ANNUAL REPORT OF THE U.S ATLANTIC SALMON ASSESSMENT COMMITTEE

REPORT NO. 26 - 2013 ACTIVITIES

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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 611; this is the sum of documented returns to traps and returns estimated by redd counts on selected Maine rivers, the lowest for the 1991-2013 time series, 35% less than observed in 2012 and 85% less than returned in 2011. Adult salmon returns to USA rivers with traps or weirs totaled 510 in 2013. Estimated return to Gulf of Maine small coastal rivers was 101 adult salmon. Most returns occurred to the Gulf of Maine Distinct Population Segment, which includes the Penobscot River and eastern Maine coastal rivers, accounting for 81% of the total return. Overall, 13% of the adult returns to the USA were 1SW salmon and 87% were MSW salmon. Most (67%) returns were of hatchery smolt origin and the balance (33%) originated from either natural reproduction or hatchery fry and eggs. A total of 6,482,000 juvenile salmon (eggs, fry, parr, and smolts), and 5,478 adults were stocked in 2013. Of those fish 35,986 juveniles carried a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 225 sea-run females and 1,400 captive/domestic and domestic females. The number of females contributing was less than 2012 (2,776); and the total egg take of 6,246,000 was lower than 2012 (10,538,000). Production of farmed salmon in Maine was not available, but was estimated at 2,063 to 8,063 (95% CI) metric tonnes 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), however there was an estimated discard of 22 kg from US marine commercial fisheries.

1.3 Adult Returns

Total return to USA rivers was 611; (Table 1.3.1), a 35% decrease from 2012 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 2012 within areas were: LIS (+68%), CNE (-83%), GOM (-34%). In 2013, the coastal populations within the Gulf of Maine area had catches at traps and weirs of 392 and an additional return of 101 (90% CI = 68 - 148) salmon estimated from 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 77% of the total return. Overall, 13% of the adult returns to the USA were 1SW salmon and 87% were MSW salmon. Most (67%) returns were of hatchery smolt origin and the balance (33%) 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 2011 was 0.051%, with the 2SW fish return rate 0.05% (Figure 1.3.3). The estimated return rate for 2SW adults from the 2011 cohort of wild smolts on the Narraguagus was 0.51% (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 1.8% of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.6 to 2.6 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2013 about 5,472,000 juvenile salmon (78% fry) were released into 13 river systems (Table 1.4.1). The number of juveniles released was less than that in 2012 (6,992,600). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and five coastal rivers within the GOM area Maine. The 319,000 parr released in 2013 were primarily the by-products of smolt production programs. The majority of smolts were stocked in one river into the GOM. In addition to juveniles, 5,478 adult salmon were released into USA rivers (Table 1.4.2). These pre-spawn adults and those released into rivers produced redds. In the Merrimack River captive reared salmon were released pre-spawn 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 2013 with USA spawners totaling 5,090. Escapement to natural spawning areas was 1,441 (returns released to rivers + stocked pre-spawn adults). Eyed egg stocking continued to be stocked into some GOM rivers for restoration purposes.

Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs included: 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 39,804 salmon released into USA waters in 2013 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 58% of the marked fish were released into the CNE area and 42% into rivers in the GOM area (Table 1.5.1).

1.5 Farm Production

Production of farmed salmon in Maine was not available, but was estimated at 5,079 metric tonnes (95% CI 2,063 to 8,096) based on a regression of production and smolt moved to pens two years before. The estimate was approximately 46% of the 11,127 metric tonnes of production reported in 2010, the highest production year in the last decade (Table 1.6.1). Zero aquaculture escapees were captured at fishways in the USA.

1.3.1 Estimated Atlantic salmon returns to USA by geographic area, 2013. "Natural" includes fish originating from natural spawning and hatchery fry.

Area	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	3	4	87	0	0	0	0	94
CNE	0	0	8	13	0	0	3	0	24
GOM[1]	67	9	326	87	3	0	2	0	493
Total	67	12	338	187	3	0	5	0	611

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

Table 1.3.2 Estimated Atlantic salmon returns to the USA, 1967-2013. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1SW	2SW	3SW	Repeat	Total	Hatchery	Natural
1967	75	574	39	93	781	114	667
1968	18	498	12	56	584	314	270
1969	32	430	16	34	512	108	404
1970	9	539	15	17	580	162	418
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1,025	495	530
1973	18	623	8	13	662	422	240
1974	52	791	35	25	903	639	264
1975	77	1,250	14	30	1,371	1,126	245
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	33	1,130	921	209
1978	145	2,269	17	33	2,464	2,082	382
1979	225	972	6	21	1,224	1,039	185
1980	707	3,437	11	57	4,212	3,870	342
1981	789	3,738	43	84	4,654	4,428	226
1982	294	4,388	19	42	4,743	4,489	254
1983	239	1,255	18	14	1,526	1,270	256
1984	387	1,969	21	52	2,429	1,988	441
1985	302	3,913	13	21	4,249	3,594	655
1986	582	4,688	28	13	5,311	4,597	714
1987	807	2,191	96	132	3,226	2,896	330
1988	755	2,386	10	67	3,218	3,015	203
1989	992	2,461	11	43	3,507	3,157	350
1990	575	3,744	18	38	4,375	3,785	590
1991	255	2,289	5	62	2,611	1,602	1,009
1992	1,056	2,255	6	20	3,337	2,678	659
1993	405	1,953	11	37	2,406	1,971	435
1994	342	1,266	2	25	1,635	1,228	407
1995	168	1,582	7	23	1,780	1,484	296
1996	574	2,168	13	43	2,798	2,092	706
1997	278	1,492	8	36	1,814	1,296	518
1998	340	1,477	3	42	1,862	1,146	716
1999	402	1,136	3	26	1,567	959	608
2000	292	535	0	20	847	562	285
2001	269	804	7	4	1,084	833	251
2002	437	505	2	23	967	832	135
2003	233	1,185	3	6	1,427	1,238	189
2004	319	1,266	21	24	1,630	1,395	235
2005	317	945	0	10	1,272	1,019	253
2006	442	1,007	2	5	1,456	1,167	289
2007	299	958	3	1	1,261	940	321
2008	812	1,758	12	23	2,605	2,191	414
2009	243	2,065	16	16	2,340	2,017	323
2010	552	1,081	2	16	1,651	1,468	183
2011	1,084	3,053	26	15	4,178	3,560	618
2012	26	879	31	5	941	731	210
2013	78	525	3	5	611	413	198

Table 1.3.3 Two sea winter (2SW) returns for 2013 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	91	0.9%
Central New England	CNE	3,435	21	0.6%
Gulf of Maine	GOM	15,670	413	2.6%
Total		29,199	525	1.8%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2013. Numbers are rounded to 1,000.

Area	N	Rivers	Eyed Egg	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
LIS	2	Connecticut, Pawcatuck	0	1,865,000	3,000		1,000	100,000	1,969,000
CNE	2	Merrimack, Saco	0	430,000	10,000	41,000	53,000	0	534,000
GOM	8	Androscoggin to Dennys	1,010,000	1,406,000	306,000	1,000	676,000	0	3,399,000
OBF	1	Aroostook	0	580,000	0	0	0	0	580,000
Total	13		1,010,000	4,281,000	319,000	42,000	730,000	100,000	6,482,000

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2013 by geographic area. Egg numbers are rounded to 1,000.

Area	Purpose	Captive Reared Domestic		Sea Run		Total
		Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	
Central New England	CNE Recreation	372				372
Central New England	CNE Restoration	2,296			19	2,315
Gulf of Maine	GOM Restoration	2,422			369	2,791
Total for USA		5,090			388	5,478

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2013. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		13,951	13,951
AD	Smolt	20,367		20,367
FLOY	Adult	2,668		2,668
PING	Smolt		313	313
PIT	Adult		1,148	1,148
PIT	Smolt		248	248
RAD	Adult		2	2
RAD	Smolt		1,107	1,107
Total		23,035	16,769	39,804

AD = Adipose clip
FLOY = T-bar tag
PIT = Passive integrated transponder
PING = ultrasonic acoustic tag
RAD = radio tag

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2013. Production for 2013 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
2013	2,063 to 8,096

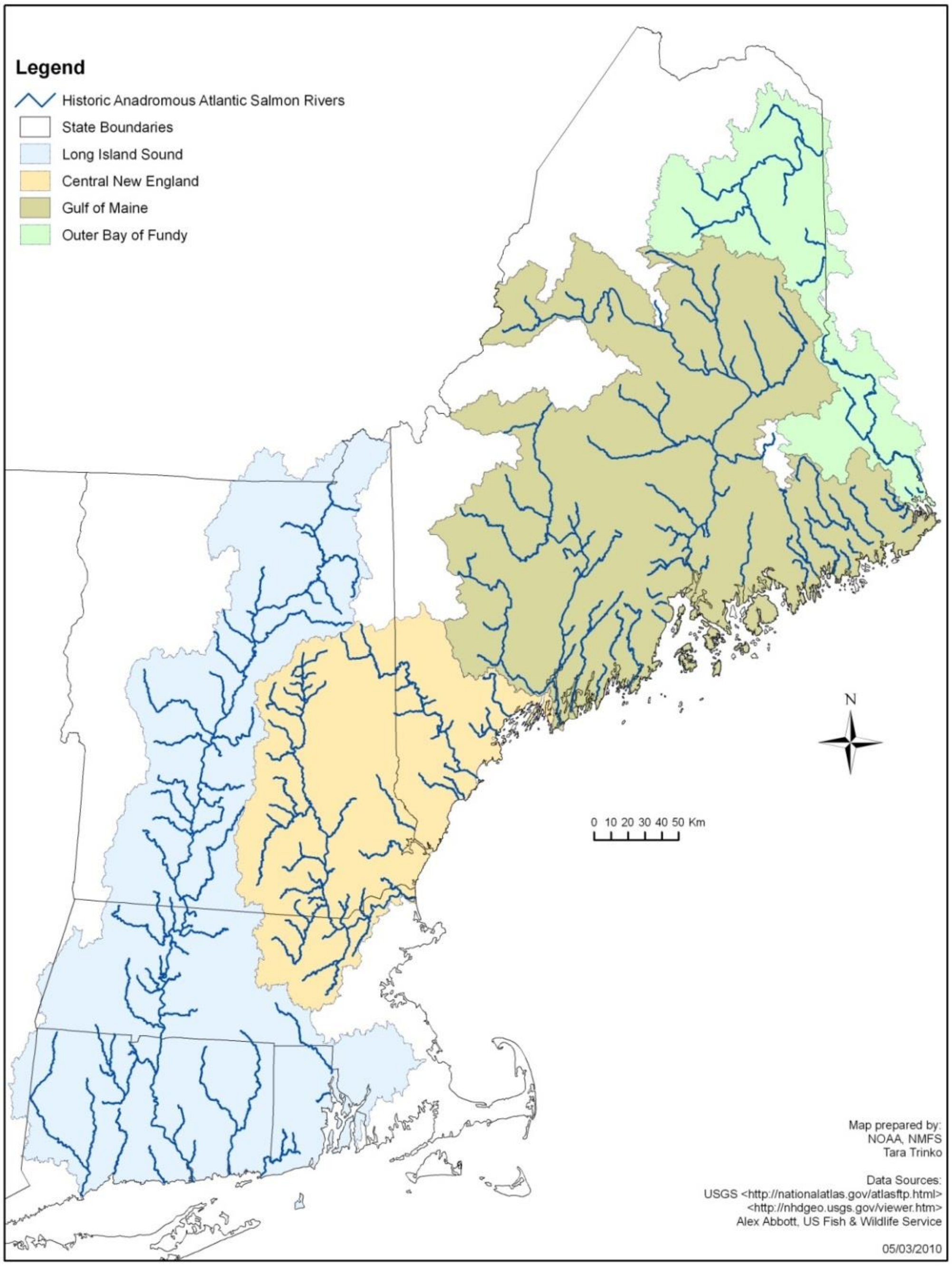

Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2013.

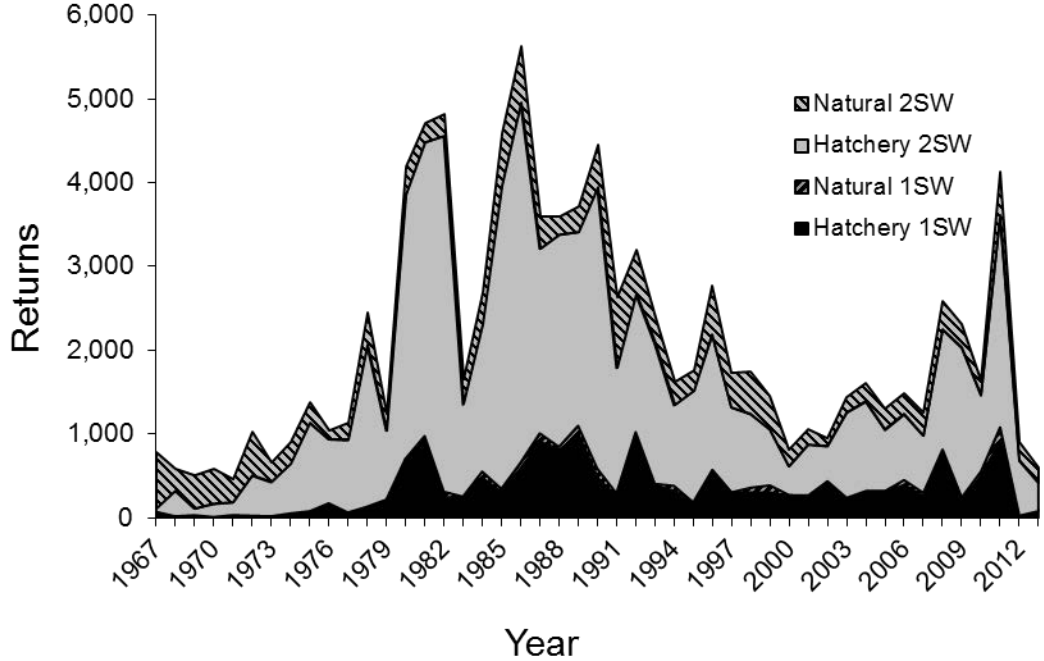

Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2013.

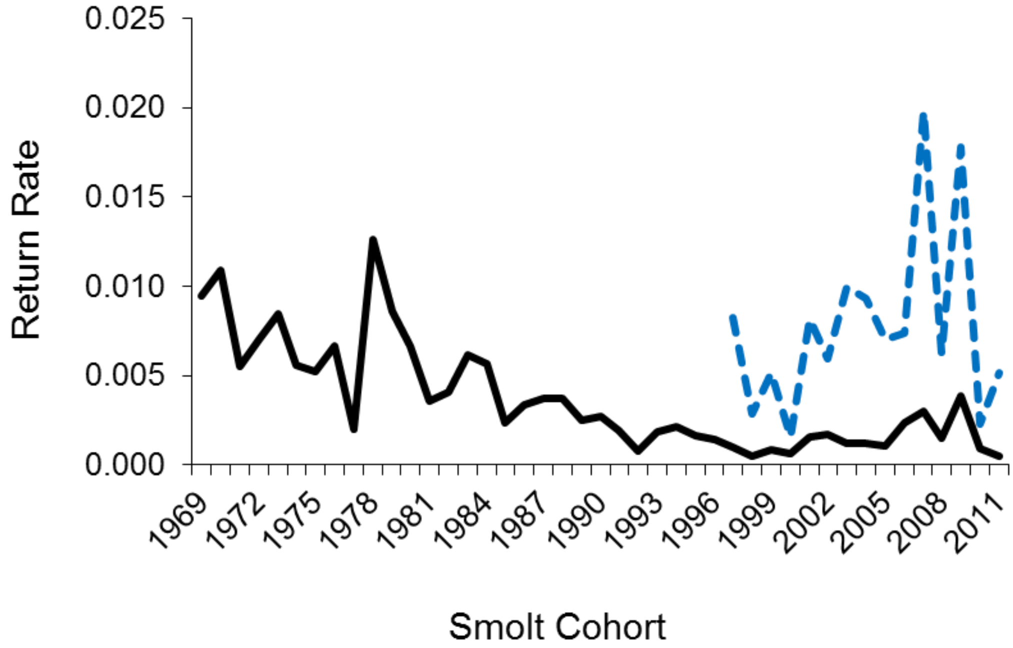

Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2 Status of Stocks

2.1 Distribution, Biology and Management

Atlantic salmon, *Salmo salar*, is a highly prized game and food fish with a circumpolar distribution. In North America, the species originally ranged from the Ungava Bay southward to Long Island Sound, encompassing most coastal New England river basins (Figure 2.1.1). As a consequence of human development, many native New England populations were extirpated (Fay et al. 2006). Salmon life history is complex because of fish use of both headwater streams and distant marine habitats (Figure 2.1.2). The life cycle for US Atlantic salmon begins with spawning in rivers during autumn, and eggs remain in the gravel and hatch during winter. Fry emerge from the gravel in spring. Juvenile salmon (parr) remain in rivers 1–3 years. When parr exceed 13 cm (5 in) in the autumn, they 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). The Connecticut River program became independent of stocks from Maine and was able to sustain genetic diversity and facilitate local adaptation (Spidle et. al. 2004). All of these populations were 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 the New England Fishery Management Council Fishery Management Plan. However, USFWS curtailed large hatchery programs in the Long Island Sound DPS 2013, but the State of Connecticut agency will continue a Legacy Program in selected portions of the Connecticut River watershed within its state. Likewise, large programs were curtailed in the Merrimack in 2014. The public-private restoration program in the Saco River will represent be the only stocking effort in the Central New England DPS. It is expected that remnant naturally-occurring populations may persist in the immediate future in both restoration areas.

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 metric tonnes 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 was historically 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 (FMP) 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 was to be in in effect through the 2013 fishing season.

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 to 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. In 2012, the Government of Greenland unilaterally set a quota for factory landings of Atlantic salmon at 35 mt. A total harvest of 34 mt was reported for the 2012 fishing season, of which 14 mt were reported as factory landings. Parties to the West Greenland Commission of NASCO raised concerns that the option of landing to a factory may result in the increased harvest of Atlantic salmon beyond historical internal use levels. The Government of Greenland maintains that the option for landing to a factory falls within the current regulatory measure adopted within NASCO and that there will be no incentive for increased harvest. A quota for factory landings was again set to 35 mt for the 2013 fishery. Negotiations on this issue are continuing both within and outside of NASCO.

2.2.1 Aquaculture

Despite declining natural populations, the Atlantic salmon mariculture industry continues to develop worldwide. In eastern Maine and Maritime Canada, companies typically rear fish to smolt stage in private freshwater facilities, transfer them into anchored net pens or sea cages, feed them, and harvest the fish when they reach market size. In the Northwest Atlantic, 66% of production is based in Canada, with 99.4% of Canadian production in the Maritimes and 0.6% in Newfoundland. The balance (44%) of Northwest Atlantic production is in eastern Maine. US production trends for Maine facilities and areas occupied by marine cages have grown exponentially for two decades. By 1998, there were at least 35 freshwater smolt-rearing facilities and 124 marine production facilities in eastern North America. Since the first experimental harvest of Atlantic salmon in 1979 of 6 mt, the mariculture industry in eastern North America has grown to produce greater than 32,000 mt annually since 1997. In Maine, production increased rapidly and peaked at about 16,500 mt in 2000, but abruptly declined to below 6,000 mt in 2005 because of a disease outbreak (infectious salmon anemia) that forced the destruction of large numbers of fish. Production practices also had to change due to a 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 6^{th} highest in the 27-year time series and valued at $73.6M. With one company in production since 2011, confidentiality policies preclude detailed reporting but estimates are made based on smolt stocking. 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.

2.3 Research Vessel Survey Indices

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

2.4 Stock Assessment

2.4.1 Hatchery Inputs

A unique element of Atlantic salmon populations in New England is the dependence on hatcheries. Since most US salmon are products of stocking, it is important to understand the magnitude of these inputs to understand salmon assessment results. US Atlantic salmon hatcheries are run by the US Fish and Wildlife Service and state agencies. Hatchery programs in the US take two forms: (i) conservation hatcheries that produce fish from remnant local stocks within a DPS and stock them into that DPS, or (ii) restoration hatcheries that produce salmon from broodstock originally established from donor populations outside their native DPS. Hatchery programs for the Gulf of Maine DPS are conservation hatcheries. All other New England hatcheries that operated in 2013 were restoration hatcheries. These restoration hatcheries developed broodstock primarily from original donor stocks from the Penobscot River Population.

For information on the numbers of hatchery fish stocked into each US system, see Appendix 7 for current year totals and Appendix 14 for historic time series. Hatchery inputs are important to understand since hatchery-reared smolts consistently produce over 75% of the adult salmon returns to the US. Cost and hatchery capacity issues prevent more extensive use of smolts. However, fry stocking is an important tool because it minimizes selection for hatchery traits at the juvenile stage, and naturally reared smolts typically have a higher marine survival rate than hatchery smolts. From a management perspective, rebuilding Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems that successfully reach the ocean and using hatchery production to optimally maintain population diversity, distribution, and abundance. However, survival at sea is a dominant factor constraining stock rebuilding across all river systems. Building sustainable Atlantic salmon populations in the US will require increasing natural production of smolts in US river systems and using hatchery production to optimally maintain population diversity and effective population sizes.

2.4.2 Stock Abundance Metrics

US Atlantic salmon populations are assessed by the US Atlantic Salmon Assessment Committee (USASAC), a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Currently, population status of Atlantic 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 1,650. 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. Reduction in stocking programs starting in 2014 will reduce future Long Island Sound and Central New England contributions to total US returns.

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 1,650 fish, less than 45% of the1977-1990 time-series median. There has been a downward trend in the production of salmon on both sides of the Atlantic (particularly populations dominated by 2SW fish), that has affected US populations. In addition, recovery from historical impacts was never sufficient, so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2013 were only 611 fish, which ranks 43rd in the 47 year time-series. Relative to the abundance in the current marine phase (1991–present), returns were the lowest in 23 years. This is in stark contrast to 2011 returns that were the highest in the modern period. The last five years have suggested extremely high variability in marine survival with some of the widest differences in interannual returns in the time-series despite relatively consistent smolt production.

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 2013 was 1.8% 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, 9% for Central New England, and 4% for Long Island Sound. Returns in 2013 were typical, in that the Penobscot River population accounted for the largest percentage (62%) 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 (14.8) and decreased southward for the Central New England (8.2) 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 4.8 for 1SW salmon and 19.6 for 2SW fish. The total cohort SAR averaged 26.8. Starting in 1997, NOAA began a program to estimate production of naturally-reared smolts in the Narraguagus River, Maine. The average 2SW cohort SAR for naturally reared Narraguagus River smolt for the past five years was 103. That rate was 5.3 times higher than the Penobscot 2SW hatchery cohort average for the same time-period.

In 2013, the SAR for 2SW hatchery smolts released in the Penobscot River was 5, ranking 42nd in the 43-year record, while the 2013 return rate for 1SW hatchery grilse was 1 ranking 43rd in the 44-year record. The 2SW return rate in the Narraguagus River in 2013 was 51.3. This analysis points out a challenge to modern salmon recovery: naturally reared smolts typically have better marine survival than hatchery fish, but the capacity of rivers to produce adequate numbers of smolts is generally well below replacement rates, under current marine survival rates.

