	0	11	0	0	0	2	87	11	0
1994	393	197	0.502	0	0	0	1	93	0	0	6	0	0	0	1	93	6	0

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	91	7	0
2002	490	88	0.179	0	10	0	11	69	1	2	6	0	0	0	21	71	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	0	0	97	3	0
2007	455	43	0.095	0	2	0	2	93	0	2	0			0	4	95	0	
2008	424	43	0.102	0	7	0	33	60		0				0	40	60		
2009	472	2	0.004	0	100		0							0	100			
2010	425	0	0.000	0										0				
Total	**9,576**	**1,598**																
Mean			**0.530**	**0**	**6**	**0**	**2**	**69**	**4**	**0**	**4**	**0**	**0**	**0**	**8**	**69**	**7**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1979	5	3	0.561	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	29	18	0.630	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1981	17	19	1.129	0	0	0	11	89	0	0	0	0	0	0	11	89	0	0
1982	29	46	1.565	0	0	0	0	89	11	0	0	0	0	0	0	89	11	0
1983	19	2	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	58	3	0.051	0	0	0	0	33	33	0	33	0	0	0	0	33	66	0
1985	42	47	1.113	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	18	28	1.592	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	117	51	0.436	0	18	0	0	67	2	0	14	0	0	0	18	67	16	0
1988	131	108	0.825	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	124	67	0.539	0	22	0	7	69	0	0	1	0	0	0	29	69	1	0
1990	135	68	0.505	0	19	0	0	79	0	0	1	0	0	0	19	79	1	0
1991	221	35	0.159	0	17	0	0	63	0	0	20	0	0	0	17	63	20	0
1992	201	118	0.587	0	5	0	0	82	1	0	12	0	0	0	5	82	13	0
1993	415	185	0.446	0	4	0	3	87	0	0	6	0	0	0	7	87	6	0
1994	598	294	0.492	0	5	0	2	88	0	0	5	0	0	0	7	88	5	0

