ANNUAL REPORT OF THE U.S ATLANTIC SALMON ASSESSMENT COMMITTEE

REPORT NO. 27 - 2014 ACTIVITIES

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PREPARED FOR
U.S. SECTION TO NASCO

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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 450; this is the sum of documented returns to traps and returns estimated by redd counts on selected Maine rivers, this is the lowest for the 1991-2014 time series, 26% less than 2013 and only 11% of the recent high return number in 2011. Adult salmon returns to USA rivers with traps or weirs totaled 358 in 2014. Estimated return to Gulf of Maine small coastal rivers was 92 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 83% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (68%) returns were of hatchery smolt origin and the balance (32%) originated from either natural reproduction or hatchery fry and eggs. A total of 4,964,986 juvenile salmon (eggs, fry, parr, and smolts), and 3,343 adults were stocked in 2014. Of those fish 259,246 juveniles carried a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 102 sea-run females and 1,475 captive/domestic and domestic females. The total number of females (1,577) contributing was similar to 2013 (1,625); and the total egg take (6,520,000) was similar to 2013 (6,246,000). Production of farmed salmon in Maine was not available, but was estimated at 2,173 to 8,205 (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), there was zero estimated discard from US marine commercial fisheries.

1.3 Adult Returns

Total return to USA rivers was 450; (Table 1.3.1), a 26% decrease from 2013 returns and an 89% decrease from 2011 returns (Table 1.3.2). Returns are reported for three meta-population areas (Figure 1.3.1); Long Island Sound (LIS), Central New England (CNE), and Gulf of Maine (GOM). Changes from 2013 within areas were: LIS (-66%), CNE (+79%), GOM (-24%). 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. In 2014 and into the future CNE rivers sea ages were based on visual size estimation at counting windows.

Most returns occurred in the Gulf of Maine area, with the Penobscot River accounting for 67% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (68%) returns were of hatchery smolt origin and the balance (32%) 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

2012 was 0.041%, with the 2SW fish return rate 0.031% (Figure 1.3.3). The estimated return rate for 2SW adults from the 2012 cohort of wild smolts on the Narraguagus was 0.94% (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 1.1% of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.3 to 1.6 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2014 about 3,455,986 juvenile salmon (78% fry) were released and 1,509,000 eggs were planted into 13 river systems (Table 1.4.1). The number of juveniles released was less than that in 2013 (5,472,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and five coastal rivers within the GOM area Maine. The majority of smolts were stocked in one river into the GOM. In addition to juveniles, 3,343 adult salmon were released into USA rivers (Table 1.4.2). A total of 848 of these were pre-spawn adults released into sub-drainages of the Merrimack River. A total of 232 were for restoration and the remaining 616 were for the spring recreational fishery that is scheduled to discontinue after 2014.

Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 262,404 salmon released into USA waters in 2013 were marked or tagged. Tags and marks for parr, smolts, and adults included: Floy, PIT, radio, acoustical, visual implant elastomer and fin clips. Nearly all of the tagging occurred 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 5,189 metric tonnes (95% CI 2,200 to 8,200) based on a regression of production and smolt moved to pens two years before. The estimate was approximately 47% 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.

Table 1.3.1 Estimated Atlantic salmon returns to USA by geographic area, 2014. "Natural" includes fish originating from natural spawning and hatchery fry. Some numbers are based on redds. Ages and origins are prorated where fish are not available for handling.

Area	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	2	0	30	0	0	0	0	32
CNE	4	0	28	10	1	0	0	0	43
GOM	88	16	179	87	2	0	2	1	375
Total	92	18	207	127	3	0	2	1	450

Table 1.3.2 Estimated Atlantic salmon returns to the USA, 1967-2014. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1 SW	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
2014	110	334	3	3	450	304	146

Table 1.3.3 Two sea winter (2SW) returns for 2014 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	30	0.3%
Central New England	CNE	3,435	38	1.1%
Gulf of Maine	GOM	15,670	249	1.6%
Total		29,199	317	1.1%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2014. 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		204,000					204,000
CNE	2	Merrimack, Saco		379,000	16,000		12,100		407,100
GOM	8	Androscoggin to Dennys	1,509,000	1,553,000	165,230		557,656		3,784,886
OBF	1	Aroostook		569,000					569,000
Total	13		1,509,000	2,705,000	181,230	0	569,756	0	4,964,986

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2014 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	616				616
Central New England	CNE	Restoration	232				232
Gulf of Maine	GOM	Restoration		2,282		213	2,495
Total for USA			848	2,282		213	3,343

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2014. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		164,815	164,815
AD	Smolt			0
FLOY	Adult	616		616
PING	Smolt		282	282
PIT	Adult		2,526	2,526
PIT	Smolt			0
VIE	Smolt		92,354	92,354
RAD	Adult		16	16
RAD	Smolt		1,795	1,795
Total		616	261,788	262,404

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

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2014. Production for 2012-2014 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
2013	2,173 to 8,205

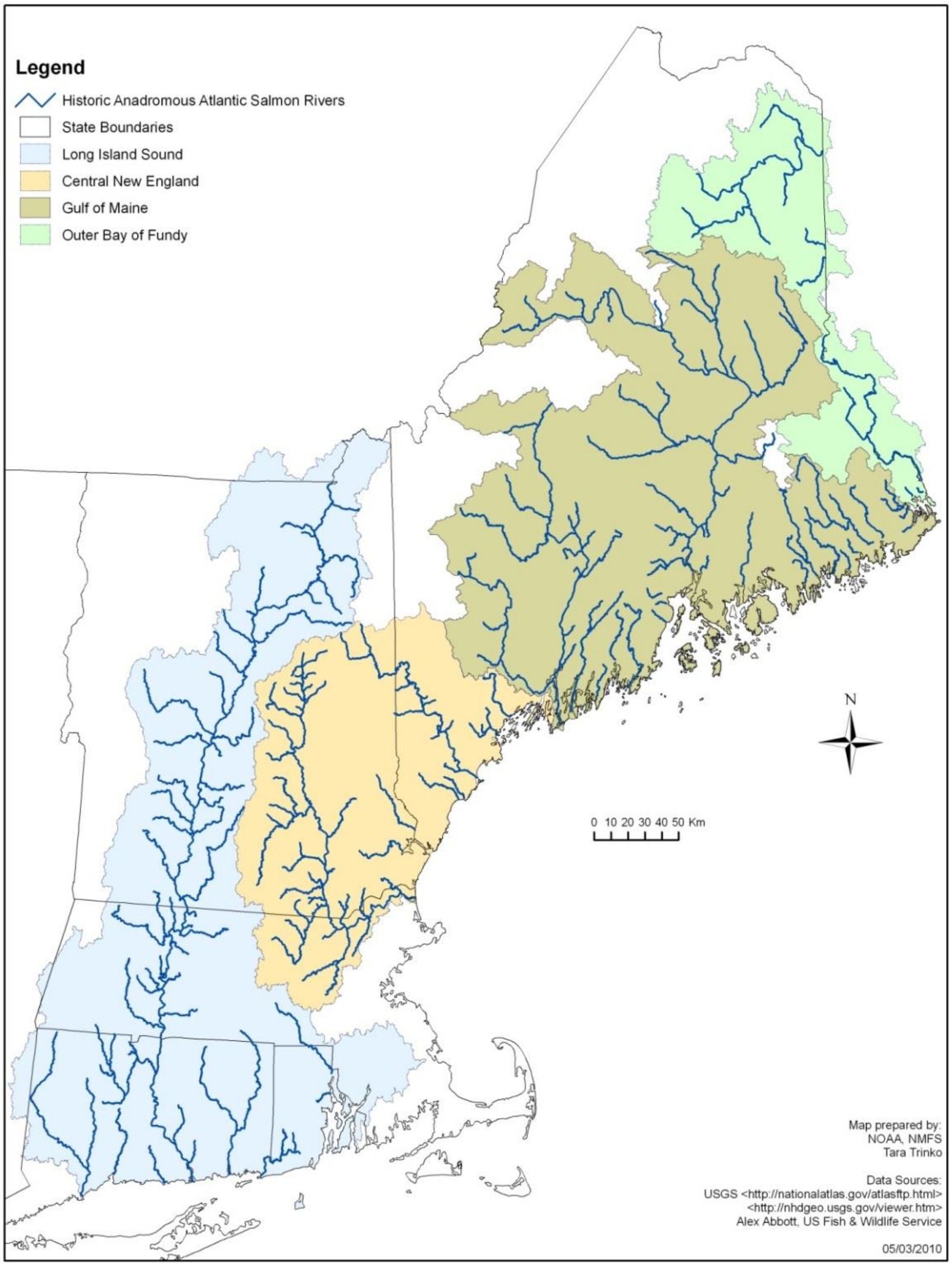

Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2014.

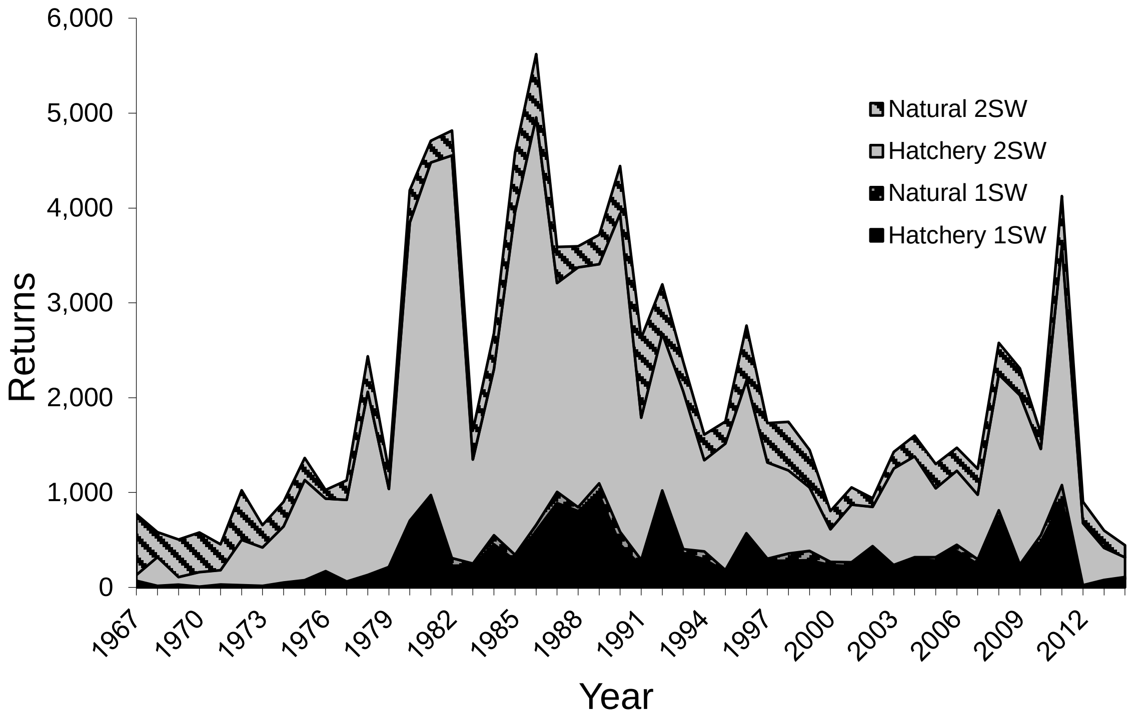

Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2014.

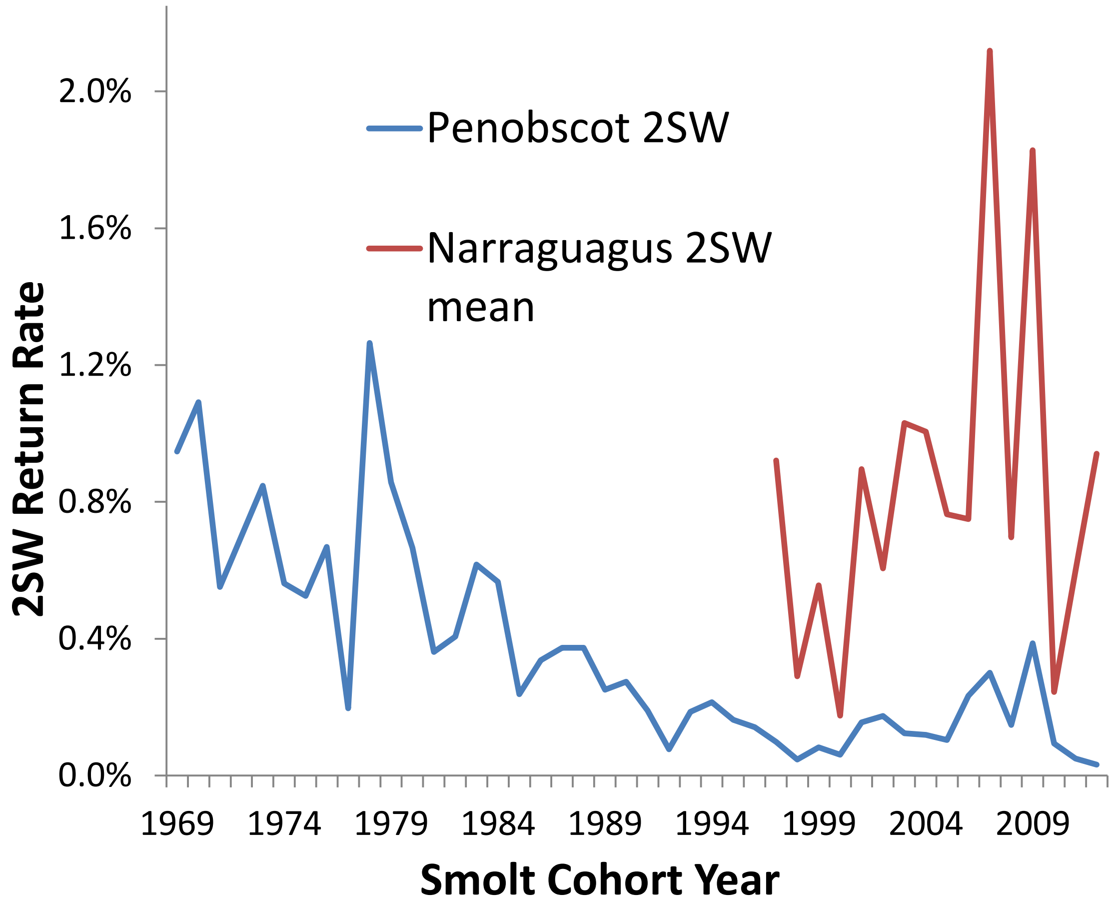

Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2 Status of Stocks

2.1 Distribution, Biology and Management

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

Strong homing capabilities of Atlantic salmon foster the formation and maintenance of local breeding groups or stocks (National Research Council 2002; Verspoor et al. 2002; Spidle et al. 2003). These stocks exhibit heritable adaptations to their home range in rivers and likely at sea. The importance of maintaining local adaptations has demonstrated utility in salmon conservation (National Research Council 2004). Because of significant declines in Atlantic salmon populations in the US, an analyses of population structure was conducted, and some populations are managed under the Endangered Species Act (ESA, 74 Federal Register 29346, June 19, 2009). The Act required that subgroups must be separable from the remainder of, and significant to, the species to which it belongs to warrant ESA protection.

Assessing population structure required broad scale consideration of geologic and climatic features that shape population structure through natural selection. For Atlantic salmon, factors such as climate, soil type, and hydrology were particularly important because these factors influence ecosystem structure and function, including transfer of energy in aquatic food chains (Fay et al. 2006). Numerous ecological classification systems were examined, which integrated the many factors necessary to discern historic structure. Biologists then delineated US Atlantic salmon populations into four discrete stock complexes that are managed separately: (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.

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

With improved regulations targeting sustainable best management practices with innovative bay-area management creating fallowing areas, farmers have increased sustainability and production, and production has rebuilt (Figure 2.2.1.1). Maine production in 2010 was over 11,000 mt the 6th highest in the 27-year time series and valued at $73.6M. With one company in production since 2011, confidentiality policies preclude detailed reporting 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 about 6,000 mt.

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 provided novel information on US salmon postsmolt ecology and status at sea (Sheehan et al. 2011).

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, state agencies, and NGOs. 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 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 1,640. 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 1,640 fish, less than 43% of the1977-1990 time-series median. There has been a downward trend in the production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish), that has affected US populations. In addition, recovery from historical impacts was never sufficient, so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2014 were only 450 fish, which ranks lowest in the 48 year time-series. Likewise, relative to the abundance in the current marine phase (1991–present), returns were the lowest on record. This is in stark contrast to 2011 returns that were the highest in the modern period. Returns the last five years suggest high interannual 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 8%, and 2014 was only 1.1% 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 85% for the Gulf of Maine, 10% for Central New England, and 5% for Long Island Sound. Returns in 2014 were typical, in that the Penobscot River population accounted for largest percentage of the total return (58%) from a single river.

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, an examination of returns from smolt stocked cohorts provides the most informative 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.

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 4.4 for 1SW salmon and 14.2 for 2SW fish. 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 86, 6 times higher than the Penobscot 2SW hatchery cohort average for the same time-period.

In 2014, the SAR for 2SW hatchery smolts released in the Penobscot River was 3.1, ranking 43rd in the 44-year record, while the 2014 return rate for 1SW hatchery grilse was 1.5 ranking 35th in the 45-year record. The 2SW return rate in the Narraguagus River in 2014 was 94.1 (12 fold higher than the Penobscot) . This metric 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. This indicates that the capacity of freshwater habitat to rear smolts must be increased through habitat restoration and enhancement for long-term recovery.

2.4.3 Juvenile Abundance Metrics

The USASAC used databases to develop regional-scale stock assessment products that assess various life history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary has been used to summarize return rates across New England for hatchery smolts (e.g. Figure 2.4.2.2 and 2.4.2.3). Examination of these data in further detail for such a long time-series is providing insights into program-specific challenges and more general regional trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, is facilitating the development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation, given the broad geographic area (186,500 km^2), with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people, with salmon habitat in cities and remote wilderness. However, taken over a long time–series, this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

Since 2009, USASAC has consolidated datasets across New England for juvenile production since at least the 1980's (some Maine data dates back > 50 years). Investigations of the juvenile production trends over time and more detailed assessments were initiated with the 2009 assessment. The first step towards investigating juvenile data trends was a graphical comparison of large parr densities throughout the region. Densities were calculated for sites with at least 10 years of estimates that are a product of electrofishing surveys throughout New England. For the model, large parr densities were ln+0.1

transformed then were analyzed with a mixed random effects model (years were fixed effects, 10 digit USGS hydrologic unit code within years were random effects, sites within 10 digit USGS hydrologic unit codes were random effects, and a "no intercept" model specification). For the Gulf of Maine DPS, data included density estimates from CPUE estimates as well as depletion-sampled estimates. The predicted year effects were then back-transformed to density units (Figure 2.4.3.1).

An examination of average densities (# per 100 m^2 habitat units) from 2008 to 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 were available and provided a good contrast: the Connecticut River basinwide estimate and the Narraguagus River smolt assessment (see USASAC 2013; a Connecticut monitoring ceased). Smolt production metrics are now limited to two longer time series in Maine – the Narraguagus River started in 1997 and Sheepscot River initiated in 2005 (Figure 2.4.3.2). These mark–recapture estimates using rotary-screw traps monitor production of stocked fish and naturally-reared fish. However, data presented are for naturally reared fish only as these are most comparable and longest time-series. Estimates suggest these rivers are producing less than the expected 2-3 smolts per unit of rearing habitat. Smolt estimates for other rivers supplement these longer time series and typically track the two primary metrics. Further analysis of smolt population dynamics is ongoing and examines other abundance indices, size and age distributions, and run timing. Because 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 1,640 fish, and returns in 2014 were only 450 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. Both adult returns and return rates (i.e. marine survival) remains among the lowest in the time series. Since 2011, returns rates have decreased to record lows for hatchery smolts and are variable for other Maine populations. The past decade has seen an increase in the variability of these metrics, compared to the preceding decades since the regime shift of the early 1990's. 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 catch (reported in numbers), aquaculture production (thousand metric tons), and commercial (no fishery) landings of Atlantic salmon from US Waters. Note that recreational catch is 0 from 1995 to present and with only one company reporting since 2010, confidentiality laws limit industry reporting.