2.4.3 Juvenile Abundance Metrics

The USASAC again made progress utilizing databases to develop regional-scale stock assessment products that assess various life history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary has been used to summarize return rates across New England for hatchery smolts (e.g. Figure 2.4.2.2 and 2.4.2.3). Examination of these data in further detail for such a long time-series is providing insights into program-specific challenges and more general regional trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, is facilitating the development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation, given the broad geographic area (186,500 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 from at least the 1980's (some Maine data dates back > 50 years). Investigations of 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 2012 showed 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. Although this index of parr density from the mixed random effects model was useful in examining trends in parr density through time, this index was not calculated for 2013 parr production. Changes in the overall Connecticut River and Merrimack River programs resulted in many fewer sites being electrofished by state and federal agencies. Also, sampling in the Gulf of Maine DPS has shifted to a Generalized Random Tessellated Stratified (GRTS) design. This design does not sample fixed sites annually as was typically done in the past, but rather samples sites that are randomly selected each year based upon stratification according to stream width categories. The GRTS design also samples using a single electrofishing pass which decreases the time spent at each site and allows a greater number of sites to be sampled within a given year. The advantage of this design over historic sampling methods is that greater spatial coverage is achieved in a more statistically valid sampling design and allows better generalization of trends in parr abundance for the GOM DPS as a whole. In future assessments, abundance indices generated from the GRTS design will be used to evaluate tends in parr abundance.

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 2011. Further analysis of smolt population dynamics is ongoing and examines other abundance indices, age distribution, and run timing. Because both these indices track natural production of smolts, the general coherency in trends indicated that environmental factors may influence smolt recruitment on a regional basis in many years. Identification of these factors and when smaller scale differences occur would enhance the ability to predict and understand smolt production dynamics.

2.5 Biological Reference Points

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

2.6 Summary

Historic Atlantic salmon abundance in New England 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 1,650 fish, and returns in 2013 were only 611 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 suggested a potential shift to higher ocean productivity but low 2012 and 2013 returns suggest a more variable pattern. Despite low wild salmon abundance in the US, mariculture is increasing worldwide and New England production should be around 6,000 mt in the next decade. As such, Atlantic salmon remains common in the marketplace despite its precarious status is US rivers.

Table 2.2.1 Recreational (reported in numbers), aquaculture production (thousand metric tonnes), 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	1992-2003 Average	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
U.S. Recreational (#)*	16	-	-	-	-	-	-	-	-	-	-
U.S. Aquaculture	10.8	6	8.5	5.3	4.7	2.7	9	6	11.1	**	**
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	10.8	6	8.5	5.3	4.7	2.7	9	6	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	2013	%CSE
Long Island Sound Complex	10094	91	0.9%
Central New England Complex	3435	21	0.6%
Gulf of Maine DPS	15670	413	2.6%
Totals	29199	525	1.8%

For further information

Anon. 2005. Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). National Marine Fisheries Service/ U.S. Fish and Wildlife Service Joint Publication. Gloucester, MA. 325 pp. http://www.nero.noaa.gov/nero/hotnews/salmon/FinalATSRPlan.pdf

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Verspoor, E., M. O'Sullivan, A.L. Arnold, D. Knox, and P.G. Amiro. 2002. Restricted matrilineal gene flow and regional differentiation among Atlantic salmon (*Salmo salar* L.) populations within the Bay of Fundy, Eastern Canada. Heredity, 89: 465–742.

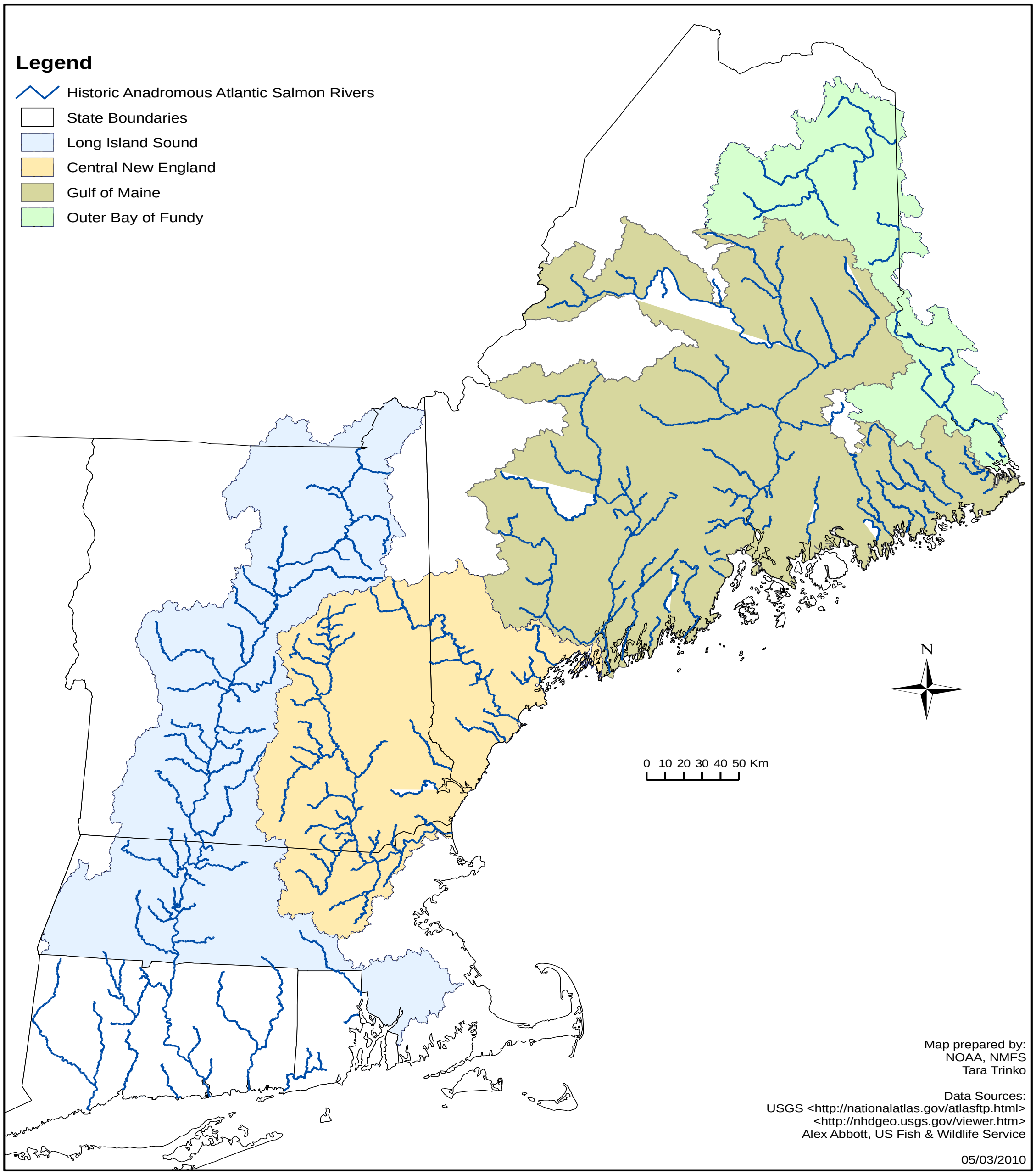

Figure 2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), Central New England (CNE), and Long Island Sound (LIS) regions.

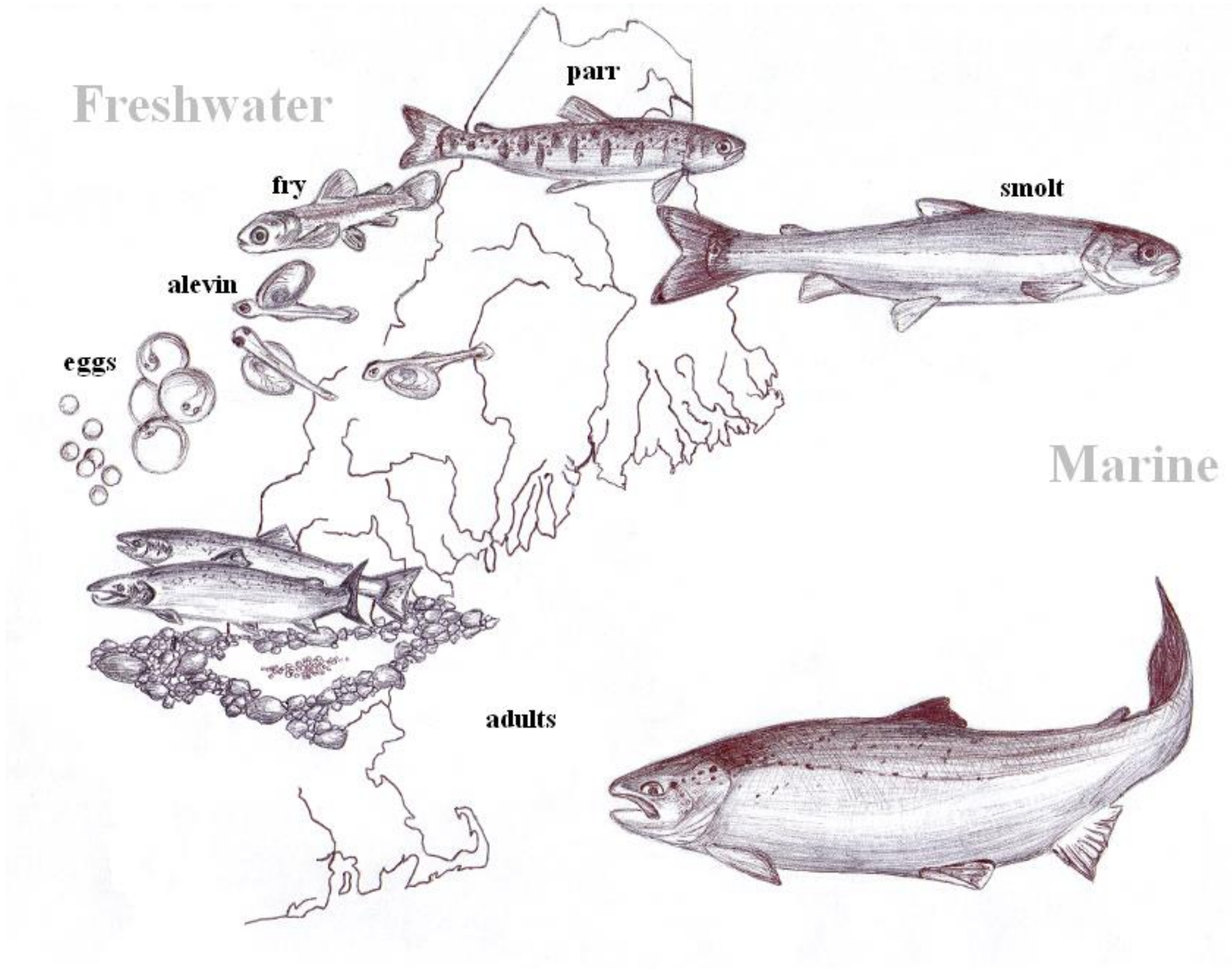

Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

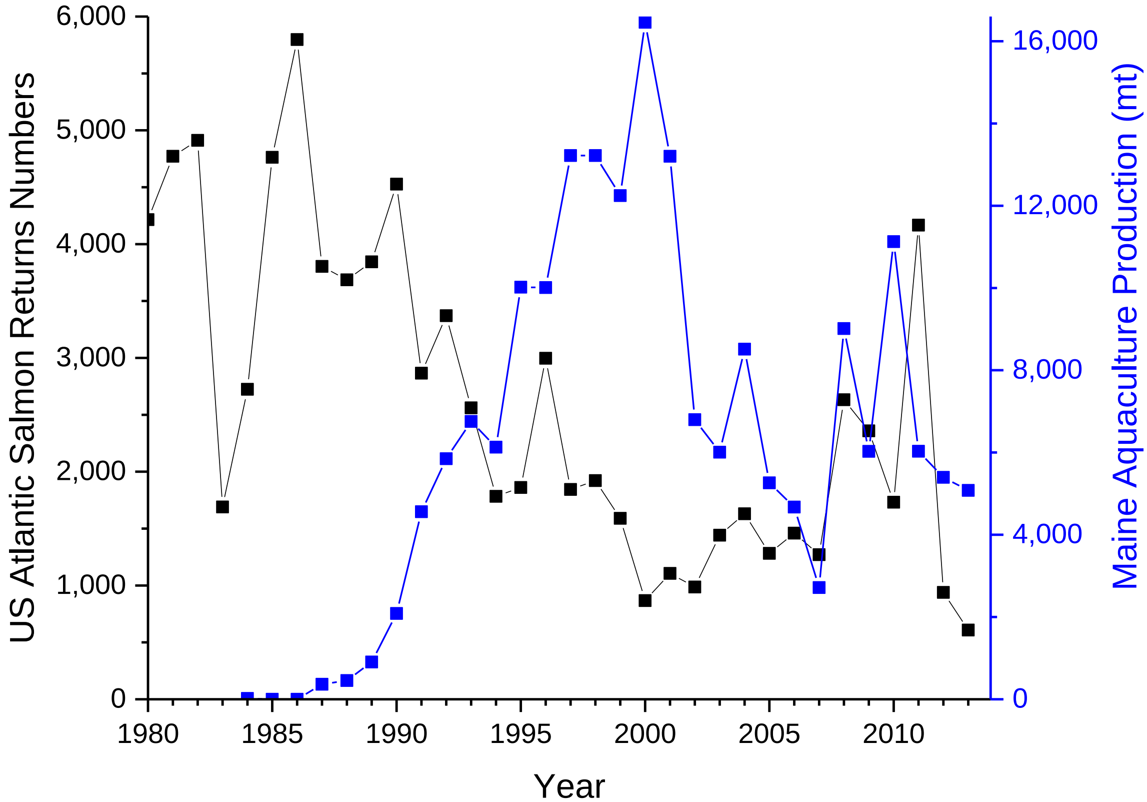

Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons).

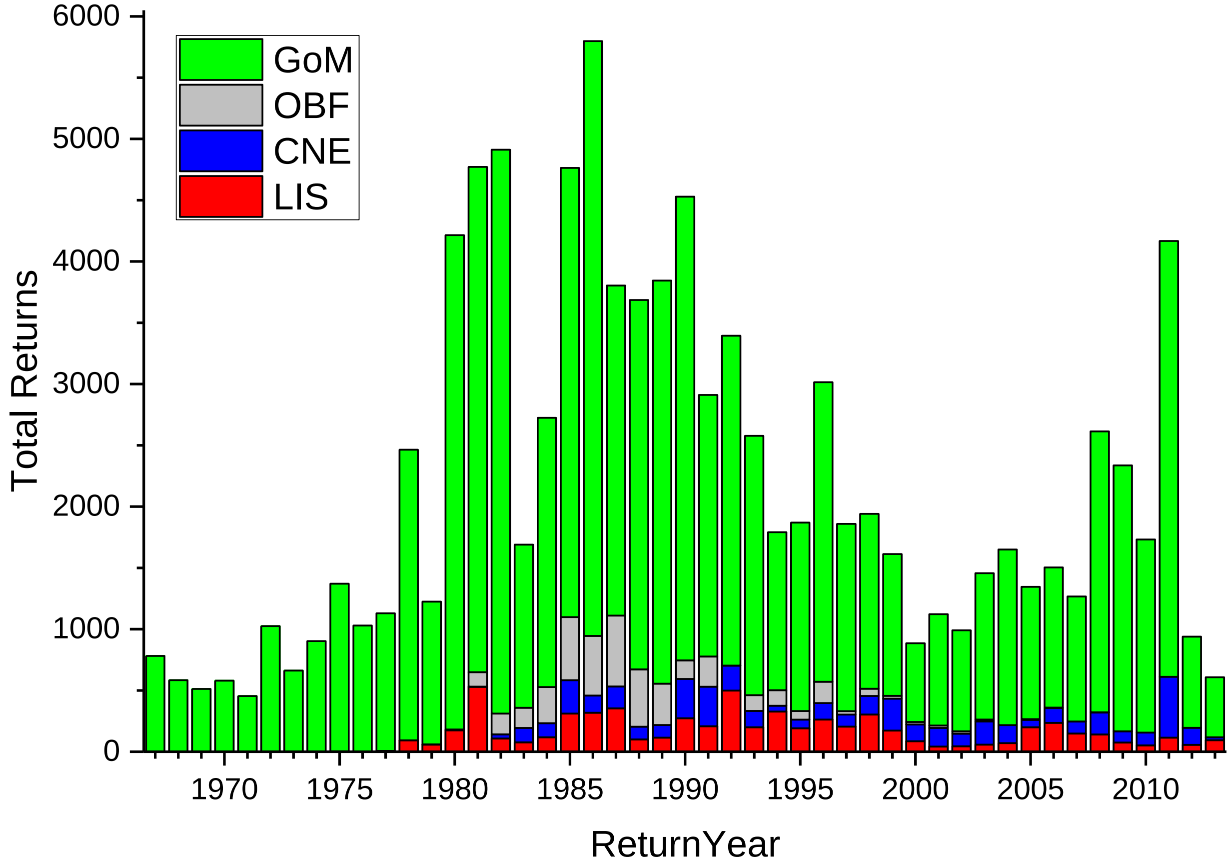

Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, Central New England complex (CNE), and Long Island Sound (LIS) complex.

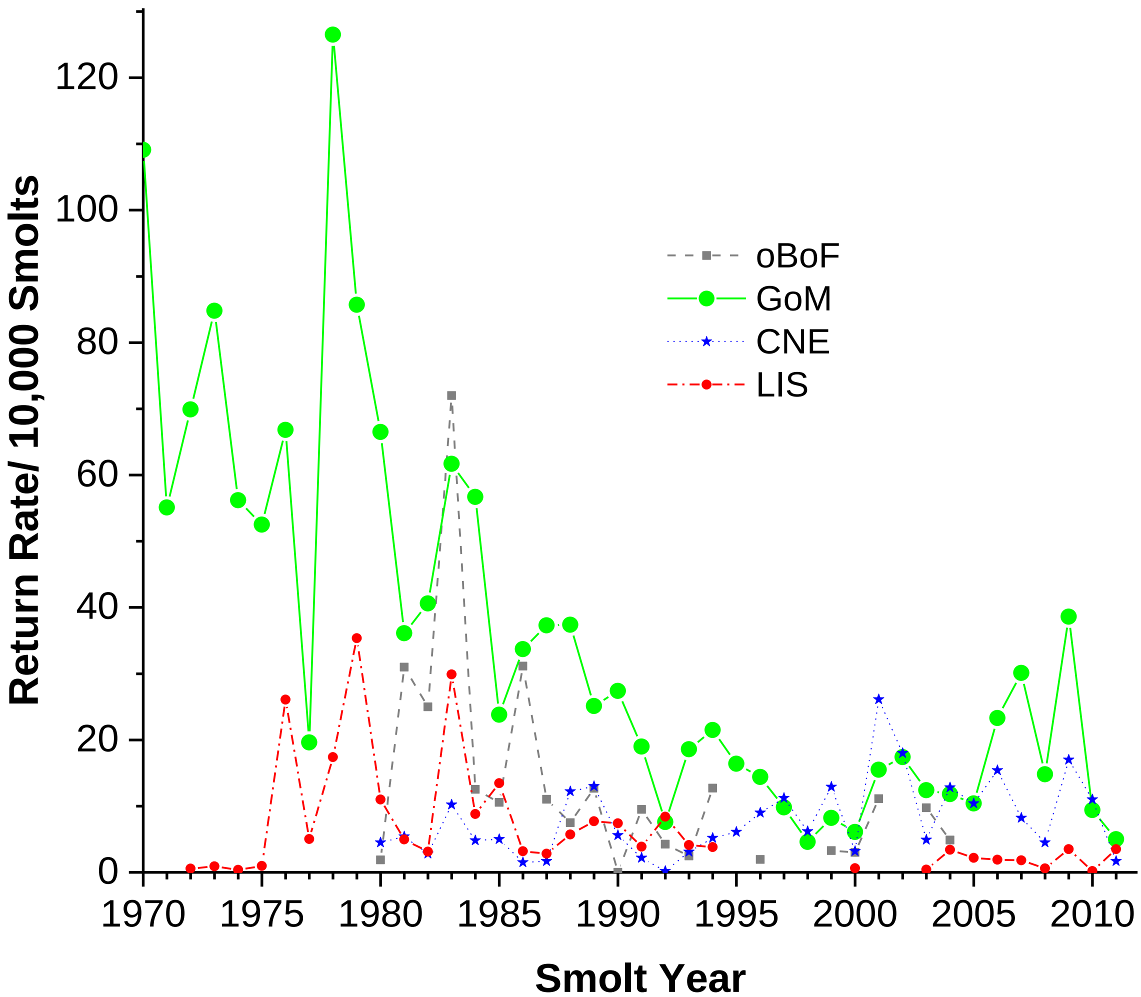

Figure 2.4.2.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

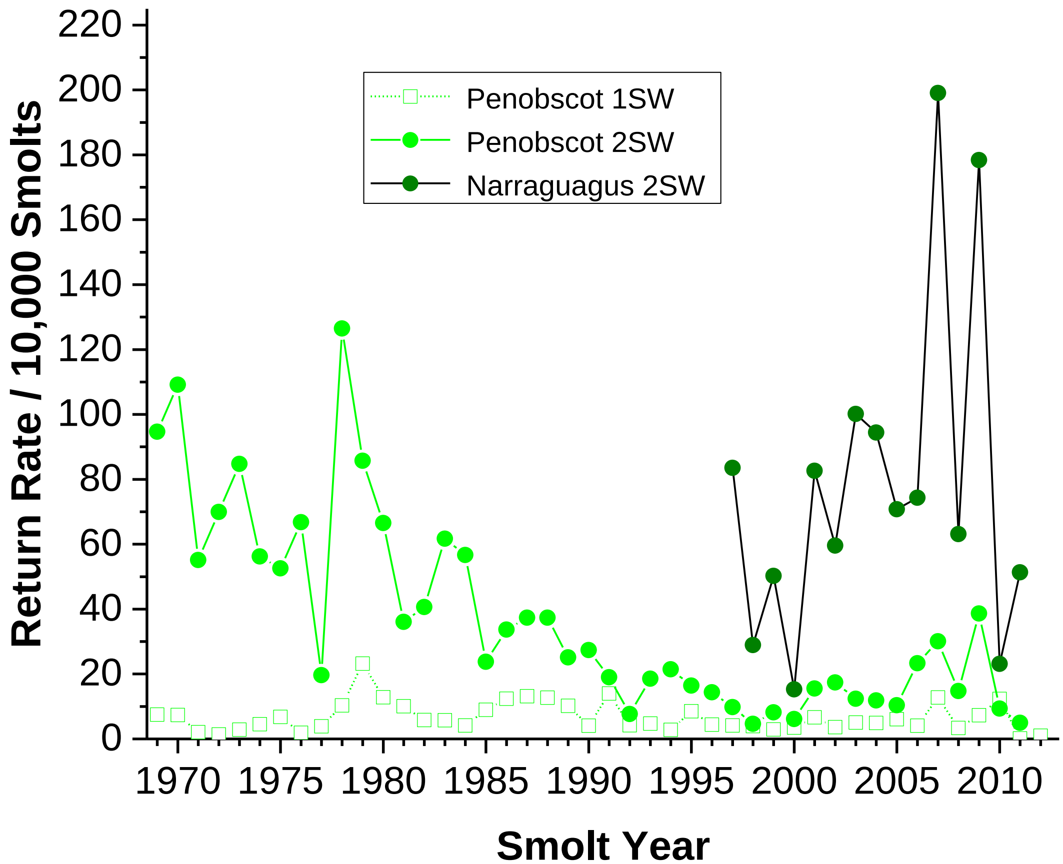

Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

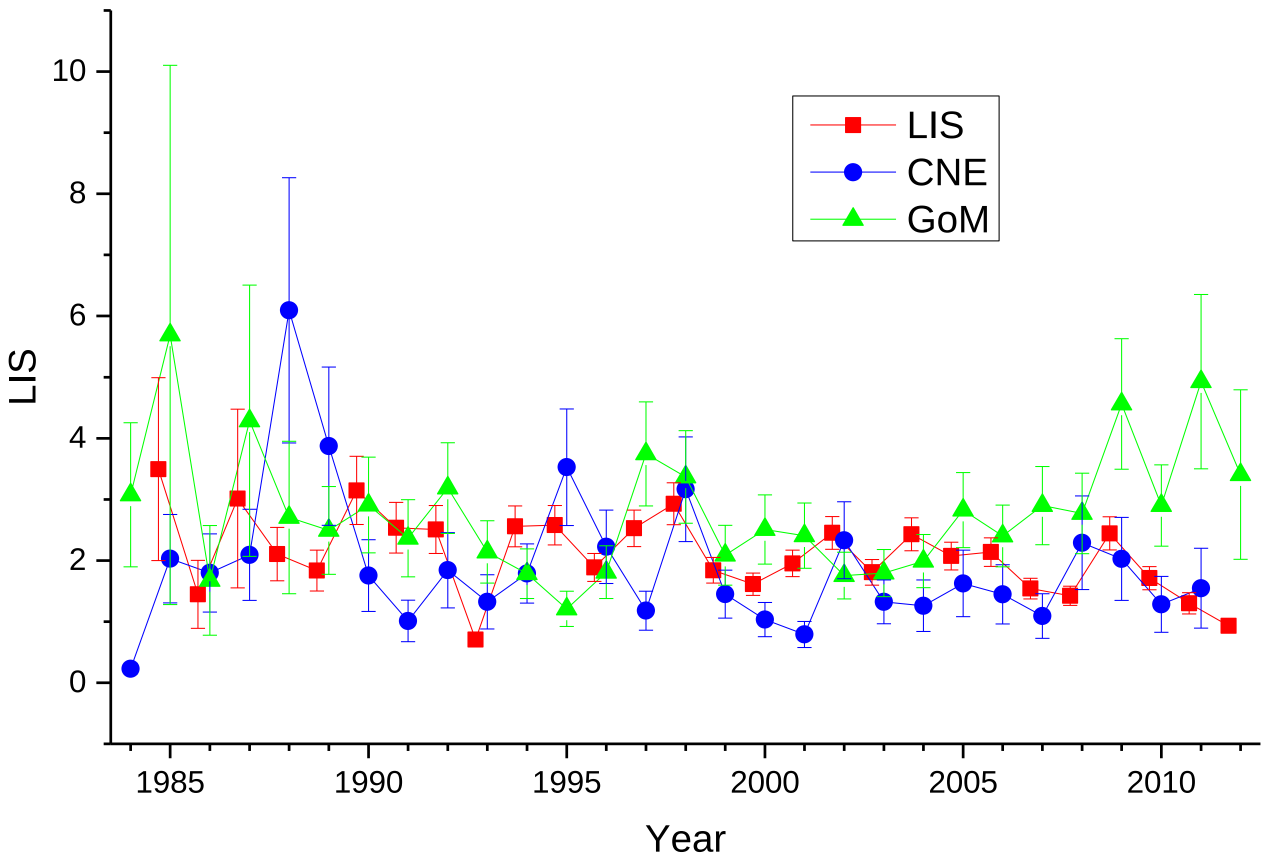

Figure 2.4.3.1 Index of large parr density from a mixed random effects model using electrofishing data from sites with > 10 years of data from 1984 through 2012 from USASAC databases for three stock complexes: Long Island Sound, Central New England, and Gulf of Maine DPS.