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	682	143	0.210	1	13	0	7	78	0	0	2	0	0	1	20	78	2	0
1996	668	101	0.151	0	16	0	11	71	1	0	1	0	0	0	27	71	2	0
1997	853	37	0.043	0	3	0	3	89	3	0	3	0	0	0	6	89	6	0
1998	912	44	0.048	0	0	0	9	84	0	0	5	0	2	0	9	84	5	2
1999	643	45	0.070	0	0	2	4	80	0	0	13	0	0	0	4	82	13	0
2000	933	66	0.071	0	6	0	0	80	0	0	14	0	0	0	6	80	14	0
2001	959	151	0.157	0	3	0	3	88	0	1	5	0	0	0	6	89	5	0
2002	728	165	0.227	1	10	0	12	72	1	1	3	0	0	1	22	73	4	0
2003	704	147	0.209	1	14	0	12	69	1	0	4	0	0	1	26	69	5	0
2004	768	121	0.157	1	11	0	0	86	0	0	2	0	0	1	11	86	2	0
2005	781	63	0.081	2	13	0	5	79	0	0	2	0	0	2	18	79	2	0
2006	585	50	0.085	0	8	0	0	88	0	0	4	0	0	0	8	88	4	0
2007	634	62	0.098	0	3	0	2	90	0	3	2			0	5	93	2	
2008	604	81	0.134	0	4	0	36	60		0				0	40	60		
2009	648	3	0.005	0	100		0							0	100			
2010	601	0	0.000	0										0				
Total	**13,880**	**2,378**																
Mean			**0.414**	**0**	**12**	**0**	**3**	**67**	**2**	**0**	**5**	**0**	**0**	**0**	**15**	**67**	**6**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	100	0	0	0
1980	20	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	17	15	0.902	0	0	0	0	87	13	0	0	0	0	0	0	87	13	0
1983	16	1	0.064	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	13	2	0.156	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0
1985	14	12	0.881	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	8	1	0.126	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
1988	33	13	0.391	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	28	19	0.680	0	63	0	11	26	0	0	0	0	0	0	74	26	0	0
1990	27	11	0.407	0	45	0	0	45	0	0	9	0	0	0	45	45	9	0
1991	37	2	0.054	0	50	0	0	0	0	0	50	0	0	0	50	0	50	0
1992	55	15	0.271	0	20	0	0	67	0	0	13	0	0	0	20	67	13	0
1993	77	52	0.673	0	13	0	6	77	0	0	4	0	0	0	19	77	4	0
1994	110	49	0.447	0	31	0	4	63	0	0	2	0	0	0	35	63	2	0
1995	115	42	0.367	2	38	0	5	52	0	0	2	0	0	2	43	52	2	0
1996	91	19	0.208	0	58	0	11	26	0	0	5	0	0	0	69	26	5	0
1997	148	4	0.027	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	119	2	0.017	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	99	2	0.020	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	25	75	0	0
2002	119	22	0.185	5	5	0	14	77	0	0	0	0	0	5	19	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	66	33	0	0
2006	86	5	0.058	0	60	0	0	40	0	0	0	0	0	0	60	40	0	0
2007	91	9	0.099	0	11	0	0	78	0	11	0			0	11	89	0	
2008	88	8	0.091	0	0	0	38	62		0				0	38	62		
2009	82	0	0.000	0	0		0							0	0			
2010	85	0	0.000	0										0				
Total	**2,194**	**365**																
Mean			**0.291**	**0**	**25**	**0**	**4**	**56**	**0**	**0**	**8**	**0**	**0**	**0**	**29**	**56**	**8**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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
1976	6	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	7	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	11	18	1.698	0	0	0	0	11	33	22	28	6	0	0	0	33	61	6