Category	1995-2004 Average	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
U.S. Recreational (#) *	-	-	-	-	-	-	-	-	-	-	-
US Aquaculture	10.8	5.3	4.7	2.7	9.0	6.0	**	**	**	**	**
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	10.8	5.3	4.7	2.7	9.0	6.0	**	**	**	**	**

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	2014	%CSE
Long Island Sound Complex	10,094	30	0.3%
Central New England Complex	3,435	38	1.1%
Gulf of Maine DPS	15,670	266	1.7%
Totals	**29,199**	**334**	**1.1%**

For further information

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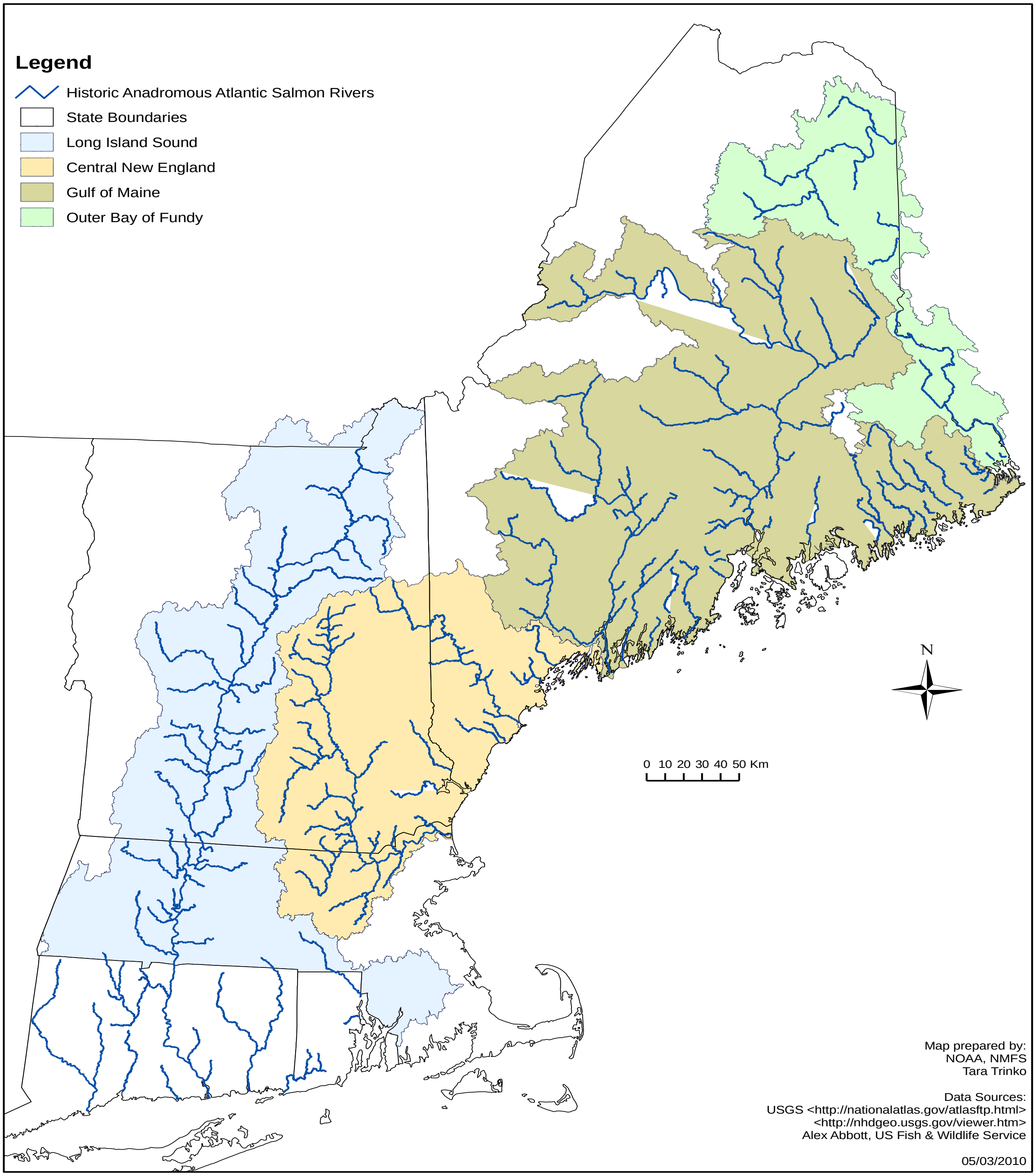

2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

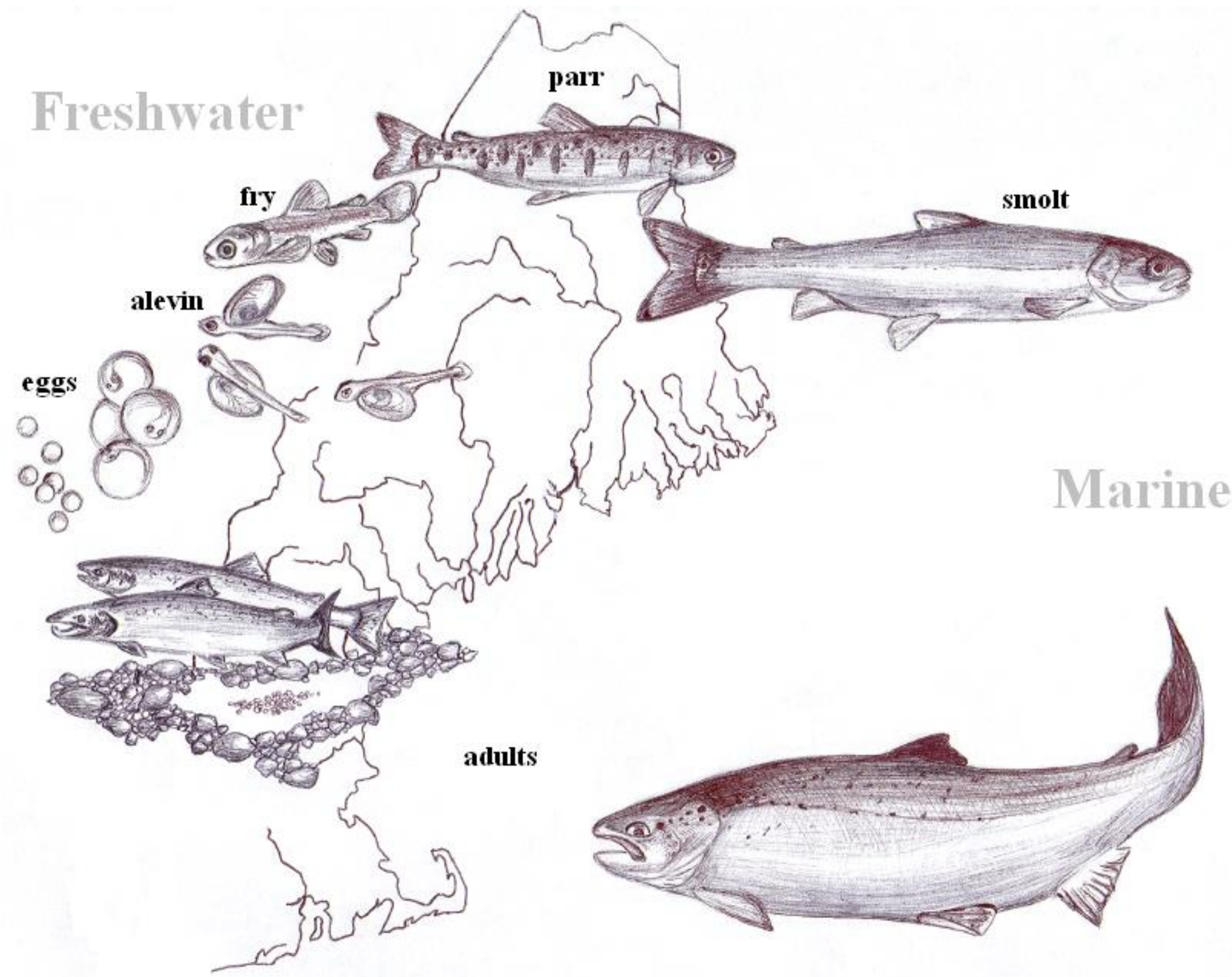

Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

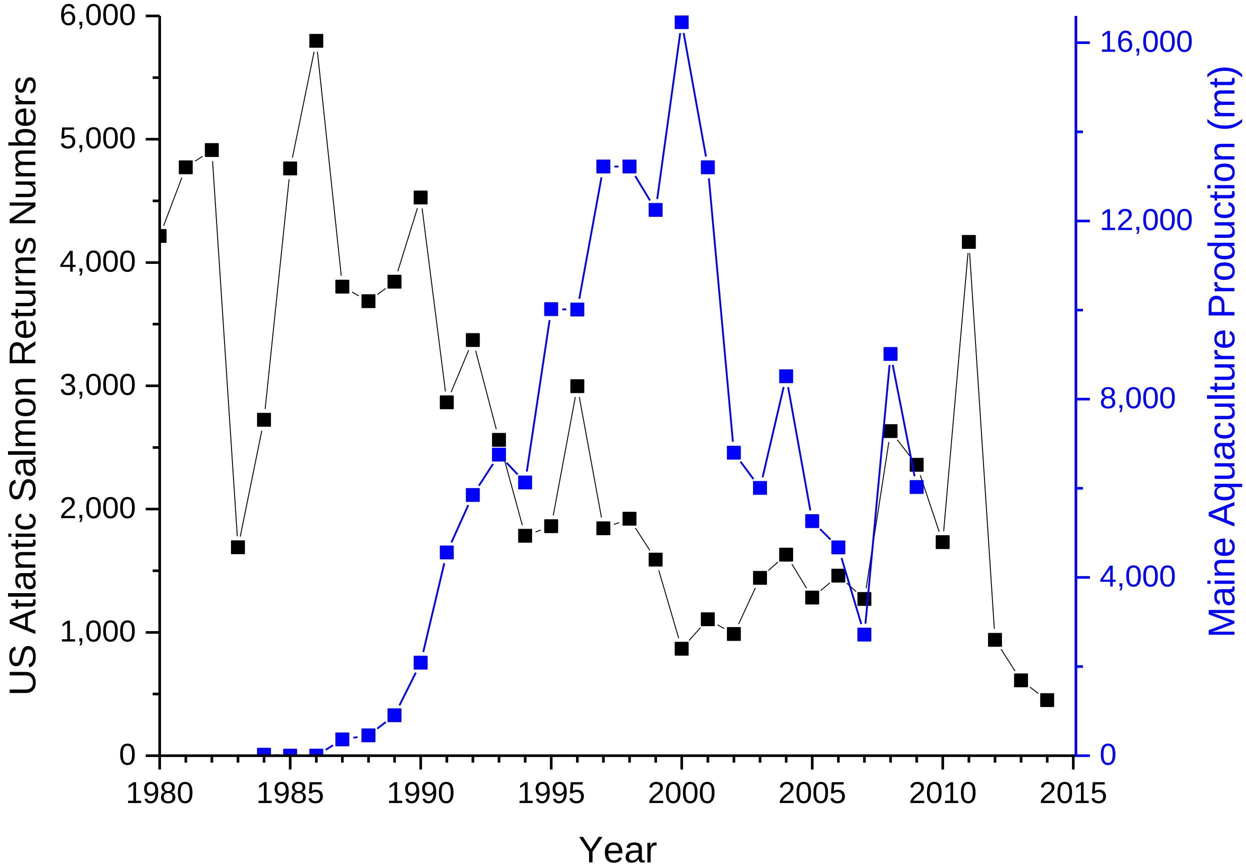

Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons), with only one company reporting since 2010, confidentiality laws limit industry reporting.

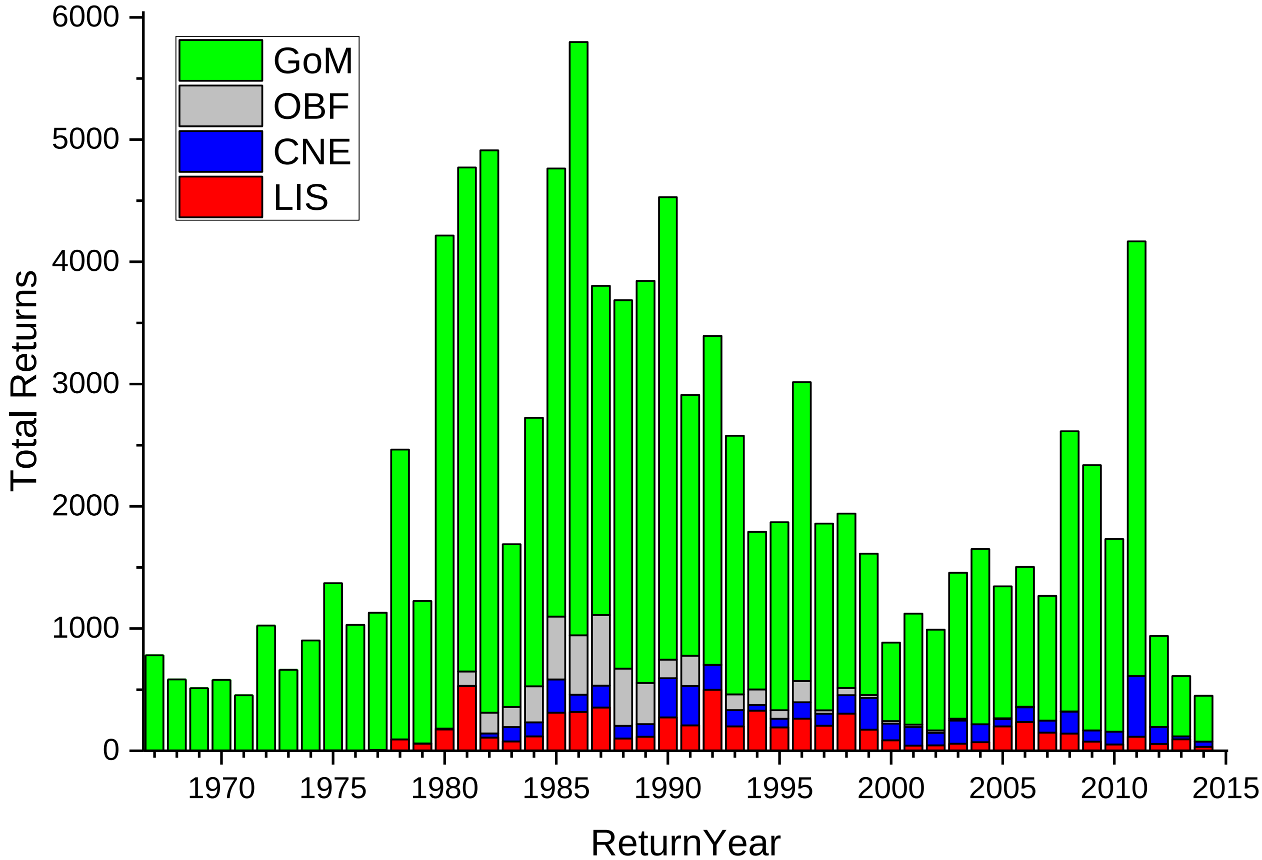

Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex from 1967 to present year.

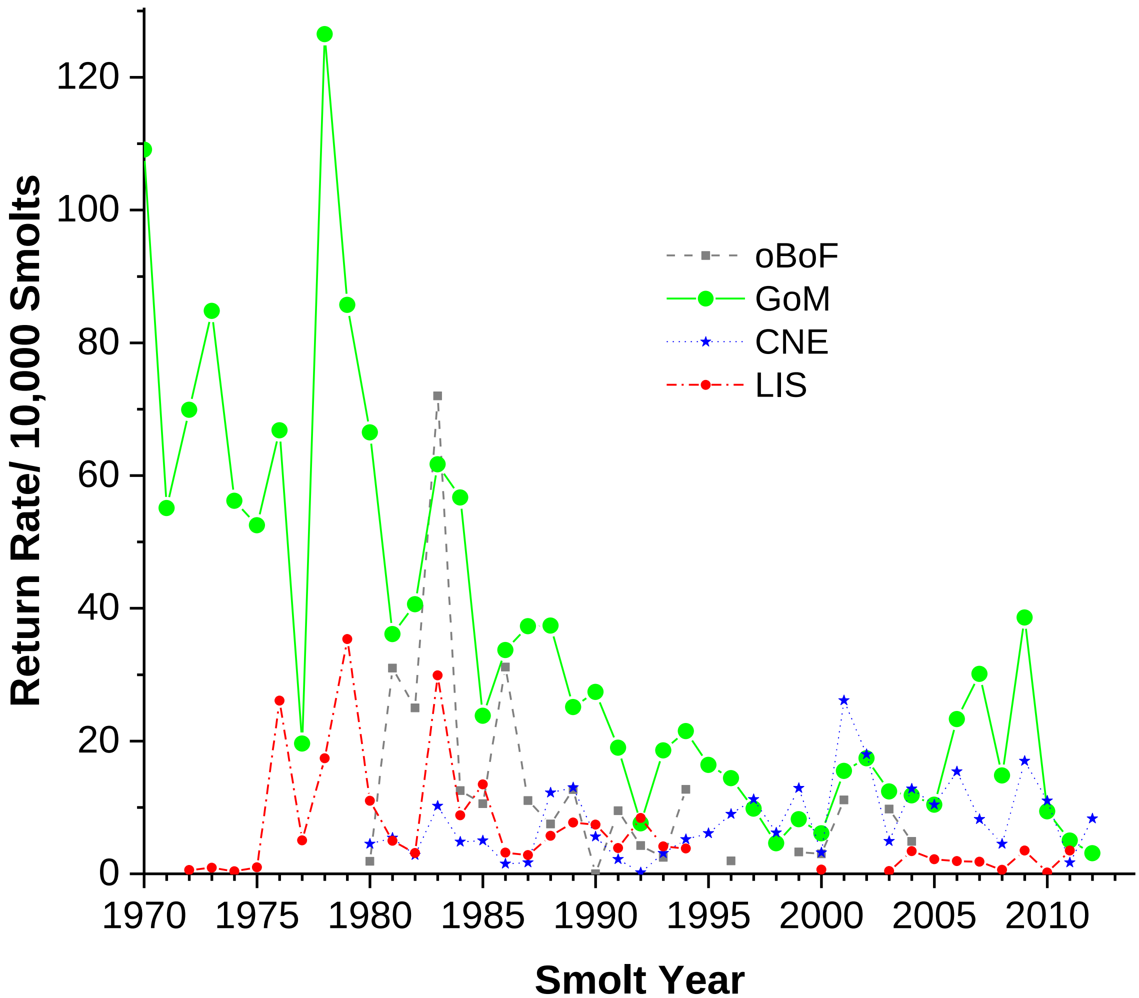

Figure 2.4.2.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

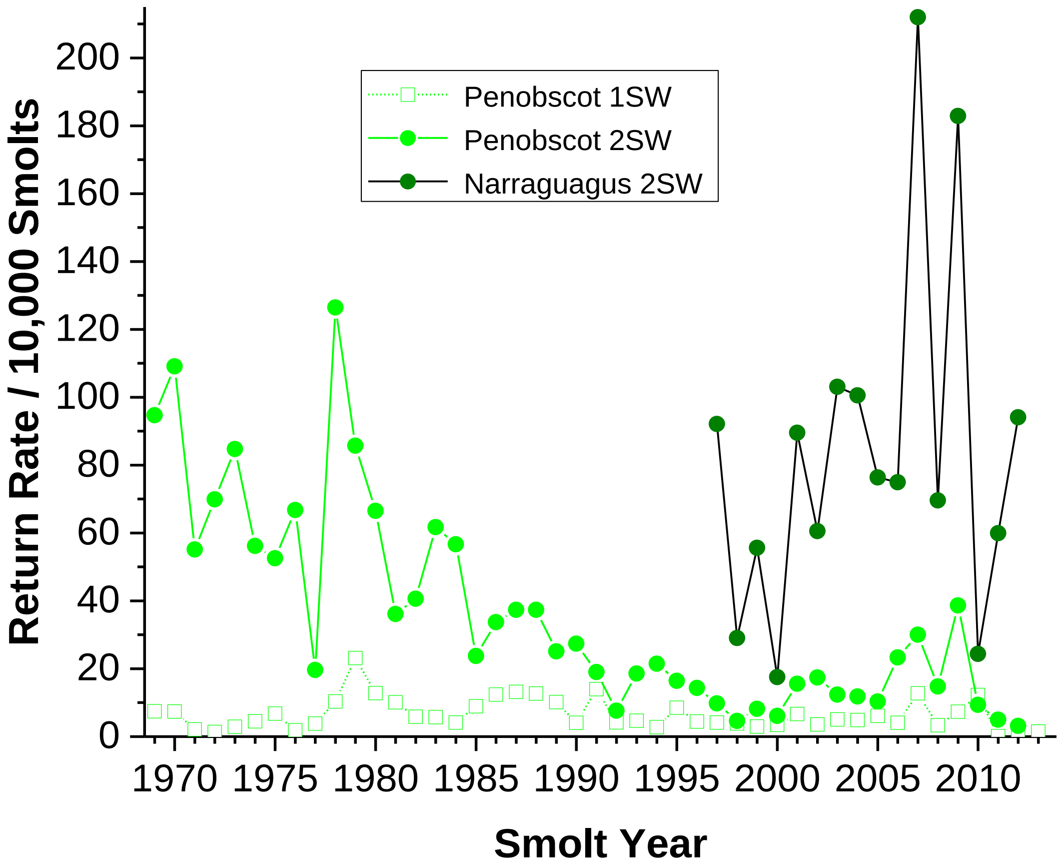

Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

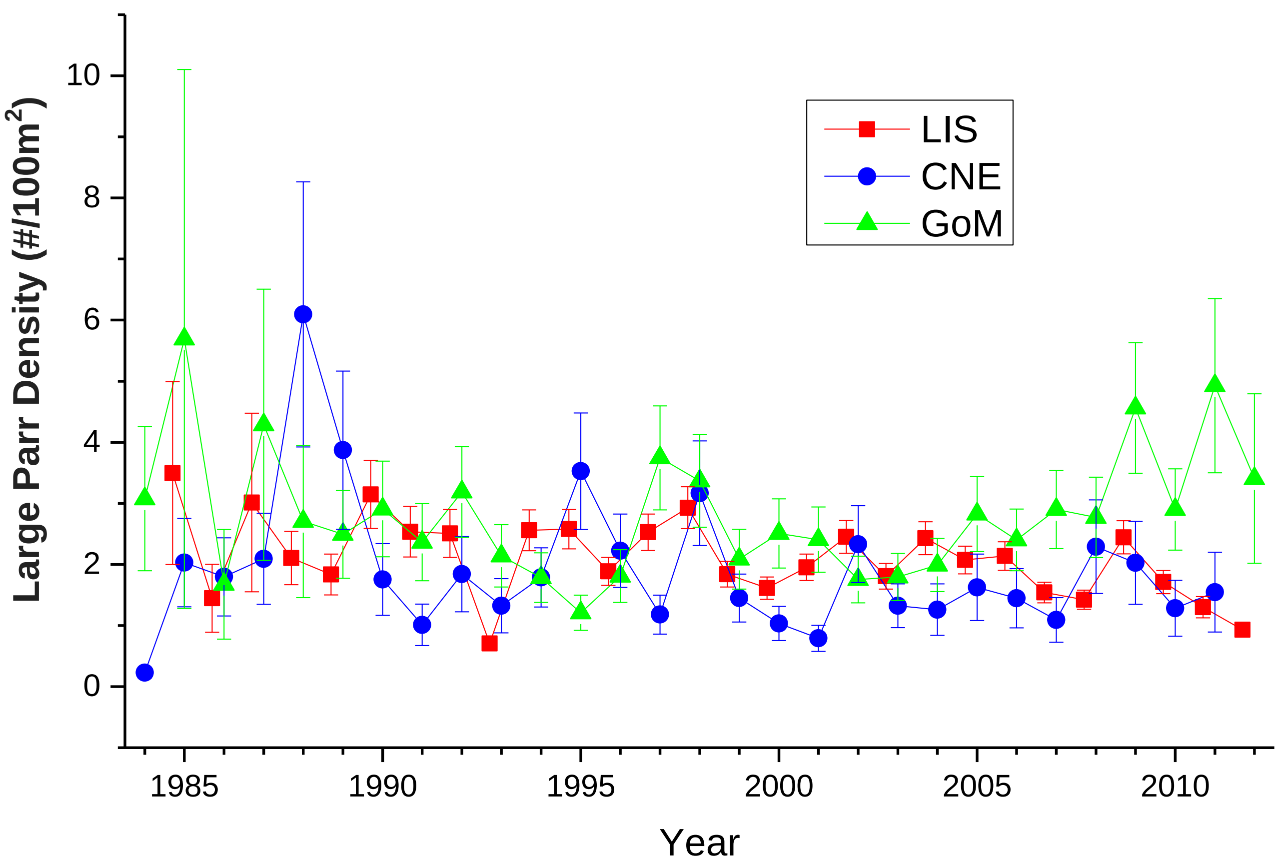

Figure 2.4.3.1 Index of large parr density from a mixed random effects model using electrofishing data from sites with > 10 years of data from 1984 through 2012 from USASAC databases for three stock complexes: Long Island Sound, Central New England, and in the Gulf of Maine DPS.

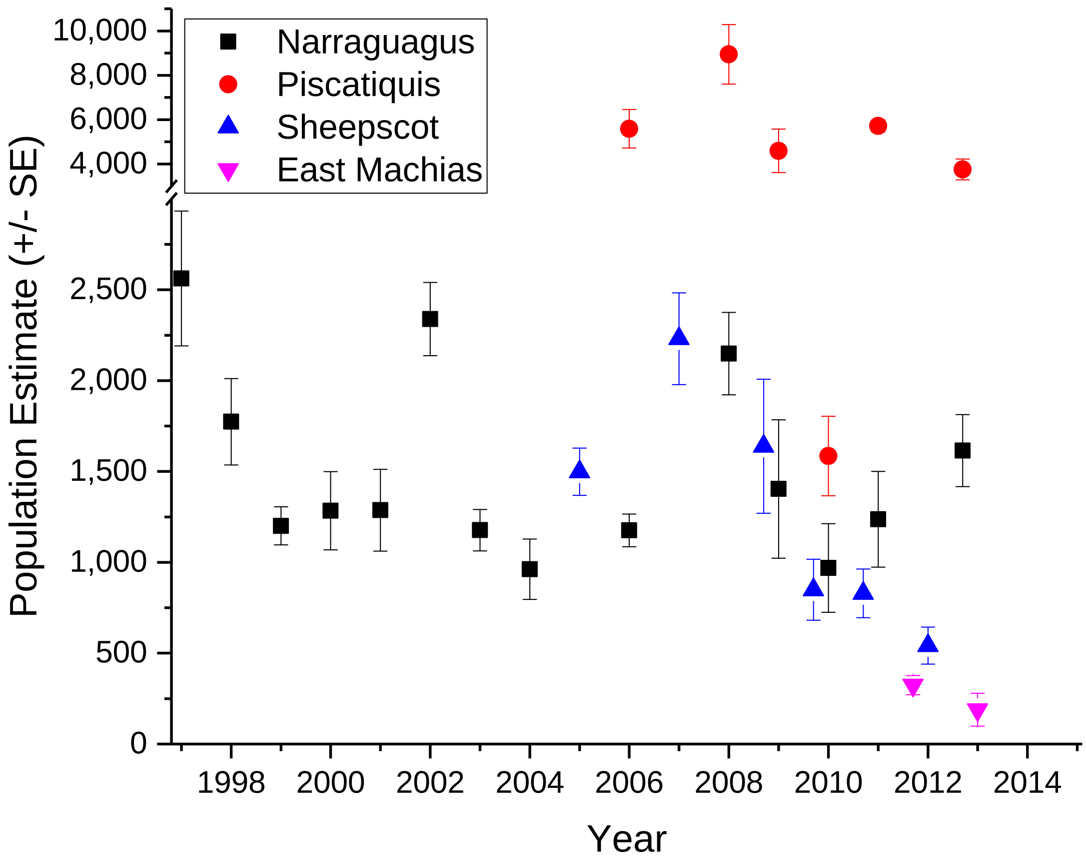

Figure 2.4.3.2 Mark-recapture population estimates of numbers of Atlantic salmon smolts emigrating from the Narraguagus, Piscatiquis, Sheepscot, and East Machias Rivers, Maine. See text for details of estimation methods.