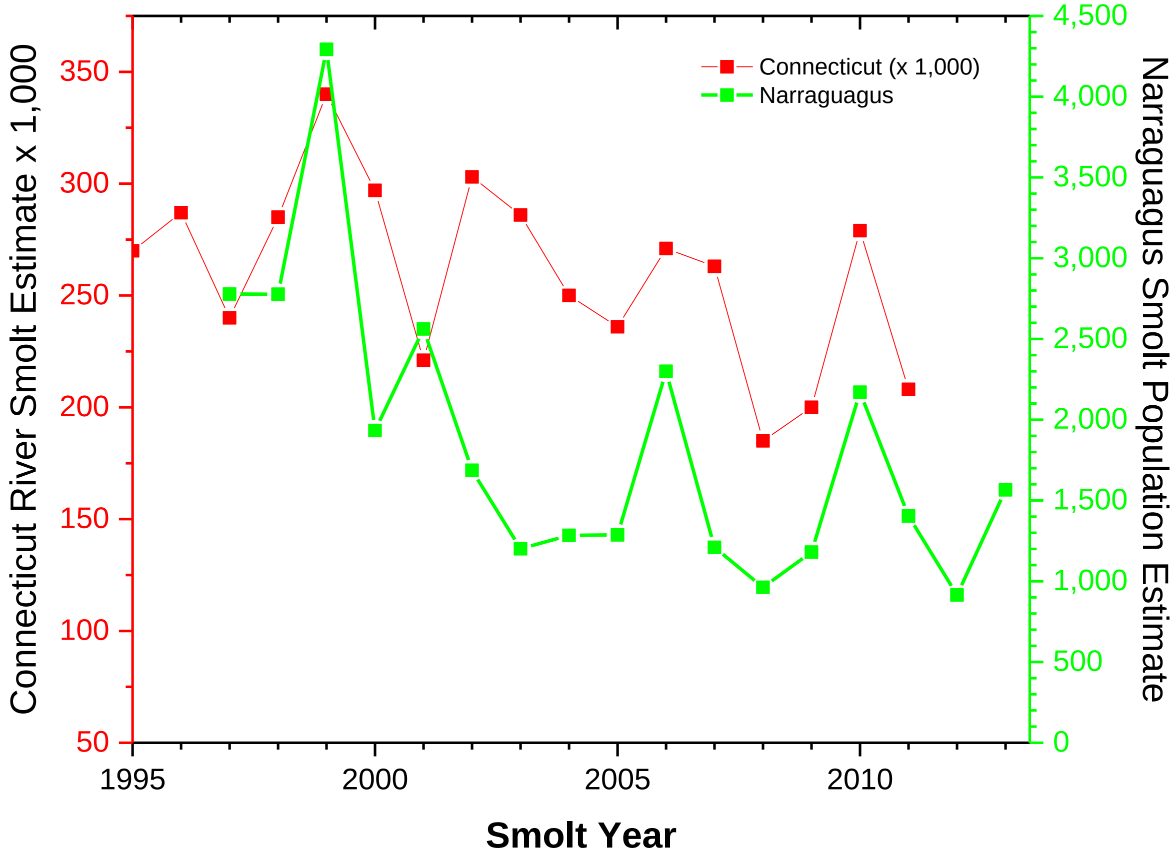

Figure 2.4.3.2 Estimates of abundance of Atlantic salmon smolts emigrating from the Narraguagus River, Maine, and the Connecticut River Basin in total. See text for details of estimation methods.

3 Long Island Sound

3.1 Long Island Sound: Connecticut River

Connecticut River Atlantic Salmon Commission (CRASC) partner agencies continued work on diadromous fish restoration in 2013. The following is a summary of work on Atlantic salmon.

3.1.1. Adult Returns

A total of 92 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 69 on the Connecticut River main stem, 6 in the Farmington River, 5 in the Salmon River, 1 in the Eightmile River, and 11 in the Westfield River. A total of 89 sea-run salmon was retained for broodstock at Richard Cronin National Salmon Station (RCNSS). Two salmon escaped the trap facility on the Westfield River and moved upstream of the first dam and one salmon was observed on video monitoring at a fishway, without a trap facility, on the Eightmile River, as it proceeding upstream.

In the past, approximately 10% of the salmon trapped at the Holyoke Dam have been radio-tagged and released upstream by TransCanada (operator of upstream hydro projects). No salmon were deliberately released this year (and thus no tagging) due to the need of the CTDEEP to retain as close to 100 broodstock as possible

Four (4%) salmon were of hatchery (smolt-stocked) origin. The remaining 88 (96%) were of wild (fry-stocked) origin. Adult returns included two grilse, with the remaining 90 determined to be two sea-winter age fish. Freshwater age distribution of wild salmon was 1^+ (11%), 2^+ (87%) and 3^+ (2%).

3.1.2. Hatchery Operations

Egg Collection
A total of 556,000 green eggs was produced at one state hatchery in 2013. Only the Kensington State Fish Hatchery (KSFH) in CT maintained domestic broodstock. Those eggs will be used for fry stocking for the Connecticut Legacy program. Sea-run broodstock held at RCNSS produced 350,200 eggs. Those eggs were eyed at RCNSS and not transferred to KSFH until fish health screening was completed. Due to poor record keeping and communication, most of the eggs had hatched prior to transfer and mandatory disinfection upon receipt at KSFH resulted in massive mortality. The net gain of sea-run eggs for the Legacy program amounted to about 20,000 fry. These will be the source of the next generation of domestic broodstock at KSFH.

3.1.3. Stocking

Juvenile Atlantic Salmon Releases
A total of 1.96 million juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2013. Totals of 408,032 fed fry and 1.45 million unfed fry were stocked into tributary systems with the assistance of hundreds of volunteers. Totals of 99,523 (2smolts),

508 (1smolts), and 3,209 (0parr) were released into lower sections of larger tributaries from Connecticut upriver into Massachusetts.

Surplus Adult Salmon Releases
Domestic broodstock surplus to program needs in the State of Connecticut were made available to anglers in identified waters in that state. Massachusetts, with its depopulation of domestic salmon broodstock at RRSFH, stocked fish for anglers in lakes and ponds.

3.1.4. Juvenile Population Status

Smolt Monitoring
Monitoring of smolts occurred at Moore Dam, at the 15 Miles Project Area, in the upper basin by TransCanada in 2013. Biologists working at Moore Dam operated the smolt sampler/trap from May 2 through June 25, capturing a total of 463 smolts. Peak passage activity occurred in mid to late May. All smolts were captured, transported immediately downstream of Vernon Dam and released. This sample size is reduced from previous years.

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, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production.

3.1.5. Fish Passage

Program cooperators continued to work to improve upstream and downstream passage at dams as well as to remove unutilized dams to benefit all diadromous fish. Projects that affect salmon are summarized below. The CRASC Fish Passage Subcommittee members coordinated main stem dam fishway inspections of fishways at Vernon, Turners Falls, and Holyoke dams and the West Springfield Dam fishway on the Westfield River, prior to operations in the spring. The State of Connecticut conducted inspections within their state and the USGS Conte Lab provided additional site 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 and consist of Turners Falls, Vernon, Bellows Falls, and Wilder dams, as well as the Northfield Mountain Pumped Storage facility, a project area (affected) spanning 140 river miles. State and Federal resource agencies directed significant staff resources at numerous meetings, site visits, plan review, deliberations, and comments, and worked closely with non-government organizations over the past year. Some highlights related to fish passage and/or areas of concern for potential negative impacts are described below.

<u>Holyoke Dam-</u> 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 with substantial guidance from the USFWS Fish Passage Engineer staff in 2013. Discussions on construction and monitoring/evaluation plans are now in progress.

Vermont Yankee Nuclear Power Plant- The owner/operator of the power plant (Entergy) stated their plans to close this facility in December 2014, in a publicized announcement in August 2013. The State of Vermont has been working with the company on the many aspects of this plan since that time.

Fifteen Mile Falls Project –TransCanada operated the smolt sampler at Moore Dam to continue to collect smolts for interim downstream passage. The final stock out of salmon fry, in some tributaries upstream of this facility in the spring of 2013, occurred in the State of Vermont, none in New Hampshire.

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

3.1.6. Genetics

No tissue samples were taken from sea-run broodstock for genetic monitoring. Mature male parr, collected from the Sawmill River, supplemented sea-run males. Mating of sea-run females utilized a 2 male: 1 female breeding matrix. A 1:1 spawning ratio was observed for domestic broodstock spawned at the KSFH.

Sea-run origin fry were stocked in Pine Brook (CT) in the spring of 2013 for mature parr production to supplement future male spawners as part of the Legacy Program.

No further results from the Atlantic Salmon Marking Study were made available in 2013.

3.1.7. General Program Information

The decision by the USFWS to stop supporting salmon restoration with its hatcheries and the subsequent withdrawal from the program by NH, MA, and VT was reported on in last year's report. The transition from the former four-state restoration program to the one-state (CT) "Legacy program" began in 2013 with MA and VT stocking out the last of its fry, the USFWS stocking out the last of its smolts, and MA stocking out all of its remaining domestic broodstock. CTDEEP stocked out some of its domestic broodstock but retained a reduced number to support its Legacy Program. It will continue to stock fed fry but at much reduced numbers and geographical distribution.

The USFWS and the CRASC (and specifically the CTDEEP) had an agreement which allowed all sea-run salmon retained at fishways to be held in the RCNSS for spawning by the CTDEEP. That was done, although survival to the fry stage at KSFH was very low. By late 2013, the USFWS decided it would not make RCNSS available to hold salmon in 2014 and the facility was placed into "winterized" status by December 2013.

The use of salmon egg incubators in schools as a tool to teach about salmon was discontinued except for in CT. Most schools in MA, VT, and NH appeared to have transferred over to Trout-in-Classroom programs. The Connecticut River Salmon Association, in cooperation with CTDEEP, maintained its Salmon-in-the-Classroom program at over 60 schools in Connecticut.

3.1.8. Migratory Fish Habitat Enhancement and Conservation

CTDEEP cooperated with partners on one fish passage project: the installation of a fish ladder at Rogers Lake on Mill Brook in Old Lyme (sponsor- Connecticut River Watershed Council). In MA, the USFWS worked with the Town of Easthampton to complete the Manhan River fishway, which has been left partially completed for several years due to lack of funds. This Denil fishway will be operational for the 2014 season. A number of partners including the USFWS and the State of MA have been working on a project to remove a dam on the Fall River (Gill, MA) for many years. Great progress toward this goal was made in 2013. The State of MA ordered a restoration of a section of the Chickley River (a Deerfield River tributary) that was first badly damaged by Hurricane Irene and then further degraded by a construction company hired to perform emergency repairs to an adjacent roadway. This restoration was completed in 2014. Various culvert replacements were completed in MA, VT, and NH.

3.2 Pawcatuck River

3.2.1. Adult Returns

Two Atlantic salmon adults were captured at the Potter Hill Fishway in 2013. The fish are of wild (fry stocked) origin.

3.2.2. Stocking

Juvenile Atlantic Salmon Releases

The Salmon in the Classroom program was responsible for stocking approximately 8,000 fry into the Pawcatuck River and its tributaries. No other Atlantic salmon fry were stocked into the Pawcatuck River in 2013. No smolts were stocked in the Pawcatuck River in 2012.

3.2.3. Juvenile Population Status

Index Station Electrofishing Surveys

Parr assessments were not conducted in 2013 due to lack of personnel.

3.2.4. Smolt Monitoring

No work was conducted on this topic during 2013.

3.2.5. Tagging

In Rhode Island, all smolts are released with adipose fin clips, however, no smolts were released in 2013.

3.2.6. 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.

Genetics

No genetics samples were collected in 2013.

General Program Information

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

Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2013.

4 Central New England

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

Twenty-two (22) Atlantic salmon were counted in the Merrimack River at the Essex Dam, Lawrence, MA. Twenty (20) captured salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Two of the fish had an adipose fin clip indicating they were previously released into the Souhegan River as juveniles; both fish were released in the Souhegan River prior to spawning season. Two fish died at the hatchery, prior to spawning and three fish were non-spawners. Four fish were kelts from 2011 and 2012. Thirteen (13) salmon were spawned which included 8 (61.5%) males and 5 (38.5%) females. Sixteen (16) fish were released in the Souhegan River after spawning, at the end of November, 2013.

Morphometric data and scale samples were taken from 20 fish. One fish was determined to be of broodstock origin. Of the nineteen sea-run salmon analyzed, seven were of hatchery smolt stocking origin (H) and twelve were of fry stocking origin (W). Of the seven hatchery smolt origin fish (36.84%), four were two sea-winter fish, one a three winter fish, one a four sea-winter fish, and three of the fish, [1(H1.3) and 2(H1.4)], were alternate year repeat spawners that first spawned in 2011.

4.1.2 Hatchery Operations

North Attleboro NFH released a total of 40,930 one-year old smolts in the Merrimack River watershed in 2013. The Souhegan River (Milford, NH) was stocked with 20,367 adipose fin clipped smolts on April 9, 10 and 12. The remaining 20,563 unmarked smolts were released in the Merrimack River below Essex Dam (Lawrence, MA) on April 16, 17 and 18.

A new year class of unfed fry (76,000) was received from Nashua NFH on April 18 for future production for the Saco River (ME) and the Merrimack River. Since the smolt production program for the Merrimack River was terminated, subsequent fish produced for the watershed were released as fall parr (25,177) in the Souhegan River on December 4, 2013.

Egg Collection

Sea-Run Broodstock

In 2013, thirteen sea-run salmon were spawned at NNFH. Fish were spawned during the period 28 October - 6 November, and produced 36,156 green eggs that resulted in 33,196 eyed eggs. All sea-run eggs were held and incubated at NNFH to avoid exposing other hatcheries to eggs that could hold infectious pathogens. NNFH achieved 91.8% eye-up in its sixth year of sea-run egg incubation. The 5 females produced an average of 7,231 eggs each. The hatchery retained approximately 5,000 sea-run eggs for captive broodstock production.

Domestic Broodstock

In fall 2012, a total of 295 female and over 300 male captive (F1 from sea-runs) broodstock spawned at NNFH; 554 fish were non-spawners. Spawners provided an estimated 853,113 green eggs. All eggs were retained at NNFH for incubation and eventual fry release to the Merrimack River and Saco River watersheds, and the Adopt-A-Salmon educational programs. Of the 295 females, 90 were four years old, 154 were three years old, and 51 were two years old. The captive broodstock spawning season began on 14 November and ended 16 January, and included 18 spawning events.

Stocking

In 2013, 111,000 Atlantic salmon fry were released into the Merrimack River watershed in April and May. Salmon fry were propagated at NNFH and were released in the Pemigwasset River.

An estimated 40,930 smolts were released into the watershed with approximately 20,563 one-year-old smolts reared by the NANFH released into the lower Merrimack River downstream of Essex Dam (Lawrence, MA) in early April. An additional 20,367 one-year-old smolts were released into the Souhegan River; these smolts received an adipose fin clip. All smolts were F1 or F2 progeny of Merrimack River lineage salmon. Smolt stocking in the lower river has been timed to reduce the potential impacts of predation by striped bass. Bass typically arrive in the estuary and near shore coastal environment proximal to the Merrimack River in mid to late April.

4.1.3 Juvenile Population Status

Yearling Fry / Parr Assessment

Since 2003, the number of fall parr sample sites had been reduced from a high of 28 to seven traditional (historic) index sites. In 2010 the number of sample sites was further reduced to six, and in 2013 no index sites were sampled. In 2013, six catch per unit effort parr sampling samples were conducted to assess the success of pre-spawn adult stocked fish.

4.1.4 General Program

The U.S. Fish and Wildlife Service determined that it would end its collaborative effort to restore Atlantic salmon in the Merrimack River watershed if the number of sea-run salmon returning to the river did not increase substantially during the May/June 2013 spring migration. Primary causes that have limited the return of salmon to the river are: poor survival of salmon in the marine environment, severely reduced population abundance from in-river habitat alteration and degradation, dams resulting in migration impediments, and an inability of fish to access spawning habitat and exit the river without impairment.

In May 2012, Service and other state and federal fishery resource agencies who have oversight of migratory fish management actions in the watershed proposed to evaluate the restoration program in year 2015. That evaluation would focus on marine survival in the Merrimack River population and other Gulf of Maine populations as one measure of success, and focus on natural spawning of salmon in the Souhegan River, a tributary to the Merrimack River, where dam removal allowed access to spawning habitat as a second measure of success. While a record number of 402 sea-run salmon returned to the river in spring 2011, the 127 fish that returned in spring 2012, and the 22 fish that returned in spring 2013 was less than desired. The rate of return of salmon (number of sea-run fish / number of juvenile fish released) to the river in 2012 and 2013 did not suggest an improvement in marine survival, and indications are that survival remains poor for salmon in the North Atlantic Ocean; also, few salmon migrated to the Souhegan River to spawn.

Sea-run salmon and gravid hatchery broodstock had been transported to and released in the Souhegan River, and adult spawning and juvenile production had been documented; however, the number of juvenile salmon produced from natural spawning is likely not enough to substantially increase future returns. In addition, the numbers of salmon that return to the river will likely decrease given continued poor marine survival, a decrease in hatchery origin fry and smolt stocked annually from federal and state hatcheries, and an expected low rate of return of salmon.

Continued federal budget constraints affecting the USFWS, Fisheries Division, also hastened evaluation and decision making regarding the Merrimack River salmon restoration effort. The Service plans to maintain efforts directed at recovery of endangered Atlantic salmon stocks in Gulf of Maine rivers and direct cost savings associated with Merrimack River salmon restoration to other migratory fish restoration initiatives in the watershed. Workforce management and realignment of USFWS effort away from Merrimack River salmon restoration will provide opportunities and benefits for other USFWS trust species initiatives in the watershed, notably American shad and river herring enhancement, American eel protection and enhancement, and aquatic habitat restoration.

Atlantic Salmon Broodstock Sport Fishery

The NHFG, via a permit system, will continue to manage an Atlantic salmon broodstock fishery in the mainstem Merrimack River (NH) and lower portion of the Pemigewasset River until year end 2014. Permit sales have remained steady in recent years, with approximately 1,400 permits sold each year since 2006. Permit sales suggest that anglers continue to value this unique opportunity to fish for Atlantic salmon in northern New England. Whereas angled Atlantic salmon required the presence of a floy tag on captured fish as well as an angler tag for harvest in previous years, rule changes have now eliminated the angler tagging requirement. Creel limits are one fish per day, five fish per season, and a minimum fish length of 15 inches.. The season is open all year for taking salmon with a catch and release season from 1 October to 31 March. In Spring 2013, 372 (age 3) domestic broodstock were released for the fishery. In fall 2013, an additional 2,296 (age 2 and 3) broodstock were released for a combined total release of 2,668 fish to support the fishery and to enhance spawning in the wild.

Adopt-A-Salmon Family

The 2013 school year marked the twenty-first year of the Adopt-A-Salmon Family Program in central New England. In January and February, an estimated 10,000 salmon eggs were distributed from the NNFH to about 30 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. Schools that received eggs also participated in an educational program at the Piscataquog River Park in west Manchester, NH. The program culminated with students releasing fry into the Piscataquog River. The program was conducted by a core group of dedicated volunteers with assistance from USFWS 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 the USFWS continue to develop and implement award winning environmental education programs based at the Amoskeag Fishways Learning and Visitors Center (Fishways) in Manchester, NH. With the Merrimack River watershed as a general focus, the partnership is offering educational outreach programming to school groups, teachers, the general public, and other targeted audiences.

Fishways is open throughout the year, offers environmental education programs from pre-school to adult, museum quality exhibits, seasonal underwater viewing windows, family centered special events, live animal programs, and a vacation series for children. Fishways visitation in 2013 was 22,614, including 12,793 students and 9,821 adults. Since its inception Fishways has documented greater than one-half-million visitors, and about 8,000 school programs have been delivered to date. The total number of outreach and partly at Center programs offered in 2013 was 162 with 7,180 students and 4,457 adults participating. Fishways continues to be an exciting, educational place to attend programs, to see wildlife and fish up-close, and to carry out environmental education and conservation programs. All agencies continue to participate as active members of the Management and Program committees that provide oversight for the Partnership.

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

Central New England - Integrated ME/NH Hatchery Production

The USFWS, Eastern New England Fishery Resources Complex developed an agreement with the State of Maine to engage in planning and implementing an Atlantic salmon restoration and enhancement project in the Saco River watershed (see section 4.2). 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 317,293 unfed fry were shipped from NNFH to the Club hatchery in February/March; prolonged spawning of domestic salmon at NNFH required eggs to be held at NNFH until hatch, with fry transferred later in the season. NANFH produced 12,055 one-year-old smolts for release to the river in April, transported13,089 parr to the Club hatchery in December, and released an additional 10,087 parr in the Little Ossipee River in December.