1979	8	43	5.584	0	0	0	0	84	5	2	9	0	0	0	0	86	14	0
1980	13	42	3.333	0	0	0	0	19	5	19	52	5	0	0	0	38	57	5
1981	6	78	13.684	0	0	0	6	81	0	5	8	0	0	0	6	86	8	0
1982	5	48	9.600	0	0	2	2	77	8	0	10	0	0	0	2	79	18	0
1983	1	23	27.479	0	4	4	17	65	4	0	4	0	0	0	21	69	8	0
1984	53	47	0.894	0	13	0	4	77	2	0	4	0	0	0	17	77	6	0
1985	15	59	3.986	0	2	0	7	69	2	0	20	0	0	0	9	69	22	0
1986	52	111	2.114	0	11	0	0	77	1	0	9	0	2	0	11	77	10	2
1987	108	264	2.449	0	2	0	9	85	0	0	4	0	0	0	11	85	4	0
1988	172	93	0.541	1	5	0	0	90	0	0	3	0	0	1	5	90	3	0
1989	103	45	0.435	2	7	0	31	60	0	0	0	0	0	2	38	60	0	0
1990	98	21	0.215	5	0	0	10	81	0	0	5	0	0	5	10	81	5	0
1991	146	17	0.117	0	6	0	6	76	12	0	0	0	0	0	12	76	12	0
1992	112	15	0.134	0	0	0	0	93	7	0	0	0	0	0	0	93	7	0
1993	116	11	0.095	0	0	0	27	45	0	9	18	0	0	0	27	54	18	0
1994	282	53	0.188	0	0	0	13	85	0	0	2	0	0	0	13	85	2	0
1995	283	87	0.308	0	0	0	22	72	0	6	0	0	0	0	22	78	0	0

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	15	85	0	0
1997	200	4	0.020	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1998	259	8	0.031	0	0	0	25	75	0	0	0	0	0	0	25	75	0	0
1999	176	8	0.046	0	0	0	12	50	0	0	38	0	0	0	12	50	38	0
2000	222	12	0.054	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2001	171	5	0.029	0	0	0	40	20	0	0	40	0	0	0	40	20	40	0
2002	141	8	0.057	0	0	0	0	88	12	0	0	0	0	0	0	88	12	0
2003	133	20	0.150	0	0	0	30	60	5	0	0	5	0	0	30	60	5	5
2004	156	35	0.225	0	0	0	3	83	3	6	6	0	0	0	3	89	9	0
2005	96	33	0.343	0	0	0	9	79	3	0	6	0	3	0	9	79	9	3
2006	101	16	0.158	0	0	0	6	25	31	0	31	0	0	0	6	25	68	0
2007	114	100	0.877	0	1	0	7	84	3	3	2			0	8	87	5	
2008	177	32	0.181	0	0	0	22	78		0				0	22	78		
2009	105	1	0.010	0	0		100							0	100			
2010	148	0	0.000	0										0				
Total	**3,980**	**1,384**																
Mean			**2.316**	**0**	**2**	**0**	**10**	**62**	**4**	**2**	**9**	**1**	**0**	**0**	**12**	**64**	**14**	**1**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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
1982	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	15	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	38	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	20	80	0	0
1996	29	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	10	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	91	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	59	5	0.085	0	0	20	0	80	0	0	0	0	0	0	0	100	0	0
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
2001	42	2	0.047	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	40	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	31	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	56	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	1	1	1.923	0	0	0	0	0	0	0	100	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
2007	12	2	0.173	0	0	0	0	100	0	0	0			0	0	100	0	
2008	31	1	0.032	0	100	0	0	0		0				0	100	0		
2009	9	0	0.000	0	0		0							0	0			