3 Long Island Sound

3.1 Long Island Sound: Connecticut River

The Connecticut River Atlantic Salmon Restoration formally ceased in 2013 and in 2014 the new Atlantic Salmon Legacy Program was initiated by the Connecticut Department of Energy and Environmental Protection (CTDEEP). The Connecticut River Atlantic Salmon Commission (CRASC) maintained an Atlantic Salmon Sub-committee to deal with lingering issues of salmon throughout the watershed. Partner agencies other than the CTDEEP focused on operating fish passage facilities to allow upstream and downstream migrants to continue to access habitat but no further field work was conducted by other agencies. CRASC and its partners continued to work on other diadromous fish restoration in 2014. The following is a summary of work on Atlantic salmon.

3.1.1. Adult Returns

A total of 32 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 26 on the Connecticut River mainstem, three in the Farmington River, one in the Salmon River, and two in the Westfield River. No sea-run salmon were retained for broodstock at any facility. All returning salmon were released at fishways, except for the West Springfield Fishway (Westfield River) which required truck transport to upstream habitat. The intent was to handle, scale sample, and Floy-tag all salmon but one fish passed through the Holyoke Fishlift undetected and several others were intentionally not handled due to their physical condition and high water temperatures.

None of the adult salmon were of hatchery (smolt-stocked) origin. All were of wild (fry-stocked) origin. Two grilse were documented in 2014; all other returns were determined to be two sea-winter age fish. Not sampled fish (and fish with no readable scales) were assigned to age groups on a proportional basis. Including these assignments, the fresh-water age distribution of adult salmon was 1+ (31%), 2+ (66%) and 3+ (3%).

3.1.2. Hatchery Operations

Egg Collection
A total of 830,406 green eggs was produced in 2014, resulting in 568,405 eyed eggs (68% rate). Only the Kensington State Fish Hatchery (KSFH) in CT maintained domestic broodstock. Contributing broodstock included 103 females and 99 males, all 3+ year-old. Those eggs will be used for fry stocking for the Connecticut Legacy Program.

3.1.3. Stocking

Juvenile Atlantic Salmon Releases
A total of 198,957 juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2014. Selected stream reaches in the Farmington River received 119,737 fry and selected reaches in the Salmon River received 79,220 fry with the assistance of many

volunteers. Totals of 109,847 fed fry and 89,110 unfed fry were stocked into these tributary systems. Stocking was conducted out of KSFH, Tripps Streamside Incubation Facility, and Burlington State Trout Hatchery. Eggs at the latter two facilities were transferred from KSFH as eyed eggs.

Surplus Adult Salmon Releases
Domestic broodstock, surplus to program needs, from the KSFH were stocked into the Shetucket and Naugatuck rivers and two selected lakes in Connecticut to create sport fishing opportunities outside the Connecticut River basin.

3.1.4. Juvenile Population Status

Smolt Monitoring
TransCanada continued sampling of smolts at the Moore Dam, Littleton, NH. The trap operated from 30 April to 23 June, with 1,220 smolts collected. The highest collection occurred on 20 May (N=100). Over 80% of the catch was collected between 1 May and 31 May, and 95% was collected by 12 June. All smolts were captured and transported for release immediately downstream of the Vernon Dam, due to an agreement with the agencies. Mortality from the trap was 4% and resulted in a total of 1,171 smolts released. No other monitoring of smolts was conducted in 2014.

Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at index stations in Connecticut by CTDEEP. Electrofishing surveys in other states were not conducted in 2014. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production.

3.1.5. Fish Passage

Hydropower Relicensing- The licenses of five large hydropower projects (four main stem dams) will expire in 2018. These projects are Turners Falls, Vernon, Bellows Falls, and Wilder dams as well as the Northfield Mountain Pumped Storage facility, a project area spanning 175 river miles. State and Federal resource agencies have spent considerable time on FERC-related processes for these re-licensings. Many Study Requests have been submitted to FERC by the agencies. Due to the termination of the salmon restoration program, none of these requested studies involved Atlantic salmon.

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

New Fishways- The Manhan River fishway, a 4-foot wide Denil, in Easthampton, MA became operational for the first time in April of 2014. The Manhan River enters the Connecticut River in Easthampton, MA. One adult salmon was observed dropping back down the fishway at the video monitored fishway exit. Only a very limited analyses of the video for counts has occurred to date. The Tiley-Pratt fishway, a small pool-and-weir, was constructed by The Nature Conservancy and the CTDEEP on the first dam on the Falls River, Essex, CT. The Falls River enters the Connecticut River in Essex, CT. This fishway will mostly benefit river herring.

3.1.6. Genetics

The genetics program previously developed for the Connecticut River program has been terminated. A 1:1 spawning ratio was used for domestic broodstock spawned at the KSFH.

Sea-run origin fry (7,423) were stocked in Pine Brook in CT in the spring of 2014 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 2014.

3.1.7. General Program Information

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-Schools program, providing eggs for 87 tanks in 61 schools in Connecticut.

3.1.8. Migratory Fish Habitat Enhancement and Conservation

There were two notable stream restoration projects in 2014. The Karp Family Dam Removal Project on Stony Brook in Suffield, CT was begun in late 2014 but not completed until early 2015.Cooperators included the CTDEEP, the USFWS, and the North Connecticut Conservation District. The Falls River Dam Removal Project on Falls River in Gill, MA was completed in late 2014. Various partners, including the USFWS and the State of Massachusetts, had been working on this project for many years.

3.2 Pawcatuck River

3.2.1. Adult Returns

Zero (0) adult salmon returned to the Pawcatuck River this year.

3.2.2. Stocking

Juvenile Atlantic Salmon Releases

The Salmon in the Classroom program was responsible for stocking approximately 5,000 fry into the Pawcatuck River and its tributaries. No other Atlantic salmon fry were stocked into the Pawcatuck River in 2014. No smolts were stocked in the Pawcatuck River in 2014.

3.2.3. Juvenile Population Status

Index Station Electrofishing Surveys
Parr assessments were not conducted in 2014 due to lack of personnel.

3.2.4. Smolt Monitoring

No work was conducted on this topic during 2014.

3.2.5. Tagging

In Rhode Island, all smolts are released with adipose fin clips, however, no smolts were released in 2014.

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 2014.

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 2014.

4 Central New England

Central New England: Merrimack River

4.1.1 Adult Returns

Forty (40) Atlantic salmon were counted in the Merrimack River at the Essex Dam, Lawrence, MA and additional one (1) fish passed with a floy tag present indicating it was from the broodstock fishery. Unlike past years, no salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Instead all fish were allowed to run the river. Thirty-four (34) fish were observed passing the Pawtucket Dam, Lowell, MA via a fish lift, with others were known to pass an unmonitored fishway at the dam. Only cursory morphometric data was collected, when possible at the viewing window at the Essex Dam. Twelve (12) of the sea-run returns had an adipose clip. The morphometric data was used to prorate the return age, all fish recorded under 26" estimate was estimated to be a 1 sea-winter return.

4.1.2 Hatchery Operations

The reduction of effort for the Merrimack Program has focus primary effort of Nashua National Fish Hatchery to the Saco River program. In 2014, the fish in the domestic broodstock were recorded as "Merrimack Stock". This nomenclature will continue when referring to fish stocked into the Saco River and recorded in the Merrimack River section of the report.

Egg Collection

Spawners provided an estimated 1,243,662 green eggs.

Sea-Run Broodstock

No sea-run fish were retained for broodstock.

Domestic Broodstock

A total of 293 female and over 295 male captive (F1 from sea-runs) broodstock spawned at Nashua NFH; 243 fish were non-spawners. Of the 293 females, 2 were four years old, 290 were three years old, and 1 was two years old. The captive broodstock spawning season began on November 7, 2014 and ended November 20, 2014, and only included 4 spawning events to reach target egg production. All eggs were retained at NNFH for incubation and eventual release to the Saco River watershed and the Adopt-A-Salmon educational programs

Stocking

Juvenile stocking is limited to educational salmon in schools program at about 12,500 eggs provided to schools to rear and release in the Merrimack River watershed.

4.1.3 Juvenile Population Status

Yearling Fry / Parr Assessment

In 2014, no parr assessment was conducted. Parr were occasionally collected in electrofishing surveys focused on other species, but are not reported here.

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.

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.

Fish have continued to be stocked that have restoration value. These include excess 232 gravid broodstock (in excess of the need under the Saco River agreement) and small amounts of fry stocked as part of the salmon in schools program. Some natural reproduction is likely occurring where fish can access suitable spawning habitat.

Atlantic Salmon Broodstock Sport Fishery

NHFG had their last planned stocking of Adult Atlantic salmon for their broodstock fishery in the spring of 2014. All 616 fish were excess broodstock from the Merrimack and Saco Programs.

Adopt-A-Salmon Family

The 2014 school year marked the twenty-second year of the Adopt-A-Salmon Family Program in central New England. In January and February, an estimated 12,500 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.

Central New England - Integrated ME/NH Hatchery Production

The FWS, Eastern New England Fishery Resources Complex has developed an agreement with MDMR to engage in planning and implementing an Atlantic salmon restoration and enhancement project in the Saco River watershed (see section 4.2.3). The agreement provides that NNFH and/or NANFH will produce juvenile Atlantic salmon for continued Saco River Salmon Club (Club) “grow-out” or release to the Saco River.

4.2 Central New England: Saco River

4.2.1 Adult Returns

Brookfield Renewable Energy Group 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 operated from 29 May to 31 October 2014. No salmon were observed moving upriver through these facilities. Three adult Atlantic salmon were captured at a third passage facility upriver at Skelton Dam, which operated from 1 June to 31 October 2014. The Saco River trapping facilities were not operated at the beginning May due to mechanical problems and safety issues associated with fixing the problems.

4.2.2 Hatchery Operations

Egg Collection

In 2014, 395,805 eyed eggs from Merrimack River origin broodstock were transferred from the Nashua National Fish Hatchery to the Saco River Salmon Hatchery. A portion of these were distributed to school programs (Fish Friends) and the remaining reared at the hatchery for release as fry.

Stocking

Juvenile Atlantic Salmon Releases

A total of 12,000 smolts raised at North Attleboro National Fish Hatchery (NANFH) were released to the river. In addition, 4,000 age 0 parr raised at NANFH were stocked in to the Saco. Approximately 366,000 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 2014.

Smolt Monitoring

No smolt monitoring was conducted in 2014.

Tagging

No salmon out planted into the Saco were tagged or marked in 2014.

4.2.4 Fish Passage

No fish passage improvements were made during 2014.

4.2.5 Genetics

No genetic samples were collected in 2014.

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 2014.

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 2014 were 375. Returns are the sum of counts at fishways and weirs (284) and estimates from redd surveys (92). 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 2014 was 211 (97 Penobscot [261 return – 162 broodstock and 2 DOA] + 114 other DPS). Because there was no rod catch, the escapement to the GOM DPS area was assumed to equal returns (estimated or released after capture) plus released pre-spawn captive broodstock (adults used as hatchery broodstock are not included).

Estimated replacement (adult to adult) of naturally reared returns to the DPS has varied since 1990 although the rate has been somewhat consistent since 1997 at or below 1 (Figure 5.1.1). Most of these were 2SW salmon that emigrated as 2 year old smolt, thus, cohort replacement rates were calculated assuming a five year lag. These were used to calculate the geometric mean replacement rate for the previous ten years (e.g. for 2000: 1991 to 2000) for the naturally reared component of the DPS overall and in each of three Salmon Habitat Recovery Units (SHRU). Despite an apparent increase in replacement rate since 2008, naturally reared returns are still well below 500 (Fig. 5.1.2).

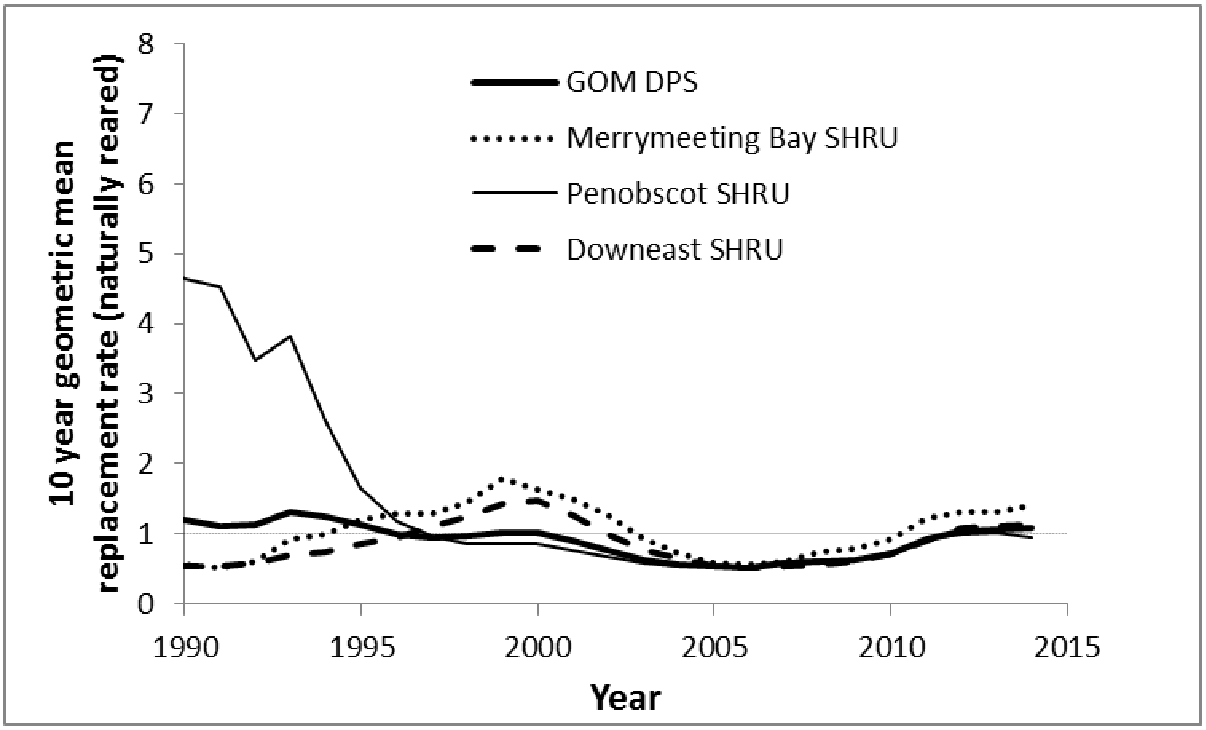

Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and the three Salmon Habitat Recovery Units (SHRU).

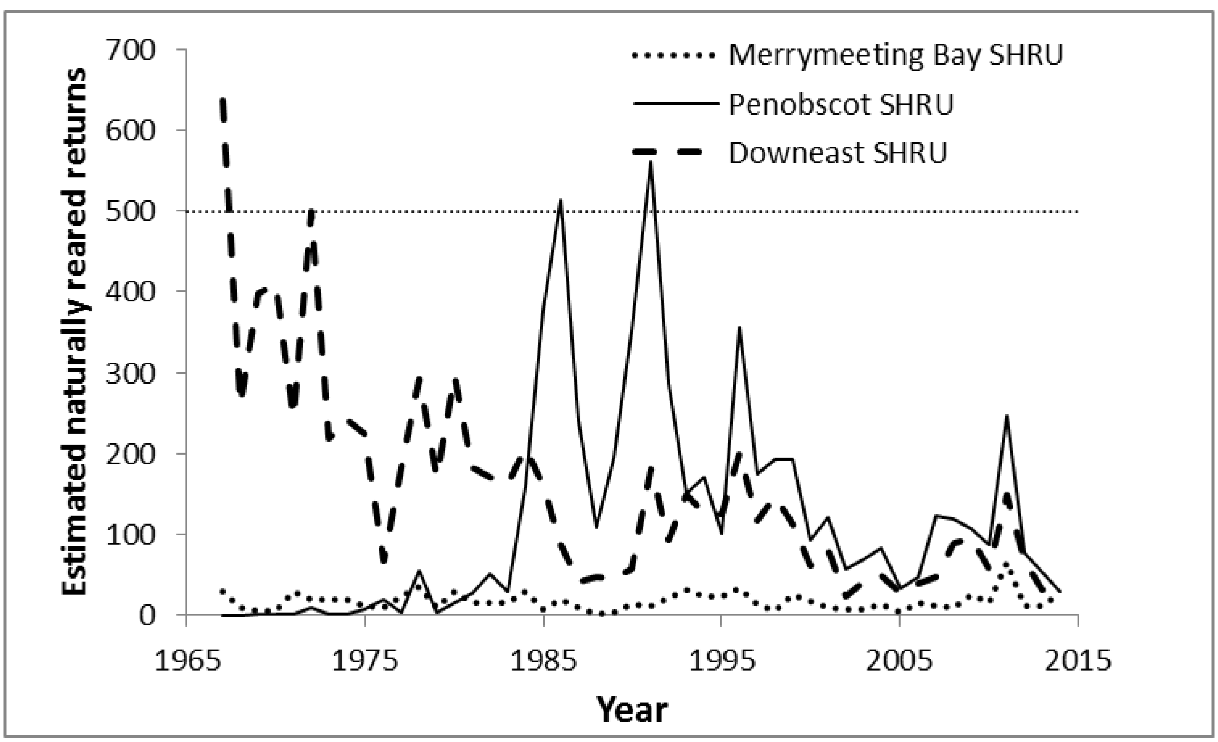

Figure 5.1.2 Estimated Naturally Reared Returns to the GOM

Small Coastal Rivers

Downeast Coastal SHRU

Dennys River
The weir in Dennysville has not been fished since 2011. At this time there are no plans to reactivate this site.

There was no spawning activity documented in the Denys River in 2014. However, due to high fall flows that limited visibility only Cathance Stream a major tributary was surveyed for redds.

East Machias River
Sixteen (16) redds attributed to wild returns were counted during the 2014 redd surveys in the East Machias River that included approximately 97% of known spawning habitat. No captive reared gravid adults were released into the East Machias because they were needed for egg production.

Machias River
A total of 11 redds were counted, covering only 40% of the known spawning habitat in the Machias drainage. Coverage was limited by high water and poor visibility.

There were 9 redds observed in Old Stream a highly productive tributary to the Machias. In 2013 only one redd had been observed, disappointing most since that was the first year true "wild" adults were to return. Since 2008 no hatchery product has been placed in Old Stream. These 9 redds can be attributed to 25 adult returns in 2010.

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 2014. 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 2SW returns from the 2011 stocked cohort were expected, as well as 1SW and MSW returns from fry stocking and natural reproduction. Staff captured two (2) 1SW hatchery origin and 1 naturally reared 2sw salmon in the fishway trap in 2014. Sea-age and origin were determined based on scale reading, marks and tags. Only 1 redd was noted in the Pleasant River during surveys that covered 85% of known spawning habitat area.

Narraguagus River
Returns to the fishway trap in 2014 (4) declined from last season (21) and remained far below the previous 10-year average (40 returns). It is important to note that high water conditions allow salmon to ascend Stillwater Dam in Cherryfield, bypassing the fishway trap. Of the four returns, 3 were two sea-winter (2SW) adults and one was a repeat spawner. In 2014, twenty redds were observed in the mainstem of the Narraguagus River. 82% of known spawning habitat was surveyed. Again as in other Downeast Rivers, high flows resulted in reduced coverage and poor visibility.

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 7 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 4 November.

Two female 2SW salmon were captured in the fishway trap on the Union River in 2014. One fish was trucked and released upstream to the West Branch of the Union, and the second salmon was returned to the river downstream of the Ellsworth Dam by Brookfield Renewable Energy Group. The second Atlantic salmon was not reported to MDMR until after the season had ended.

Penobscot SHRU

Ducktrap River
Three (3) redds were observed during surveys in late November that encompassed 73% of the spawning habitat area in the Ducktrap River watershed.

Cove Brook. No spawner surveys were conducted in 2014

Merrymeeting Bay SHRU

Sheepscot River
There were 26 total redds observed in the Sheepscot River in 2014. Of these 17 were in the West Branch and 9 were in the mainstem. 80% of known spawning habitat was surveyed. The number of redds observed was an increase from previous years and did not follow the trends observed in other rivers where the trend was a decrease. Factors influencing marine survival such as lifestage stocked may be responsible for the returns but data is not available yet to explain this year's numbers.

Sandy River (Kennebec Drainage)

The Sandy River is a tributary to the Kennebec River. In 2014 80% of known spawning habitat was surveyed and 5 redds were observed. Origin of the redds observed in the Sandy River are from adult salmon trapped at the Lockwood fish lift (18) that were transported and placed in the Sandy River.

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 (Pleasant, Narraguagus and Union rivers) combined with redd count data from the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot 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 92 (90% CI = 38 - 218) (Table 5.1.1). Estimates include returns to the Union River.

Table 5.1.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 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
2014	38	92	218

5.1.3 Large Rivers

Penobscot River
2014 was the first year that the fish lift at the Milford Dam was operational. With removal of the Veazie Dam in 2013, Milford is now the first dam returning adult salmon encounter in the Penobscot River. The new fish lift at the Milford Hydro-Project owned by Brookfield Renewable Energy Group became operational in the spring of 2014. The Milford fish lift was operated daily by MDMR staff from 5 May through 12 November, 2014. The fish lift was also used to collect adult sea-run Atlantic salmon broodstock for the U.S. Fish and Wildlife Service (USFWS).

We captured 261 sea-run Atlantic salmon during the 2014 season (Table 5.1.2). This represents a 32% decrease from last year's catch of 381 sea-run salmon, and is considerably lower than the ten year average (2004-2013) of 1,379 fish. This year's median capture date was 29 June, seventeen days later than 2013.

Scales collected from 258 salmon captured at the Milford fish lift were analyzed to characterize the age and origin structure of the 2014 run. The origins of ten salmon captured at the fish lift 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 (174; 67%), along with 83 1SW salmon (32%), two (2) 3SW fish, and two (2) repeat spawners. Approximately 92% (239) of the salmon that returned were of hatchery origin and the remaining 8% (22) were of wild or naturally reared origin.