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 April 30th to October 31st, 2012. Three salmon were observed moving upriver through these facilities; however, the count could exceed 3 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 determine the age and origin for the total run. Of the three sea-run Atlantic salmon counted at Cataract, all were 2SW adults, two were of hatchery origin and one was of wild origin.

4.2.2 Hatchery Operations

Egg Collection

In 2013, 317,293 fry 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.

Stocking

Juvenile Atlantic Salmon Releases

In April 2013, a total of 12,100 smolts were transported from North Attleboro National Fish Hatchery (NANFH) and released to the river. In addition 10,101 age 0 parr were transferred from NANFH to the Saco River Salmon Club Hatchery in 2012 held overwinter and stocked in the mainstem Saco in 2013. Approximately 319,000 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.

4.2.3 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 2013.

Smolt Monitoring
No smolt monitoring was conducted in 2013.

Tagging
No salmon out planted into the Saco were tagged or marked in 2013.

4.2.4 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 2013 smolt, fry and parr stockings.

4.2.5 Genetics

No genetic samples were collected in 2013.

4.2.6 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.

Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2013.

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 2013 were 493. Returns are the sum of counts at fishways and weirs (392) and estimates from redd surveys (101). 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. Fall conditions were suitable for adult dispersal throughout the rivers, and conditions allowed redd counting.

Escapement to these same rivers in 2013 was 121 (9 Penobscot [return – broodstock] + 112 other DPS). With 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).

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).

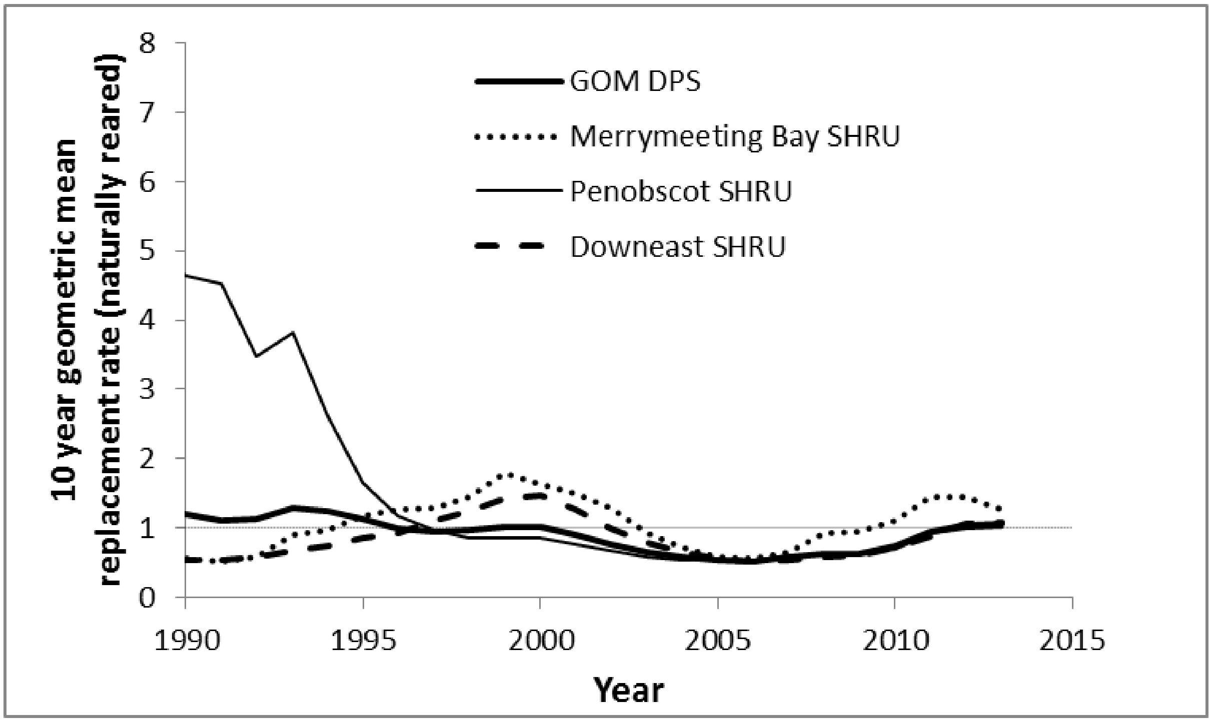

Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the Gulf of Maine Distinct population segment and the three Salmon Habitat Recovery Units (SHRU).

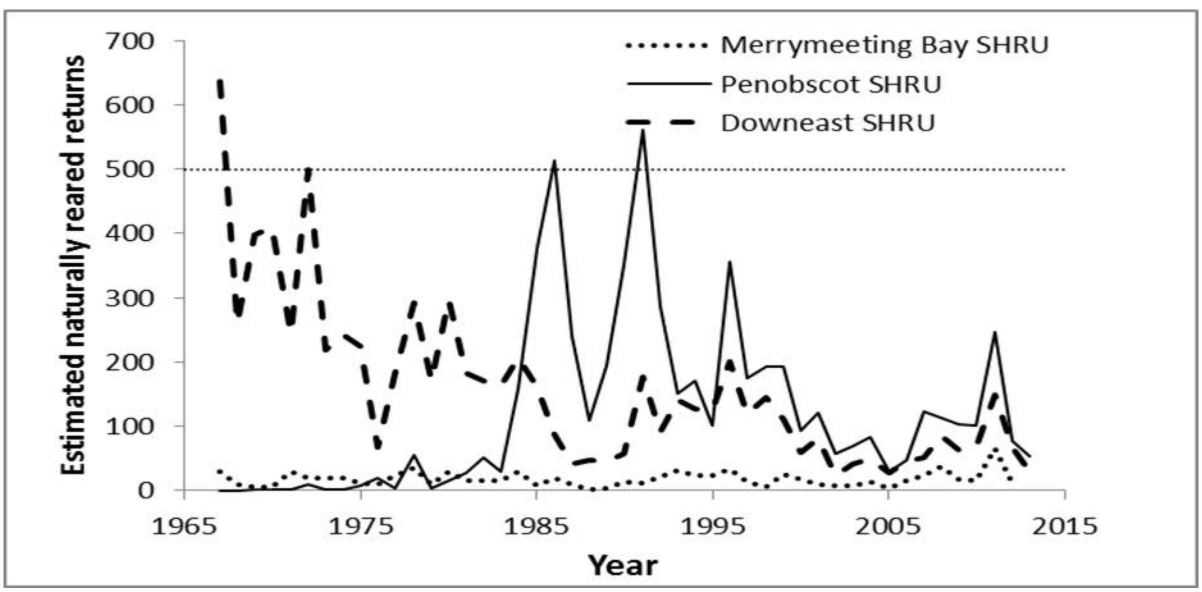

Figure 5.1.2 Estimated Naturally Reared Returns to the Gulf of Maine.

Small Coastal Rivers

Downeast Coastal SHRU

Dennys River
The Dennys weir was not fished in 2013.

Due to lack of recruitment, the use of captive reared gravid adults was discontinued in 2013. Despite spawning activities observed during the falls of 2011 and 2012, very few to no 0+ parr were observed during annual juvenile assessment surveys. Managers are making the shift back to using unfed fry for 2014.

There was no spawning activity documented in the Dennys River in 2013.

East Machias River
Six (6) redds attributed to wild returns were counted during the 2013 redd surveys in the East Machias River that included approximately 96% of known spawning habitat area. No captive reared gravid adults were released into the East Machias because they were needed for egg production.

Machias River
We counted a total of 1 redd, covering approximately 58% of the spawning habitat area in the Machias drainage. This was unexpected since it was hoped that a larger number of adults would return to Old Stream due to changes in management. No hatchery product had been introduced to old Stream since 2008. This would have been the first year that sea-run adults from sea-run parents returned to Old Stream. Since previous years have had reliable returns and large parr abundances are still high relative to other streams, we are hopeful that returns in 2014 will rebound (see Juvenile Assessment Section).

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 again in 2013 from 30 April to 29 October. The trapping facility allows staff to intercept returns resulting from natural reproduction and recent smolt stocking of 50,000 smolts annually (2011-2013) 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 one (1) 2SW hatchery origin adult male in the fishway trap in 2013. Sea-age and origin were determined based on scale reading, marks and tags. Forty (40) redds were observed in the Pleasant River during surveys that covered 84% of spawning habitat area. All these redds were located in the same reach smolts were released in 2011, indicating that they may have been hatchery origin. Based on the redd count it is apparent that the falls where the trap is located are not a barrier to upstream migration.

Narraguagus River
Maine Department of Marine Resources (DMR), Sea Run Fisheries and Habitat staff operated the Stillwater Dam fishway trap on the Narraguagus River in Cherryfield, Maine from 28 April to 29 October, 2013. Staff handled twenty-one (21) adult Atlantic salmon (12

females and 9 males) captured in the fishway trap. Captures were predominately multi-sea winter (MSW) size-class salmon; four (4) wild origin (includes naturally spawned and fry stocked salmon), and fourteen (14) hatchery origin MSW returns. Three (3) hatchery origin, one-sea winter (1SW) salmon were captured in 2013. Sixteen (16) of the hatchery origin salmon were attributed to smolt stocking and one (1) was attributed to 0+ parr stocking. Sea-age and origin were determined based on scale reading and the observations of marks and tags. Returns to the fishway trap in 2013 (21) were up slightly from last season (18) and remained below the previous 10-year average (40 returns) In 2013, 57 redds were counted during surveys by canoe and foot covering approximately 84% of spawning habitat area.

Penobscot SHRU

Ducktrap River
Three (3) redds were observed during surveys in late November that encompassed 80% 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 45% of identified Atlantic salmon spawning habitat in the system. No Atlantic salmon spawning activity has been detected for 15 years (1999 to 2013), despite repeated and extensive searches annually.

Union River
The fish trap at Ellsworth Dam on the Union River is operated by the dam owners, Black Bear Hydro Partners (BBH), under protocols established by the DMR. Commercial alewife fisherman operated the trap in cooperation with BBH from 3 May to 17 June after which BBH operated the trap three days per week (typically Monday, Wednesday, and Friday) to provide passage for Atlantic salmon until 13 November. The only salmon captured in 2013 was a male (age 2SW) which was captured by the alewife harvesters on 17 June. The fish was held in the trap for about one hour until the DMR and BBH arrived to analyze scale samples, confirm wild origin, and release the fish upriver. No aquaculture escapees were trapped in 2013. Approximately 150,000 river herring were transported from the trap to up river spawning habitat in Graham and Leonard Lakes to meet spawning escapement goals. Trap catch of river herring in excess of escapement goals was sold commercially for bait.

Merrymeeting Bay SHRU

Sheepscot River
The river was surveyed, focusing on spawning habitat in the upper portion of the mainstem and West Branch, with five redds observed. Surveys encompassed 95% 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) = 0.5594 ln (redd count) + 1.2893] based on redd and adult counts from 2005-2010 on the Narraguagus River, Dennys River, and Pleasant River (USASAC 2010). Total estimated return based on redd counts for the small coastal rivers was 101 (90% CI = 68 - 148) (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 returns in the small coastal GOM DPS rivers from 1991 to 2013. 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	76	115	167
2013	68	101	148

Large Rivers

Penobscot River

The Veazie Dam fishway trap was operated daily from 30 April through 14 July, 2013 to enumerate adult salmon returns to the Penobscot River, to collect biological data from individual fish according to established sampling protocols (age and origin from scale samples, fork length, dorsal and caudal fin scores, and fish condition), and to observe marks and tags applied to hatchery origin parr and smolts at Green Lake National Fish Hatchery (GLNFH) prior to their release. The trap was also used to collect adult sea-run Atlantic salmon broodstock for the U.S. Fish and Wildlife Service hatchery program. The Veazie fishway trap was closed on 14 July due to the removal of the dam and fishway as part of the ongoing Penobscot River Restoration Project. Following the closure of the Veazie fishway trap, the DMR staff installed a video surveillance camera near the exit of the Milford Dam Denil fishway to continue to enumerate adult salmon returns to the Penobscot River for 2013. The Milford fishway camera began recording on 08 August and ceased on 01 November. The camera was set to record 24 hours a day for this period; however, issues including poor visibility due to low light or turbidity, malfunctions in the recording software, and downtime related to downloading of files from the computer resulted in 1,547 hours of video. Of the 1,547 hours of video, 1,373 occurred after the breach of the Veazie forebay cofferdam on 21 September.

We captured 381 sea-run Atlantic salmon (372 in the Veazie fishway trap and 9 on the Milford video camera) during the 2013 season. This represents a decrease of 243 fish from the 2012 total catch of 624 sea-run salmon, and is lower than the ten year average (2003-2012) of 1,452 Atlantic salmon. The 2013 catch is the lowest total return for a single season since the Veazie trapping facility began operation in 1978. This year's median capture date was 12 June, thirteen days later than 2012.

Scales collected from 366 salmon captured at the Veazie fishway trap were analyzed to characterize the age and origin structure of the 2013 run. The age and origin of six salmon captured at Veazie and nine salmon observed on the Milford video were prorated based on the observed proportions, taking into account the extent of dorsal fin deformity when possible. The majority of returning salmon were age 2SW (319; 84%), along with fifty-seven (57) 1SW salmon (15%), three (3) 3SW fish, and two (2) repeat spawners. Approximately 88% (334) of the salmon that returned were of hatchery origin and the remaining 12% (47) were of wild origin.

Nearly one quarter of this year's run (23%; 87 salmon) was observed to have at least one mark applied (all adipose clipped) prior to being released as a hatchery smolt (Table 1.5.1). Forty-seven (47) of those also had a visual implant elastomer tag (VIE) observed behind one of its eyes indicating the stocking location of that fish in the drainage. A single MSW, long absence, repeat spawner male salmon was observed with an adipose punch and a passive integrated transponder (PIT) tag. The tag number indicates this fish was originally captured on 01 July, 2011 as a grilse and released back to the river that same day.

All 372 Atlantic salmon captured at the Veazie trap were transported to the USFWS Craig Brook National Fish Hatchery in Orland as broodstock. This was well short of 580 sea-run adult Atlantic salmon needed to support the Penobscot River hatchery fry, parr, and smolt stocking programs (280 - 2SW females; 230 - 2SW males; and 50 - 1SW grilse).

Maine DMR staff collected and archived tissue samples for genetic analysis from 371 of the 372 salmon captured at the Veazie trap. An adipose punch was not collected from (1) fish because it was a repeat spawner originally caught in 2011, and would have produced a duplicate sample in the archive. Tissue samples were sent to the USFWS Northeast Fishery Center in Lamar, PA for genetic analysis.

All salmon handled at the Veazie trap or observed on the Milford video camera were screened for injuries and other abnormalities as part of DMR standard operating procedures. In 2013, 33% of returning Atlantic salmon were observed to have at least one injury. Of the injured fish, lamprey wounds and lacerations accounted for the majority of injuries (54 and 38 observations, respectively).

Finally, based on video results from the Milford fishway, we conservatively estimate an escapement of at least nine (9) Atlantic salmon including one (1) grilse (1SW) and eight (8) multi-sea winter salmon (6 MSW females and 2 MSW males) above Veazie Dam on the Penobscot River in 2013.

Androscoggin River
The Brunswick fishway trap was operated from 15 April to 15 November, 2013. Two (2) adult Atlantic salmon were captured in 2013, one (1) naturally reared 2SW salmon and one (1) hatchery origin 2SW salmon. Biological data was collected from both fish in accordance with DMR protocols, with the presence of marks and tags recorded. Each fish was tagged with acoustic radio transmitters and PIT tags and released downriver as part of an upstream passage efficiency study being conducted by Brookfield Renewable Energy Partners, L.P. (Brookfield Energy). Neither fish returned to the Brunswick Fishway trap during the 2013 trapping season, however, both were located in the Kennebec River near the Lockwood Hydro Power facility in Waterville and remained there throughout the trapping season.

Kennebec River
The Lockwood fish lift was operated by Brookfield Energy (formerly NextEra Energy) staff from 15 April to 21 October, 2013. Seven (7) 2SW sea-run Atlantic salmon were captured at the Lockwood fish lift facility, six (6) were wild origin and one (1) was of hatchery origin. Biological data and tissue samples were taken from each individual fish in accordance with DMR protocols and existing marks and tags recorded. All seven adult Atlantic salmon were trucked and released to the Sandy River, a tributary to the Kennebec River.

Sebasticook River
The Benton Falls fish lift on the Sebasticook River (tributary to the Kennebec River joining downstream of the Lockwood facility) was operated from 29 April to 30 October, 2013. One (1) MSW Atlantic salmon was captured in 2013. Only visual observations are recorded at this facility.

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% 2010 and 2011, 0.77%).

Table 5.1.2. Summary table of Atlantic salmon survival rates from the Penobscot and Narraguagus Rivers. All rates for hatchery origin stocks were based on marked groups. Data represent cohorts that 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	0.20
2009	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	559,828	2,585	0.46
2010	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	567,086	1,230	0.22
2011	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	554,000	275	0.05
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
2011	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	915	7	0.77
2011	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	59,000	25	0.04

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 4.9 million eggs for the Maine program in 2013: 1.7 million eggs from Penobscot sea-run broodstock; 1.6 million eggs from two domestic broodstock populations; 1.5 million eggs from six captive broodstock populations.

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. In 2013 CBNFH used year class crosses as well as spawning optimization software to avoid spawning closely related individuals within captive broodstock populations.

A total of 174 Penobscot origin females, 4 domestic females, and 507 captive females were spawned at CBNFH between the 7th and 25th of November. At GLNFH, 391 age four and 126 age three domestic females were spawned to provide eggs for in-stream egg planting in the Sandy River, a tributary to the Kennebec River.

Egg Transfers

CBNFH transferred 939K Penobscot eyed eggs to GLNFH for parr and age 1 smolt production, 209K eyed eggs to two facilities operated by the Downeast Salmon Federation for private rearing (Pleasant and East Machias strains), 58K eyed Penobscot eggs to DMR for egg planting in Cove Brook, 122K eyed Sheepscot eggs for egg planting in the Sheepscot River, 80,000 eyed Narraguagus eggs for planting in the Narraguagus River, and 26,000 eyed Machias eggs for planting in the Crooked River (a tributary to the Machias River).

GLNFH transferred 830K eyed Penobscot domestic origin eggs to DMR for egg planting in the Sandy River (654K) and for the Penobscot River (176K).

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 2013.

Wild Broodstock Collection and Domestic Broodstock Production

All 372 adult sea-run Atlantic salmon captured at the Veazie Dam, on the Penobscot River, were transported to CBNFH for use as broodstock.

Parr collection targets for the Dennys, East Machias, Machias, Narraguagus, and Sheepscot populations were increased by 50 each in 2013 to address concerns of diminishing genetic diversity and low re-capture rates of hatchery-origin parr. The collection target for the Pleasant population had been increased by 100 in 2012 and therefore remained static in 2013. Given the low returns to the Penobscot River in 2012 and 2013, CBNFH and DMR personnel elected to collect parr for use as future broodstock for the first time in 2013 with a collection target of 500 parr collected from throughout the drainage. In addition to increasing the parr collection targets for each population, greater attention was given to ensuring parr were collected in a manner that equalized the distribution of hatchery-origin products and wild reproduction.

In 2013, 1,877 wild parr (135, Dennys; 208, East Machias; 305, Machias; 335, Narraguagus; 469, Penobscot; 202, Pleasant; 223, Sheepscot) were collected by CBNFH, Maine Fishery Resources Office (MEFRO), and DMR personnel and transported to CBNFH for captive rearing.

GLNFH retained approximately 1,200 fish from the 2012 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.

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 reared at CBNFH 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 from either facility 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 2013. 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 2013.

Stocking

Stocking activities in Maine resulted in the release of over 4.32 million Atlantic salmon in 2013. 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 (553K), Machias (59K), and Pleasant (62K). North Attleboro National Fish Hatchery (NANFH) released 12K age 1 smolts and 10K age 0 parr into the Saco River.

Temperature advanced age 0 parr reared at GLNFH released into the Penobscot Basin totaled 214K. Ambient age 0 parr reared at CBNFH released into the Sheepscot River totaled 14K; all CBNFH origin parr were marked with adipose fin clips. The Downeast Salmon Federation released 78K ambient age 0 parr reared by the East Machias Atlantic Salmon Resource Center; East Machias parr were adipose fin clipped.

CBNFH produced approximately 1.32 million unfed fry for the Penobscot, 730K; East Machias, 19K; Machias, 172K; Narraguagus, 287K; Pleasant, 94K; and Sheepscot, 18K, for release 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 85.5% - 104.4%; fry released in the Penobscot Basin had DIs ranging from 86.7% to 103.2%. Additional fry, reared by various privately operated hatcheries, were released into the Pleasant (180K), Aroostook (579K) and Saco (317K) rivers.

Adults

No gravid broodstock were released in 2013. Following spawning, 369 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2013. 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: Dennys (24); East Machias (74); Machias (201), Narraguagus (214); Pleasant (124); Sheepscot (142).

GLNFH released 1,643 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River.

Egg Take at CBNFH

CBNFH continued the photoperiod treatment conducted since 2010 on Penobscot sea run broodstock to delay the onset of spawning in 2013. As CBNFH relies solely on ambient water sources, eggs taken in October may be 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 re-sets 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 2013 treatment extended the light available during the summer solstice [June 21] for ten days. This treatment increases the likelihood that eggs will be collected and incubated in more favorable conditions.

5.3 Juvenile Population Status

Juvenile abundance estimates

MEDMR conducted electrofishing surveys to monitor spatial and temporal abundance of Atlantic salmon juveniles at 324 sites in 2013. Two hundred and seventy-two (272) of the locations were sampled using a catch-per-unit-effort protocol, 35 sites were sampled using a multi-pass depletion protocol, and 17 locations were sampled to evaluate the presence/absence of juvenile Atlantic salmon. The sampling effort encompassed several projects including a juvenile abundance index, egg planting assessment, adult translocation study assessment, and large woody debris. DMR collected 666 scale samples and 2,228 fork length measurements from juvenile salmon in 2013.

2013 was the third year that a Generalized Random Tessellated Stratified (GRTS) design with unequal probability of selection was used for establishing sampling locations for juvenile Atlantic salmon population assessment. For 2013 a total of 174 sites were selected, including 62 sites for the Down East SHRU; 62 sites for the Penobscot SHRU; and 50 sites for the Merrymeeting Bay SHRU (Figure 5.3.1).

Two sampling methods were used to estimate juvenile abundance; the first estimated total abundance at sites on each river through multiple pass depletion (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 for catch per unit effort (CPUE) and produced relative abundance in fish/minute (Table 5.3.2). Annually, CPUE sampling is 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 years.