Means includes year classes with complete return data (year classes of 2006 and earlier).

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 .__

2010	29	0	0.000	0										0				
Total	**628**	**23**																
Mean			**0.131**	**0**	**3**	**1**	**1**	**28**	**0**	**0**	**6**	**0**	**0**	**0**	**4**	**29**	**6**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0	0	0	0	34	67	0	0
2003	25	13	0.526	8	38	0	8	46	0	0	0	0	0	8	46	46	0	0
2004	28	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	26	2	0.076	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2006	25	3	0.119	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
2007	28	5	0.178	0	0	0	0	100	0	0	0			0	0	100	0	

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	22	0.821	0	0	0	36	64		0				0	36	64		
2009	24	0	0.000	0	0		0							0	0			
2010	28	0	0.000	0										0				
Total	**483**	**114**																
Mean			**0.230**	**0**	**20**	**0**	**3**	**56**	**0**	**0**	**0**	**0**	**0**	**0**	**24**	**56**	**0**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	62	0	0	12	0	0	0	25	62	12	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3	0	0	0	11	86	3	0
2005	84	1	0.012	0	0	0	100	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	0	0	80	20	0
2007	57	5	0.088	0	0	0	0	80	0	0	20			0	0	80	20	
2008	63	8	0.127	0	0	0	50	50		0				0	50	50		

Means includes year classes with complete return data (year classes of 2006 and earlier).

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 .

2009	65	1	0.015	0	100		0							0	100			
2010	60	0	0.000	0										0				
Total	**1,572**	**300**																
Mean			**0.207**	**0**	**4**	**0**	**9**	**75**	**0**	**0**	**6**	**0**	**0**	**0**	**13**	**75**	**6**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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	27	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	91	6	0
1984	8	103	12.875	0	0	0	24	64	1	5	3	0	0	0	24	69	7	0
1985	20	171	8.680	0	0	0	11	62	2	6	19	0	0	0	11	68	21	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	74	12	0
1988	43	219	5.081	0	0	0	16	78	0	0	6	0	0	0	16	78	6	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	92	315	3.405	0	0	0	2	93	1	1	4	0	0	0	2	94	5	0
1993	132	158	1.197	0	0	0	5	89	0	1	4	0	0	0	5	90	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	72	8	0
1996	124	117	0.942	0	0	0	36	50	2	7	6	0	0	0	36	57	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
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

Means includes year classes with complete return data (year classes of 2006 and earlier).

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 .

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	0	0	13	72	15	0
2007	161	220	1.370	0	0	0	9	86	0	0	4			0	9	86	4	
2008	125	104	0.834	0	0	0	42	58		0				0	42	58		
2009	102	5	0.049	0	0		100							0	100			
2010	100	0	0.000	0										0				
Total	**2,391**	**4,714**																
Mean			**5.598**	**0**	**0**	**0**	**17**	**72**	**1**	**3**	**8**	**0**	**0**	**0**	**17**	**75**	**9**	**0**

Means includes year classes with complete return data (year classes of 2006 and earlier).