Only 2% of this year's run (6 salmon) were observed to have at least one mark applied (adipose clip or caudal punch) prior to being released as a hatchery smolt. A single MSW, long absence, repeat spawner male salmon was observed with an caudal punch and a passive integrated transponder (PIT) tag. The tag number indicates this male salmon was originally captured on June 12, 2012 as a 2SW and transported to the USFWS Craig Brook National Fish Hatchery in Orland (CBNFH) for broodstock and later released back to the river post spawn.

Additional data collected at the Milford fish lift included counts of other species present during each tending day. River herring (*Alosa spp.),* smallmouth bass (*Micropterus dolomieu*), American shad (*Alosa sapidissima*), and sea lamprey (*Petromyzon marinus*) were the most abundant species observed in 2014.

Androscoggin River
The Brunswick Dam fishway trap was operated from 16 May to 14 November, 2014 (Table 5.1.2). Four (4) 2SW adult Atlantic salmon were captured at the Brunswick fishway trap. Due to upstream passage study requirements each fish was tagged with radio transmitters. Two of the returning Atlantic salmon remained in the Androscoggin River upstream of Brunswick. One was of naturally reared origin and one was of hatchery reared origin. One of the tagged salmon was tracked into the Little River during the spawning season where it was observed spawning with another salmon. It is believed that the other salmon may have

been a non-tagged salmon that passed through the Brunswick fishway while being cleaned. That fifth salmon was not documented as an official return to Maine.

Two of the tagged salmon dropped back downstream below Brunswick. One of the salmon did return to the Brunswick trap only to drop back downstream a second time and was then captured at the Lockwood fish lift facility on the Kennebec River and trucked upstream to the Sandy River, where it remained throughout the spawning season. That salmon was not counted as a return to the Androscoggin River, but rather to the Kennebec River. Both of the Atlantic salmon that dropped out of the Androscoggin River System were of hatchery origin.

Table 5.1.2 Counts of sea-run, Atlantic salmon returns to Maine rivers in 2014 by gender and sea-age: (One sea-winter, 1SW; two sea-winter, 2SW; three sea-winter, 3SW; multi sea-winter, MSW; and repeat spawner, RPT). Also included are counts of aquaculture (AQS) and captive reared freshwater (CRF) adult captures. Drainages are grouped by Salmon Habitat Recovery Unit (SHRU).

				Male				Female				Unknown		Adult Counts		
River	Open Date	Median Catch Date	Close Date	1SW	2SW	3SW	RPT	1SW	2SW	3SW	RPT	1SW	MSW	Sea-run	AQS	CRF
Downeast Coastal SHRU																
Dennys River*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Narraguagus River	28 Apr	19 Jul	30 Oct	0	3	0	1	0	0	0	0	0	0	4	0	0
Pleasant River	12 May	13 Jul	22 Oct	2	0	0	0	0	1	0	0	0	0	3	0	0
Union River	07 May	23 Jun	04 Nov	0	0	0	0	0	2	0	0	0	0	2	0	0
Penobscot Bay SHRU																
Penobscot River	05 May	29 Jun	12 Nov	83	64	1	2	0	110	1	0	0	0	261	0	0
Merrymeeting Bay SHRU																
Lower Kennebec River	05 May	14 Jul	14 Nov	3	3	0	0	0	12	0	0	0	0	18	0	0
Lower Androscoggin R.	15 Apr	24 Jul	14 Nov	0	1	0	0	0	2	0	0	0	0	3	0	0
Sebasticook River	07 May	--	14 Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				88	71	1	3	0	127	1	0	0	0	291	0	0

* No trap was installed or operated at this facility in 2014.

Kennebec River

The Lockwood fish lift was operated by Brookfield Renewable Energy Group from 5 May to 14 November 2014 (Table 5.1.2). Eighteen (18) adult Atlantic salmon were captured at the Lockwood fish lift. Of those, fifteen (15) were 2SW and three (3) were 1SW. All 18 adult Atlantic salmon were trucked and released to the Sandy River.

Sebasticook River

The Benton Falls fish lift facility was operated by MDMR staff from 7 May to 14 August 2014 (Table 5.1.2). No Atlantic salmon were captured at Benton this year.

Survival Estimates

Atlantic salmon survival rates were calculated for marked hatchery stocks and naturally reared stocks for the Narraguagus and Penobscot Rivers (Table 5.1. 3). 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, 0.78%).

Table 5.1.3. 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 where all 2 sea-winter adult returns have been accounted for. Therefore, in some cases some 3 sea-winter adults may still be at large.

Cohort Year	Salmon Habitat Recovery Unit	Drainage	Source	Survival From	Survival To	Number Stocked or Estimated	Number of survivors	% Survival
2010	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	62,400	78	0.13
2010	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	2,376	25	1.05
2011	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	64,000	37	0.06
2011	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1,785	14	0.78
2012	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	59,100	17	0.03
2012	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1,213	6	0.49
2008	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	512,500	1,007	0.20
2009	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	559,828	2,583	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	283	0.05
2012	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	555,200	230	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 4,447,793 million eggs for the Maine program in 2014: 775,100 thousand eggs from Penobscot sea-run broodstock; 1,653,293 million eggs from two domestic broodstock populations; 2,019,400 million eggs from six captive broodstock populations. Due to the continued low number of returning adults to the Penobscot, and corresponding reduction in available eggs, domestic-origin eggs produced at GLNFH will be incorporated into smolt production as for the 2014 cohort.

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 2014 CBNFH used year class crosses as well as spawning optimization software to avoid spawning closely related individuals within captive broodstock populations

A total of 102 Penobscot sea-run origin females, 1 domestic female, and 519 captive females were spawned at CBNFH between the 28th of October and the 25th of November. At GLNFH, 354 age four and 203 age three domestic females were spawned to provide eggs for smolt production, fry production, and in-stream egg planting.

Egg Transfers

CBNFH transferred 290K Penobscot eyed eggs to GLNFH for age 1 smolt production, 396K 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 and 118K eyed Sheepscot eggs for egg planting in the Sheepscot River.

GLNFH transferred 1.18M eyed, Penobscot domestic origin eggs to DMR for egg planting in the Sandy River (1.15M) and for the Penobscot River (30K).

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 2014.

Wild Broodstock Collection and Domestic Broodstock Production

A total of 214 adult sea-run Atlantic salmon captured at the Milford Dam, on the Penobscot River, was 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. This increase was carried over in 2014. Given the low returns to the Penobscot River in 2012, 2013 and 2014, CBNFH and DMR personnel elected to collect parr for use as future broodstock in 2014 with a collection target of 1500 parr collected from throughout the basin.

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 2014, 2,393 wild parr (35, Dennys; 237, East Machias; 301, Machias; 306, Narraguagus; 1103, Penobscot; 202, Pleasant; 209, 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 2013 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 2014. Incoming adults were isolated in the screening facility to undergo sampling procedures and await the results of PCR testing. No suspects were identified in 2014.

Stocking

Stocking activities in Maine resulted in the release of over 4.75M Atlantic salmon in 2014. 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 (558K). Of the 558K, 92K were marked with adipose clips and visual implant elastomer (VIE) tags. No age 0 parr were released from GLNFH in 2014; due to the small number of sea-run origin eggs in 2013 all juveniles from that cohort are being retained at GLNFH for release in 2015.

Ambient age 0 parr reared at CBNFH released into the Sheepscot River totaled 15K; all CBNFH origin parr were marked with adipose fin clips. The Downeast Salmon Federation released 150K ambient age 0 parr reared by the East Machias Atlantic Salmon Resource Center; East Machias parr were adipose fin clipped.

The two federally operated hatcheries, CBNFH and GLNFH produced approximately 1.41 million unfed fry [Penobscot, 811K; Machias, 210K; Narraguagus, 263K; Sheepscot, 23K; Union, 22K], for release throughout the Distinct Population Segment (DPS).

Several privately operated hatcheries continued to support Atlantic salmon stocking efforts in 2014. Two hatcheries operated by the Downeast Salmon Federation released fry and age 0 parr into both the Pleasant (114K fry) and East Machias (16K fry and 150K 0 parr).

Adults

No gravid broodstock were released in 2014. Following spawning, 213 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2014. 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 (38); East Machias (168); Machias (292), Narraguagus (202); Pleasant (168); Sheepscot (74). GLNFH released 1,220 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River. In addition, the USDA released 120 excess adults 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 2014. 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 2014 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

ME-DMR conducted electrofishing surveys to monitor spatial and temporal abundance of Atlantic salmon juveniles at 401 sites in 2014. Three hundred one (301) of the locations were sampled using a catch-per-unit-effort protocol, 12 sites were sampled using a multi-pass depletion protocol, and 8 locations were sampled to collect parr broodstock for the captive reared broodstock program. The sampling effort encompassed several projects including a juvenile abundance index, egg planting assessment, adult translocation study assessment, and large woody debris. DMR collected 436 scale samples and 1,101 fork length measurements from juvenile salmon in 2014.

2014 was the fourth 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 2014, a total of 125 sites were sampled; 59 for the Downeast SHRU, 26 for the Penobscot SHRU, and 40 for the Merrymeeting Bay SHRU

Two sampling methods are 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 (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.

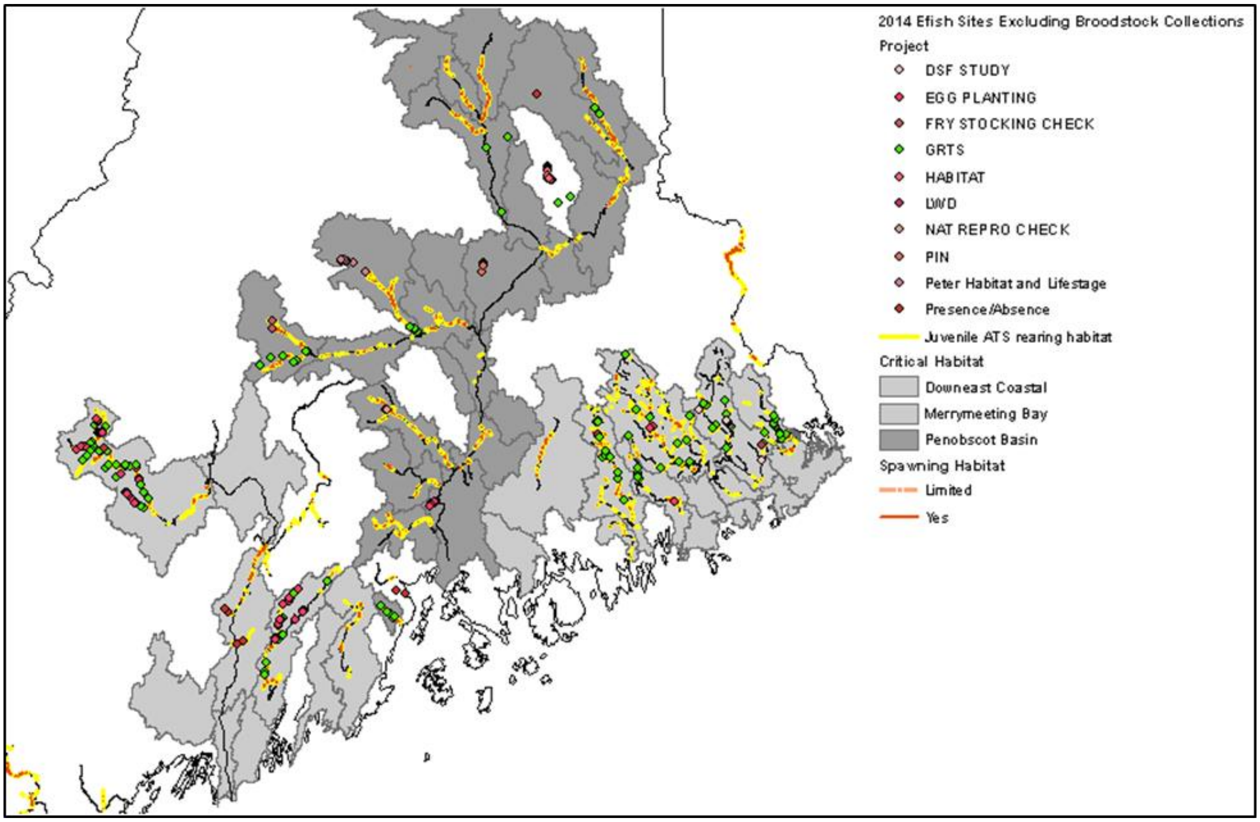

Figure 5.3.1. Locations of juvenile salmon assessments work performed in 2014.

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, 2014. Drainages are grouped by Salmon Habitat Recovery Unit (line).

		Parr				YOY			
Drainage	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Dennys	2014	2	0.45	0.48	0.51	2	6.46	9.25	12.05
East Machias	2014	2	4.43	10.56	16.69	2	0	0	0
Machias	2014	2	0	0.05	0.09	2	0	0.01	0.02
Narraguagus	2014	2	1.39	6.15	10.91	2	3.33	9.95	16.57
Pleasant	2014	2	1.87	3.49	5.11	2	0.7	6.23	11.76
Sheepscot	2014	11	0	4.76	34.96	11	0	8.83	60.64
Ducktrap	2014	1	0	0	0	1	0	0	0
Penobscot	2014	3	10.59	15.61	16.37	3	0	55.95	79.32
Piscataquis	2014	3	0.4	4.21	7.39	3	4.21	16.25	18.45

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, 2014. Drainages are grouped by Salmon Habitat Recovery Unit (line).

		Parr				YOY			
Drainage	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Dennys	2014	11	0	0	0.39	11	0	0.4	3.51
East Machias	2014	17	0	1.98	5.4	17	0	0	6.75
Machias	2014	23	0	0.55	2.71	23	0	0.2	9.34
Narraguagus	2014	21	0	0.8	3.37	21	0	2.6	12.98
Pleasant	2014	12	0	0.5	1.5	12	0	1.3	4.17
Sandy River	2014	65	0	0.59	2.19	65	0	0.39	7.5
Sheepscot	2014	30	0	0.2	2.8	30	0	0.5	5.4
Ducktrap	2014	6	0	0	0.19	6	0	0	0
East Branch Penobscot	2014	3	0	0	0.19	3	0	0	0
Mattawamkeag	2014	4	0	0.3	3.73	4	0	0	1.18
Penobscot	2014	25	0	1.17	3.53	25	0	0.71	10.06
Piscataquis	2014	20	0	0.36	3.46	20	0	1.22	7.19

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), 2007 to 2014.

		Density (fish / 100m^2)								CPUE (fish / minute)							
		Parr				YOY				Parr				YOY			
SHRU	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Downeast Coastal	2007	55	0	2.88	22.32	53	0.42	7.33	58.85	139	0	0.56	5.05	139	0	1.79	15.31
	2008	43	0	3.55	20.15	43	0	7.02	73.83	20	0	0	2.4	20	0	0.59	8.75
	2009	56	0	3.75	32.53	56	0	7.66	36.54	58	0	0.75	5.45	58	0	1.62	15.37
	2010	29	0.54	5.17	28	29	0	8.03	89.09	109	0	1	8.84	109	0	1.4	15.54
	2011	19	0	2.83	94.58	19	0	3.41	65.74	162	0	0.8	8.74	162	0	0.6	6.32
	2012	9	0.56	2.75	11.36	9	0	0.72	19.88	73	0	0.44	3.19	73	0	0.37	5.4
	2013	6	0	1.48	2.49	6	0	1.17	13.59	85	0	0.6	8	85	0	0	8.4
	2014	10	0	1.63	16.69	10	0	2.02	16.57	84	0	0.6	5.4	84	0	0.88	12.98
Merrymeeting Bay	2007	33	0	0.28	50.27	33	0	4.03	69.76	34	0	0	2.6	34	0	0.23	5.03
	2008	26	0	1.64	21.65	27	0	2.17	38.85	20	0	0.36	0.77	20	0	0	1.4
	2009	17	0	6.01	21.74	17	0	3.12	28.07	48	0	0	3.27	48	0	0.19	9.35
	2010	22	0	2.14	16.57	21	0	3.03	109.94	112	0	0	2.94	112	0	0.8	29.4
	2011	17	0	8.65	44.45	17	0	1.89	43.26	56	0	0.2	4.37	56	0	0.2	9.8
	2012	20	0	2.25	16	20	0	6.65	77.48	108	0	0.2	4.92	108	0	0.4	12.97
	2013	15	0	4.92	41.11	15	0	8.86	61.68	103	0	0.2	2.8	103	0	0.4	6.6
	2014	11	0	4.76	34.96	11	0	8.83	60.64	95	0	0.4	2.8	95	0	0.4	7.5
Penobscot	2007	49	0	0	33.73	25	0	0	66.78	50	0	0.38	2.51	50	0	0	1.8
	2008	11	0	6.69	17.75	11	0	19.94	47.08	74	0	0	0.95	74	0	0	0.38
	2009	10	0	7.89	20.39	10	4.07	29.8	39.74	119	0	0	2.93	119	0	0.75	7.79
	2010	11	0	11.5	22.07	12	0	10.68	92.68	112	0	0	3.91	112	0	0.77	15.95
	2011	5	0	6.99	14.9	5	0	4.06	49.8	87	0	0	3.82	87	0	0	5.72
	2012	13	0	1.47	12.99	13	0	21.9	69.88	85	0	0	3.05	85	0	0.4	13.96
	2013	10	0	10.61	25	12	0	6.54	105.14	85	0	0.53	4.53	85	0	0.19	12.2
	2014	7	0	7.39	16.37	7	0	16.25	79.32	58	0	0.79	3.73	58	0	0.54	10.06

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.

Maine MDMR captured Atlantic salmon smolts using rotary screw traps (RST) in four Maine rivers (East Machias, Narraguagus, Piscataquis, and Sheepscot) to estimate smolt production and monitor migration timing in spring 2014. The East Machias River site was operated in partnership with the Downeast Salmon Federation (DSF). Additionally, Brookfield Renewable Energy Group captured smolts for downstream passage telemetry studies on the Sandy River a tributary of the Kennebec River. RST deployments occurred between 18 April and 13 June depending on river conditions and smolt captures at each assessment site (Table 5.3.4). A total of 2,035 smolts of hatchery and wild origin were captured in Maine rivers in 2014.

Table 5.3.4. Atlantic salmon smolt trap deployments, total captures, and capture timing by origin in Maine rivers, 2014.

River	Dates Deployed		Origin	Total Captures	First Capture	Median Capture Date	Last Capture
East Machias	30-Apr	13-Jun	H	123	4-May	21-May	11-Jun
			W	36	3-May	18-May	1-Jun
Narraguagus	23-Apr	3-Jun	W	523	1-May	15-May	2-Jun
Piscataquis	6-May	6-Jun	W	955	7-May	17-May	4-Jun
Sandy	18-Apr	12-Jun	W	83	23-May	26-May	2-Jun
Sheepscot	26-Apr	8-Jun	H	181	30-Apr	22-May	5-Jun
			W	134	29-Apr	10-May	5-Jun
			TOTAL	2,035			

A subsample of captured smolts undergo biological sampling including measurement of length (mm) and live weight (0.1g), observation of marks, fin condition, relative smolt development, and notation of any injury or mortality. Depending on site specific sampling plans, smolts were differentially marked or tagged to aide in mark and recapture or tracking. MDMR marked 1,465 smolts with a caudal punch in 2014 (Table 5.3.5). Scale samples and genetic tissue were collected for analysis from all rivers. No PIT tags were applied to smolts in 2014. Brookfield Renewable Energy Group marked 83 smolts with caudal clips. NOAA Fisheries and MDMR applied hydro acoustic “pinger” tags to 50 smolts from the Sandy River to study movements in Merrymeeting Bay.

Scale analysis indicated wild origin smolts were predominately age-2 (Table 5.3.5). The East Machias River had the highest proportion of age-3 smolts; a demographic shift driven by elimination of drainage-wide unfed fry stocking while transitioning to 0+ parr stocking. East Machias and Sheepscot River hatchery origin smolts were predominately age-1 (p8). However, older age-class hatchery origin smolts (p20 and p32) were found proportionally greater in the East Machias River. Sheepscot River smolts of both origins were larger at all ages compared to all rivers (Table 5.3.6). Both age-2 and age-3 wild smolts captured in the Piscataquis River were smaller than smolts in all rivers.

Table 5.3.5. Freshwater age distribution of Atlantic salmon smolts by origin captured in Maine rivers, 2014.

			Smolt Age						
River	Origin	n	1	2	3	4	p8	p20	p32
East Machias	H	116	--	--	--	--	64.1%	35.0%	0.9%
	W	36	0.0%	58.3%	41.7%	0.0%	--	--	--
Narraguagus	W	212	0.0%	83.5%	15.1%	1.4%	--	--	--
Piscataquis	W	562	0.0%	88.4%	11.6%	0.0%	--	--	--
Sandy	W	81	0.0%	75.3%	24.7%	0.0%	--	--	--
Sheepscot	H	158	--	--	--	--	84.8%	14.6%	0.6%
	W	133	0.0%	81.2%	18.8%	0.0%	--	--	--

Table 5.3.6. Mean length (mm ± s.d.) and weight (g ± s.d.) of Atlantic salmon smolts by age and origin captured in Maine rivers, 2014.

River	Origin	n	Age Code	Fork Length (mm)	Wet Weight (g)
East Machias	H	75	p8	162±17	38.9±13.5
	H	41	p20	183±18	55.2±17.0
	W	21	2	178±12	51.1±11.7
	W	15	3	190±18	63.3±16.6
Narraguagus	W	177	2	168±12	48.3±10.9
	W	32	3	181±17	55.8±15.7
Piscataquis	W	491	2	146±10	29.8±6.2
	W	65	3	159±9	36.0±5.9
Sandy	W	61	2	152±12	36.3±8.9
	W	20	3	160±12	41.3±9.4
Sheepscot	H	134	p8	167±10	52.4±10.0
	H	23	p20	193±14	75.0±17.1
	W	108	2	187±19	67.0±22.0
	W	25	3	193±18	73.9±24.0

Scientists generated population estimates (Table 5.3.7) using the 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. The East Machias, Piscataquis and Sheepscot River population estimates are based on a one site mark-recapture design. A two site mark-recapture design was used on the Narraguagus River to estimate the number smolts exiting the system for a seventeenth year. Obtaining a population estimate was not a sampling objective for the Sandy River. A more detailed report on smolt population enumeration and dynamics is included in Working Paper WP15-02- Smolts Update.

Table 5.3.7. Maximum likelihood mark-recapture population estimates for wild and hatchery origin Atlantic salmon smolts emigrating from Maine rivers, 2014.

River	Estimate Type	Origin	Population Estimate
East Machias	One site	Hatchery	852 ± 238
		Wild	189 ± 90
		Combined	1019 ± 205
Narraguagus	Two site	Wild	1,615 ± 198
Piscataquis	One site	Wild	3464 ± 336
Sheepscot	One site	Hatchery	1,294 ± 345
		Wild	542 ± 102
		Combined	1,650 ± 234

5.4 Fish Passage

Penobscot River PIT Network

Summary Compiled by George Maynard and Joe Zydlewski (USGS)

Starting in 2011, a cooperative effort between the MDMR, the University of Maine (UM), and the United States Geological Survey's Maine Cooperative Fish and Wildlife Research Unit (CFWRU), led to the installation of antennas to monitor movement of fish marked with passive integrated transponder (PIT) tags in the Penobscot River system. The original array consisted of antennas at eight dams (Veazie, Milford, West Enfield, and Weldon on the Penobscot River, Howland, Brown's Mill, and Guilford on the Piscataquis River, and Pumpkin Hill on the Passadumkeag River). This year's array is configured differently to reflect changes in hydropower management and monitoring efforts. Veazie Dam was removed, and is no longer part of the array. New antennas were installed at Milford to monitor the new fish lift. The old array is still operational at Milford, as the old Denil fishway was in operation for parts of the migration. Arrays upstream of Howland and West

Enfield were not deployed this year, as low salmon returns were anticipated and staff time was limited.