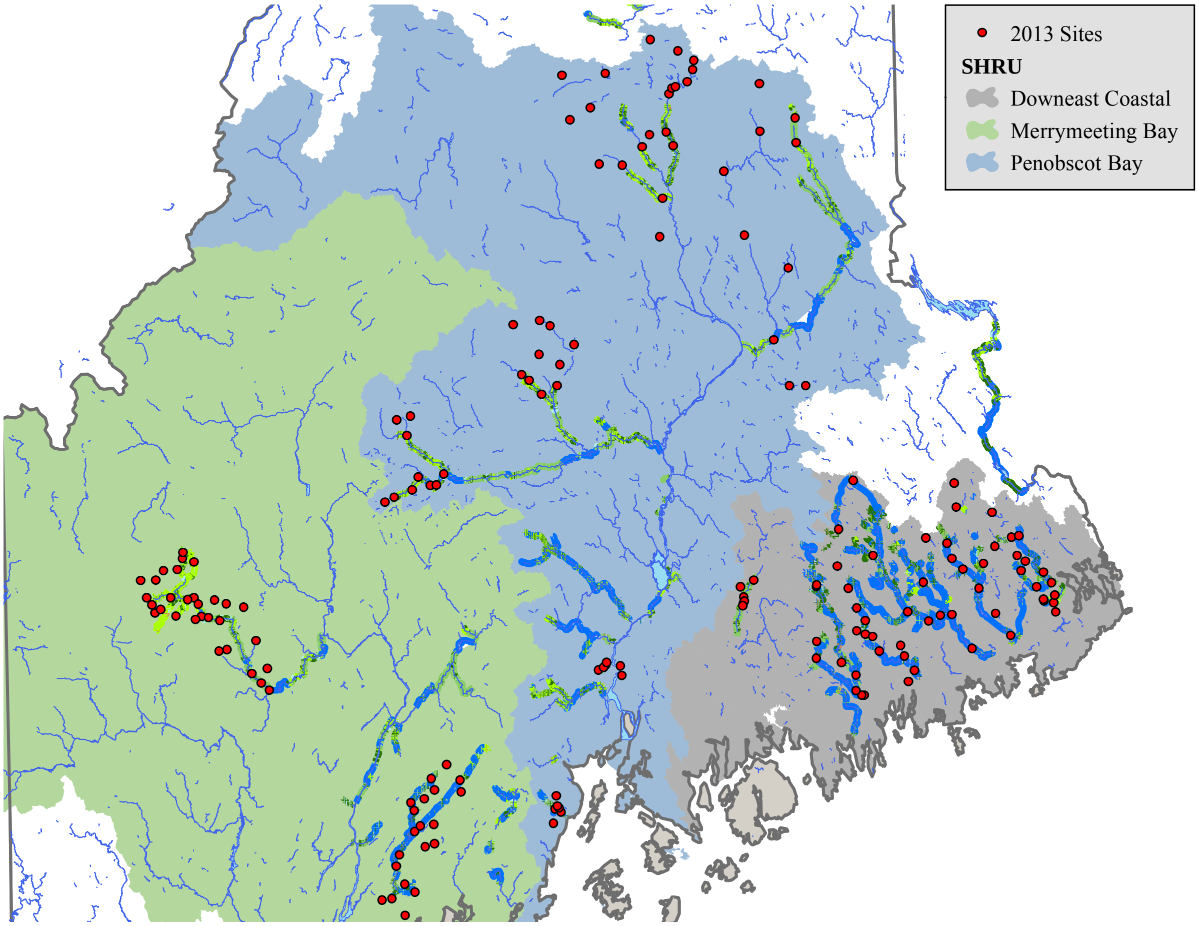

Figure 5.3.1. Locations of sites selected for juvenile salmon assessments in 2013 based on the GRTS design. Green shaded stream segments represent surveyed rearing habitat.

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, 2013. Drainages are grouped by Salmon Habitat Recovery Unit (line).

Drainage	Density fish / 100m^2								
		Parr				YOY			
	Year	Min	Median	Max	N	Min	Median	Max	N
Dennys	2013	0.4	0.4	0.4	1.0	0.4	0.4	0.4	1.0
East Machias	2013	0.7	1.5	2.3	2.0	0.0	1.0	2.0	2.0
Machias	2013	2.5	2.5	2.5	1.0	5.6	5.6	5.6	1.0
Narraguagus	2013	2.3	2.3	2.3	1.0	13.6	13.6	13.6	1.0
Pleasant	2013	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Kennebec	2013	0.0	1.1	8.1	4.0	7.5	21.2	55.6	4.0
Sheepscot	2013	0.0	5.1	41.1	11.0	0.0	7.6	61.7	11.0
Penobscot	2013	8.7	13.7	16.3	3.0	3.1	15.2	105.1	3.0
Piscataquis	2013	0.0	10.0	25.0	7.0	0.0	3.0	33.1	9.0

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, 2013. Drainages are grouped by Salmon Habitat Recovery Unit (line).

Drainage	CPUE fish / minute								
		Parr				YOY			
	Year	Min	Median	Max	N	Min	Median	Max	N
Dennys	2013	0.0	0.0	2.0	10.0	0.0	0.0	0.0	10.0
East Machias	2013	0.0	0.9	3.2	26.0	0.0	0.0	3.1	26.0
Machias	2013	0.0	1.1	4.2	24.0	0.0	0.6	7.0	24.0
Narraguagus	2013	0.0	0.2	8.0	10.0	0.0	0.7	8.4	10.0
Pleasant	2013	0.0	0.4	2.4	11.0	0.0	0.2	0.6	11.0
Union	2013	0.0	0.6	1.7	4.0	0.0	0.0	0.0	4.0
Kennebec	2013	0.0	0.4	2.8	83.0	0.0	0.4	6.6	83.0
Sheepscot	2013	0.0	0.2	1.8	20.0	0.0	0.3	6.0	20.0
East Branch Penobscot	2013	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0
Mattawamkeag	2013	0.0	0.0	1.9	5.0	0.0	0.0	3.7	5.0
Penobscot	2013	0.0	1.2	3.6	25.0	0.0	2.0	12.2	25.0
Piscataquis	2013	0.0	0.7	4.5	43.0	0.0	0.2	5.6	43.0
Ducktrap	2013	0.0	0.0	0.4	9.0	0.0	0.0	0.0	9.0

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 2013.

		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	0.0	**1.0**	3.5	155	0.0	**1.4**	4.3
	2007	55	0.00	**2.9**	22.3	53	0.4	**7.3**	58.9	133	0.0	**0.6**	5.1	141	0.0	**1.6**	15.3
	2008	43	0.00	**3.6**	20.2	43	0.0	**7.0**	73.8	18	0.0	**0.0**	1.0	18	0.0	**0.3**	8.8
	2009	56	0.00	**3.7**	32.5	56	0.0	**7.7**	36.5	49	0.0	**0.8**	20.4	54	0.0	**1.6**	15.4
	2010	29	0.54	**5.2**	28.0	29	0.0	**8.0**	89.1	91	0.0	**1.0**	8.8	96	0.0	**1.4**	15.5
	2011	19	0.00	**2.8**	94.6	19	0.0	**3.4**	65.7	173	0.0	**0.8**	8.7	173	0.0	**0.6**	6.3
	2012	9	0.6	2.8	11.4	9	0.0	0.7	19.9	68	0.0	**0.5**	3.2	69	0.0	**0.2**	5.4
	2013	6	0.0	1.5	2.5	6	0.0	1.2	13.6	85	0.0	**0.6**	8.0	85	0.0	**0.0**	8.4
Penobscot Bay	2006	74	0.00	**0.2**	26.9	48	0.0	**0.0**	67.2	24	0.0	**0.0**	1.6	34	0.0	**0.0**	2.2
	2007	49	0.00	**0.0**	33.7	25	0.0	**0.0**	66.8	41	0.0	**0.0**	2.5	53	0.0	**0.0**	1.8
	2008	11	0.00	**6.7**	17.8	11	0.0	**19.9**	47.1	82	0.0	**0.0**	1.5	88	0.0	**0.0**	6.8
	2009	10	0.00	**7.9**	20.4	10	4.1	**29.8**	39.7	161	0.0	**0.0**	2.9	163	0.0	**0.0**	4.5
	2010	7	0.00	**17.0**	22.1	8	0.0	**0.7**	29.5	86	0.0	**0.0**	3.9	95	0.0	**0.8**	16.0
	2011	5	0.00	**7.0**	14.9	5	0.0	**4.1**	49.8	87	0.0	**0.0**	3.8	87	0.0	**0.0**	5.7
	2012	13	0.0	1.5	13.0	13	0.0	21.9	69.9	90	0.0	**0.0**	3.1	90	0.0	**0.8**	14.0
	2013	10	0.0	10.6	25.0	12	0.0	6.5	105.1	85	0.0	**0.5**	4.5	85	0.0	**0.2**	12.2
Merrymeeting Bay	2006	42	0.00	**1.3**	23.4	41	0.0	**0.3**	25.3	12	0.0	**0.0**	0.6	11	0.0	**0.0**	4.0
	2007	33	0.00	**0.3**	50.3	33	0.0	**4.0**	69.8	37	0.0	**0.0**	2.6	33	0.0	**0.2**	5.0
	2008	26	0.00	**1.6**	21.7	27	0.0	**2.2**	38.9	38	0.0	**0.0**	0.8	39	0.0	**0.0**	1.4
	2009	17	0.00	**6.0**	21.7	17	0.0	**3.1**	28.1	46	0.0	**0.0**	3.3	48	0.0	**0.2**	9.4
	2010	22	0.00	**2.1**	16.6	21	0.0	**3.0**	109.9	110	0.0	**0.0**	2.9	112	0.0	**0.8**	29.4
	2011	17	0.00	**8.7**	44.5	17	0.0	**1.9**	43.3	45	0.0	**0.2**	4.4	45	0.0	**0.2**	9.8
	2012	20	0.0	2.3	16.0	20	0.0	6.6	77.5	108	0.0	**0.2**	4.9	107	0.0	**0.4**	13.0
	2013	15	0.0	4.9	41.1	15	0.0	8.86	61.68	103	0.0	**0.2**	2.8	103	0.0	**0.4**	6.6

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. More details on smolt populations are included in Working Paper WP14-01- Smolts Update.

Narraguagus River - We handled 366 smolts in 2013. A subset of smolts was scale sampled (n= 111) and tissue sampled for genetics (n=206). The observed age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) was: 84% age 2 and 16% age 3 (Table 5.3.4). Age 2 smolts averaged 171 ±14 mm fork length (n=171) and 49.0 ± 13.0 g live weight (n = 61) (Tables 5.3.3 and 5.4.6 and Figures 5.3.1 and 5.3.2). The population estimate for smolts from the one-site method was 873 ± 130 smolts. The two-site method estimate for the total number of smolts was 1,566±499 (Figure 5.3.3). The two-site method also produced an estimate of 1386 ±303 naturally-reared smolts.

Sheepscot River - We captured 757 smolts at the Sheepscot River site, 533 of which were found to be marked with an adipose clip, indicating they were stocked as age 0 parr in 2011 or 2012. A subsample of scales (n=713) and tissue samples (n=218) was collected from smolts. We analyzed scale samples to determine age and origin distributions ages and to generate mean fork length and weight (Tables 5.3.3 and 5.3.6 and Figures 5.3.1 and 5.3.2). An additional 21 fish not marked with an adipose clip were determined to be of hatchery origin. The Sheepscot River's naturally reared smolt component was composed of 83.0% age 2, 15.7% age 3, and 1.3% age 4 (Table 5.4.5). Age 2 naturally-reared smolts averaged 186 ± 18 mm fork length (n = 131) and 67.9 ± 20.7 g live weight (n = 132) (Tables 5.3.6 and 5.3.7, Figures 5.3.1 and 5.3.2). The population estimate of naturally-reared smolts was 967± 198. The estimate of smolts of hatchery origin (stocked as fall parr in 2011 and 2012) was 2,116 ± 164.

Piscataquis River - We collected 2,129 smolts (all naturally reared) in the Piscataquis River RSTs, 1,078 of which were marked and released 3.2 km upstream. Of these marked smolts, 396 (36.7%) were recaptured. The age composition of smolts was: 85.9% age 2 and 14.1% age 3 based on scale reading (n=751, Table 5.3.5). Age 2 smolts averaged 149 ± 12 mm fork length (n = 618) and 31.2 ± 7.7 g live weight (n = 614) (Tables 5.4.6 and 5.4.7, Figures 5.4.1 and 5.4.2). The population estimate of emigrating smolts was 5,713 ± 271.

East Machias River - We captured 142 smolts at the East Machias site, 42 of which were found to be marked with an adipose clip, indicating they were stocked as age 0 parr in 2011 or 2012. A subset of smolts was scale sampled (n= 141) and tissue sampled for genetics (n=140). The observed age distribution of naturally-reared smolts was: 87.5% age 2 and 12.5% age 3 (Table 5.3.5). Age 2 smolts averaged 184 ±14 mm fork length (n=84) and 59.3 ± 14.7 g live weight (n=84) (Tables 5.3.6 and 5.3.7 and Figures 5.3.1 and 5.3.2). The population estimate of naturally-reared smolts was 322 ± 49 and the estimate of hatchery-origin smolts was 238 ± 81.

Sandy River - One-hundred and fifty smolts were captured in the Sandy River in 2013. A subset of smolts was scale sampled (n= 111) and tissue sampled for genetics (n=206). The observed age distribution of naturally-reared smolts (smolts produced from either fry stocking or wild spawning) was: 84% age 2 and 16% age 3 (Table 5.3.5). Age 2 smolts averaged 171 ±14 mm fork length (n=171) and 49.0 ± 13.0 g live weight (n = 61) (Tables 5.3.6 and Figures 5.3.1 and 5.3.2).

Smolt Run Timing - In 2013, the median capture date of smolts on the Narraguagus and Piscataquis Rivers was later than in 2012, while the median capture date on the Sheepscot River was earlier than in 2012 (Figures 5.3.4. and 5.3.5.).

DISCUSSION

The population estimate generated for naturally reared smolts in the Narraguagus River was higher than in 2012, and is similar to the 10-year average of the past 10 years. The Sheepscot River estimate was the lowest since 2009 (the first year estimates were made), and the Piscataquis estimate was higher than the past two years.

On the Piscataquis River, river flow and temperature remained near optimal levels for RST operation during most of the 2013 season. This contributed to the highest recorded smolt catch at this site (2,129 new smolts) and an average capture efficiency of 36.7%. The estimated smolt population of 5,713 ± 271 smolts results in approximately 2 smolts/100 m^2 of habitat. All smolts were wild origin produced from natural spawning only.

In 2013, the median capture date of smolts on the Narraguagus and Sheepscot Rivers was similar to the previous two years. The Piscataquis River median date in 2013 was two weeks earlier than in 2012, but similar to those of previous years. Overall run timing was similar among the Narraguagus, Sheepscot, and Piscataquis Rivers, while the East Machias run was considerably later.

Mean fork length and mean live weight of age 2 naturally reared smolts emigrating from the Narraguagus River were similar to past years. Sheepscot River smolts were larger than the past two years, probably due to poor environmental conditions in 2010 and 2011 which may have negatively influenced growth rates in 2011 and 2012.

Mean smolt size in the Piscataquis River remained similar to the five-year average, which indicates that the large smolt size seen in Piscataquis smolts in 2012 was an anomaly and was probably the result of a larger percentage of the emigrating population (50.2%) being age 3+. This year, the majority of smolts (85.9%) were age 2+. Piscataquis smolts were smaller (and more abundant) than those observed elsewhere in Maine, suggesting density dependent growth.

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

	2013				5 year average (2008-2012)			
River	1	2	3	4	1	2	3	4
East Machias	0%	87.5%	12.5%	0%	N/A	N/A	N/A	N/A
Narraguagus	0%	84.0%	16.0%	0%	0.5%	87.1%	12.2%	0.2%
Piscataquis	0%	85.9%	14.1%	0%	0.3%	65.0%	34.1%	0.5%
Sandy	0%	80.1%	19.9%	0%	N/A	N/A	N/A	N/A
Sheepscot	0%	83.0%	15.7%	1.3%	2.3%	92.4%	5.3%	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			
			5 year average				5 year average	
River	n	2013	n	('08-'12)	n	2013	n	('08-'12)
East Machias	35	170±18	0	N/A	84	184±14	N/A	N/A
Narraguagus	0	N/A	1189	171±17	61	171±14	491	170±16
Piscataquis	0	N/A	0	N/A	618	149±12	1888	143±12
Sandy	0	N/A	0	N/A	113	161±14	N/A	N/A
Sheepscot	92	163±10	414	160±10	131	186±18	736	187±19

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**			
			5 year average				**5 year average**	
River	**n**	**2013**	**n**	**('08-'12)**	**n**	**2013**	**n**	**('08-'12)**
East Machias	35	50.5±15.8	0	N/A	84	59.3±14.7	0	N/A
Narraguagus	0	N/A	1185	50.5±16.2	61	49.0±13.0	487	49.9±15.5
Piscataquis	0	N/A	0	N/A	614	31.2±7.7	1863	28.4±7.5
Sandy	0	N/A	0	N/A	112	41.7±11.0	0	N/A
Sheepscot	92	48.3±8.9	387	44.5±9.0	132	67.9±20.7	730	67.6±20.5

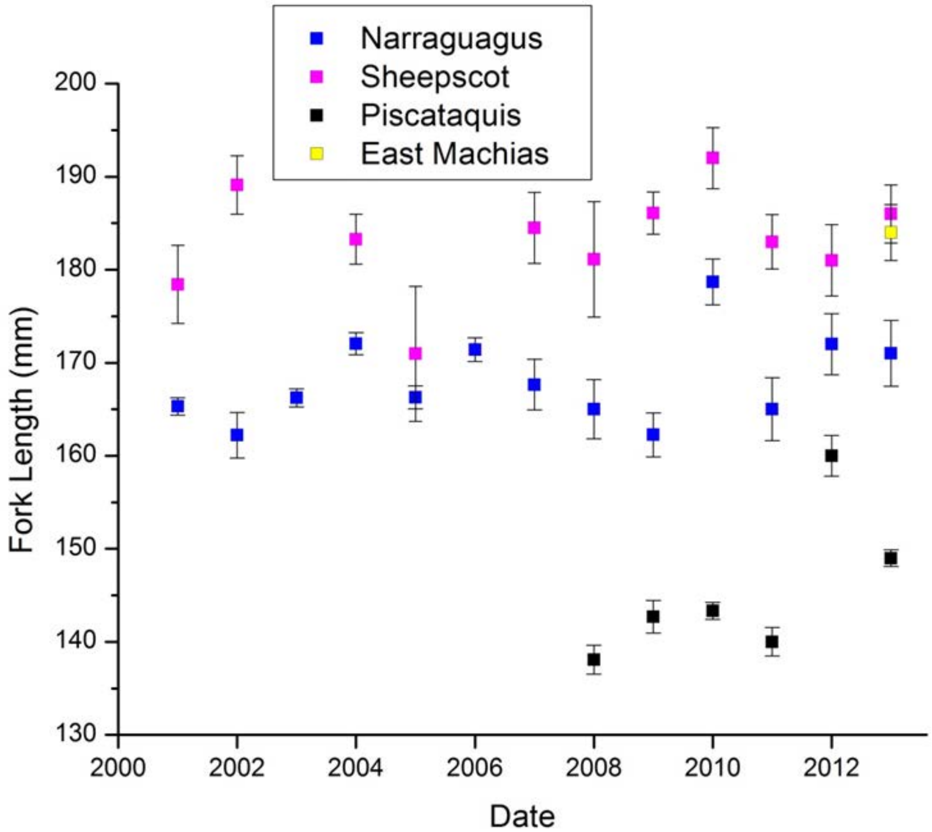

Figure 5.3.2. Mean fork length (mm) ± 95% C.I. of age 2+ smolts collected in selected Maine rivers, 2001-2013.

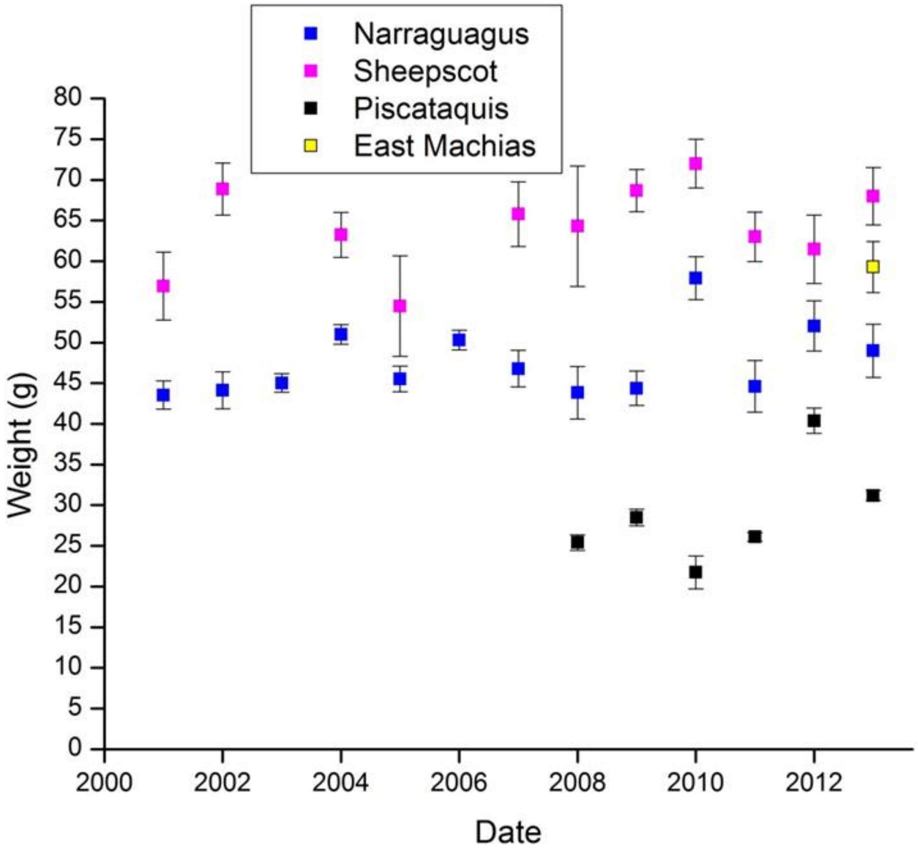

Figure 5.3.3. Mean live weight (g) ± 95% C.I. of age 2+ smolts, collected in selected Maine rivers, 2001-2013.

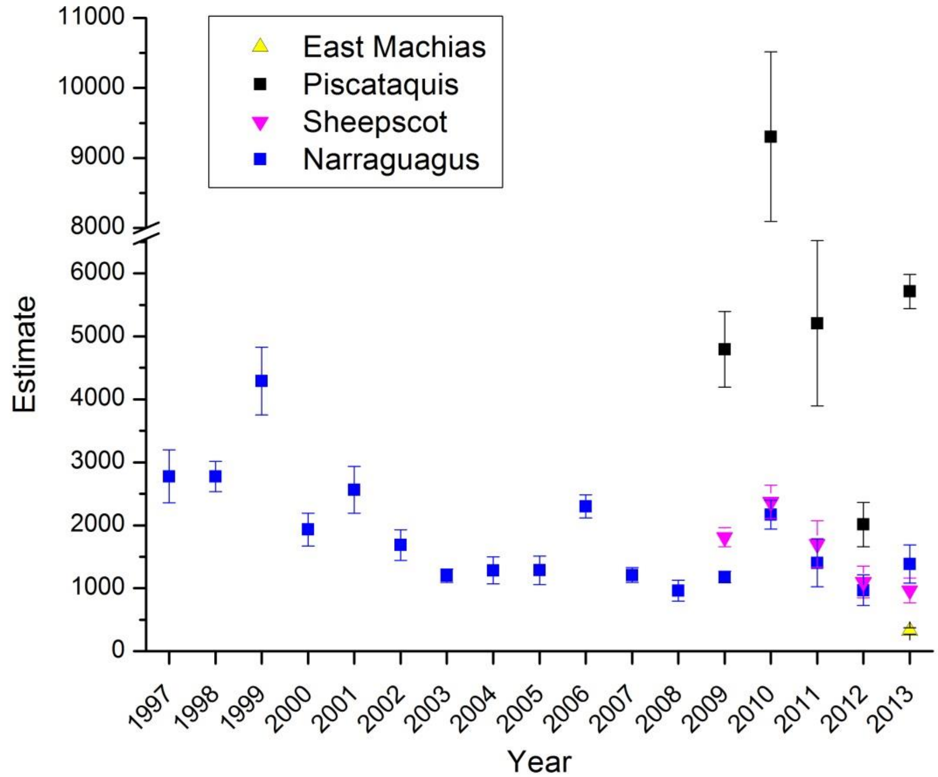

Figure 5.3.4. Population Estimates (± Std. Error) of emigrating naturally reared smolts in the Narraguagus River, Sheepscot River, East Machias River and Piscataquis River, Maine, from 1997 to 2013 using DARR 2.0.2.