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		
1981	13.684		1.129	1.261		0.000		20.297
1982	9.600	0.000	1.565	2.429		0.902		19.274
1983	27.479		0.108	0.143		0.064		
1984	0.894		0.051	0.022		0.156		12.875
1985	3.986	0.000	1.113	1.224		0.881		8.680
1986	2.114		1.592	2.791		0.126		14.690
1987	2.449	0.000	0.436	0.449	0.165	0.740		18.108
1988	0.541	0.000	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	0.492	0.502	0.166	0.447	0.652	1.612
1995	0.308	0.136	0.210	0.184	0.041	0.367	0.192	2.629
1996	0.150	0.000	0.151	0.115	0.607	0.208	0.170	0.942
1997	0.020	0.000	0.043	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	0.157	0.165	0.160	0.096	0.188	0.659
2002	0.057	0.000	0.227	0.179	0.799	0.185	0.381	0.536
2003	0.150	0.000	0.209	0.211	0.526	0.071	0.284	1.430
2004	0.225	0.000	0.157	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	0.158	0.000	0.085	0.093	0.119	0.058	0.069	0.517
2007	0.877	0.173	0.098	0.095	0.178	0.099	0.088	1.370
2008	0.181	0.032	0.134	0.102	0.821	0.091	0.127	0.834

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	PW	CT	CTAH	SAL	FAR	WE	PN
2009	0.010	0.000	0.005	0.004	0.000	0.000	0.015	0.049
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean	**2.386**	**0.139**	**0.424**	**0.543**	**0.236**	**0.299**	**0.215**	**5.801**
StDev	**5.572**	**0.461**	**0.472**	**0.739**	**0.255**	**0.316**	**0.187**	**6.713**

Note: MK = Merrimack, PW = Pawcatuck, CT = Connecticut (basin), CTAH = Connecticut (above Holyoke), SAL = Salmon, FAR = Farmington, WE = Westfield, PN = Penobscot. Fry return rates for the Penobscot River are likely an over estimate because they include returns produced from spawning in the wild. Other Maine rivers are 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 only include year classes with complete return data (2006 and earlier).

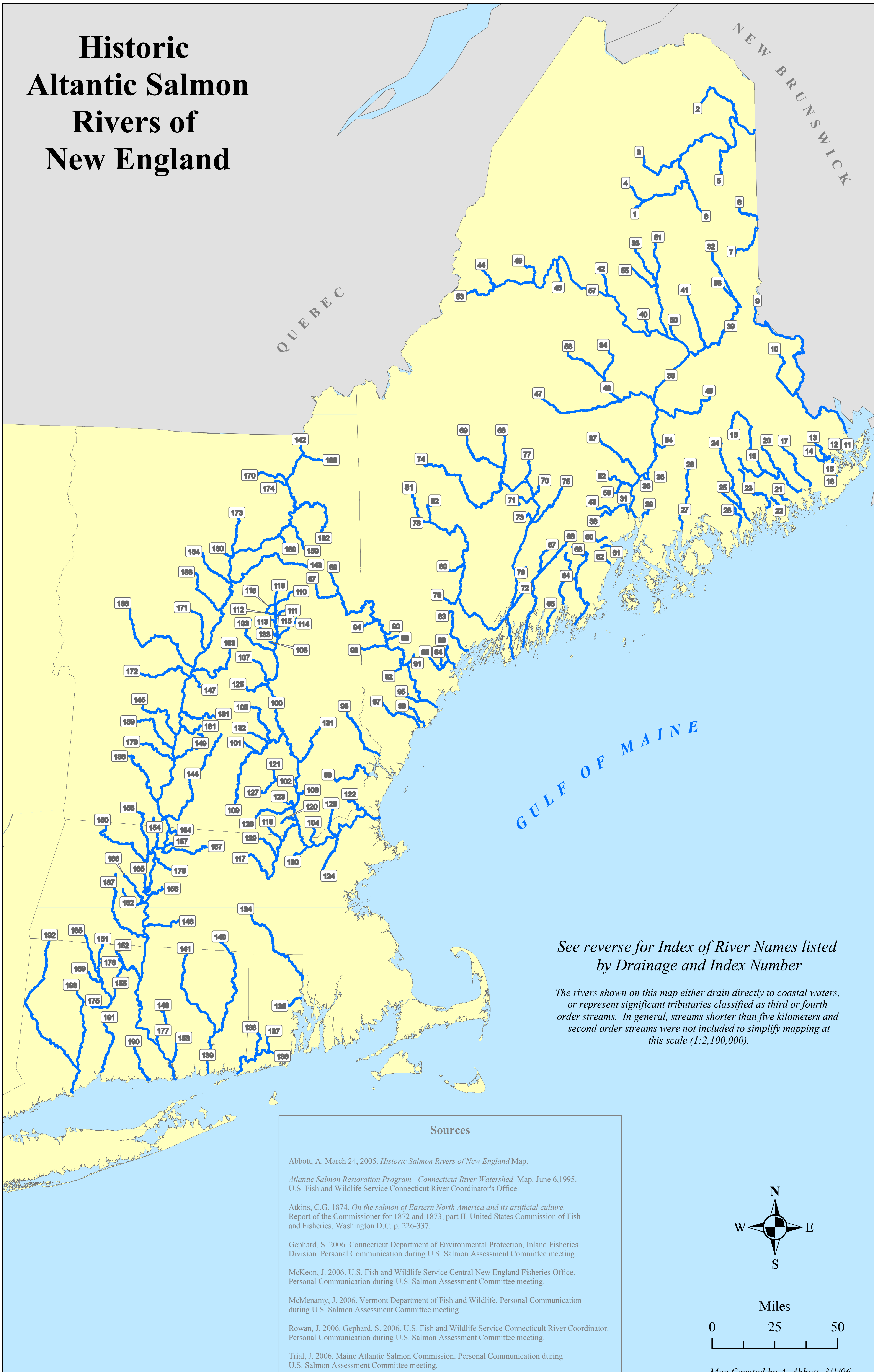
Appendix 20. Summary of age distributions of adult Atlantic salmon that were stocked in New England as fry.