Antenna deployments consist of a minimum of two antennas (custom built) to detect fish (at least one at the top and bottom of each fishway), a multiplexor (Digital Angel FS1001M) to decode and store detections, and a cellular modem (Verizon Raven XT) to transmit data to a central monitoring location. There, data are downloaded using PuTTY v0.62 (a free and open-source tel-net client) and stored as text files (*.txt). Text files include tag numbers detected along with timestamps and antenna numbers, as well as information on noise levels, which can be used to assess antenna efficiency.

This year the majority of multi-sea winter salmon (MSW) captured at the Milford Dam fish lift was trucked to the Craig Brook National Fish Hatchery (CBNFH) in Orland, Maine to be used as broodstock. A subset (n=64) were radio tagged (and PIT tagged) and released downstream of the Milford Dam as part of two telemetry studies to evaluate the efficiency of the new fish lift. Fifty-two (52) of these fish were subsequently recaptured at the Milford Dam and trucked to the CBNFH hatchery as broodstock. Five (5) escaped upstream of Milford, and seven (7) are still unaccounted for.

Three (3) of the MSW Atlantic salmon released to the Milford head pond were detected at the West Enfield fishway. PIT tag number EZ1501 was radio tagged and released at Ayer's Island boat ramp as part of a radio tag study on 19 May. It was detected at West Enfield on 9 June. Tags EZ1504 and EZ1505 were radio tagged and released at the Brewer boat ramp on 26 May and 27 May, respectively. Tag EZ1504 is known to have escaped the Milford fish lift facility on 5 June when it was inadvertently allowed to pass by the gates of the sorting facility. This fish was detected at West Enfield on 9 June. Fish EZ1505 was detected at West Enfield on 8 June. It is not clear how salmon EZ1501 or EZ1505 passed the Milford Dam, as MDMR staff did not observe any other MSW salmon escaping the fish lift facility back to the river. It may be possible that these fish were able to pass over the Milford Dam during high flows. On 27 August, two additional radio tagged MSW salmon were recaptured and released to the Milford Dam headpond. These fish were not detected at upstream PIT tag receivers.
Twenty-eight 1SW salmon (grilse) were released to the Milford Dam head pond with PIT tags. None of these fish were detected at upstream PIT tag receivers.

This year marks the second year of PIT monitoring of species other than Atlantic salmon. MDMR biologists tagged and released 58 sea lamprey, 646 river herring (blueback herring and alewife), and eleven (11) American shad. Thirty-seven (37) river herring were detected at West Enfield. They averaged 5.5 days of travel time between release at Milford and first detection at the West Enfield fishway. Of the 37 river herring detected, twenty (20) passed upstream of the facility. None of the sea lamprey or American shad were detected at upstream PIT tag receivers.

Souadabscook Stream – Gristmill Road Crossing

MDMR collaborated with the Atlantic Salmon Federation and US Fish and Wildlife Service to design and install fish passage (20 foot long Alaskan Steeppass Fishway) on Souadabscook Stream at the Grist Mill Road crossing in Carmel, Maine to allow anadromous alewives access to Etna Pond (362 acres). The crossing is at an historic mill site that is now in ruins. A ledge drop occurs under the bridge that was a result of both the historic mill development and the bridge construction. With fish passage restored Etna Pond will support a run of approximately 85,000 adult alewives annually.

Souadabscook Stream – Gristmill Road Crossing Project: Before, during and after construction

5.5 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick (3), the Lockwood fish lift on the Kennebec River (18), the Narraguagus River (4), The Pleasant River (3) and the Penobscot River (259). In total 287 genetic samples were collected in 2014 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 2014, DPS broodstock (collected in 2013) 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 (Salmon-in-Schools)

2014 marked the twentieth year of FWS' 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 many rivers within the DPS. In addition to educational facilities, local businesses are 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 (Service) and National Oceanographic and Atmospheric Administration - National Marine Fisheries Service (NMFS), in close collaboration with Maine Department of Marine Resources and the Penobscot Indian Nation. The draft was reviewed by the Department of Interior Office of the Regional Solicitor in late fall of 2012. Revisions are nearly complete to the draft plan in response to issues raised by the Regional Solicitor's Office. The Service and NMFS target date for publishing a notice of availability for public review in the Federal Register, in late spring of 2015. 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 2014, a number of small-scale habitat protection projects were completed in the Narraguagus and Pleasant River watersheds and large-scale projects are in development throughout the DPS.

Habitat Connectivity

Numerous studies have identified how stream barriers can disrupt ecological processes, 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 (MDIFW), Maine Department of Marine Resources (MDMR), Maine Forest Service (MFS), Maine Department of Transportation (MDOT), Maine Natural Areas Program (MNAP), Maine Coastal Program, Maine Audubon, The Nature Conservancy, Trout Unlimited, Atlantic Salmon Federation, Maine Rivers, National Oceanic and Atmospheric Agency (NOAA), USDA Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), Androscoggin Soil and Water Conservation District, and local land trusts.

After 8 years of fieldwork, well over half of the state's perennial stream crossings have been assessed (see Map 5.7.1). Almost 10,000 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 2015, stream barrier surveys will be completed in the St. Croix, Kennebec, West Branch Penobscot, Androscoggin, and numerous small Downeast and southern Maine watersheds.

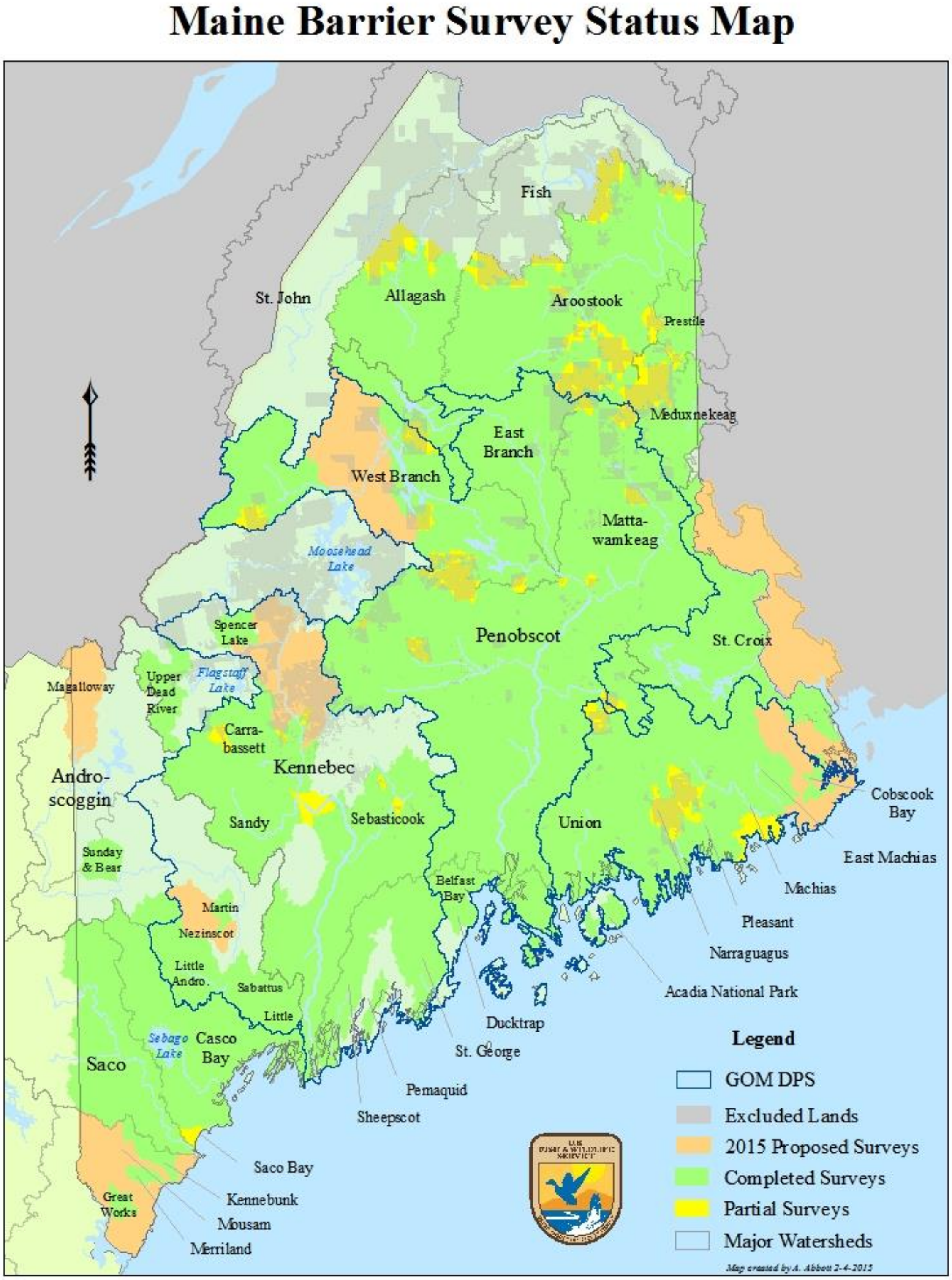

Figure 5.7.1 Extent of barrier surveys conducted in Maine to present. Almost 10,000 road-stream crossings have been assessed within the Gulf of Maine DPS since 2006.

Stream Smart training: In 2014 Maine Audubon continued to lead a statewide partnership to educate professionals responsible for road-stream crossings on how to improve stream habitat by creating better crossings. The partnership hosted 10 workshops around the state (in southern, central, and northern Maine) with over 200 attendees. Since 2012 over 700 people representing over 80 towns have attended Stream Smart workshops. Workshops 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, the Nature Conservancy, and US Army Corps.
One Stream Smart workshop was delivered specifically for Maine Department of Transportation staff at their request.

Of the 10 total workshops, 5 "train-the-trainer" workshops where delivered for the Maine Coast Heritage Trust land protection staff, regional land use and transportation planners and Soil and Water Conservation District and NRCS staff. The focus for these workshops was to provide information and training to professionals that work with communities at the local level to encourage community level outreach.

Figure 5.7.2: Stream Smart training provides instruction on culvert assessment and design methodologies.

Three of the workshops were Stream Assessment Field trainings targeting but not limited to prior Stream Smart workshop attendees. The focus of the field trainings provides 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

USFS Aquatic Organism Passage (AOP) Training: The Gulf of Maine Coastal Program and Project SHARE organized and hosted a five-day Advanced Stream Simulation Design Course this week. The workshop taught participants how to design road-stream crossing structures that provide unimpeded fish and other aquatic organism passage, restore natural channel processes through the structure, and maximize the long-term stability of the structure. The course was held at the Appalachian Mountain Club's lodge near Greenville, ME and was led by national experts including Bob Gubernick (USFS) and Dale Higgins (USFS). A diverse set of participants came from throughout New England and included private consulting engineers, staff from Maine Department of Transportation, USFWS, NGOs and NRCS. critical aquatic habitats in the Northeast.

Figure 5.7.3. Classroom and field instruction provide participants with advance Stream Simulation design instruction.

Online data viewer: 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

Stream Connectivity Projects

In 2014, 33 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 229 km of stream were 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, towns, 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 miles of stream habitat access.

Connectivity Activity	Watershed	Site Name	KM above
Log Dam Pull	Machias	Holmes Brook	5.9
Log Dam Pull	Machias	Thompson	9.5
Debris Pull	Machias	Fletcher 1	5.6
Log and Rock Dam Pull	Machias	Fletcher 2a	2.6
Debris Pull	Machias	Fletcher 2b	2.6
Log Dam Pull	Machias	Fletcher 2c	2.3
Rock Dam Pull	Machias	Elwell 1a	4.3
Rock Dam Pull	Machias	Elwell 1b	4.3
Log Dam Pull	Machias	Unknown 1a	21.7
Rock Dam Pull	Machias	Unknown 1b	21.3

Log Dam Pull	Machias	Dead 1	9.8
Log Dam Pull	Machias	Dead 2	3.3
Log Dam Pull	Machias	Dead 3	16.4
Log Dam Pull	Narraguagus	35 Brook #3a	12.8
Rock Dam Pull	Narraguagus	35 Brook #3b	12.5
Log Dam Pull	Narraguagus	35 Brook #4a	12.1
Log-Rock Dam Pull	Narraguagus	35 Brook #4b	11.5
Concrete Arch	St. Croix	Billy Brown	2.6
Open Arch	St. Croix	W.B. Amazon	10.8
Concrete Arch	Narraguagus	Sinclair Trib	2.3
Decommission	Narraguagus	Rocky Trib	1.3
Decommission	East Machias	Trib below Love Lake	6.2
Decommission	East Machias	Richardson Brk Trib 1	0.3
Decommission	East Machias	Richardson Brk Trib 2	0.3
Metal Arch	East Machias	Richardson Brk Trib 3	1.0
Concrete Arch	East Machias	Creamer Trib	1.0
Metal Arch	East Machias	RB trib to Northern	3.0
Metal Arch	East Machias	Meadow Brook	2.6
Embedded Box	Kennebec	Warm Brook	22.3
Bridge	West Branch Pleasant	Henderson Brook	3.3
Bridge	Sebec	Salmon Stream	2.3
Bridge	Sebec	Salmon Stream	5.2
		Total	229.3

Figure 5.7.4. Stream Simulation design replacement culvert in Kennebec River watershed.

Figure 5.7.5. Culvert replacement in East Machias River watershed.

Pleasant River Focus Area Initiative

Project goals: To restore runs of **diadromous** fish that include but are not limited to the federally endangered Atlantic salmon, to selectively restore geomorphic characteristics and functions of Maine's rivers and streams, and to enhance in-stream habitat complexity and aquatic connectivity to benefit **resident and diadromous** fish, eastern brook trout, and other native aquatic species at a landscape scale.

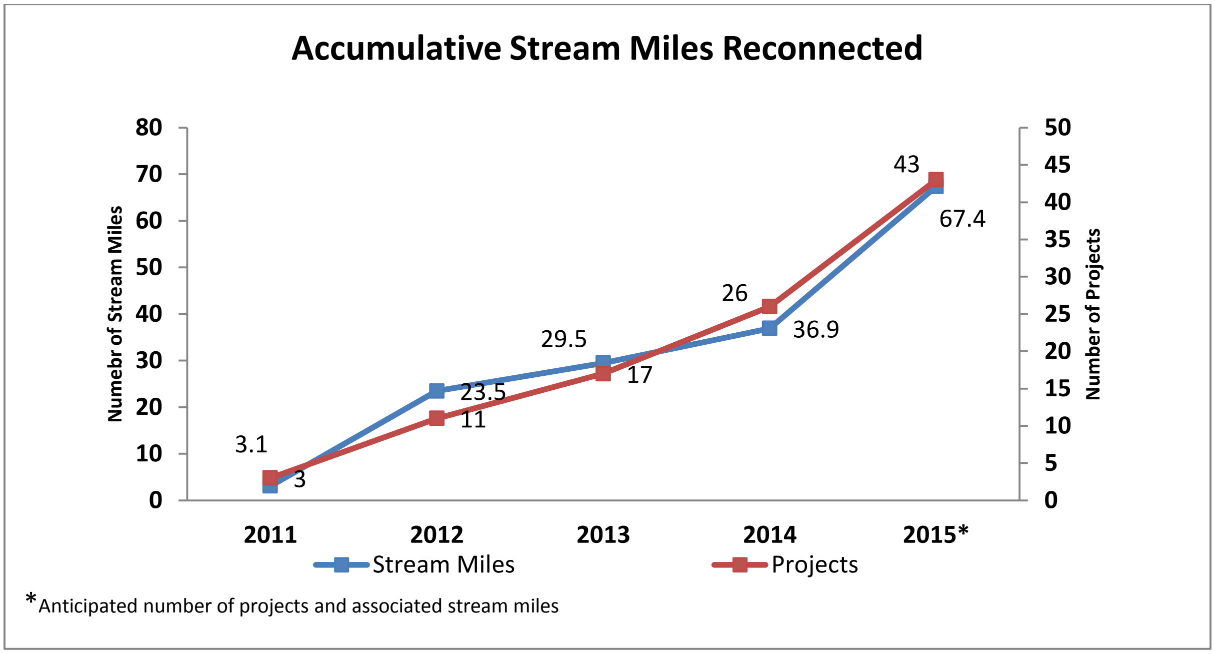

Figure 5.7.6. Summary of reconnected stream reaches within the Pleasant River a tributary of the Penobscot River.

Stream connectivity progress to date: Extensive outreach and education with specific focus on road-stream crossings that occurred during the first two years of the focused partnership stream restoration effort has helped pave the way for collaborative on-the-ground restoration. Currently close to 37 stream miles have been re-connected. All 37 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 7.4 stream miles from 9 projects reconnected during 2014, 2.6 miles will directly benefit Atlantic salmon by allowing juvenile salmon to freely migrate to historic rearing habitat and to access cold water thermal refugia. Photos and site descriptions of 2014 completed projects can be found in Appendix I. Projects included in this report are projects for which Ben Naumann has provided significant assistance including, but not limited to: project identification, planning, coordination, engineering surveys, endangered species consultations, electrofishing, and oversight during project implementation. It is anticipated that 17 projects will be completed during 2015 that will re-connect a total of 30.5 miles of streams, 15.4 miles benefiting Atlantic salmon and brook trout, 13 benefiting just brook trout and 2.1 stream and 5975 lake acres benefiting alewives. Currently one project is planned for 2016 and more are likely to be added.

2014 Upper Penobscot River restoration effort: Stream connectivity efforts have broadened to include projects throughout the state; however the upper Penobscot Basin remains a focus area. Six of the nine projects completed in 2014 were in the Penobscot basin reconnecting 5.3 stream miles. In the Penobscot basin alone a total of 8 projects are anticipated to be complete in 2015.

5.7.4 Habitat Complexity

Narraguagus Focus Area Restoration

Project SHARE has identified the Upper Narraguagus Watershed as a high-priority focus area for salmonid habitat restoration. The Narraguagus River is located in Maine's Downeast, region within the geographic range of the federally listed-endangered Atlantic salmon. Other native fish species include Eastern brook trout (identified in steep decline throughout its range by the Eastern Brook Trout Joint Venture), American eel, alewife, shad, and sea lamprey.

Over the last thirteen years SHARE, in collaboration with state and federal agencies, landowners, and nonprofit organizations, has developed a habitat restoration program with principal focus on the five Downeast Maine Atlantic salmon watersheds. The group has identified threats to habitat connectivity and function and opportunities to restore cold water refugia and rearing habitat, and conducted cooperative projects that have removed those threats and/or restored connectivity and natural stream function. Watershed-scale threat assessments of the Narraguagus River have documented summer water temperatures in main stem river reaches above sub-lethal stress levels, approaching acute lethal levels. Remnant dams and associated legacy reservoirs are identified heat sinks contributing to warmer temperatures. Undersized culverts at road/stream crossings present stream connectivity threats and are barriers to upstream coldwater refugia.

Climate change predictions present threats in addition to legacy effects of past land use. Stream temperatures are expected to rise in most rivers; the threat to salmon recovery is high where temperatures are near sub-lethal or lethal thresholds for salmon (Beechie et al. 2013). Average air temperatures across the Northeast have risen 1.5˚ F since 1970, with winter temperatures rising most rapidly, 4˚ between 1970 and 2000 (NECIA 2007). However, increased water temperature is not the only threat associated with climate change. Precipitation and timing of significant aquatic events (intense rain, ice-out, spring flooding, and drought, among them) are "master variables" that influence freshwater ecosystems and are predicted to change, according to all climate model predictions. Jacobson et. al. (2009) provide a preliminary assessment summarizing impacts to Maine's freshwater ecosystems, predicting a wetter future, with more winter precipitation in the form of rain and increased precipitation intensity. Although it is not possible to predict specific changes at a given location, several 100- to 500-year precipitation events have occurred in recent years.

Climate change will affect the inputs of water to aquatic systems in Maine, and temperature changes will affect freezing dates and evaporation rates, with earlier spring runoff and decreased snow depth. Stream gauges in Maine show a shift in peak flows to earlier in spring, with lower flows later in the season. New England lake ice-out dates have advanced by up to two weeks since the 1800s. Water levels and temperatures cue migration of sea-run fish such as alewives, shad, and Atlantic salmon into our rivers, and the arrival or concentration of birds that feed on these fish. Lower summer flows will reduce aquatic habitats like coldwater holding pools and spawning beds. This complex interplay of climate effects, restoration opportunities, and potential salmonid responses poses a considerable challenge for effectively restoring salmon populations in a changing climate (Beechie et al. 2013). However, past land use practices often have degraded habitats to a greater degree than that predicted from climate change, presenting substantial opportunities to improve salmon habitats more than enough to compensate for expected climate change over the next several decades (Battin et al., 2007).

Process-based habitat restoration provides a holistic approach to river restoration practices that better addresses primary causes of ecosystem degradation (Roni et al., 2008). Historically, habitat restoration actions focused on site-specific habitat characteristics designed to meet perceived “good” habitat conditions (Beechie et al. 2010). These actions favored engineering solutions that created artificial and unnaturally static habitats, and attempted to control process and dynamics rather than restore them. By contrast, efforts to reestablish system process promote recovery of habitat and biological diversity. Process restoration focuses on critical drivers and functions that are the means by which the ecosystem and the target species within it can be better able to adapt to future events, such as those predicted associated with climate change.

SHARE is collaborating in this project with a team of scientists in a 5- to 7-year applied science project taking a holistic, natural process-based, approach to river and stream restoration in an 80-square-mile area in Hancock and Washington Counties. The vision, from the perspective of restoration of Atlantic salmon as an endangered species, is to restore the return of spawning adult Atlantic salmon from the sea to the Upper Narraguagus River sub-watershed to escapement levels that are self-sustaining. The work will be guided by a team of scientists and restoration actions will be based on the four principles of process-based restoration of river systems:

- Restoration actions should address the root causes of degradation;
- Actions should be consistent with the physical and biological potential of the site;
- Actions should be at a scale commensurate with environmental problems; and
- Actions should have clearly articulated expectations for ecosystem dynamics.

This project, a collaboration with the National Oceanographic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the University of Maine, Maine’s Department of Marine Resources, Boston College, Connecticut College, and the Canadian Rivers Institute, will test the hypothesis that reconnecting river and stream habitat, improving habitat suitability, and reintroducing salmon to unoccupied habitat, will increase the number of salmon smolts leaving the sub-watershed en route to the ocean.

Water Temperature

A Water Temperature Working Group was established in Maine to begin developing a coordinated stream temperature monitoring array that can be integrated with regional and national efforts. The Group recently met in order to standardize protocols, discuss the use of the Spatial Hydro-Ecological Decision Support (SHEDS) web application, and to coordinate locations and equipment needs for the coming field season. Under the guidance of the Group, USFWS personnel deployed four temperature loggers within the Casco Bay watershed; others are currently planning deployments for the 2015 field season. In addition, the Group plans to host a state-wide protocol workshop in early spring of 2015, in order to standardize this technique throughout Maine.
Goals of the group are to:

- Conduct a comprehensive inventory of existing data for current and past water temperature monitoring efforts.
- Identify a central database for locations and water temperature data.
- Create a distribution network for stream temperature data loggers.