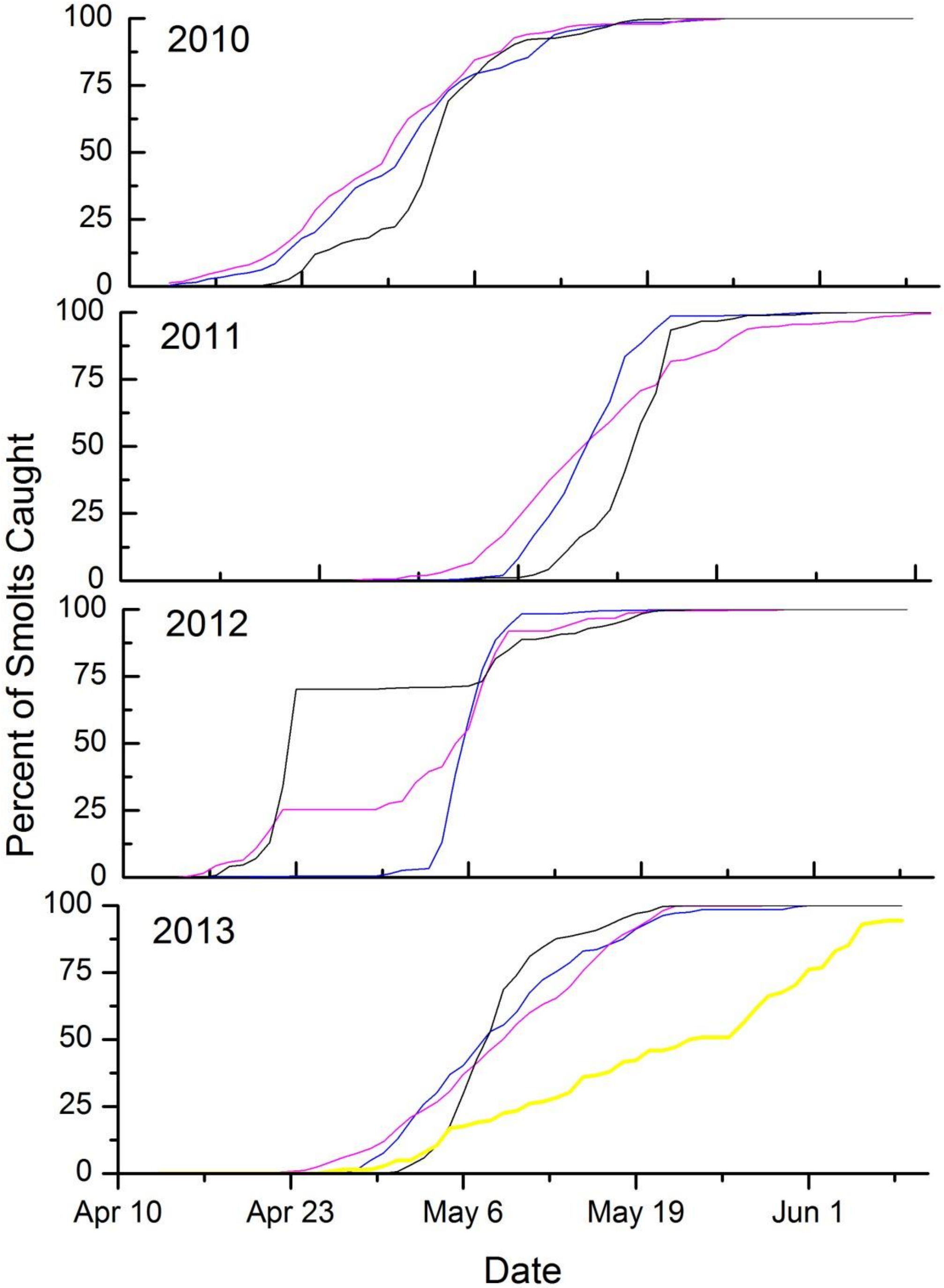

Figure 5.3.5. Cumulative percentage smolt catch for smolts of all origins in rotary screw traps by date (run timing) on the Narraguagus (blue line), Sheepscot (pink line), Piscataquis (black line), and East Machias (yellow line) rivers, Maine, for years 2010 to 2013.

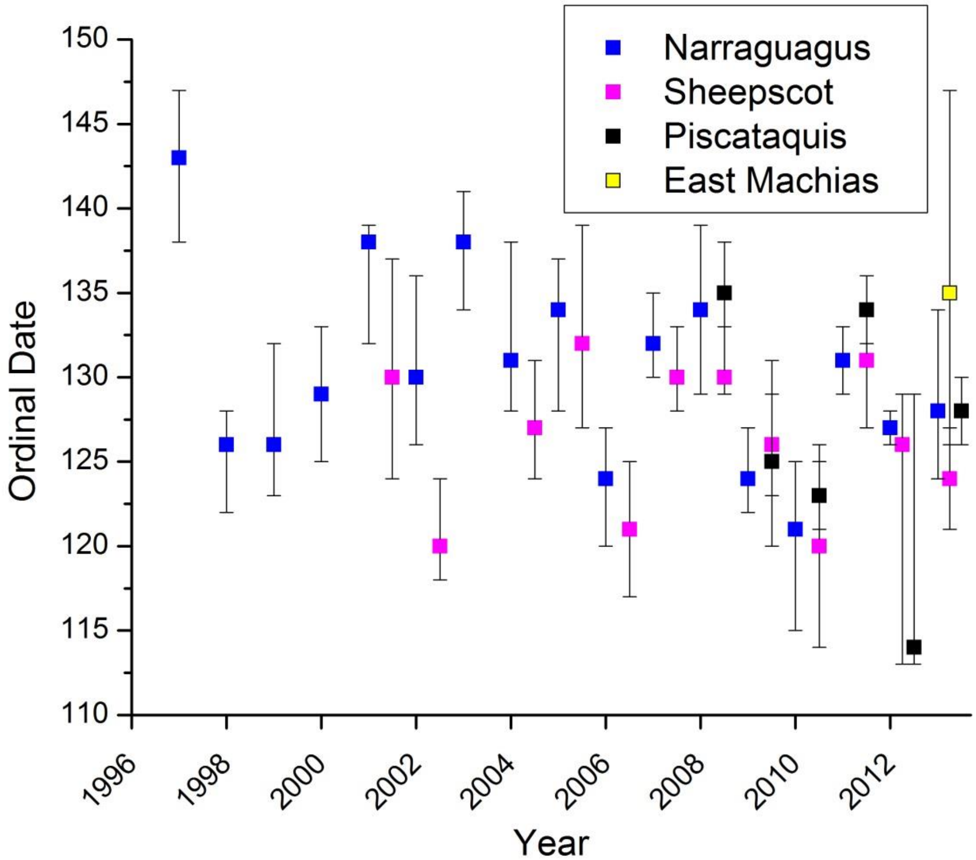

Figure 5.3.6. Ordinal day (days from January) of median smolt catch of naturally-reared smolts in rotary screw traps on the Narraguagus, Sheepscot, East Machias and Piscataquis Rivers, 1997-2013. Error bars represent 25th and 75th percentiles of median run dates.

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Stevens, D. L. Jr. and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. J. of the Amer. Stat. Assoc. 99(465): 262-278.

5.4 Fish Passage

Penobscot River Restoration Project

Following the removal of The Great Works Dam during the summer of 2013, the next step in the project (removal of the Veazie Dam) began in June of 2013 (Figure 5.4.1). Veazie Dam was located on the Penobscot River in Veazie and Eddington, 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 September. Construction has begun on a fish lift at the Milford Dam, and the Howland Dam bypass construction is planned to follow.

Figure 5.4.1 Aerial view of the Veazie Dam on the Penobscot River before removal (top photo) and the view near the end of destruction in September 2013.

5.5 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick (2), the Lockwood fish lift on the Kennebec River (7), the Narraguagus River (20), The Pleasant River (1) and the Penobscot River (371). In total 401 genetic samples were collected in 2013 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 2013, DPS broodstock (collected in 2012) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.6 General Program Information

U. S. Fish & Wildlife Service Schools Programs

2013 marked the nineteenth year of USFWS' outreach and education program, Salmon-in-Schools, 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 program contributes fry to the Dennys, Machias, East Machias, Pleasant, Narraguagus, Sheepscot, Union and Penobscot rivers. In addition to educational facilities, a local 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 Atlantic Salmon Federation [Maine Council] program "Fish Friends". Fish Friends offers educational opportunities in Maine schools reaching thousands of students, cooperating teachers and parents annually. The two programs, working in partnership, reach over 3,600 people each school year.

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 and National Oceanographic and Atmospheric Administration - National Marine Fisheries Service, 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, was 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.

5.7 Migratory Fish Habitat Enhancement and Conservation

Habitat Protection

In 2013, a number of large-scale headwater habitat protection projects were initiated in the East Machias and Pleasant Penobscot River watersheds. These projects will provide long-term protection to important Atlantic salmon spawning and rearing areas.

Habitat Connectivity

Numerous studies have identified how stream barriers can disrupt ecological process, including hydrology, passage of large woody debris and movement of organisms. 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.

Barrier Surveys: 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, Maine Department of Marine Resources, 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 8 years of fieldwork, nearly half of the state has been surveyed (Figure 5.7.1). Almost 7,000 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 2014, stream barrier surveys will be completed in the St. Croix and Upper Androscoggin River watersheds.

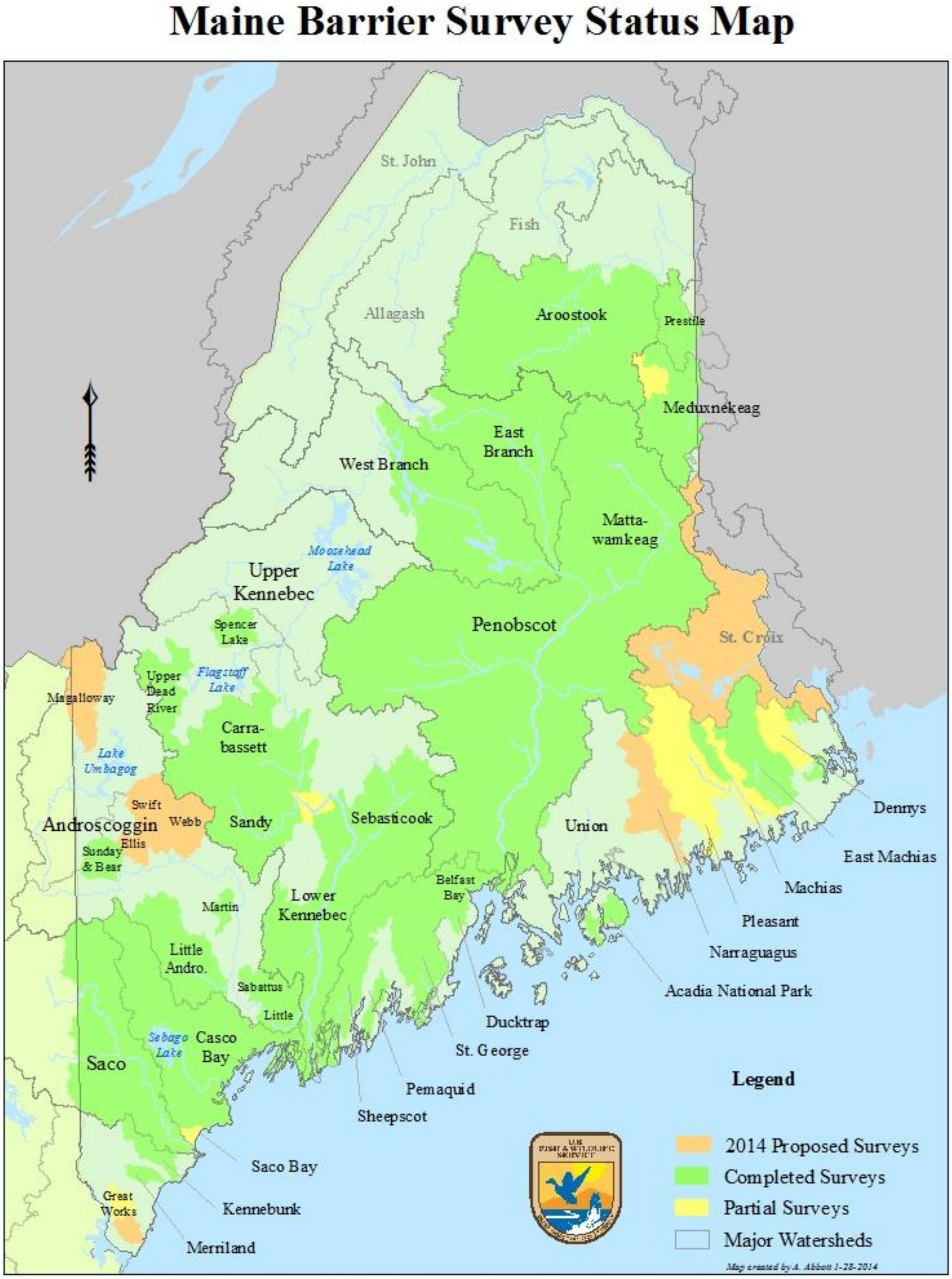

Figure 5.7.1 Maine barrier survey map.

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. In 2013, the partnership hosted 6 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.

In 2012 and 2013, over 450 people attended one-day, hands-on workshops that provided an introduction to stream survey techniques and approaches for developing initial recommendations for road-stream crossings.   The training provided information to allow participants to:

- Understand stream survey tools and techniques including longitudinal profiles, cross sections and bed characterization
- Learn approaches to understand specific site conditions at road-stream crossing
- Collect data from road-stream crossing sites and input into spreadsheets
- Develop recommendations for properly sized and installed structures.

An additional 5 "train-the-trainer" workshops are being planned for 2014 that will focus on sharing priorities with towns and land trusts.

USFS Aquatic Organism Passage (AOP) Training – The Gulf of Maine Coastal Program and Project SHARE hosted a 4-day workshop to teach the latest techniques on designing and building bridges and culverts that allow streams and the aquatic life they support to flow naturally. More than 30 natural resource professionals attended including ecologists, biologists, consultants, hydrologists, civil engineers, forestry managers, public works staff, and restoration practitioners. In addition, four professionals from the Penobscot Indian Nation and Passamaquoddy Tribe attended.

 

The workshop introduced the USDA Forest Service's Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings and featured nationally recognized experts, including instructors from the Forest Service's Aquatic Organism Passage Virtual Design team.

Participants learned the necessary skills to design road-stream crossing structures (bridges and culverts) that

- maximize the long-term stability of the structure,
- provide unimpeded passage for aquatic organisms, and
- restore natural channel characteristics and fluvial processes.

Hands-on site visits complemented and reinforced key concepts as participants assessed and discussed the ecological, geomorphic, hydrologic, and engineering issues at each site. The workshop was held at Appalachian Mountain Club's Gorman Chairback Lodge and Cabins near Long Pond. Maine Sustainable Forestry Initiative, USDA Forest Service, Project SHARE, USFWS, AMC, and National Fish and Wildlife Foundation all sponsored the event.

Organizers will host an advanced AOP design course in 2014.

<u>Online data viewer</u> – An online data viewer that provides easy access to habitat and barrier datasets has been developed: http://mapserver.maine.gov/streamviewer/streamdocHome.html. The viewer is hosted by the Maine Office of GIS and contains Atlantic salmon spawning and rearing habitat, HUC12 focus areas and modeled rearing datasets along with dams and public-road stream crossings. The Stream Habitat Viewer was created to enhance statewide stream restoration and conservation efforts. The Viewer provides a starting point for towns, private landowners, and others to learn more about stream habitats across the state. The Viewer allows you to:

- Display habitats of conservation and restoration interest, like alewife, Atlantic salmon, sea-run rainbow smelt, wild eastern brook trout and tidal marshes.

- Display locations of dams and surveyed public road crossings that are barriers.
- Click on habitats and barriers to learn about their characteristics.
- Perform queries based on the geographic interest.
- Contact experts for technical assistance and funding information.

2013 Highlighted Connectivity Projects

Penobscot River Restoration Project

The Penobscot River Restoration Trust owns the site of the now former Veazie Dam, located on the Penobscot River in Veazie and Eddington, Maine, near the head of tide. The buttress-style dam was built in 1913, and dams have been documented at the site as early as the 1830's, blocking fish passage for nearly 200 years.

The removal of the dam and some of the ancillary structures was completed during the months of July through November 2013; additional work at the site related to the remaining powerhouse is expected to be complete in 2014 (Figure 5.7.2). It is now possible for Atlantic salmon and all species of sea-run fish to pass the site and travel upstream past the former Great Works site, all the way to the Milford Dam in Old Town and Milford.

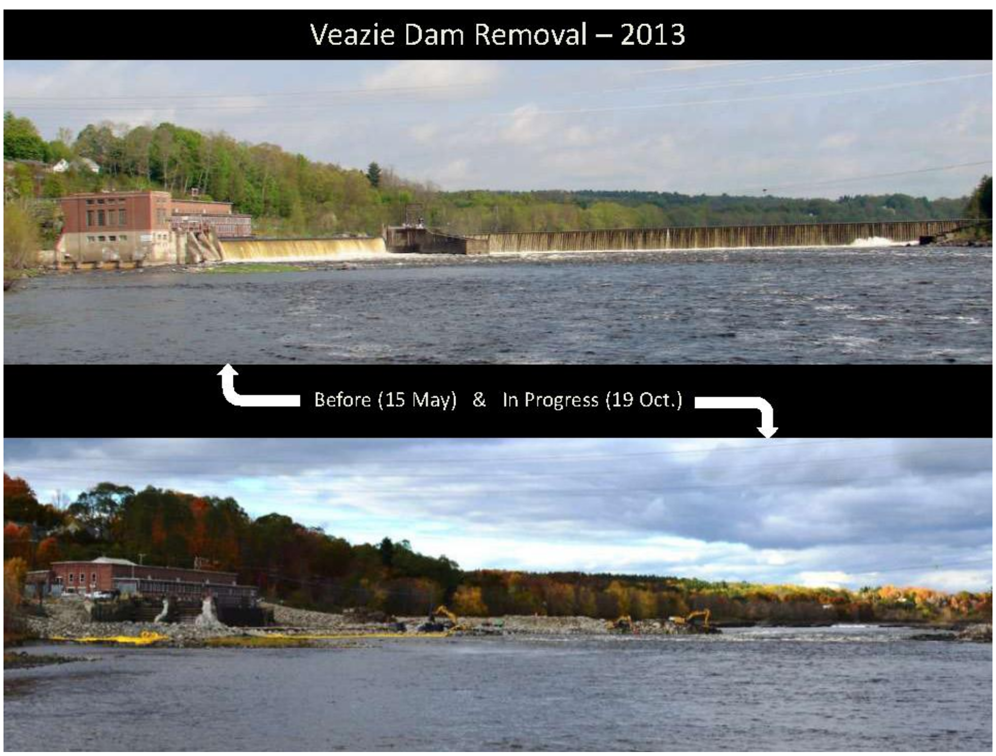

Figure 5.7.2 Penobscot River before and after dam removal.

The site included two powerhouse buildings and structures related to the collection of Atlantic salmon brood stock. The smaller of the powerhouse buildings was demolished this past summer. The larger powerhouse building, "Powerhouse A" is being considered for possible reuse.

The dam removal work is being completed by Sargent Corporation, headquartered in Old Town, Maine.

Other Stream Connectivity Projects

In 2013, 23 additional 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 74 kilometers of stream was made accessible as a result of these projects. These efforts were made possible due to strong partnerships including Natural Resource Conservation Service, Penobscot Indian Nation, 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 numerous private landowners.

Table 5.7.1: Projects restoring stream connectivity in Maine Atlantic salmon watersheds, indicating project type, stream and watershed name and km of stream habitat access.

Type	Stream Name	Watershed	Km. Opened
Culvert replacement	Barrell Brook	Narraguagus River	1.1
Culvert replacement	Barrell Brook	Narraguagus River	6.0
Culvert replacement	Richardson Brook	East Machias River	7.4
Dam removal	Trout Brook	Hobart Stream	0.3
Dam removal	Flatiron Brook	Hobart Stream	0.5
Dam removal	Alder Brook	Hobart Stream	1.1
Dam removal	Bog Stream	Pleasant River	18.7
Remnant dam removal	Pembroke Stream	Machias River	12.1
Remnant dam removal	Holmes Brook	Machias River	0.4
Culvert replacement	Unnamed trib to Big Springy Brook	East Branch Penobscot	6.9
Culvert replacement	Unnamed trib to East Branch	East Branch Penobscot	7.7
Culvert removal	Unnamed trib to Big Springy Brook	East Branch Penobscot	1.6
Culvert replacement	Lucia Pond outlet	West Branch Pleasant	1.6
Culvert replacement	Unnamed Trib to Indian Pond #1	West Branch Pleasant	1.6
Culvert replacement	Unnamed Trib to Indian Pond #2	West Branch Pleasant	1.6
Culvert replacement	Mill Brook	East Branch Pleasant	1.9
Culvert replacement	NA	Piscataquis	1.3
Culvert replacement	Little Houston	West Branch Pleasant	1.6
Rock ramp	Coleman Stream	Ducktrap	0.0
Fishway	Davis Holbrook Pond	Penobscot	0.0
Remnant dam removal	Narraguagus River	Narraguagus River	0.0
Remnant dam removal	Barrows Lake Outlet	East Machias River	0.0
Remnant dam removal	Barrows Stream	East Machias River	0.0
Remnant dam removal	Northern Stream	East Machias River	0.0
Total			73.5

Pleasant River Focus Area Initiative

USDA, USFWS and MDMR and MDIFW began a cooperative aquatic stream restoration and enhancement initiative in 2011 to increase the pace of on-the-ground projects in the Penobscot River watershed. Because there are large numbers of problem culverts in the Penobscot River watershed, NRCS and partners are using the Pleasant River sub-watershed as a focus area for 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.

A typical project implemented through the partnership is one completed on Little Houston Brook in 2013. The pre-existing structure consisted of a three foot metal culvert that was undersized for the stream and was perched at the culvert outlet (Figure 5.7.3). FishXing software (U.S. Forest Service) was used to determine if juvenile brook trout were able to pass through the culvert. Maximum and minimum monthly flows from three USGS gauges (Kingsbury Stream, Black Stream and Piscataquis River) were averaged and extrapolated to the Little Houston Brook watershed. The conclusion was juvenile brook trout could not pass through the culvert during any month due to a velocity barrier created by the undersized culvert. Atlantic salmon parr have been caught by anglers in Big Houston Stream and are likely to colonize little Houston Brook if accessible. These projects are also critical to restoring stream processes including sediment transport and woody debris passage in smaller headwater streams. Many partners made this project happen. Technical assistance and in-kind technical assistance was provided by NRCS, consulting foresters, MDIFW, MDMR, and USFWS. Financial assistance was provided by the Atlantic Salmon Federation and USFWS.

Figure 5.7.3. Above left photo shows the culvert inlet prior to replacement. The above right photo shows the post construction waste block bridge. The three foot culvert was replaced with a 14 foot bridge.

An important component of this effort is providing extensive outreach and education that has helped pave the way for collaborative on-the-ground restoration. Currently close to 30 stream miles have been re-connected, and over 1,100 additional acres of lake habitat are now accessible to alewives (Figure 5.7.4). All 30 stream miles will benefit brook trout, allowing individuals to migrate to historic spawning/nursery habitat, re-colonize suitable habitat and to enhance genetic diversity. Of the six stream miles reconnected during 2013, four miles will directly benefit Atlantic salmon by allowing juvenile salmon to freely migrate to historic rearing habitat and to access cold water thermal refugia.