	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	10	0	4	81	4	0	4	0	0	0	13	81	9	0
Connecticut (basin)	0	15	0	4	76	2	0	5	0	0	0	20	76	7	0
Farmington	0	26	0	5	61	0	0	8	0	0	0	31	61	8	0
Merrimack	0	2	0	14	69	5	2	10	1	0	0	16	72	15	1
Pawcatuck	0	17	2	2	68	0	0	13	0	0	0	19	70	13	0
Penobscot	0	0	0	20	72	1	3	8	0	0	0	20	74	9	0
Salmon	0	23	0	6	71	0	0	0	0	0	0	28	71	0	0
Westfield	0	9	0	11	78	0	0	7	0	0	0	19	78	7	0
Overall Mean:	**0**	**13**	**0**	**8**	**72**	**1**	**1**	**7**	**0**	**0**	**0**	**21**	**73**	**8**	**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
Aroostook	Aroostook River	1
	Little Madawaska River	2
	Big Machias River	3
	Mooseleuk Stream	4
	Presque Isle Stream	5
	Saint Croix Stream	6
St. John	Meduxnekeag River	7
	North Branch Meduxnekeag River	8
St. Croix	Saint Croix River	9
	Tomah Stream	10
Boyden	Boyden Stream	11
Pennamaquan	Pennamaquan River	12
Dennys	Dennys River	13
	Cathance Stream	14
Hobart	Hobart Stream	15
Orange	Orange River	16
East Machias	East Machias River	17
Machias	Machias River	18
	Mopang Stream	19
	Old Stream	20
Chandler	Chandler River	21
Indian	Indian River	22
Pleasant	Pleasant River	23
Narraguagus	Narraguagus River	24
	West Branch Narraguagus River	25
Tunk	Tunk Stream	26
Union	Union River	27
	West Branch Union River	28
Penobscot	Orland River	29
	Penobscot River	30
	Cove Brook	31
	East Branch Mattawamkeag River	32
	East Branch Penobscot River	33
	East Branch Pleasant River	34
	Eaton Brook	35
	Felts Brook	36
	Kenduskeag Stream	37
	Marsh Stream	38
	Mattawamkeag River	39
	Millinocket Stream	40
	Molunkus Stream	41
	Nesowadnehunk Stream	42
	North Branch Marsh Stream	43
	North Branch Penobscot River	44
	Passadumkeag River	45
	Pine Stream	46
	Piscataquis River	47
	Pleasant River (Penobscot)	48
	Russell Stream	49
	Salmon Stream	50
	Seboeis River	51
	Souadabscook Stream	52
	South Branch Penobscot River	53
	Sunkhaze Stream	54
	Wassataquoik Stream	55
	West Branch Mattawamkeag River	56
	West Branch Penobscot River	57
	West Branch Pleasant River	58
	West Branch Souadabscook Stream	59
Passagassawakeag	Passagassawakeag River	60
Little	Little River	61
Ducktrap	Ducktrap River	62
Saint George	Saint George River	63
Medomak	Medomak River	64
	Pemaquid River	65
Sheepscot	Sheepscot River	66
	West Branch Sheepscot River	67
Kennebec	Kennebec River	68
	Carrabassett River	69
	Carrabassett Stream	70
	Craigin Brook	71
	Eastern River	72
	Messalonskee Stream	73
	Sandy River	74
	Sebasticook River	75
	Togus Stream	76
	Wesserunsett Stream	77
Androscoggin	Androscoggin River	78
	Little Androscoggin River	79
	Nezinscot River	80
	Swift River	81
	Webb River	82
Royal	Royal River	83
Presumpscot	Presumpscot River	84
	Mill Brook (Presumpscot)	85
	Piscataqua River (Presumpscot)	86
Saco	Saco River	87
	Breakneck Brook	88
	Ellis River	89
	Hancock Brook	90
	Josies Brook	91
	Little Ossipee River	92
	Ossipee River	93
	Shepards River	94
	Swan Pond Brook	95
Kennebunk	Kennebunk River	96
Mousam	Mousam River	97
Cocheco	Cocheco River	98
Lamprey	Lamprey River	99
Merrimack	Merrimack River	100
	Amey Brook	101
	Baboosic Brook	102
	Baker River	103
	Beaver Brook	104
	Blackwater River	105
	Bog Brook	106
	Cockermouth River	107
	Cohas Brook	108
	Contoocook River	109
	East Branch Pemigewasset River	110
	Eastman Brook	111
	Glover Brook	112
	Hubbard Brook	113
	Mad River	114
	Mill Brook (Merrimack)	115
	Moosilauke Brook	116
	Nashua River	117
	Nissitissit River	118
	Pemigewasset River	119
	Pennichuck Brook	120
	Piscataquog River	121
	Powwow River	122
	Pulpit Brook	123
	Shawsheen River	124
	Smith River	125
	Souhegan River	126
	South Branch Piscataquog River	127
	Spicket River	128
	Squannacook River	129
	Stony Brook	130
Merrimack	Suncook River	131
	Warner River	132
	West Branch Brook	133
Blackstone	Blackstone River	134
Pawtuxet	Pawtuxet River	135
Pawcatuck	Pawcatuck River	136
	Beaver River	137
	Wood River	138
Thames	Thames River	139
	Quinebaug River	140
	Shetucket River	141
Connecticut	Connecticut River	142
	Ammonoosuc River	143
	Ashuelot River	144
	Black River	145
	Blackledge River	146
	Bloods Brook	147
	Chicopee River	148
	Cold River	149
	Deerfield River	150
	East Branch Farmington River	151
	East Branch Salmon Brook	152
	Eightmile River	153
	Fall River	154
	Farmington River	155
	Fort River	156
	Fourmile Brook	157
	Green River	158
	Israel River	159
	Johns River	160
	Little Sugar River	161
	Manhan River	162
	Mascoma River	163
	Mill Brook (Connecticut)	164
	Mill River (Hatfield)	165
	Mill River (Northhampton)	166
	Millers River	167
	Mohawk River	168
	Nepaug River	169
	Nulhegan River	170
	Ompompanoosuc River	171
	Ottauquechee River	172
	Passumpsic River	173
	Paul Stream	174
	Pequabuck River	175
	Salmon Brook	176
	Salmon River	177
	Sawmill River	178
	Saxtons River	179
	Stevens River	180
	Sugar River	181
	Upper Ammonoosuc River	182
	Waits River	183
	Wells River	184
	West Branch Farmington River	185
	West River	186
	Westfield River	187
	White River	188
	Williams River	189
Hammonasset	Hammonasset River	190
Quinnipiac	Quinnipiac River	191
Housatonic	Housatonic River	192
	Naugatuck River	193


Historic
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Rivers of
New England
QUEBEC
NEW BRUNSWICK
GULF OF MAINE
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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