The group is working with Dan Isaak (USFS) and Ben Letcher (USGS) to use water temperature data to model and identify catchments that may be more resilient to temperature increases in the future. The work will be using previous and current data sets from all over the state to develop a model to predict future stream temperature conditions and identify resilient sub-watersheds.

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6 Outer Bay of Fundy

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

Adult Returns

Aroostook River

The Tinker fishway trap on the Aroostook River was operated by Algonquin Power Company from 4 August to 31 October. One Atlantic salmon was captured and released upstream in 2014. The salmon was a wild 2SW female.

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.

6.2 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 569,000 non-feeding fry into the Aroostook River in under the supervision of DMR biologists.

Adult Salmon Releases

Aroostook River

No adults were stocked in 2014.

6.2 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed in 2014.

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 stream temperature modeling. 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 2012-2014 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.

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 2014 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 2014 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 2015.

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 and PN (Kocik, Atkinson)
            1. age-structured adult return numbers (add 1SW and 3SW)
        iii. Fry rr for GoM, BoF (Sweka, Atkinson) - continuing work on fry equivalents (FE) see below

2) Re-development of model in R to facilitate broader use that @Risk Version (Kocik, Sweka)

3) GRTS investigation (Atkinson)
    a. What we have learned
    b. Is it working for us
    c. Ad hoc 1 person pers shru

4) Penobscot smolt studies and retrospective lessons learned (Kocik)

5) Emerging Issues Identified Intercession or at Annual Meeting –

6) Potential Theme 2015– 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
Rory	Saunders	Rory.Saunders@noaa.gov	NOAA	Orono, ME
John	Sweka*	John_Sweka@fws.gov	FWS	Lamar, PA
Peter	Lamothe	Peter_Lamothe@fws.gov	FWS	East Orland, ME
Jason	Overlock	jason.overlock@maine.gov	ME	Hallowell, ME
Paul	Christman	paul.christman@maine.gov	ME	Hallowell, ME
Michael	Bailey	michael_bailey@fws.gov	FWS	Nashua, NH
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT	Old Lyme, CT

*via conference call

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	Steve Gephard	Steve.Gephard@po.state.ct.us	Connecticut River Update (PPT)
PS14-03	Michael Bailey	michael_bailey@fws.gov	Merrimack River Update (PPT)
PS14-04	Ernie Atkinson	ernie.atkinson@maine.edu	Saco, DPS, OBF Updates (PPT)
PS14-05	John Sweka	john_sweka@fws.gov	Database Update
PS14-06	Rory Saunders	rory.saunders@noaa.gov	ICES/NASCO Update (PPT)
WP14-01	Colby Brucks, Chrsitine Lipsky, Ernest Atkinson, James Hawkes, Ruth Hass-Castro, Randy Spencer, Paul Christman, and Kyle Winslow	Christine.Lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smolt Studies:2014
WP14-02	Graham Goulette, James Hawkes, John Kocik, and Paul Christman	james.hawkes@noaa.gov	Update on NOAA Fisheries Service Coastal Maine Atlantic Salmon Smolt Telemetry Studies: 2014
WP14-03	David Bean, Chris Vonderweidt, Jon Lewis, and Marcy Nelson	David.Bean@noaa.gov	Maine and neighboring Canadian Commercial Aquaculture Activities and Production
WP14-04	Ruth Haas-Castro	ruth.haas-castro@noaa.gov	Review of Image Analysis Studies: 2013 (PART 1) and Work Plan for 2014 (PART 2)

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 culture 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. This can refer to a number or just as a group of fish.
Egg Deposition	Salmon eggs that are deposited in gravelly reaches of the river. This can refer to the action of depositing eggs by the fish, a group of unspecified number of eggs per event, or a specific number of eggs.
Fecundity	The reproductive rate of salmon represented by 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	Adults produced from naturally reared 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.

8.4.2 Life History related

Green Egg	Life stage from spawning until faint eyes appear.
Eyed Egg	Life stage from the appearance of faint eyes until hatching.
Sac Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Feeding Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Fed Fry	Fry subsequent to being fed an artificial or natural diet. Often used interchangeably with the term “feeding fry” and most often associated with stocking activities.
Unfed Fry	Fry that have not been fed an artificial diet or natural diet. Most often associated with stocking activities.
Parr	Life stage immediately following the fry stage until the commencement of migration to the sea as smolts.
Age 0 Parr	Life stage occurring during the period from August 15 to December 31 of the year of hatching, often referring to fish that are stocked from a hatchery during this time. The two most common hatchery stocking products are (1) parr that have been removed from an accelerated growth program for smolts and are stocked at lengths >10 cm and (2) parr that have been raised to deliberately produce more natural size-at-age fish and are stocked at lengths ≤10 cm.
Age 1 Parr	Life stage occurring during the period from January 1 to December 31 one year after hatching.
Age 2 Parr	Life stage occurring during the period from January 1 to December 31 two years after hatching.
Parr 8	A parr stocked at age 0 that migrates as 1 Smolt (8 months spent in freshwater).

Parr 20	A parr stocked at age 0 that migrates as 2 Smolt (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	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	Life stage occurring during the period from July 1 to December 31 of the year the salmon became a smolt. Typically encountered in the ocean.
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 (MSW) 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	Life stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to home waters to spawn again.

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

8.5 Appendicies

Appendix 1. Estimated Atlantic salmon returns to the USA, 1967-2014. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1 SW	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
2014	110	334	3	3	450	304	146

Appendix 2. Two sea winter (2SW) returns for 2014 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	30	0.3%
Central New England	CNE	3,435	38	1.1%
Gulf of Maine	GOM	15,670	266	1.7%
Total		29,199	334	1.1%

Appendix 3. Number of juvenile Atlantic salmon stocked in USA, 2014. 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		204,000					204,000
CNE	2	Merrimack, Saco		379,000	16,000		12,100		407,100
GOM	8	Androscoggin to Dennys	1,509,000	1,553,000	165,230		557,656		3,784,886
OBF	1	Aroostook		569,000					569,000
Total	13		1,509,000	2,705,000	181,230	0	569,756	0	4,964,986

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2014 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	616				616
Central New England	CNE	Restoration	232				232
Gulf of Maine	GOM	Restoration		2,282		213	2,495
Total for USA			848	2,282		213	3,343

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2014. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		164,815	164,815
AD	Smolt			0
FLOY	Adult	616		616
PING	Smolt		282	282
PIT	Adult		2,526	2,526
PIT	Smolt			0
VIE	Smolt		92,354	92,354
RAD	Adult		16	16
RAD	Smolt		1,795	1,795
Total		616	261,788	262,404

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

Appendix 6. Aquaculture production (metric tonnes) in New England from 1997 to 2014. Production for 2012-2014 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
2014	2,173 to 8,205

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2014.

United States

No. of fish stocked by lifestage

River	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	0	199,000	0	0	0	0	0	199,000
Total for Connecticut Program								**199,000**
Androscoggin	0	1,000	0	0	0	0	0	1,000
Aroostook	0	569,000	0	0	0	0	0	569,000
Dennys	0	84,000	0	0	0	0	0	84,000
East Machias	0	16,000	149,800	0	0	0	0	165,800
Kennebec	1,151,000	2,000	0	0	0	0	0	1,153,000
Machias	27,000	210,000	400	0	0	0	0	237,400
Narraguagus	79,000	263,000	0	0	0	0	0	342,000
Penobscot	89,000	815,000	0	0	0	557,700	0	1,461,700
Pleasant	46,000	114,000	0	0	0	0	0	160,000
Saco	0	366,000	16,000	0	0	12,100	0	394,100
Sheepscot	118,000	23,000	15,000	0	0	0	0	156,000
Union	0	24,000	0	0	0	0	0	24,000
Total for Maine Program								**4,748,000**
Merrimack	0	12,000	0	0	0	0	0	12,000
Total for Merrimack Program								**12,000**
Pawcatuck	0	5,000	0	0	0	0	0	5,000
Total for Pawcatuck Program								**5,000**
Total for United States								**4,964,000**
Grand Total								**4,964,000**

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 2014.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	38	0	0	38
East Machias	Restoration	0	168	0	0	168
Machias	Restoration	0	292	0	0	292
Merrimack	Restoration	232	0	0	0	232
Merrimack	Recreation	616	0	0	0	616
Narraguagus	Restoration	0	202	0	0	202
Penobscot	Restoration	0	1,340	0	213	1,553
Pleasant	Restoration	0	168	0	0	168
Sheepscot	Restoration	0	74	0	0	74
Total		848	2,282	0	213	3,343

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.

Appendix 9.1. Atlantic salmon marking database for New England; marked fish released in ***2014***.

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
DMR		Adult	H	Androscoggin	RAD	3	AP	June	Androscoggin
DMR		Adult	H	Androscoggin	RAD	1	AP	Aug	Androscoggin
USFWS	4	Adult	H	Dennys	PIT	38	PUNCH	Dec	Dennys
EMARC	0	Parr	H	East Machias	AD	149,815		Oct	East Machias
USFWS	3	Adult	H	East Machias	PIT	14	PUNCH	Nov	East Machias
USFWS	4	Adult	H	East Machias	PIT	70	PUNCH	Nov	East Machias
USFWS	5	Adult	H	East Machias	PIT	84	PUNCH	Nov	East Machias
NOAA		Smolt	W	Kennebec	PING	50		May	Kennebec
USFWS	5	Adult	H	Machias	PIT	127	PUNCH	Dec	Machias
USFWS	3	Adult	H	Machias	PIT	99	PUNCH	Dec	Machias
USFWS	4	Adult	H	Machias	PIT	66	PUNCH	Dec	Machias
NHFGD	3+	Adult	H	Merrimack	FLOY	616		May	Merrimack
USFWS	3	Adult	H	Narraguagus	PIT	92	PUNCH	Nov	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	58	PUNCH	Nov	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	52	PUNCH	Nov	Narraguagus
Brookfield	1	Smolt	H	Penobscot	RAD	257		May	Androscoggin
Brookfield	1	Smolt	H	Penobscot	RAD	1,323		May	Penobscot
Brookfield	1	Smolt	H	Penobscot	RAD	49		June	Penobscot
DMR		Adult	H	Penobscot	PIT	1		Aug	Penobscot
DMR		Adult	H	Penobscot	RAD	7	PIT	June	Penobscot
DMR		Adult	H	Penobscot	RAD	4	PIT	May	Penobscot
DMR		Adult	H	Penobscot	PIT	28		July	Penobscot
DMR		Adult	H	Penobscot	RAD	1	PIT	Sept	Penobscot
DMR		Adult	H	Penobscot	PIT	1		Oct	Penobscot
Miller Hydro	1	Smolt	H	Penobscot	RAD	10		June	Androscoggin

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
Miller Hydro	1	Smolt	H	Penobscot	RAD	156		May	Androscoggin
USDA		Adult	H	Penobscot	PIT	121	PUNCH	Dec	Penobscot
USFWS		Adult	H	Penobscot	PIT	213	PUNCH	Nov	Penobscot
USFWS	3	Adult	H	Penobscot	PIT	483	PUNCH	Dec	Penobscot
USFWS	4	Adult	H	Penobscot	PIT	737	PUNCH	Dec	Penobscot
USFWS	1	Smolt	H	Penobscot	VIE	46,405	AD	April	Penobscot
USFWS	1	Smolt	H	Penobscot	VIE	45,949	AD	May	Penobscot
USGS	1	Smolt	H	Penobscot	PING	232		May	Penobscot
USFWS	3	Adult	H	Pleasant	PIT	57	PUNCH	Nov	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	55	PUNCH	Nov	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	56	PUNCH	Nov	Pleasant
USFWS	3	Adult	H	Sheepscot	PIT	14	PUNCH	Dec	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	30	PUNCH	Dec	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	30	PUNCH	Dec	Sheepscot
USFWS	0	Parr	H	Sheepscot	AD	15,000		Sept	Sheepscot

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

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2014.

	1SW		2SW		3SW		Repeat			2010-2014
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	0	0	2	1	0	0	0	0	**3**	15
Connecticut	0	2	0	30	0	0	0	0	**32**	68
Kennebec	0	3	2	13	0	0	0	0	**18**	20
Merrimack	4	0	25	10	1	0	0	0	**40**	135
Narraguagus	0	0	2	1	0	0	0	1	**4**	63
Pawcatuck	0	0	0	0	0	0	0	0	**0**	2
Penobscot	82	1	153	21	2	0	2	0	**261**	1,141
Pleasant	2	0	0	1	0	0	0	0	**3**	2
Saco	0	0	3	0	0	0	0	0	**3**	26
Union	0	0	1	1	0	0	0	0	**2**	1
Total	**88**	**6**	**188**	**78**	**3**	**0**	**2**	**1**	**366**	**1,473**

Note: The origin/age distribution for returns to the Merrimack River in 2014 were based on observed distributions over the previous 10 years because fish were not handled in 2014.

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2014.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	103	830,000
Merrimack	Domestic	293	1,244,000
Penobscot	Domestic	557	1,653,000
Dennys	Captive	40	148,000
East Machias	Captive	99	452,000
Machias	Captive	141	640,000
Narraguagus	Captive	112	355,000
Pleasant	Captive	74	259,000
Sheepscot	Captive	56	164,000
Total	**Captive/Domestic**	**1,475**	**5,745,000**
Penobscot	Sea Run	102	775,000
Total	**Sea Run**	**102**	**775,000**
Grand Total for Year	**2014**	**1,577**	**6,520,000**

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.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco															
1993-2004	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															
1977-2004	1,475	16,853,000	7,900	21,749	140,646,000	5,900	0	0		1,950	24,262,000	10,100	25,174	181,761,000	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
2014	0	0		103	830,000	8,100	0	0		0	0		103	830,000	8,100
Total Connecticut	2,071	21,264,000	7,400	33,662	208,352,000	6,100	0	0		2,395	28,934,000	9,700	38,128	258,550,000	6,300
Dennys															
1939-2004	26	214,000	7,600	0	0		868	3,552,000	4,100	40	330,000	7,700	934	4,096,000	5,000
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
2009	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
2014	0	0		0	0		40	148,000	3,700	0	0		40	148,000	3,700
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,410	5,937,000	4,267	40	330,000	7,700	1,601	7,168,000	4,500
East Machias															
1995-2004	0	0		0	0		817	3,385,000	4,200	0	0		817	3,385,000	4,200
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
2014	0	0		0	0		99	452,000	4,600	0	0		99	452,000	4,600
Total East Machias	0	0		0	0	0	1,565	6,413,000	4,055	0	0		1,565	6,413,000	4,100
Kennebec															
1979-2004	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Total Kennebec	5	50,000	10,000	0	0	0	0	0		0	0		5	50,000	10,000
Lamprey															

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
1992-2004	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															
1941-2004	456	3,263,000	7,300	0	0		1,433	5,890,000	4,200	8	52,000	6,400	1,897	9,205,000	6,200
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
2014	0	0		0	0		141	640,000	4,500	0	0		141	640,000	4,500
Total Machias	456	3,263,000	7,300	0	0	0	2,764	11,319,000	4,018	8	52,000	6,400	3,228	14,634,000	4,200
Merrimack															
1983-2004	1,166	8,935,000	7,900	8,985	47,361,000	5,000	0	0		222	2,161,000	10,400	10,373	58,458,000	6,200
2005	13	111,000	8,500	191	691,000	3,600	0	0		65	697,000	10,700	269	1,499,000	5,600
2006	42	377,000	9,000	269	1,097,000	4,100	0	0		49	582,000	11,900	360	2,056,000	5,700
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
2009	48	369,000	7,700	516	2,380,000	4,600	0	0		55	577,000	10,500	619	3,326,000	5,400
2010	28	201,000	7,200	135	721,000	5,300	0	0		57	669,000	11,700	220	1,591,000	7,200
2011	107	935,000	8,700	103	408,000	4,000	0	0		0	0		210	1,343,000	6,400

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
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
2014	0	0		293	1,244,000	4,200	0	0		0	0		293	1,244,000	4,200
Total Merrimack	1,582	12,306,000	8,000	11,980	59,106,000	4,000	0	0		540	5,708,000	11,100	14,102	77,121,000	5,200
Narraguagus															
1962-2004	0	1,303,000		0	0		1,411	5,140,000	3,700	0	0		1,411	6,443,000	3,700
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
2014	0	0		0	0		112	355,000	3,200	0	0		112	355,000	3,200
Total Narraguagus	0	1,303,000		0	0	0	2,851	11,059,000	4,100	0	0		2,851	12,362,000	4,100
Orland															
1967-2004	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															
1992-2004	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															
1871-2004	18,282	156,885,000	7,900	6,212	15,970,000	2,600	0	0		0	0		24,494	172,855,000	7,400
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
2014	102	775,000	7,600	557	1,653,000	3,000	0	0		0	0		659	2,428,000	3,700
Total Penobscot	20,935	178,707,000	8,100	9,741	28,291,000	3,400	329	1,400,000	4,300	0	0		31,005	208,398,000	5,600
Pleasant															
2001-2004	0	0		0	0		66	401,000	6,000	0	0		66	401,000	6,000
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400

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
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
2014	0	0		0	0		74	259,000	3,500	0	0		74	259,000	3,500
Total Pleasant	0	0		123	469,000	5,900	642	2,421,000	3,827	0	0		765	2,889,000	4,100
Sheepscot															
1995-2004	18	125,000	6,900	0	0		666	2,722,000	3,900	45	438,000	9,900	729	3,285,000	4,500
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
2014	0	0		0	0		56	164,000	2,900	0	0		56	164,000	2,900
Total Sheepscot	18	125,000	6,900	0	0	0	1,427	5,410,000	3,555	45	438,000	9,900	1,490	5,973,000	3,600
St Croix															
1993-2004	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															
1974-2004	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	33,662	208,351,000	6,100	0	0		2,395	28,935,000	9,700	38,128	258,550,000	6,300
Dennys	26	214,000	7,600	125	687,000	4,600	1,410	5,937,000	4,300	40	330,000	7,700	1,601	7,168,000	4,400
East Machias	0	0		0	0		1,565	6,413,000	4,100	0	0		1,565	6,413,000	4,100
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		2,764	11,319,000	4,000	8	52,000	6,400	3,228	14,634,000	4,200
Merrimack	1,582	12,306,000	8,000	11,980	59,105,000	4,000	0	0		540	5,709,000	11,100	14,102	77,121,000	5,200
Narraguagus	0	1,303,000		0	0		2,851	11,059,000	4,100	0	0		2,851	12,362,000	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	20,935	178,707,000	8,100	9,741	28,290,000	3,400	329	1,400,000	4,300	0	0		31,005	208,398,000	5,600
Pleasant	0	0		123	468,000	5,900	642	2,420,000	3,800	0	0		765	2,889,000	4,100
Sheepscot	18	125,000	6,900	0	0		1,427	5,409,000	3,600	45	438,000	9,900	1,490	5,973,000	3,600
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	**25,800**	**222,614,000**	**8,600**	**56,187**	**296,909,000**	**5,300**	**10,988**	**43,957,000**	**4,000**	**3,041**	**35,540,000**	**11,700**	**96,016**	**599,024,000**	**6,200**

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							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin								
2001-2004	0	6,000	0	0	0	0	0	6,000
2005	0	0	0	0	0	0	0	0
2006	0	1,000	0	0	0	0	0	1,000
2007	0	1,000	0	0	0	0	0	1,000
2008	0	1,000	0	0	0	0	0	1,000
2009	0	2,000	0	0	0	0	0	2,000
2010	0	1,000	0	0	0	0	0	1,000
2011	0	1,000	0	0	0	0	0	1,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	1,000	0	0	0	500	0	1,500
2014	0	1,000	0	0	0	0	0	1,000
Totals:Androscoggin	**0**	**16,000**	**0**	**0**	**0**	**500**	**0**	**16,500**
Aroostook								
1978-2004	0	2,122,000	317,400	38,600	0	32,600	29,800	2,540,400
2005	0	133,000	0	0	0	0	0	133,000
2006	0	324,000	0	0	0	0	0	324,000
2007	0	854,000	0	0	0	0	0	854,000
2008	0	365,000	0	0	0	0	0	365,000
2009	0	458,000	0	0	0	0	0	458,000
2010	0	527,000	0	0	0	0	0	527,000
2011	0	237,000	0	0	0	0	0	237,000
2012	0	731,000	0	0	0	0	0	731,000
2013	0	580,000	0	0	0	0	0	580,000
2014	0	569,000	0	0	0	0	0	569,000
Totals:Aroostook	**0**	**6,900,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**7,318,400**
Cocheco								
1988-2004	0	1,958,000	50,000	10,500	0	5,300	0	2,023,800
Totals:Cocheco	**0**	**1,958,000**	**50,000**	**10,500**	**0**	**5,300**	**0**	**2,023,800**
Connecticut								
1967-2004	0	100,402,000	2,830,600	1,812,800	0	3,769,700	1,197,900	110,013,000
2005	0	7,805,000	0	0	0	0	85,100	7,890,100
2006	0	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
2007	0	6,345,000	0	600	2,300	600	99,000	6,447,500
2008	0	6,041,000	0	0	2,400	0	50,000	6,093,400
2009	0	6,476,000	3,900	0	14,400	0	49,100	6,543,400
2010	0	6,009,000	0	6,300	19,000	0	42,700	6,077,000
2011	0	6,010,000	5,200	9,500	10,000	0	81,700	6,116,400
2012	0	1,733,000	3,100	7,500	4,000	0	71,000	1,818,600
2013	0	1,857,000	3,200	0	0	600	99,500	1,960,300
2014	0	199,000	0	0	0	0	0	199,000
Totals:Connecticut	**0**	**148,725,000**	**2,849,700**	**1,836,700**	**64,700**	**3,771,900**	**1,828,100**	**159,076,100**