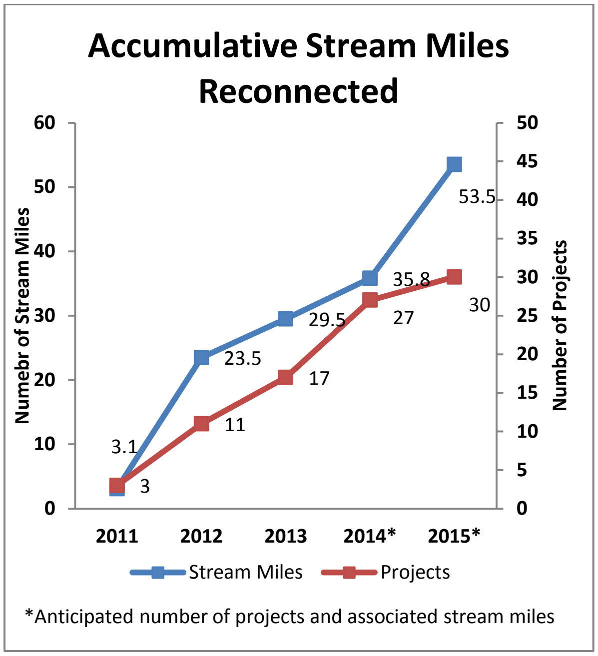

Figure 5.7.4. Accumulative stream miles reconnected.

It is anticipated that 10 projects will be completed during 2014 that will re-connect 6.3 miles of streams benefiting brook trout and 4 miles benefiting Atlantic salmon.

Habitat Complexity

A large wood (LW) habitat improvement project was initiated by Dartmouth College, USFS, USFWS Gulf of Maine Coastal Program, and DMR 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. In 2013, two reaches were treated with LWD additions on the Crooked River and Pembroke Stream in the Machias River watershed.

All sites 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 to prevent further erosion and sedimentation in the stream.

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 assessments will be conducted in 2014.

Streambank Stabilization

A large-scale innovative streambank stabilization project was implemented on the Sandy River in Farmington in 2013. The project constructed an engineered log jam revetment as an alternative to a proposed rock bendway weir. The project will maintain and enhance the pool and resting habitat for adult salmon, collect and maintain nutrients and organics, and provide high quality aquatic macro-invertebrate production habitat.

The 400 ft. long large wood structure will continue to generate turbulence and scour on the outside extent of the structure, maintaining and enhancing the pool. Under the structure and at the near bank interface, velocities would be greatly reduced due to the logs and rootwads protecting the toe potentially instigating some fine deposition. However, the pool geometry is expected to remain virtually the same, with the exception that the thalweg would be shifted approximately 15 away from the existing bank line.

<u>Water Temperature</u>

A Water Temperature Working Group has been established in Maine to begin development of a coordinated stream temperature monitoring array that can be integrated with regional and national efforts. Goals of the group are to:

- Conduct a comprehensive inventory of existing data for current and past water temperature monitoring efforts.
- Identify a network of 'reference sites', intended to be maintained in "perpetuity".
- Develop minimum standards for data collection methods for a project to meet so that its water temperature observations can be usable in a regional network analysis.
- Develop databases and distribution network for Maine water temperature data.

The group is working with Dan Isaak (USFS) and Ben Letcher (USGS) to use existing water temperature data to model and identify catchments that may be more resilient to temperature increases in the future. The work is using existing stream temperature datasets from Downeast Atlantic salmon streams to develop a model to predict future stream temperature conditions and identify resilient sub-watersheds.

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 2013 Tinker Dam trap catch on the Aroostook River was 9 Atlantic salmon, compared to 35 in 2012. Four of the salmon captured were of wild origin and five were of hatchery origin. The Tinker trap was opened on 8 September and closed on 23 October.

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 2013 the ASNM stocked over 579,000 unfed fry.

6.2 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 579,000 non-feeding fry into the Aroostook River in under the supervision of DMR biologists.

Adult Salmon Releases

Aroostook River

No adults were stocked in 2013.

6.2 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed in 2013.

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

No fish passage programs were active in the Aroostook River program.

6.6 Genetics

No genetics programs were active in the Aroostook River program.

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) 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 (7.3).

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 (Figure 7.1.1) 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 qualifying 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, however some management of salmon, with stocking, will still occur. In 2013, a similar decision was made to stop restoration efforts on the Merrimack River. The Pawcatuck River in Rhode Island continues monitoring for adult salmon returns but is conducted mainly as an education outreach tool rather than a restoration program. 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 continues to consider how these programs should be considered in the overall framework of salmon restoration. 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 non-restoration 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-type program and decisions on re-categorization of other New England rivers could be made during the next one to three years.

7.2 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 2013 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 2013 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 to moving forward were 1) making sure that the core needs of the ICES working group are met since that is mission essential, 2) making sure that the document continues to deliver programmatic data since it has become the one stop shopping venue for New England and NASCO managers for US data, 3) working towards providing data for the Gulf of Maine for each individual Salmon Habitat Recovery Unit with associated metrics of progress, and 4) making sure that as more data is developed and analyzed it is 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.

7.3 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-July 2014.

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 CNE, GoM, BoF (Sweka, Atkinson, Bailey) - continuing work on fry equivalents (FE) see below

2) Fry Equivalents - Return Rates for Atlantic salmon stocked as Fry – (**Sweka**, Bailey, Kocik) 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 – need more development?
    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 2015 meeting as all at-sea return data will be available (**Cox**, Firmenich, Flanery, Domina, Lipsky).

4) Discussion of Categorization/labeling of salmon programs (Saunders, Bailey, Gephard)

5) Redd-Based Estimate Benchmark 2012 Revision Working Paper in 2015 – (**Lipsky**, Kocik, Atkinson)
    a. Goal written document outlining 2012 benchmark and interim improvements
    b. Move Union River and other rivers to this metric to create Coastal River Estimate, separate by SHRU
    c. Discuss in paper strategy to work on spatial scale for <100% survey given spawner distribution
    d. Document fishway issues in the Narraguagus and role of high flows, next steps for moving forward. Next benchmark 2014 – 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

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. 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?

b. Gayle Zydlewski UMaine hydroacoustic surveys on Penobscot River.

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	Jonesboro, ME
John	Kocik	John.Kocik@noaa.gov	NOAA	Orono, ME
Christine	Lipsky	Christine.Lipsky@noaa.gov	NOAA	Orono, ME
Ken	Sprankle	ken_sprankle@fws.gov	FWS	Sunderland, MA
Rory	Saunders	Rory.Saunders@noaa.gov	NOAA	Orono, ME
John	Sweka	John_Sweka@fws.gov	FWS	Lamar, PA
Michael	Bailey	michael_bailey@fws.gov	FWS	Nashua, NH
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT	Old Lyme, CT

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

Number	Authors	E-Mail Address	Title
PS14-01	Christine Dudley	christine.dudley@dem.ri.gov	Pawcatuck River Update (email)
PS14-02	Ken Sprankle	ken_spankle@fws.gov	Connecticut River Update (PPT)
PS14-03	Michael Bailey	michael_bailey@fws.gov	Merrimack River Updae (PPT)
PS14-04	Ernie Atkinson	ernie.atkinson@maine.edu	Saco, DPS, OBF Updates (PPT)
PS14-05	John Sweka	jonn_sweka@fsw.gov	Database Update
PS14-06	Rory Saunders	rory.saunders@noaa.gov	ICES/NASCO Update (PPT)
WP14-01	Christine Lipsky	christine.lipsky@noaa.gov	Penobscot Rivert Smotl Marking and Trapping, 2000-2005
WP14-02	Christine Lipsky, Ernie Atkinson, James Hawkes, Ruth Haas-Castro, Randy Spencer, Paul Christman, Colby Bruchs, and Kyle Winslow	christine.lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smoth Studies: 2013
wP14-03	Davi Bean, Chris Vonderweidt, Joh Lewis, and Marcy Nelson	david.bean@noaa.gov	Maine and neighboring Canadian Commercial Aquaculture Activities and Production
WP14-04	John F. Kocik, Susan E. Wigley, and Daniel Kircheis	john.kocik@noaa.gov	Annual Bycatch Update Atlantic Salmon 2013
WP14-05	Ruth Haas-Castro	ruth.haas-castro@noaa.gov	Review of Image Analysis Studies: 2103 (PART 1) and Work Plan for 2014 (PART 2)
WP14-06	James Hawkes, Michael O'Malley, Gramham Goulette, and Rory Saunders	james.hawkes@noaa.gov	A snapshot of the environment and total fish biomass distibution encountered during the Atlantic salmon smolt migration in the Penobscot Estuary, Maine

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

8.4.1 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.

8.4.2 Life History related

Green Egg	The stage from spawning until faint eyes appear.
Eyed Egg	The stage from the appearance of faint eyes until hatching.
Fry	
Sac Fry	The period from hatching until end of primary dependence on the yolk sac.
Feeding Fry	The period from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Fed Fry	Fry stocked subsequent to being fed an artificial diet. Often used interchangeably with the term "feeding fry" when associated with stocking activities.
Unfed Fry	Fry stocked without having been fed an artificial diet or natural diet. Most often associated with stocking activities.
Parr	Life history stage immediately following the fry stage until the commencement of migration to the sea as smolts.
Age 0 Parr	The period from August 15 to December 31 of the year of hatching.
Age 1 Parr	The period from January 1 to December 31 one year after hatching.
Age 2 Parr	The period from January 1 to December 31 two years after hatching.
Parr 8	Parr stocked at age 0 that migrate as 1 Smolts (8 months spent in freshwater).
Parr 20	Parr stocked at age 0 that migrate as 2 Smolts (20 months spent in freshwater).

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

Reconditioned Kelt	A kelt that has been restored to a feeding condition in captivity.
Repeat Spawners	Salmon that return numerous times to the river for the purpose of reproducing. Previous spawner.

8.5 Appendicies

Appendix 1. Estimated Atlantic salmon returns to the USA, 1967-2013. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	*Sea age*					*Origin*	
	1SW	*2SW*	*3SW*	*Repeat*	*Total*	*Hatchery*	*Natural*
1967	*75*	*574*	*39*	*93*	*781*	*114*	*667*
1968	18	498	12	56	584	314	270
1969	32	430	16	34	512	108	404
1970	9	539	15	17	580	162	418
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1,025	495	530
1973	18	623	8	13	662	422	240
1974	52	791	35	25	903	639	264
1975	77	1,250	14	30	1,371	1,126	245
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	33	1,130	921	209
1978	145	2,269	17	33	2,464	2,082	382
1979	225	972	6	21	1,224	1,039	185
1980	707	3,437	11	57	4,212	3,870	342
1981	789	3,738	43	84	4,654	4,428	226
1982	294	4,388	19	42	4,743	4,489	254
1983	239	1,255	18	14	1,526	1,270	256
1984	387	1,969	21	52	2,429	1,988	441
1985	302	3,913	13	21	4,249	3,594	655
1986	582	4,688	28	13	5,311	4,597	714
1987	807	2,191	96	132	3,226	2,896	330
1988	755	2,386	10	67	3,218	3,015	203
1989	992	2,461	11	43	3,507	3,157	350
1990	575	3,744	18	38	4,375	3,785	590
1991	255	2,289	5	62	2,611	1,602	1,009
1992	1,056	2,255	6	20	3,337	2,678	659
1993	405	1,953	11	37	2,406	1,971	435
1994	342	1,266	2	25	1,635	1,228	407
1995	168	1,582	7	23	1,780	1,484	296
1996	574	2,168	13	43	2,798	2,092	706
1997	278	1,492	8	36	1,814	1,296	518
1998	340	1,477	3	42	1,862	1,146	716
1999	402	1,136	3	26	1,567	959	608
2000	292	535	0	20	847	562	285
2001	269	804	7	4	1,084	833	251
2002	437	505	2	23	967	832	135
2003	233	1,185	3	6	1,427	1,238	189
2004	319	1,266	21	24	1,630	1,395	235
2005	317	945	0	10	1,272	1,019	253
2006	442	1,007	2	5	1,456	1,167	289
2007	299	958	3	1	1,261	940	321
2008	812	1,758	12	23	2,605	2,191	414
2009	243	2,065	16	16	2,340	2,017	323
2010	552	1,081	2	16	1,651	1,468	183
2011	1,084	3,053	26	15	4,178	3,560	618
2012	26	879	31	5	941	731	210
2013	78	525	3	5	611	413	198

Appendix 2. Two sea winter (2SW) returns for 2013 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	91	0.9%
Central New England	CNE	3,435	21	0.6%
Gulf of Maine	GOM	15,670	413	2.6%
Total		29,199	525	1.8%

Appendix 3. Number of juvenile Atlantic salmon stocked in USA, 2013. Numbers are rounded to 1,000.

Area	N	Rivers	Eyed Egg	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
LIS	2	Connecticut, Pawcatuck	0	1,865,000	3,000		1,000	100,000	1,969,000
CNE	2	Merrimack, Saco	0	430,000	10,000	41,000	53,000	0	534,000
GOM	8	Androscoggin to Dennys	1,010,000	1,406,000	306,000	1,000	676,000	0	3,399,000
OBF	1	Aroostook	0	580,000	0	0	0	0	580,000
Total	13		1,010,000	4,281,000	319,000	42,000	730,000	100,000	6,482,000

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2013 by geographic area. Egg numbers are rounded to 1,000.

Area	Purpose	Captive Reared Domestic		Sea Run		Total
		Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	
Central New England	CNE Recreation	372				372
Central New England	CNE Restoration	2,296			19	2,315
Gulf of Maine	GOM Restoration	2,422			369	2,791
Total for USA		5,090			388	5,478

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2013. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		13,951	13,951
AD	Smolt	20,367		20,367
FLOY	Adult	2,668		2,668
PING	Smolt		313	313
PIT	Adult		1,148	1,148
PIT	Smolt		248	248
RAD	Adult		2	2
RAD	Smolt		1,107	1,107
Total		23,035	16,769	39,804

AD = Adipose clip

FLOY = T-bar tag

PIT = Passive integrated transponder

PING = ultrasonic acoustic tag

RAD = radio tag

Appendix 6. Aquaculture production (metric tonnes) in New England from 1997 to 2013. Production for 2013 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
2013	2,063 to 8,096

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2013.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	1,857,000	3,200	0	0	600	99,500	1,960,300
Total for Connecticut Program							**1,960,300**
Androscoggin	1,000	0	0	0	500	0	1,500
Aroostook	580,000	0	0	0	0	0	580,000
East Machias	20,000	77,600	0	0	0	0	97,600
Kennebec	2,000	0	0	0	600	0	2,600
Machias	172,000	800	1,400	0	59,100	0	233,300
Narraguagus	288,000	0	0	0	0	0	288,000
Penobscot	722,000	214,000	0	0	553,000	0	1,489,000
Pleasant	180,000	0	0	0	62,300	0	242,300
Saco	319,000	10,100	0	0	12,100	0	341,200
Sheepscot	18,000	14,000	0	0	0	0	32,000
Union	2,000	0	0	0	0	0	2,000
Total for Maine Program							**3,309,500**
Merrimack	111,000	0	41,200	0	40,900	0	193,100
Total for Merrimack Program							**193,100**
Pawcatuck	8,000	0	0	0	0	0	8,000
Total for Pawcatuck Program							**8,000**
Total for United States							**5,470,900**
Grand Total							**5,470,900**

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 2013.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	24	0	0	24
East Machias	Restoration	0	74	0	0	74
Machias	Restoration	0	201	0	0	201
Merrimack	Restoration/Recreation	2,296	0	0	0	2,296
Merrimack	Restoration	0	0	0	19	19
Merrimack	Recreation	0	372	0	0	372
Narraguagus	Restoration	0	214	0	0	214
Penobscot	Restoration	0	1,643	0	369	2,012
Pleasant	Restoration	0	124	0	0	124
Sheepscot	Restoration	0	142	0	0	142
Total		2,296	2,794	0	388	5,478

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 ***2013*** *.*

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		PIT	18	DUCP	Nov	Sheepscot
USFWS	4	Adult	H		PIT	43	DUCP	Nov	Sheepscot
USFWS	3	Adult	H		PIT	81	DUCP	Nov	Sheepscot
USFWS	0	Parr	H		AD	13,951		Sept	Sheepscot
USFWS	5	Adult	H	Dennys	PIT	5	DUCP	Nov	Dennys
USFWS	4	Adult	H	Dennys	PIT	19	DUCP	Nov	Dennys
EMARC	0		H	East Machias	AD	77,568		Nov	East Machias
USFWS	4	Adult	H	East Machias	PIT	37	DUCP	Nov	East Machias
USFWS	5	Adult	H	East Machias	PIT	37	DUCP	Nov	East Machias
USFWS	3	Adult	H	Machias	PIT	113	DUCP	Dec	Machias
USFWS	4	Adult	H	Machias	PIT	39	DUCP	Dec	Machias
USFWS	5	Adult	H	Machias	PIT	49	DUCP	Dec	Machias
NHFGD	2	Adult	H	Merrimack	FLOY	1,496	FLOY	Oct	Merrimack
NHFGD	3+	Adult	H	Merrimack	FLOY	372		April	Merrimack
NHFGD	3+	Adult	H	Merrimack	FLOY	800		Nov	Merrimack
NHFGD	1	Smolt	H	Merrimack	AD	20,367		April	Merrimack
DMR	2	Smolt	H	Narraguagus	PIT	4		April	Narraguagus
DMR	2	Smolt	H	Narraguagus	PIT	9		May	Narraguagus
DMR	2	Smolt	W	Narraguagus	PIT	56		May	Narraguagus
DMR		Smolt	W	Narraguagus	PIT	6		April	Narraguagus
DMR		Smolt	W	Narraguagus	PIT	100		May	Narraguagus
DMR	2	Smolt	W	Narraguagus	PIT	2		April	Narraguagus
DMR	3	Smolt	W	Narraguagus	PIT	10		May	Narraguagus
DMR	3	Smolt	W	Narraguagus	PIT	1		April	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	64	DUCP	Dec	Narraguagus

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	3	Adult	H	Narraguagus	PIT	118	DUCP	Dec	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	32	DUCP	Dec	Narraguagus
DMR	4	Adult	H	Penobscot	RAD	2	PIT	June	Lower Andros
HDR	1	Smolt	H	Penobscot	RAD	300		May	Lower Andros
NOAA	1	Smolt	H	Penobscot	PING	71	AD	April	Penobscot
NOAA	1	Smolt	H	Penobscot	PING	75	AD	May	Penobscot
Normandeau	1	Smolt	H	Penobscot	RAD	626		May	Lower Kenneb
Normandeau	1	Smolt	H	Penobscot	RAD	181		May	Lower Andros
USFWS		Adult	W	Penobscot	PIT	369		Nov	Penobscot
USGS	1	Smolt	H	Penobscot	PING	75		April	Piscataquis
USGS	1	Smolt	H	Penobscot	PING	82		April	Penobscot
USGS	1	Smolt	H	Penobscot	PING	10		May	Penobscot
USGS	1	Smolt	H	Penobscot	PIT	60		May	Penobscot
USFWS	5	Adult	H	Pleasant	PIT	28	DUCP	Dec	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	31	DUCP	Dec	Pleasant
USFWS	3	Adult	H	Pleasant	PIT	65	DUCP	Dec	Pleasant

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; DUCP = Double upper caudal punch.

*Appendix 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in **2013**.*

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,668		3,449
Hatchery Juvenile	112,032	112,032	113,379
Wild Adult			369
Wild Juvenile			175
Total			**117,372**

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2013.

	1SW		2SW		3SW		Repeat			2009-2013
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	0	0	1	1	0	0	0	0	**2**	20
Connecticut	0	3	4	85	0	0	0	0	**92**	77
Kennebec	0	0	1	7	0	0	0	0	**8**	23
Merrimack	0	0	6	12	0	0	3	0	**21**	142
Narraguagus	3	0	14	4	0	0	0	0	**21**	64
Pawcatuck	0	0	0	2	0	0	0	0	**2**	2
Penobscot	54	3	275	44	3	0	2	0	**381**	1,481
Pleasant	0	0	1	0	0	0	0	0	**1**	2
Saco	0	0	2	1	0	0	0	0	**3**	29
Union	0	0	0	1	0	0	0	0	**1**	0
Total	**57**	**6**	**304**	**157**	**3**	**0**	**5**	**0**	**532**	**1,839**

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2013.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	77	556,000
Merrimack	Domestic	295	853,000
Penobscot	Domestic	517	1,713,000
Pleasant	Domestic	4	29,000
Dennys	Captive	46	111,000
East Machias	Captive	70	252,000
Machias	Captive	114	342,000
Narraguagus	Captive	118	279,000
Pleasant	Captive	78	262,000
Sheepscot	Captive	81	230,000
Total	**Captive/Domestic**	**1,400**	**4,627,000**
Connecticut	Sea Run	46	325,000
Merrimack	Sea Run	5	36,000
Penobscot	Sea Run	174	1,258,000
Total	**Sea Run**	**225**	**1,619,000**
Grand Total for Year	**2013**	**1,625**	**6,246,000**

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 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
Cocheco															
1993-2003	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															
1977-2003	1,438	16,573,000	7,900	19,874	128,896,000	5,900	0	0		1,897	23,773,000	10,200	23,209	169,242,000	6,400
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
2013	46	325,000	7,100	77	556,000	7,200	0	0		0	0		123	881,000	7,200
Total Connecticut	2,071	21,264,000	7,400	33,559	207,522,000	6,000	0	0		2,395	28,934,000	9,700	38,025	257,720,000	6,200
Dennys															
1939-2003	26	214,000	7,600	0	0		780	3,172,000	4,100	40	330,000	7,700	846	3,716,000	5,100
2004	0	0		0	0		88	380,000	4,300	0	0		88	380,000	4,300
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100

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
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	
2012	0	0		0	0		0	0		0	0		0	0	
2013	0	0		0	0		46	111,000	2,400	0	0		46	111,000	2,400
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,370	5,789,000	4,333	40	330,000	7,700	1,561	7,020,000	4,500
East Machias															
1995-2003	0	0		0	0		752	3,133,000	4,300	0	0		752	3,133,000	4,300
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
2012	0	0		0	0		65	160,000	2,500	0	0		65	160,000	2,500
2013	0	0		0	0		70	252,000	3,600	0	0		70	252,000	3,600
Total East Machias	0	0		0	0	0	1,466	5,961,000	4,000	0	0		1,466	5,961,000	4,000
Kennebec															
1979-2003	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															

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run 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
1992-2003	6	32,000	4,800	0	0		0	0		0	0		6	32,000	4,800
Total Lamprey	6	32,000	4,800	0	0	0	0	0		0	0		6	32,000	4,800
Machias															
1941-2003	456	3,263,000	7,300	0	0		1,313	5,277,000	4,100	8	52,000	6,400	1,777	8,592,000	6,200
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
2012	0	0		0	0		113	288,000	2,500	0	0		113	288,000	2,500
2013	0	0		0	0		114	342,000	3,000	0	0		114	342,000	3,000
Total Machias	456	3,263,000	7,300	0	0	0	2,623	10,679,000	4,064	8	52,000	6,400	3,087	13,994,000	4,300
Merrimack															
1983-2003	1,107	8,441,000	7,900	8,756	46,551,000	5,100	0	0		180	2,113,000	12,000	10,043	57,104,000	6,300
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

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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
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
2013	5	36,000	7,200	295	853,000	2,900	0	0		0	0		300	889,000	3,000
Total Merrimack	1,582	12,306,000	8,000	11,687	57,863,000	4,000	0	0		540	5,708,000	10,000	13,809	75,876,000	5,200
Narraguagus															
1962-2003	0	1,303,000		0	0		1,292	4,687,000	3,600	0	0		1,292	5,990,000	3,600
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
2012	0	0		0	0		145	433,000	3,000	0	0		145	433,000	3,000
2013	0	0		0	0		118	279,000	2,400	0	0		118	279,000	2,400
Total Narraguagus	0	1,303,000		0	0	0	2,739	10,704,000	4,145	0	0		2,739	12,007,000	4,100
Orland															
1967-2003	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															
1992-2003	16	143,000	8,900	2	2,000	1,100	0	0		9	61,000	6,600	27	206,000	7,700
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

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
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
2012	2	5,000	2,500	550	2,000	0	0	0		0	0		552	7,000	0
Total Pawcatuck	20	157,000	5,300	556	8,000	700	0	0		13	76,000	4,700	589	241,000	3,400
Penobscot															
1871-2003	17,929	153,656,000	7,900	5,192	13,443,000	2,600	0	0		0	0		23,121	167,099,000	7,500
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
2012	259	1,950,000	7,500	373	1,101,000	3,000	0	0		0	0		632	3,051,000	4,800
2013	174	1,258,000	7,200	517	1,713,000	3,300	0	0		0	0		691	2,971,000	4,300
Total Penobscot	20,833	177,932,000	8,200	8,641	25,311,000	3,400	329	1,400,000	4,300	0	0		29,803	204,643,000	5,800
Pleasant															
2001-2003	0	0		0	0		43	222,000	5,400	0	0		43	222,000	5,400
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

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
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
2012	0	0		68	133,000	2,000	55	145,000	2,600	0	0		123	278,000	2,300
2013	0	0		4	29,000	7,300	78	262,000	3,400	0	0		82	291,000	3,500
Total Pleasant	0	0		123	469,000	5,900	568	2,162,000	4,164	0	0		691	2,630,000	4,400
Sheepscot															
1995-2003	18	125,000	6,900	0	0		588	2,414,000	3,900	45	438,000	9,900	651	2,977,000	4,600
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
2012	0	0		0	0		89	231,000	2,600	0	0		89	231,000	2,600
2013	0	0		0	0		81	230,000	2,800	0	0		81	230,000	2,800
Total Sheepscot	18	125,000	6,900	0	0	0	1,371	5,246,000	3,645	45	438,000	9,900	1,434	5,809,000	3,700
St Croix															
1993-2003	39	291,000	7,400	0	0		0	0		0	0		39	291,000	7,400
Total St Croix	39	291,000	7,400	0	0	0	0	0		0	0		39	291,000	7,400
Union															
1974-2003	600	4,611,000	7,900	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.