	Number of fish stocked by life stage							
	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Dennys								
1975-2004	0	1,619,000	176,100	7,300	0	363,000	29,200	2,194,600
2005	0	215,000	21,700	0	0	56,700	0	293,400
2006	0	295,000	27,600	0	0	56,500	0	379,100
2007	0	257,000	0	0	0	56,500	0	313,500
2008	0	292,000	0	0	0	0	200	292,200
2009	0	317,000	0	0	0	0	600	317,600
2010	0	430,000	0	0	0	0	0	430,000
2011	0	539,000	0	0	0	0	0	539,000
2014	0	84,000	0	0	0	0	0	84,000
Totals:Dennys	**0**	**4,048,000**	**225,400**	**7,300**	**0**	**532,700**	**30,000**	**4,843,400**
Ducktrap								
1986-2004	0	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**0**	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias								
1973-2004	0	2,076,000	7,500	42,600	0	108,400	30,400	2,264,900
2005	0	216,000	0	0	0	0	0	216,000
2006	0	199,000	0	0	0	0	0	199,000
2007	0	245,000	0	0	0	0	0	245,000
2008	0	261,000	0	0	0	0	0	261,000
2009	0	186,000	0	0	0	0	0	186,000
2010	0	266,000	0	0	0	0	0	266,000
2011	0	180,000	0	0	0	0	0	180,000
2012	0	88,000	53,200	0	0	0	0	141,200
2013	0	20,000	77,600	0	0	0	0	97,600
2014	0	16,000	149,800	0	0	0	0	165,800
Totals:East Machias	**0**	**3,753,000**	**288,100**	**42,600**	**0**	**108,400**	**30,400**	**4,222,500**
Kennebec								
2001-2004	0	104,000	0	0	0	0	0	104,000
2005	0	34,000	0	0	0	0	0	34,000
2006	40000	8,000	0	0	0	0	0	47,598
2007	34000	20,000	0	0	0	0	0	53,878
2008	246000	3,000	0	0	0	0	0	249,331
2009	159000	2,000	0	0	0	200	0	161,609
2010	600000	147,000	0	0	0	0	0	746,849
2011	810000	2,000	0	0	0	0	0	811,500
2012	921000	2,000	0	0	0	0	0	922,888
2013	654000	2,000	0	0	0	600	0	656,682
2014	1151000	2,000	0	0	0	0	0	1,153,330
Totals:Kennebec	**4,615,000**	**326,000**	**0**	**0**	**0**	**800**	**0**	**4,941,665**
Lamprey								
1978-2004	0	1,592,000	427,700	58,800	0	201,400	32,800	2,312,700
Totals:Lamprey	**0**	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Machias								
1970-2004	0	2,850,000	96,900	118,100	0	191,300	44,100	3,300,400
2005	0	476,000	0	200	0	0	0	476,200
2006	0	638,000	2,000	1,500	0	0	0	641,500
2007	0	470,000	0	2,200	0	0	0	472,200
2008	0	585,000	100	400	0	0	0	585,500
2009	0	291,000	300	0	0	0	0	291,300
2010	0	510,000	0	0	0	0	0	510,000
2011	0	347,000	0	500	0	0	0	347,500
2012	0	231,000	0	1,400	0	0	0	232,400
2013	0	172,000	800	1,400	0	59,100	0	233,300
2014	27000	210,000	400	0	0	0	0	237,387
Totals:Machias	**27,000**	**6,780,000**	**100,500**	**125,700**	**0**	**250,400**	**44,100**	**7,327,687**
Merrimack								
1975-2004	0	32,345,000	231,200	597,700	0	1,469,000	638,100	35,281,000
2005	0	962,000	1,400	400	0	50,000	0	1,013,800
2006	0	1,011,000	0	0	0	50,000	0	1,061,000
2007	0	1,140,000	0	0	0	50,000	0	1,190,000
2008	0	1,766,000	3,400	9,600	0	88,900	0	1,867,900
2009	0	1,051,000	0	0	0	91,100	0	1,142,100
2010	0	1,481,000	80,000	9,300	0	72,900	0	1,643,200
2011	0	892,000	93,800	0	0	34,900	0	1,020,700
2012	0	1,016,000	22,000	0	0	33,800	0	1,071,800
2013	0	111,000	0	41,200	0	40,900	0	193,100
2014	0	12,000	0	0	0	0	0	12,000
Totals:Merrimack	**0**	**41,787,000**	**431,800**	**658,200**	**0**	**1,981,500**	**638,100**	**45,496,600**
Narraguagus								
1970-2004	0	2,970,000	62,900	14,600	0	107,800	84,000	3,239,300
2005	0	352,000	0	0	0	0	0	352,000
2006	0	478,000	17,500	0	0	0	0	495,500
2007	0	346,000	15,700	0	0	0	0	361,700
2008	0	485,000	21,000	0	0	54,100	0	560,100
2009	0	449,000	0	0	0	52,800	0	501,800
2010	0	698,000	0	0	0	62,400	0	760,400
2011	0	465,000	0	0	0	64,000	0	529,000
2012	0	389,000	0	0	0	59,100	0	448,100
2013	0	288,000	0	0	0	0	0	288,000
2014	79000	263,000	0	0	0	0	0	342,145
Totals:Narraguagus	**79,000**	**7,183,000**	**117,100**	**14,600**	**0**	**400,200**	**84,000**	**7,878,045**
Pawcatuck								
1979-2004	0	5,382,000	1,209,200	263,200	0	76,400	500	6,931,300
2005	0	5,000	0	0	0	16,600	0	21,600
2006	0	85,000	0	0	0	12,800	0	97,800
2007	0	115,000	0	4,900	0	6,400	0	126,300
2008	0	313,000	0	0	0	6,000	0	319,000

	Number of fish stocked by life stage							
	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
2009	0	86,000	0	0	0	5,400	0	91,400
2010	0	290,000	0	0	0	3,900	0	293,900
2011	0	6,000	0	0	0	0	0	6,000
2012	0	6,000	0	0	0	0	0	6,000
2013	0	8,000	0	0	0	0	0	8,000
2014	0	5,000	0	0	0	0	0	5,000
Totals:Pawcatuck	**0**	**6,301,000**	**1,209,200**	**268,100**	**0**	**127,500**	**500**	**7,906,300**
Penobscot								
1970-2004	0	15,747,000	4,272,800	1,394,400	0	12,710,200	2,508,200	36,632,600
2005	0	1,899,000	295,400	0	0	555,500	0	2,749,900
2006	0	1,509,000	293,500	0	0	555,200	0	2,357,700
2007	0	1,606,000	337,800	0	0	559,900	0	2,503,700
2008	0	1,248,000	216,600	0	0	554,600	0	2,019,200
2009	0	1,023,000	172,200	0	0	561,100	0	1,756,300
2010	0	999,000	258,800	0	0	567,100	0	1,824,900
2011	0	952,000	298,000	0	0	554,000	0	1,804,000
2012	353000	1,073,000	325,700	0	0	555,200	0	2,306,679
2013	233000	722,000	214,000	0	0	553,000	0	1,722,193
2014	89000	815,000	0	0	0	557,700	0	1,461,360
Totals:Penobscot	**675,000**	**27,593,000**	**6,684,800**	**1,394,400**	**0**	**18,283,500**	**2,508,200**	**57,138,532**
Pleasant								
1975-2004	0	287,000	16,000	1,800	0	57,500	26,900	389,200
2005	0	76,000	0	0	0	5,900	0	81,900
2006	0	284,000	0	0	0	0	15,200	299,200
2007	0	177,000	0	0	0	0	0	177,000
2008	0	171,000	0	0	0	0	0	171,000
2009	0	97,000	0	0	0	0	300	97,300
2010	0	142,000	0	0	0	0	0	142,000
2011	0	124,000	0	0	0	61,000	0	185,000
2012	0	40,000	0	0	0	60,200	0	100,200
2013	0	180,000	0	0	0	62,300	0	242,300
2014	46000	114,000	0	0	0	0	0	159,500
Totals:Pleasant	**46,000**	**1,692,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**2,044,600**
Saco								
1975-2004	0	4,810,000	438,700	201,200	0	344,100	9,500	5,803,500
2005	0	340,000	0	18,000	0	1,700	0	359,700
2006	0	106,000	0	0	0	0	0	106,000
2007	0	576,000	0	0	0	0	0	576,000
2008	0	358,000	9,100	0	0	0	0	367,100
2009	0	1,000	0	0	0	0	0	1,000
2010	0	302,000	0	0	0	26,500	0	328,500
2011	0	238,000	16,000	0	0	12,000	0	266,000
2012	0	396,000	0	12,800	0	11,900	0	420,700
2013	0	319,000	10,100	0	0	12,100	0	341,200
2014	0	366,000	16,000	0	0	12,100	0	394,100

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Saco	**0**	**7,812,000**	**489,900**	**232,000**	**0**	**420,400**	**9,500**	**8,963,800**
Sheepscot								
1971-2004	0	2,058,000	100,400	20,600	0	92,200	7,100	2,278,300
2005	9000	201,000	15,900	0	0	0	0	225,700
2006	9000	151,000	16,600	0	0	0	0	176,600
2007	0	198,000	0	0	0	0	0	198,000
2008	0	218,000	13,000	0	0	0	0	231,000
2009	0	185,000	17,900	0	0	0	0	202,900
2010	9000	114,000	14,500	0	0	0	0	137,500
2011	0	129,000	15,000	0	0	0	0	144,000
2012	70000	50,000	15,700	0	0	0	0	136,069
2013	122000	18,000	14,000	0	0	0	0	154,476
2014	118000	23,000	15,000	0	0	0	0	155,668
Totals:Sheepscot	**337,000**	**3,345,000**	**238,000**	**20,600**	**0**	**92,200**	**7,100**	**4,040,213**
St Croix								
1981-2004	0	1,268,000	470,400	158,300	0	808,000	20,100	2,724,800
2006	0	0	27,600	0	0	0	0	27,600
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0
Totals:St Croix	**0**	**1,268,000**	**498,000**	**158,300**	**0**	**808,000**	**20,100**	**2,752,400**
Union								
1971-2004	0	436,000	371,400	0	0	379,700	251,000	1,438,100
2005	0	2,000	0	0	0	0	0	2,000
2006	0	2,000	0	0	0	0	0	2,000
2007	0	22,000	0	0	0	0	0	22,000
2008	0	23,000	0	0	0	0	0	23,000
2009	0	28,000	0	0	0	0	0	28,000
2010	0	19,000	0	0	0	0	0	19,000
2011	0	19,000	0	0	0	0	0	19,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	2,000	0	0	0	0	0	2,000
2014	0	24,000	0	0	0	0	0	24,000
Totals:Union	**0**	**578,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,580,100**
Upper StJohn								
1979-2004	0	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
Totals:Upper StJohn	**0**	**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.

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin	0	16,000	0	0	0	500	0	**16,300**
Aroostook	0	6,900,000	317,400	38,600	0	32,600	29,800	**7,318,500**
Cocheco	0	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	0	148,724,000	2,849,700	1,836,700	64,800	3,771,900	1,828,200	**159,010,500**
Dennys	0	4,048,000	225,400	7,300	0	532,800	30,000	**4,843,600**
Ducktrap	0	68,000	0	0	0	0	0	**68,000**
East Machias	0	3,751,000	288,100	42,600	0	108,400	30,400	**4,220,700**
Kennebec	4,615,000	326,000	0	0	0	900	0	**4,941,500**
Lamprey	0	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	27,000	6,780,000	100,400	125,600	0	250,400	44,100	**7,327,900**
Merrimack	0	41,787,000	431,700	658,100	0	1,981,400	638,100	**45,496,500**
Narraguagus	79,000	7,184,000	117,100	14,600	0	400,300	84,000	**7,878,600**
Pawcatuck	0	6,300,000	1,209,200	268,100	0	127,500	500	**7,905,500**
Penobscot	675,000	27,592,000	6,684,800	1,394,400	0	18,283,500	2,508,200	**57,138,000**
Pleasant	46,000	1,693,000	16,000	1,800	0	247,000	42,400	**2,045,500**
Saco	0	7,812,000	489,800	232,000	0	420,300	9,500	**8,963,300**
Sheepscot	337,000	3,346,000	238,000	20,600	0	92,200	7,100	**4,040,700**
St Croix	0	1,270,000	498,000	158,300	0	808,000	20,100	**2,754,000**
Union	0	577,000	371,400	0	0	379,700	251,000	**1,579,100**
Upper StJohn	0	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**273,890,000**	**15,771,500**	**4,882,800**	**64,800**	**27,649,200**		**5,583,900**	**333,555,400**

Summaries for each river vary by length of time series.

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

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

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin									
1983-2004	30	523	6	2	6	84	0	1	**652**
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**
2014	0	2	0	0	0	1	0	0	**3**
Total for Androscoggin	57	602	6	2	10	108	0	1	**786**
Cocheco									
1992-2004	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2004	36	3,503	28	2	52	1,471	12	0	**5,104**
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**
2014	0	0	0	0	2	30	0	0	**32**
Total for Connecticut	58	3,612	28	2	136	2348	14	3	**6,201**
Dennys									
1967-2004	35	314	0	1	31	744	3	31	**1,159**
2006	2	2	0	0	1	1	0	0	**6**
2007	1	1	0	0	0	1	0	0	**3**
2008	0	1	0	0	1	3	0	3	**8**
2009	0	0	0	0	0	6	1	1	**8**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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									
1985-2004	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2004	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2004	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**
2014	0	2	0	0	3	13	0	0	**18**
Total for Kennebec	24	258	6	7	12	94	0	0	**401**
Lamprey									
1979-2004	10	17	1	0	11	16	0	0	**55**
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									
1967-2004	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									
1982-2004	307	1,211	21	8	121	989	26	0	**2,683**
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**
2007	8	52	0	0	1	12	1	0	**74**
2008	6	77	0	0	5	29	1	0	**118**
2009	4	41	2	0	1	28	2	0	**78**
2010	29	40	0	0	7	7	1	0	**84**
2011	128	155	12	1	11	90	5	0	**402**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2012	0	81	15	0	1	27	3	0	**127**
2013	0	6	0	3	0	12	0	0	**21**
2014	4	25	1	0	0	10	0	0	**40**
Total for Merrimack	503	1,777	52	12	153	1214	39	0	**3,750**
Narraguagus									
1967-2004	92	650	19	54	89	2,396	71	155	**3,526**
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**
2014	0	2	0	0	0	1	0	1	**4**
Total for Narraguagus	185	804	23	56	123	2489	72	160	**3,912**
Pawcatuck									
1982-2004	2	148	1	0	1	15	1	0	**168**
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**
2014	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot									
1968-2004	10,463	42,507	287	697	670	3,699	35	97	**58,455**
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**
2010	410	819	0	11	23	53	0	0	**1,316**
2011	696	2,167	3	12	45	201	1	0	**3,125**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2012	8	531	6	2	5	69	0	3	**624**
2013	54	275	3	2	3	44	0	0	**381**
2014	82	153	2	2	1	21	0	0	**261**
Total for Penobscot	13,444	51,336	304	744	838	4384	37	102	**71,189**
Pleasant									
1967-2004	5	12	0	0	14	228	3	2	**264**
2012	0	0	0	0	0	2	0	0	**2**
2013	0	1	0	0	0	0	0	0	**1**
2014	2	0	0	0	0	1	0	0	**3**
Total for Pleasant	7	13	0	0	14	231	3	2	**270**
Saco									
1985-2004	112	571	3	7	23	67	3	0	**786**
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**
2014	0	3	0	0	0	0	0	0	**3**
Total for Saco	179	707	5	7	50	119	6	0	**1,073**
Sheepscot									
1967-2004	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2004	274	1,841	9	28	1	16	0	0	**2,169**
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**
2014	0	1	0	0	0	1	0	0	**2**
Total for Union	274	1,842	9	28	1	18	0	0	**2,172**

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	602	6	2	10	108	0	1	786
Cocheco	0	0	1	1	6	10	0	0	18
Connecticut	58	3,612	28	2	136	2,348	14	3	6,201
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	258	6	7	12	94	0	0	401
Lamprey	10	17	1	0	13	16	0	0	57
Machias	32	329	9	2	33	1,592	41	131	2,169
Merrimack	503	1,777	52	12	153	1,214	39	0	3,750
Narraguagus	185	804	23	56	123	2,489	72	160	3,912
Pawcatuck	2	151	1	0	1	25	1	0	181
Penobscot	13,444	51,336	304	744	838	4,384	37	102	71,189
Pleasant	7	13	0	0	14	231	3	2	270
Saco	179	707	5	7	50	119	6	0	1,073
Sheepscot	6	38	0	0	30	358	10	0	442
Union	274	1,842	9	28	1	18	0	0	2,172

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 2009 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	0	0	39	59	2	0
2009	472	61	0.129	0	3	0	0	97	0	0	0			0	3	97	0	
2010	425	20	0.047	0	25	0	5	70		0				0	30	70		
2011	438	12	0.027	0	83		17							0	100			
2012	85	0	0.000	0										0				
Total	**10,099**	**1,690**																
Mean			**0.505**	**0**	**6**	**0**	**3**	**69**	**3**	**0**	**4**	**0**	**0**	**0**	**9**	**69**	**7**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	39	59	2	0
2009	648	79	0.122	0	4	0	0	95	0	0	1			0	4	95	1	
2010	601	29	0.048	0	28	0	7	66		0				0	35	66		
2011	601	13	0.022	8	77		15							8	92			
2012	173	0	0.000	0										0				
Total	**14,654**	**2,498**																
Mean			**0.397**	**0**	**11**	**0**	**4**	**67**	**2**	**0**	**4**	**0**	**0**	**0**	**15**	**67**	**6**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	38	62	0	0
2009	82	4	0.049	0	0	0	0	100	0	0	0			0	0	100	0	
2010	85	4	0.047	0	25	0	0	75		0				0	25	75		
2011	76	0	0.000	0	0		0							0	0			
2012	35	0	0.000	0										0				
Total	**2,305**	**373**																
Mean			**0.278**	**0**	**24**	**0**	**5**	**57**	**0**	**0**	**7**	**0**	**0**	**0**	**29**	**57**	**8**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	22	78	0	0
2009	105	13	0.124	0	0	0	8	92	0	0	0			0	8	92	0	
2010	148	7	0.047	0	0	0	0	100		0				0	0	100		
2011	89	3	0.034	0	100		0							0	100			
2012	102	0	0.000	0										0				
Total	**4,171**	**1,406**																
Mean			**2.211**	**0**	**2**	**0**	**10**	**63**	**4**	**2**	**9**	**0**	**0**	**0**	**12**	**66**	**13**	**1**

Means includes year classes with complete return data (year classes of 2009 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	0	0	33	67	0	0
2009	9	2	0.234	0	0	0	0	100	0	0	0			0	0	100	0	

Means includes year classes with complete return data (year classes of 2009 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		0				0	0	0		
2011	1	0	0.000	0	0		0							0	0			
2012	1	0	0.000	0										0				
Total	**630**	**27**																
Mean			**0.132**	**0**	**4**	**1**	**1**	**34**	**0**	**0**	**5**	**0**	**0**	**0**	**5**	**35**	**5**	**0**

Means includes year classes with complete return data (year classes of 2009 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 (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	12	2	0.165	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0	0	0	0	34	67	0	0
2003	25	13	0.526	8	38	0	8	46	0	0	0	0	0	8	46	46	0	0
2004	28	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	26	2	0.076	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2006	25	3	0.119	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
2007	28	5	0.178	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0

Means includes year classes with complete return data (year classes of 2009 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	0	0	36	64	0	0
2009	24	2	0.085	0	0	0	0	100	0	0	0			0	0	100	0	
2010	28	4	0.143	0	50	0	25	25		0				0	75	25		
2011	24	0	0.000	0	0		0							0	0			
2012	15	0	0.000	0										0				
Total	**522**	**120**																
Mean			**0.254**	**0**	**19**	**0**	**5**	**58**	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**58**	**0**	**0**

Means includes year classes with complete return data (year classes of 2009 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 (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1988	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	62	0	0	12	0	0	0	25	62	12	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3	0	0	0	11	86	3	0
2005	84	1	0.012	0	0	0	100	0	0	0	0	0	0	0	100	0	0	0
2006	73	5	0.069	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2007	57	5	0.088	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2008	63	9	0.143	0	0	0	44	44	0	0	11	0	0	0	44	44	11	0

Means includes year classes with complete return data (year classes of 2009 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	11	0.170	0	9	0	0	82	0	0	9			0	9	82	9	
2010	60	2	0.033	0	0	0	0	100		0				0	0	100		
2011	59	1	0.017	100	0		0							100	0			
2012	39	0	0.000	0										0				
Total	**1,670**	**314**																
Mean			**0.199**	**0**	**4**	**0**	**10**	**74**	**0**	**0**	**7**	**0**	**0**	**0**	**14**	**74**	**7**	**0**

Means includes year classes with complete return data (year classes of 2009 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 .

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 2009 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	0	0	42	58	0	0
2009	102	50	0.489	0	0	0	10	88	0	0	2			0	10	88	2	
2010	100	24	0.240	0	0	0	12	83		4				0	12	87		
2011	95	0	0.000	0	0		0							0	0			
2012	107	0	0.000	0										0				
Total	**2,593**	**4,783**																
Mean			**5.277**	**0**	**0**	**0**	**17**	**72**	**1**	**3**	**7**	**0**	**0**	**0**	**17**	**74**	**8**	**0**

Means includes year classes with complete return data (year classes of 2009 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	0.122	0.129	0.085	0.049	0.170	0.489
2010	0.047	0.000	0.048	0.047	0.143	0.047	0.033	0.240
2011	0.034	0.000	0.022	0.027	0.000	0.000	0.017	0.000
2012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean	**2.273**	**0.134**	**0.404**	**0.517**	**0.227**	**0.284**	**0.201**	**5.442**
StDev	**5.414**	**0.436**	**0.464**	**0.724**	**0.244**	**0.310**	**0.182**	**6.580**

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).

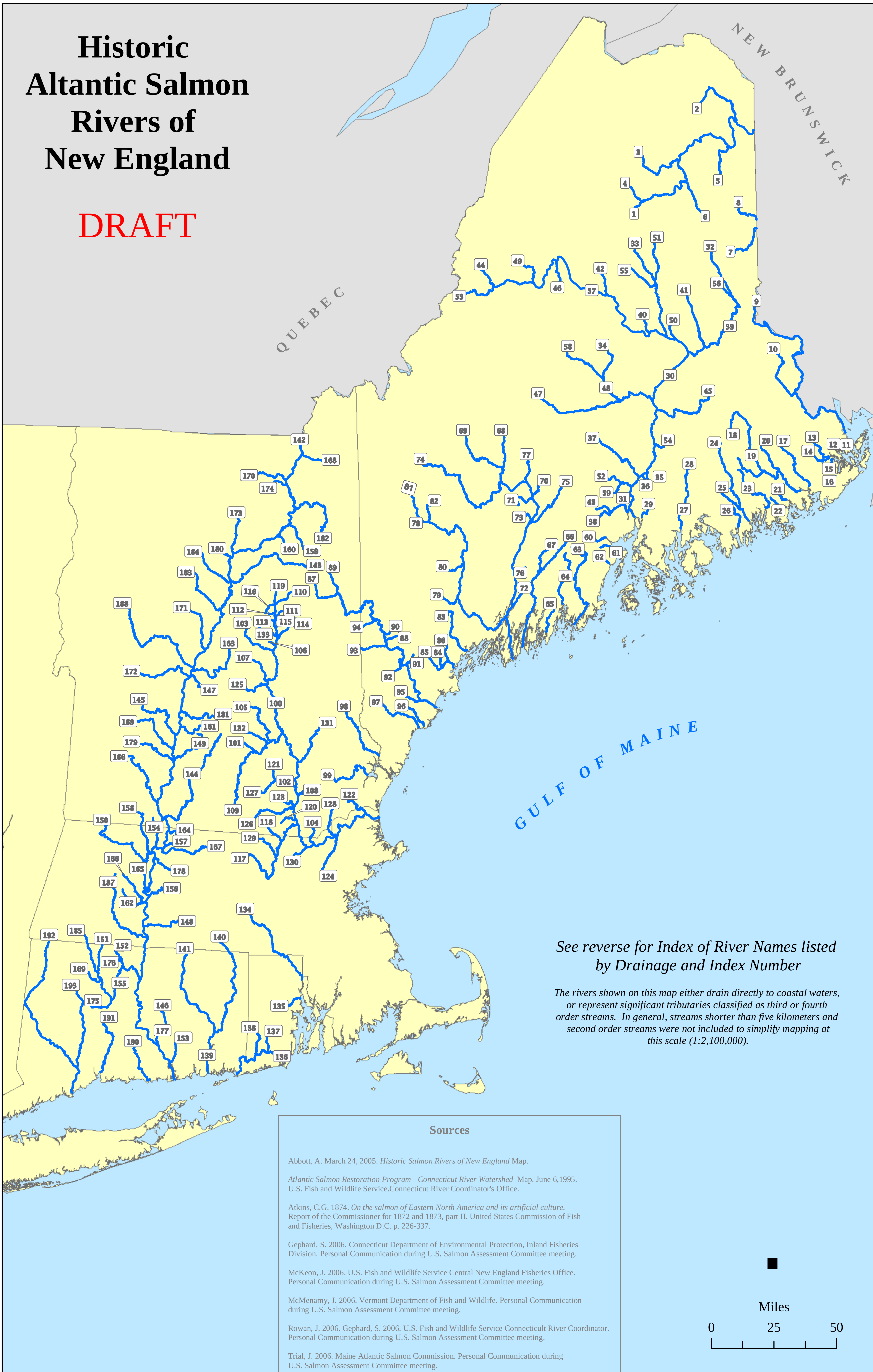
Appendix 20. Summary of age distributions of adult Atlantic salmon that were stocked in New England as fry.