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
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	2,071	21,264,000	7,400	33,559	207,521,000	6,000	0	0		2,395	28,935,000	9,700	38,025	257,720,000	6,200
Dennys	26	214,000	7,600	125	687,000	4,600	1,370	5,789,000	4,300	40	330,000	7,700	1,561	7,020,000	4,500
East Machias	0	0		0	0		1,466	5,961,000	4,000	0	0		1,466	5,961,000	4,000
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		2,623	10,678,000	4,100	8	52,000	6,400	3,087	13,994,000	4,300
Merrimack	1,582	12,306,000	8,000	11,687	57,862,000	4,000	0	0		540	5,709,000	10,000	13,809	75,877,000	5,200
Narraguagus	0	1,303,000		0	0		2,739	10,704,000	4,100	0	0		2,739	12,007,000	4,100
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	20	157,000	5,300	556	8,000	700	0	0		13	76,000	4,700	589	241,000	3,500
Penobscot	20,833	177,932,000	8,200	8,641	25,310,000	3,400	329	1,400,000	4,300	0	0		29,803	204,642,000	5,800
Pleasant	0	0		123	468,000	5,900	568	2,161,000	4,200	0	0		691	2,630,000	4,400
Sheepscot	18	125,000	6,900	0	0		1,371	5,245,000	3,700	45	438,000	9,900	1,434	5,809,000	3,700
St Croix	39	291,000	7,400	0	0		0	0		0	0		39	291,000	7,400
Union	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Grand Total	**25,698**	**221,839,000**	**8,600**	**54,691**	**291,856,000**	**5,300**	**10,466**	**41,938,000**	**4,000**	**3,041**	**35,540,000**	**11,700**	**93,896**	**591,176,000**	**6,300**

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							
2001-2003	4,000	0	0	0	0	0	4,000
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
2013	1,000	0	0	0	500	0	1,500
Totals:Androscoggin	**14,000**	**0**	**0**	**0**	**500**	**0**	**14,500**
Aroostook							
1978-2003	1,953,000	317,400	38,600	0	32,600	29,800	2,371,400
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
2013	580,000	0	0	0	0	0	580,000
Totals:Aroostook	**6,331,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**6,749,400**
Cocheco							
1988-2003	1,958,000	50,000	10,500	0	5,300	0	2,023,800
Totals:Cocheco	**1,958,000**	**50,000**	**10,500**	**0**	**5,300**	**0**	**2,023,800**
Connecticut							
1967-2003	92,719,000	2,827,500	1,810,300	0	3,769,700	1,101,500	102,228,000
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
2013	1,857,000	3,200	0	0	600	99,500	1,960,300
Totals:Connecticut	**148,526,000**	**2,849,700**	**1,836,700**	**64,700**	**3,771,900**	**1,828,100**	**158,877,100**
Dennys							
1975-2003	1,400,000	132,100	7,300	0	306,700	29,200	1,875,300

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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							
1986-2003	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-2003	1,757,000	7,500	42,600	0	108,400	30,400	1,945,900
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
2013	20,000	77,600	0	0	0	0	97,600
Totals:East Machias	**3,737,000**	**138,300**	**42,600**	**0**	**108,400**	**30,400**	**4,056,700**
Kennebec							
2001-2003	52,000	0	0	0	0	0	52,000
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
2013	2,000	0	0	0	600	0	2,600
Totals:Kennebec	**403,000**	**0**	**0**	**0**	**800**	**0**	**403,800**
Lamprey							
1978-2003	1,592,000	427,700	58,800	0	201,400	32,800	2,312,700
Totals:Lamprey	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**
Machias							
1970-2003	2,471,000	93,800	118,100	0	191,300	44,100	2,918,300
2004	379,000	3,100	0	0	0	0	382,100

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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
2013	172,000	800	1,400	0	59,100	0	233,300
Totals:Machias	**6,570,000**	**100,100**	**125,700**	**0**	**250,400**	**44,100**	**7,090,300**
Merrimack							
1975-2003	30,789,000	227,500	597,700	0	1,419,000	638,100	33,671,300
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
2013	111,000	0	41,200	0	40,900	0	193,100
Totals:Merrimack	**41,775,000**	**431,800**	**658,200**	**0**	**1,981,500**	**638,100**	**45,484,600**
Narraguagus							
1970-2003	2,502,000	62,900	14,600	0	107,800	84,000	2,771,300
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
2013	288,000	0	0	0	0	0	288,000
Totals:Narraguagus	**6,920,000**	**117,100**	**14,600**	**0**	**400,200**	**84,000**	**7,535,900**
Pawcatuck							
1979-2003	4,825,000	1,209,200	263,200	0	70,300	500	6,368,200
2004	557,000	0	0	0	6,100	0	563,100
2005	5,000	0	0	0	16,600	0	21,600
2006	85,000	0	0	0	12,800	0	97,800
2007	115,000	0	4,900	0	6,400	0	126,300
2008	313,000	0	0	0	6,000	0	319,000
2009	86,000	0	0	0	5,400	0	91,400
2010	290,000	0	0	0	3,900	0	293,900

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2011	6,000	0	0	0	0	0	6,000
2012	6,000	0	0	0	0	0	6,000
2013	8,000	0	0	0	0	0	8,000
Totals:Pawcatuck	**6,296,000**	**1,209,200**	**268,100**	**0**	**127,500**	**500**	**7,901,300**
Penobscot							
1970-2003	13,935,000	3,903,600	1,394,400	0	12,158,500	2,508,200	33,899,700
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
2013	722,000	214,000	0	0	553,000	0	1,489,000
Totals:Penobscot	**26,778,000**	**6,684,800**	**1,394,400**	**0**	**17,725,800**	**2,508,200**	**55,091,200**
Pleasant							
1975-2003	240,000	16,000	1,800	0	57,500	18,100	333,400
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
2013	180,000	0	0	0	62,300	0	242,300
Totals:Pleasant	**1,578,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**1,885,100**
Saco							
1975-2003	4,435,000	438,700	201,200	0	338,700	9,500	5,423,100
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
2013	319,000	10,100	0	0	12,100	0	341,200
Totals:Saco	**7,446,000**	**473,900**	**232,000**	**0**	**408,300**	**9,500**	**8,569,700**
Sheepscot							
1971-2003	1,760,000	84,800	20,600	0	92,200	7,100	1,964,700

Number of fish stocked by life stage							
	Fry	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
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
2013	18,000	14,000	0	0	0	0	32,000
Totals:Sheepscot	**3,322,000**	**223,000**	**20,600**	**0**	**92,200**	**7,100**	**3,664,900**
St Croix							
1981-2003	1,268,000	467,600	158,300	0	803,900	20,100	2,717,900
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							
1971-2003	433,000	371,400	0	0	379,700	251,000	1,435,100
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
2013	2,000	0	0	0	0	0	2,000
Totals:Union	**554,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,556,100**
Upper StJohn							
1979-2003	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	13,000	0	0	0	500	0	**13,900**
Aroostook	6,331,000	317,400	38,600	0	32,600	29,800	**6,749,500**
Cocheco	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	148,525,000	2,849,700	1,836,700	64,800	3,771,900	1,828,200	**158,811,500**
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	3,735,000	138,300	42,600	0	108,400	30,400	**4,055,100**
Kennebec	403,000	0	0	0	900	0	**403,700**
Lamprey	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	6,570,000	100,000	125,600	0	250,400	44,100	**7,090,100**
Merrimack	41,775,000	431,700	658,100	0	1,981,400	638,100	**45,484,000**
Narraguagus	6,921,000	117,100	14,600	0	400,300	84,000	**7,536,500**
Pawcatuck	6,295,000	1,209,200	268,100	0	127,500	500	**7,900,500**
Penobscot	26,777,000	6,684,800	1,394,400	0	17,725,800	2,508,200	**55,090,500**
Pleasant	1,579,000	16,000	1,800	0	247,000	42,400	**1,885,900**
Saco	7,445,000	473,800	232,000	0	408,200	9,500	**8,568,800**
Sheepscot	3,322,000	223,000	20,600	0	92,200	7,100	**3,665,000**
St Croix	1,269,000	498,000	158,300	0	808,000	20,100	**2,753,900**
Union	553,000	371,400	0	0	379,700	251,000	**1,555,200**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**271,262,000**	**15,590,200**	**4,882,800**	**64,800**	**27,079,500**	**5,583,900**	**324,398,700**

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									
1983-2003	27	516	6	2	6	83	0	1	**641**
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**
2013	0	1	0	0	0	1	0	0	**2**
Total for Androscoggin	57	600	6	2	10	107	0	1	**783**
Cocheco									
1992-2003	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2003	36	3,503	28	2	47	1,407	12	0	**5,035**
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**
2013	0	4	0	0	3	85	0	0	**92**
Total for Connecticut	58	3,612	28	2	134	2318	14	3	**6,169**
Dennys									
1967-2003	35	313	0	1	31	744	3	31	**1,158**
2004	0	1	0	0	0	0	0	0	**1**
2006	2	2	0	0	1	1	0	0	**6**
2007	1	1	0	0	0	1	0	0	**3**
2008	0	1	0	0	1	3	0	3	**8**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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									
1985-2003	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2003	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2003	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**
2013	0	1	0	0	0	7	0	0	**8**
Total for Kennebec	24	256	6	7	9	81	0	0	**383**
Lamprey									
1979-2003	10	17	1	0	11	16	0	0	**55**
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									
1967-2003	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									
1982-2003	290	1,119	19	8	119	974	26	0	**2,555**
2004	17	92	2	0	2	15	0	0	**128**
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**
2007	8	52	0	0	1	12	1	0	**74**
2008	6	77	0	0	5	29	1	0	**118**
2009	4	41	2	0	1	28	2	0	**78**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2010	29	40	0	0	7	7	1	0	**84**
2011	128	155	12	1	11	90	5	0	**402**
2012	0	81	15	0	1	27	3	0	**127**
2013	0	6	0	3	0	12	0	0	**21**
Total for Merrimack	499	1,752	51	12	153	1204	39	0	**3,710**
Narraguagus									
1967-2003	92	650	19	54	88	2,388	70	154	**3,515**
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**
2013	3	14	0	0	0	4	0	0	**21**
Total for Narraguagus	185	802	23	56	123	2488	72	159	**3,908**
Pawcatuck									
1982-2003	2	148	1	0	1	14	1	0	**167**
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**
2012	0	0	0	0	0	2	0	0	**2**
2013	0	0	0	0	0	2	0	0	**2**
Total for Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot									
1968-2003	10,187	41,555	277	681	665	3,640	32	95	**57,132**
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**
2008	713	1,295	0	4	23	80	0	0	**2,115**
2009	185	1,683	2	1	12	74	1	0	**1,958**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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**
2013	54	275	3	2	3	44	0	0	**381**
Total for Penobscot	13,362	51,183	302	742	837	4363	37	102	**70,928**
Pleasant									
1967-2003	5	12	0	0	14	227	3	2	**263**
2004	0	0	0	0	0	1	0	0	**1**
2012	0	0	0	0	0	2	0	0	**2**
2013	0	1	0	0	0	0	0	0	**1**
Total for Pleasant	5	13	0	0	14	230	3	2	**267**
Saco									
1985-2003	109	561	3	7	21	63	3	0	**767**
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**
2013	0	2	0	0	0	1	0	0	**3**
Total for Saco	179	704	5	7	50	119	6	0	**1,070**
Sheepscot									
1967-2003	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2003	274	1,840	9	28	1	15	0	0	**2,167**
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**
2013	0	0	0	0	0	1	0	0	**1**
Total for Union	274	1,841	9	28	1	17	0	0	**2,170**

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	600	6	2	10	107	0	1	**783**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,612	28	2	134	2,318	14	3	**6,169**
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	256	6	7	9	81	0	0	**383**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	499	1,752	51	12	153	1,204	39	0	**3,710**
Narraguagus	185	802	23	56	123	2,488	72	159	**3,908**
Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot	13,362	51,183	302	742	837	4,363	37	102	**70,928**
Pleasant	5	13	0	0	14	230	3	2	**267**
Saco	179	704	5	7	50	119	6	0	**1,070**
Sheepscot	6	38	0	0	30	358	10	0	**442**
Union	274	1,841	9	28	1	17	0	0	**2,170**

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 2008 and later).

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	0	0	4	95	0	0
2008	424	44	0.104	0	7	0	32	59	0	0	2			0	39	59	2	
2009	472	61	0.129	0	3	0	0	97		0				0	3	97		
2010	425	6	0.014	0	83		17							0	100			
2011	438	0	0.000	0										0				
Total	**10,014**	**1,664**																
Mean			**0.517**	**0**	**6**	**0**	**2**	**69**	**4**	**0**	**4**	**0**	**0**	**0**	**8**	**70**	**7**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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 2008 and later).

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	0	0	5	93	2	0
2008	604	83	0.137	0	4	0	35	59	0	0	2			0	39	59	2	
2009	648	78	0.120	0	4	0	0	96		0				0	4	96		
2010	601	10	0.017	0	80		20							0	100			
2011	601	1	0.002	100										100				
Total	**14,481**	**2,466**																
Mean			**0.404**	**0**	**11**	**0**	**3**	**67**	**2**	**0**	**5**	**0**	**0**	**0**	**14**	**68**	**6**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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 2008 and later).

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	0	0	11	89	0	0
2008	88	8	0.091	0	0	0	38	62	0	0	0			0	38	62	0	
2009	82	4	0.049	0	0	0	0	100		0				0	0	100		
2010	85	1	0.012	0	100		0							0	100			
2011	76	0	0.000	0										0				
Total	**2,270**	**370**																
Mean			**0.284**	**0**	**25**	**0**	**3**	**56**	**0**	**0**	**7**	**0**	**0**	**0**	**28**	**57**	**8**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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 2008 and later).

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	0	0	8	87	5	0
2008	177	32	0.181	0	0	0	22	78	0	0	0			0	22	78	0	
2009	105	13	0.124	0	0	0	8	92		0				0	8	92		
2010	148	0	0.000	0	0		0							0	0			
2011	89	0	0.000	0										0				
Total	**4,069**	**1,396**																
Mean			**2.273**	**0**	**2**	**0**	**10**	**63**	**4**	**2**	**9**	**0**	**0**	**0**	**11**	**65**	**13**	**1**

Means includes year classes with complete return data (year classes of 2008 and later).

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	0	0	100	0	0
2008	31	3	0.096	0	33	0	0	67	0	0	0			0	33	67	0	
2009	9	2	0.234	0	0	0	0	100		0				0	0	100		

Means includes year classes with complete return data (year classes of 2008 and later).

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		0							0	0			
2011	1	0	0.000	0										0				
Total	**629**	**27**																
Mean			**0.134**	**0**	**3**	**1**	**1**	**32**	**0**	**0**	**5**	**0**	**0**	**0**	**4**	**33**	**5**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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 (%) 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
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	0	0	100	0	0

Means includes year classes with complete return data (year classes of 2008 and later).

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	0			0	36	64	0	
2009	24	2	0.085	0	0	0	0	100		0				0	0	100		
2010	28	3	0.108	0	67		33							0	100			
2011	24	0	0.000	0										0				
Total	**507**	**119**																
Mean			**0.227**	**0**	**19**	**0**	**3**	**58**	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**58**	**0**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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 (%) 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
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	0	0	80	20	0
2008	63	9	0.143	0	0	0	44	44	0	0	11			0	44	44	11	

Means includes year classes with complete return data (year classes of 2008 and later).

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	10	0.154	0	10	0	0	90		0				0	10	90		
2010	60	0	0.000	0	0		0							0	0			
2011	59	1	0.017	100										100				
Total	**1,631**	**311**																
Mean			**0.201**	**0**	**4**	**0**	**9**	**75**	**0**	**0**	**7**	**0**	**0**	**0**	**13**	**75**	**7**	**0**

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 2008 and later).

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	0	0	9	86	4	0
2008	125	104	0.834	0	0	0	42	58	0	0	0			0	42	58	0	
2009	102	49	0.479	0	0	0	10	90		0				0	10	90		
2010	100	3	0.030	0	0		100							0	100			
2011	95	0	0.000	0										0				
Total	**2,486**	**4,761**																
Mean			**5.442**	**0**	**0**	**0**	**16**	**72**	**1**	**3**	**8**	**0**	**0**	**0**	**16**	**75**	**9**	**0**

Means includes year classes with complete return data (year classes of 2008 and later).

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	0.096	0.137	0.104	0.821	0.091	0.143	0.834

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	**PW**	**CT**	**CTAH**	**SAL**	**FAR**	**WE**	**PN**
2009	0.124	0.234	0.120	0.129	0.085	0.049	0.154	0.479
2010	0.000	0.000	0.017	0.014	0.108	0.012	0.000	0.030
2011	0.000	0.000	0.002	0.000	0.000	0.000	0.017	0.000
Mean	**2.316**	**0.131**	**0.414**	**0.530**	**0.230**	**0.291**	**0.207**	**5.598**
StDev	**5.495**	**0.449**	**0.468**	**0.731**	**0.250**	**0.313**	**0.185**	**6.659**

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).

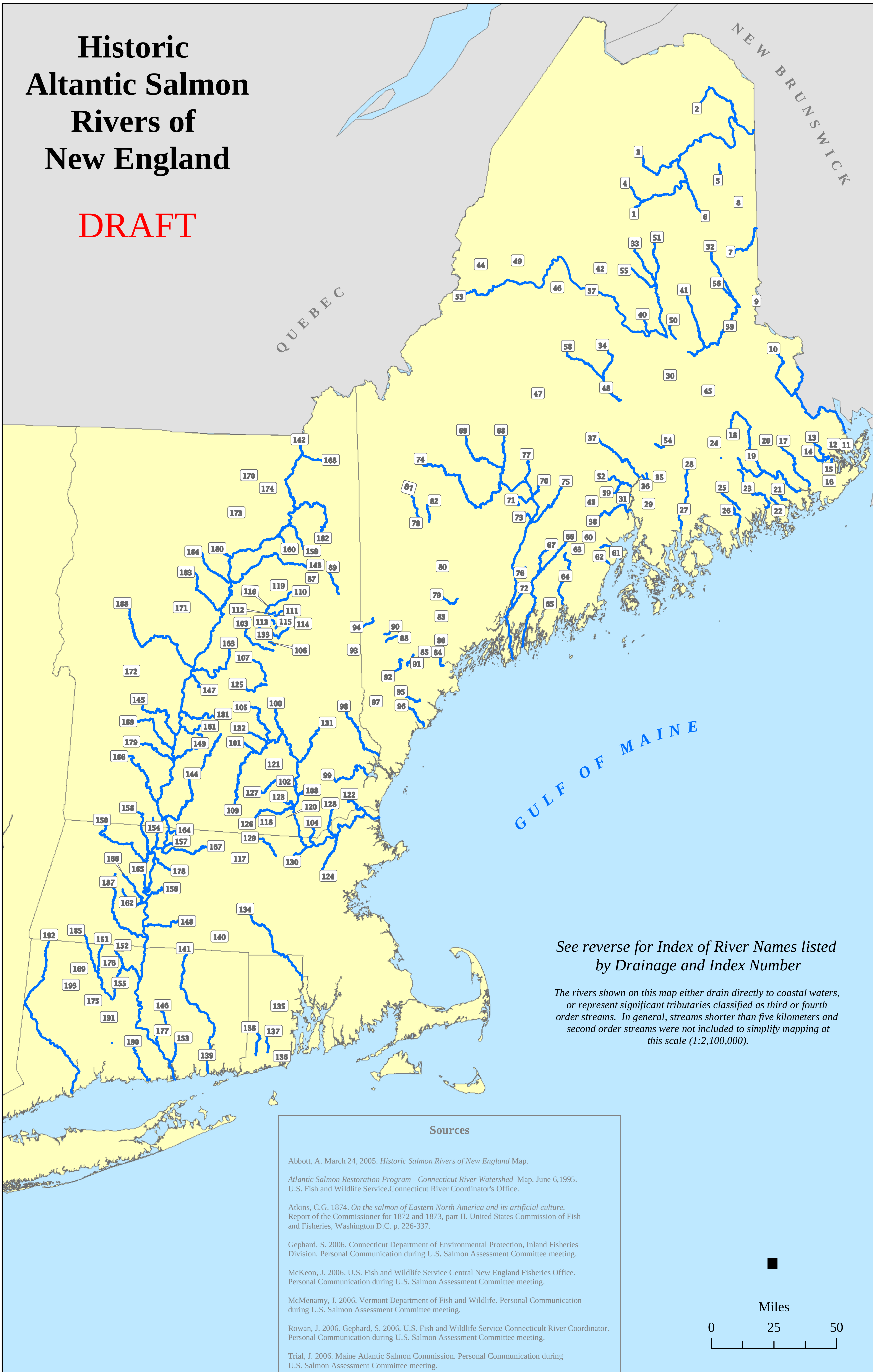
Appendix 20. Summary of age distributions of adult Atlantic salmon that were stocked in New England as fry.

	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	9	0	4	81	4	0	4	0	0	0	13	81	8	0
Connecticut (basin)	3	14	0	5	77	2	0	5	0	0	3	19	77	7	0
Farmington	0	27	0	5	62	0	0	8	0	0	0	32	62	8	0
Merrimack	0	2	0	11	70	4	2	10	1	0	0	13	72	14	1
Pawcatuck	0	8	2	2	78	0	0	11	0	0	0	10	80	11	0
Penobscot	0	0	0	20	72	1	3	7	0	0	0	20	75	8	0
Salmon	0	24	0	7	73	0	0	0	0	0	0	31	73	0	0
Westfield	5	4	0	10	78	0	0	8	0	0	5	15	78	8	0
Overall Mean:	**1**	**11**	**0**	**8**	**74**	**1**	**1**	**7**	**0**	**0**	**1**	**19**	**75**	**8**	**0**

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

Historic Altantic Salmon Rivers of New England

DRAFT



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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