	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)	0	15	0	4	76	2	0	5	0	0	0	19	76	7	0
Farmington	0	25	0	5	62	0	0	7	0	0	0	29	63	8	0
Merrimack	0	4	0	10	71	4	2	9	1	0	0	15	73	14	1
Pawcatuck	0	8	2	2	78	0	0	10	0	0	0	10	80	10	0
Penobscot	0	0	0	17	73	1	3	7	0	0	0	17	75	8	0
Salmon	0	23	0	6	70	0	0	0	0	0	0	29	70	0	0
Westfield	4	4	0	9	79	0	0	8	0	0	4	13	79	8	0
Overall Mean:	**1**	**11**	**0**	**7**	**74**	**1**	**1**	**6**	**0**	**0**	**1**	**18**	**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).

Sources

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Orange	Orange River	16		Swift River	81		Blackledge River	146
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Little	Little River	61		Souhegan River	126	Quinnipiac	Quinnipiac River	191
Ducktrap	Ducktrap River	62		South Branch Piscataquog River	127	Housatonic	Housatonic River	192
Saint George	Saint George River	63		Spicket River	128		Naugatuck River	193
Medomak	Medomak River	64		Squannacook River	129			
	Pemaquid River	65		Stony Brook	130			

ANNUAL REPORT OF THE U.S ATLANTIC SALMON ASSESSMENT COMMITTEE

REPORT NO. 27 - 2014 ACTIVITIES

KITTERY, MAINE
February 9-12, 2015

PREPARED FOR
U.S. SECTION TO NASCO

Table of Contents

1 Executive Summary

1.1 Abstract

Total return to USA rivers was 450; this is the sum of documented returns to traps and returns estimated by redd counts on selected Maine rivers, this is the lowest for the 1991-2014 time series, 26% less than 2013 and only 11% of the recent high return number in 2011. Adult salmon returns to USA rivers with traps or weirs totaled 358 in 2014. Estimated return to Gulf of Maine small coastal rivers was 92 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 83% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (68%) returns were of hatchery smolt origin and the balance (32%) originated from either natural reproduction or hatchery fry and eggs. A total of 4,964,986 juvenile salmon (eggs, fry, parr, and smolts), and 3,343 adults were stocked in 2014. Of those fish 259,246 juveniles carried a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 102 sea-run females and 1,475 captive/domestic and domestic females. The total number of females (1,577) contributing was similar to 2013 (1,625); and the total egg take (6,520,000) was similar to 2013 (6,246,000). Production of farmed salmon in Maine was not available, but was estimated at 2,173 to 8,205 (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), there was zero estimated discard from US marine commercial fisheries.

1.3 Adult Returns

Total return to USA rivers was 450; (Table 1.3.1), a 26% decrease from 2013 returns and an 89% decrease from 2011 returns (Table 1.3.2). Returns are reported for three meta-population areas (Figure 1.3.1); Long Island Sound (LIS), Central New England (CNE), and Gulf of Maine (GOM). Changes from 2013 within areas were: LIS (-66%), CNE (+79%), GOM (-24%). 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. In 2014 and into the future CNE rivers sea ages were based on visual size estimation at counting windows.

Most returns occurred in the Gulf of Maine area, with the Penobscot River accounting for 67% of the total return. Overall, 24% of the adult returns to the USA were 1SW salmon and 76% were MSW salmon. Most (68%) returns were of hatchery smolt origin and the balance (32%) 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

2012 was 0.041%, with the 2SW fish return rate 0.031% (Figure 1.3.3). The estimated return rate for 2SW adults from the 2012 cohort of wild smolts on the Narraguagus was 0.94% (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 1.1% of the 2SW conservation spawner requirements for USA, with returns to the three areas ranging from 0.3 to 1.6 % of spawner requirements (Table 1.3.3).

1.4 Stock Enhancement Programs

During 2014 about 3,455,986 juvenile salmon (78% fry) were released and 1,509,000 eggs were planted into 13 river systems (Table 1.4.1). The number of juveniles released was less than that in 2013 (5,472,000). Fry were stocked in the Connecticut, Merrimack, Saco, Penobscot, and five coastal rivers within the GOM area Maine. The majority of smolts were stocked in one river into the GOM. In addition to juveniles, 3,343 adult salmon were released into USA rivers (Table 1.4.2). A total of 848 of these were pre-spawn adults released into sub-drainages of the Merrimack River. A total of 232 were for restoration and the remaining 616 were for the spring recreational fishery that is scheduled to discontinue after 2014.

Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 262,404 salmon released into USA waters in 2013 were marked or tagged. Tags and marks for parr, smolts, and adults included: Floy, PIT, radio, acoustical, visual implant elastomer and fin clips. Nearly all of the tagging occurred 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 5,189 metric tonnes (95% CI 2,200 to 8,200) based on a regression of production and smolt moved to pens two years before. The estimate was approximately 47% 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.

Table 1.3.1 Estimated Atlantic salmon returns to USA by geographic area, 2014. "Natural" includes fish originating from natural spawning and hatchery fry. Some numbers are based on redds. Ages and origins are prorated where fish are not available for handling.

Area	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	2	0	30	0	0	0	0	32
CNE	4	0	28	10	1	0	0	0	43
GOM	88	16	179	87	2	0	2	1	375
Total	92	18	207	127	3	0	2	1	450

Table 1.3.2 Estimated Atlantic salmon returns to the USA, 1967-2014. "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
2014	110	334	3	3	450	304	146

Table 1.3.3 Two sea winter (2SW) returns for 2014 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	30	0.3%
Central New England	CNE	3,435	38	1.1%
Gulf of Maine	GOM	15,670	249	1.6%
Total		29,199	317	1.1%

Table 1.4.1 Number of juvenile Atlantic salmon stocked in USA, 2014. 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		204,000					204,000
CNE	2	Merrimack, Saco		379,000	16,000		12,100		407,100
GOM	8	Androscoggin to Dennys	1,509,000	1,553,000	165,230		557,656		3,784,886
OBF	1	Aroostook		569,000					569,000
Total	13		1,509,000	2,705,000	181,230	0	569,756	0	4,964,986

Table 1.4.2 Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2014 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	616				616
Central New England	CNE	Restoration	232				232
Gulf of Maine	GOM	Restoration		2,282		213	2,495
Total for USA			848	2,282		213	3,343

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2014. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		164,815	164,815
AD	Smolt			0
FLOY	Adult	616		616
PING	Smolt		282	282
PIT	Adult		2,526	2,526
PIT	Smolt			0
VIE	Smolt		92,354	92,354
RAD	Adult		16	16
RAD	Smolt		1,795	1,795
Total		616	261,788	262,404

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

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2014. Production for 2012-2014 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
2013	2,173 to 8,205

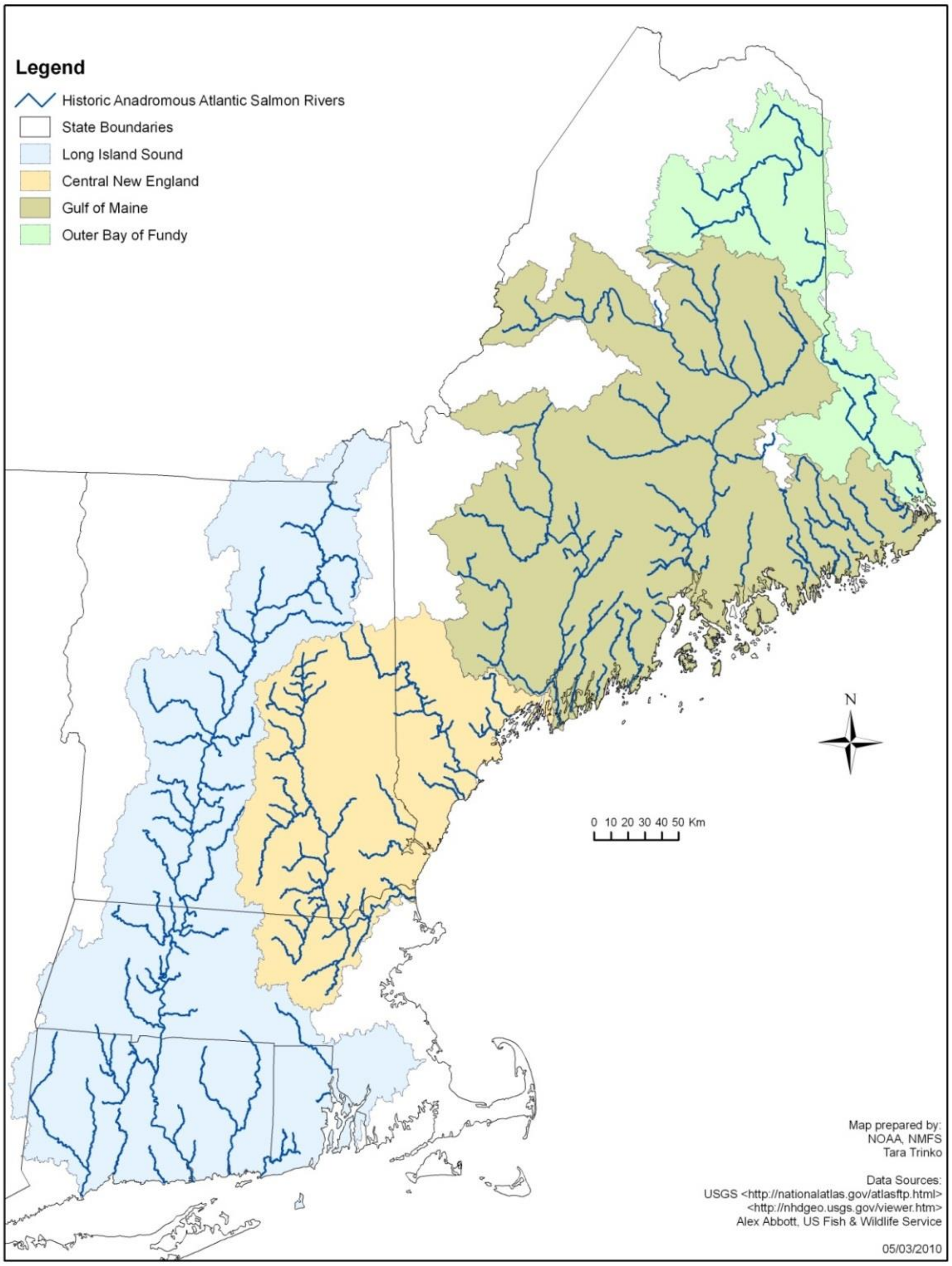

Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2014.

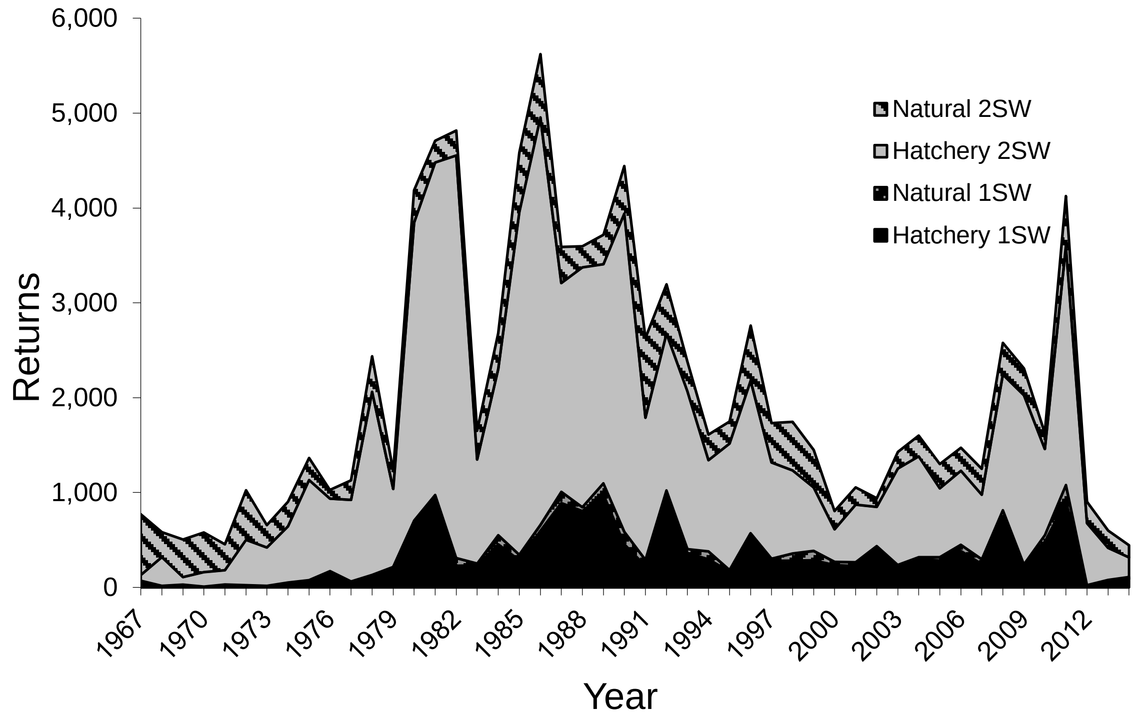

Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2014.

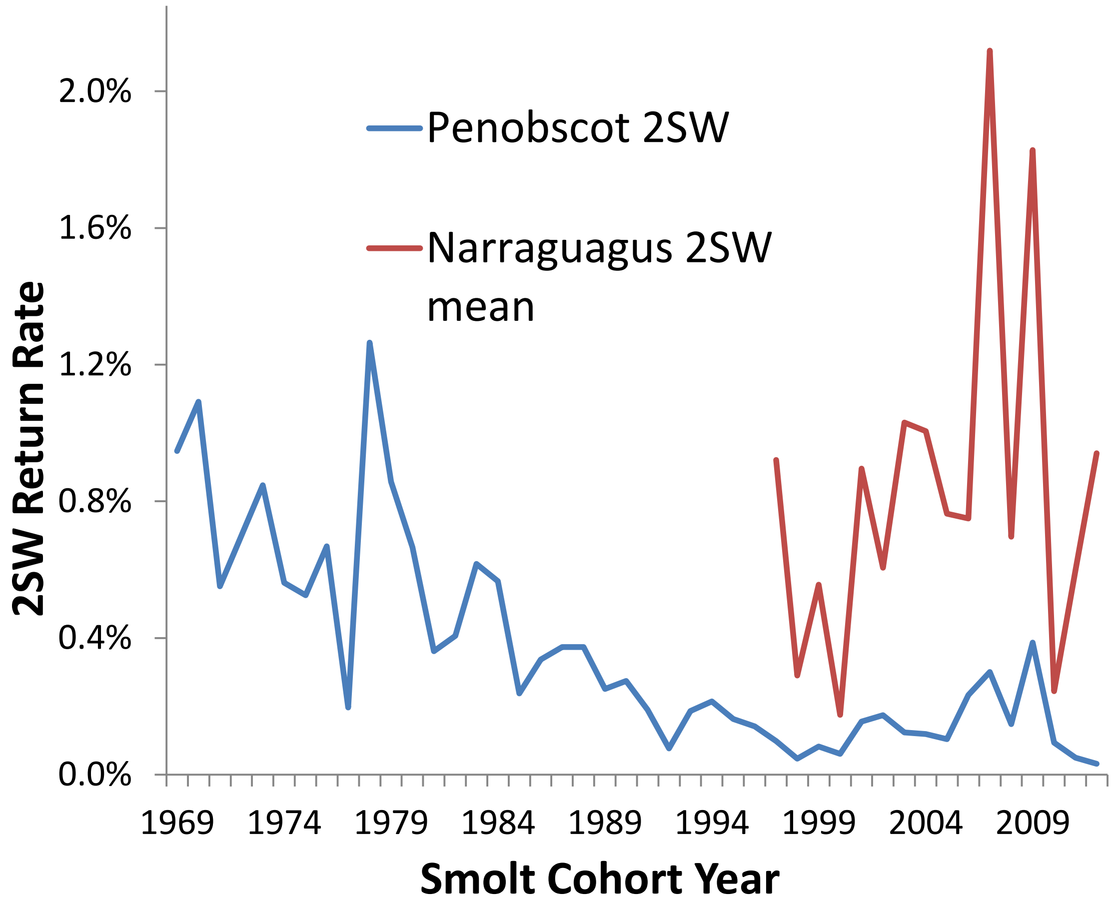

Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by cohort of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River dashed line), USA.

2 Status of Stocks

2.1 Distribution, Biology and Management

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

Strong homing capabilities of Atlantic salmon foster the formation and maintenance of local breeding groups or stocks (National Research Council 2002; Verspoor et al. 2002; Spidle et al. 2003). These stocks exhibit heritable adaptations to their home range in rivers and likely at sea. The importance of maintaining local adaptations has demonstrated utility in salmon conservation (National Research Council 2004). Because of significant declines in Atlantic salmon populations in the US, an analyses of population structure was conducted, and some populations are managed under the Endangered Species Act (ESA, 74 Federal Register 29346, June 19, 2009). The Act required that subgroups must be separable from the remainder of, and significant to, the species to which it belongs to warrant ESA protection.

Assessing population structure required broad scale consideration of geologic and climatic features that shape population structure through natural selection. For Atlantic salmon, factors such as climate, soil type, and hydrology were particularly important because these factors influence ecosystem structure and function, including transfer of energy in aquatic food chains (Fay et al. 2006). Numerous ecological classification systems were examined, which integrated the many factors necessary to discern historic structure. Biologists then delineated US Atlantic salmon populations into four discrete stock complexes that are managed separately: (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.

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

With improved regulations targeting sustainable best management practices with innovative bay-area management creating fallowing areas, farmers have increased sustainability and production, and production has rebuilt (Figure 2.2.1.1). Maine production in 2010 was over 11,000 mt the 6th highest in the 27-year time series and valued at $73.6M. With one company in production since 2011, confidentiality policies preclude detailed reporting 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 about 6,000 mt.

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 provided novel information on US salmon postsmolt ecology and status at sea (Sheehan et al. 2011).

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, state agencies, and NGOs. 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 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 1,640. 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 1,640 fish, less than 43% of the1977-1990 time-series median. There has been a downward trend in the production of salmon on both side of the Atlantic (particularly populations dominated by 2SW fish), that has affected US populations. In addition, recovery from historical impacts was never sufficient, so US populations were at low absolute abundance when the current period of lower marine survival began.

Returns to US waters in 2014 were only 450 fish, which ranks lowest in the 48 year time-series. Likewise, relative to the abundance in the current marine phase (1991–present), returns were the lowest on record. This is in stark contrast to 2011 returns that were the highest in the modern period. Returns the last five years suggest high interannual 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 8%, and 2014 was only 1.1% 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 85% for the Gulf of Maine, 10% for Central New England, and 5% for Long Island Sound. Returns in 2014 were typical, in that the Penobscot River population accounted for largest percentage of the total return (58%) from a single river.

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, an examination of returns from smolt stocked cohorts provides the most informative 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.

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 4.4 for 1SW salmon and 14.2 for 2SW fish. 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 86, 6 times higher than the Penobscot 2SW hatchery cohort average for the same time-period.

In 2014, the SAR for 2SW hatchery smolts released in the Penobscot River was 3.1, ranking 43rd in the 44-year record, while the 2014 return rate for 1SW hatchery grilse was 1.5 ranking 35th in the 45-year record. The 2SW return rate in the Narraguagus River in 2014 was 94.1 (12 fold higher than the Penobscot) . This metric 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. This indicates that the capacity of freshwater habitat to rear smolts must be increased through habitat restoration and enhancement for long-term recovery.

2.4.3 Juvenile Abundance Metrics

The USASAC used databases to develop regional-scale stock assessment products that assess various life history stages and artificial hatchery production and wild production in streams. This type of analysis and graphical summary has been used to summarize return rates across New England for hatchery smolts (e.g. Figure 2.4.2.2 and 2.4.2.3). Examination of these data in further detail for such a long time-series is providing insights into program-specific challenges and more general regional trends. The incorporation of more juvenile data across regions, especially the progression made in importing Maine juvenile data, is facilitating the development and exploration of juvenile indices and development of new metrics. The development of these indices will take time and thoughtful evaluation, given the broad geographic area (186,500 km^2), with variable climates and salmon habitat at near sea level to higher elevations of the Appalachian Mountains. The impact of development is also varied in this region of 14.3 million people, with salmon habitat in cities and remote wilderness. However, taken over a long time–series, this variable climate and environment could provide analytical opportunities that will enhance our understanding of juvenile production dynamics and factors that influence both capacity and variability.

Since 2009, USASAC has consolidated datasets across New England for juvenile production since at least the 1980’s (some Maine data dates back > 50 years). Investigations of the juvenile production trends over time and more detailed assessments were initiated with the 2009 assessment. The first step towards investigating juvenile data trends was a graphical comparison of large parr densities throughout the region. Densities were calculated for sites with at least 10 years of estimates that are a product of electrofishing surveys throughout New England. For the model, large parr densities were ln+0.1

transformed then were analyzed with a mixed random effects model (years were fixed effects, 10 digit USGS hydrologic unit code within years were random effects, sites within 10 digit USGS hydrologic unit codes were random effects, and a "no intercept" model specification). For the Gulf of Maine DPS, data included density estimates from CPUE estimates as well as depletion-sampled estimates. The predicted year effects were then back-transformed to density units (Figure 2.4.3.1).

An examination of average densities (# per 100 m^2 habitat units) from 2008 to 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 were available and provided a good contrast: the Connecticut River basinwide estimate and the Narraguagus River smolt assessment (see USASAC 2013; a Connecticut monitoring ceased). Smolt production metrics are now limited to two longer time series in Maine – the Narraguagus River started in 1997 and Sheepscot River initiated in 2005 (Figure 2.4.3.2). These mark–recapture estimates using rotary-screw traps monitor production of stocked fish and naturally-reared fish. However, data presented are for naturally reared fish only as these are most comparable and longest time-series. Estimates suggest these rivers are producing less than the expected 2-3 smolts per unit of rearing habitat. Smolt estimates for other rivers supplement these longer time series and typically track the two primary metrics. Further analysis of smolt population dynamics is ongoing and examines other abundance indices, size and age distributions, and run timing. Because 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 1,640 fish, and returns in 2014 were only 450 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. Both adult returns and return rates (i.e. marine survival) remains among the lowest in the time series. Since 2011, returns rates have decreased to record lows for hatchery smolts and are variable for other Maine populations. The past decade has seen an increase in the variability of these metrics, compared to the preceding decades since the regime shift of the early 1990's. 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 catch (reported in numbers), aquaculture production (thousand metric tons), and commercial (no fishery) landings of Atlantic salmon from US Waters. Note that recreational catch is 0 from 1995 to present and with only one company reporting since 2010, confidentiality laws limit industry reporting.

Category	1995-2004 Average	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
U.S. Recreational (#) *	-	-	-	-	-	-	-	-	-	-	-
US Aquaculture	10.8	5.3	4.7	2.7	9.0	6.0	**	**	**	**	**
Commercial											
United States	-	-	-	-	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	10.8	5.3	4.7	2.7	9.0	6.0	**	**	**	**	**

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	2014	%CSE
Long Island Sound Complex	10,094	30	0.3%
Central New England Complex	3,435	38	1.1%
Gulf of Maine DPS	15,670	266	1.7%
Totals	**29,199**	**334**	**1.1%**

For further information

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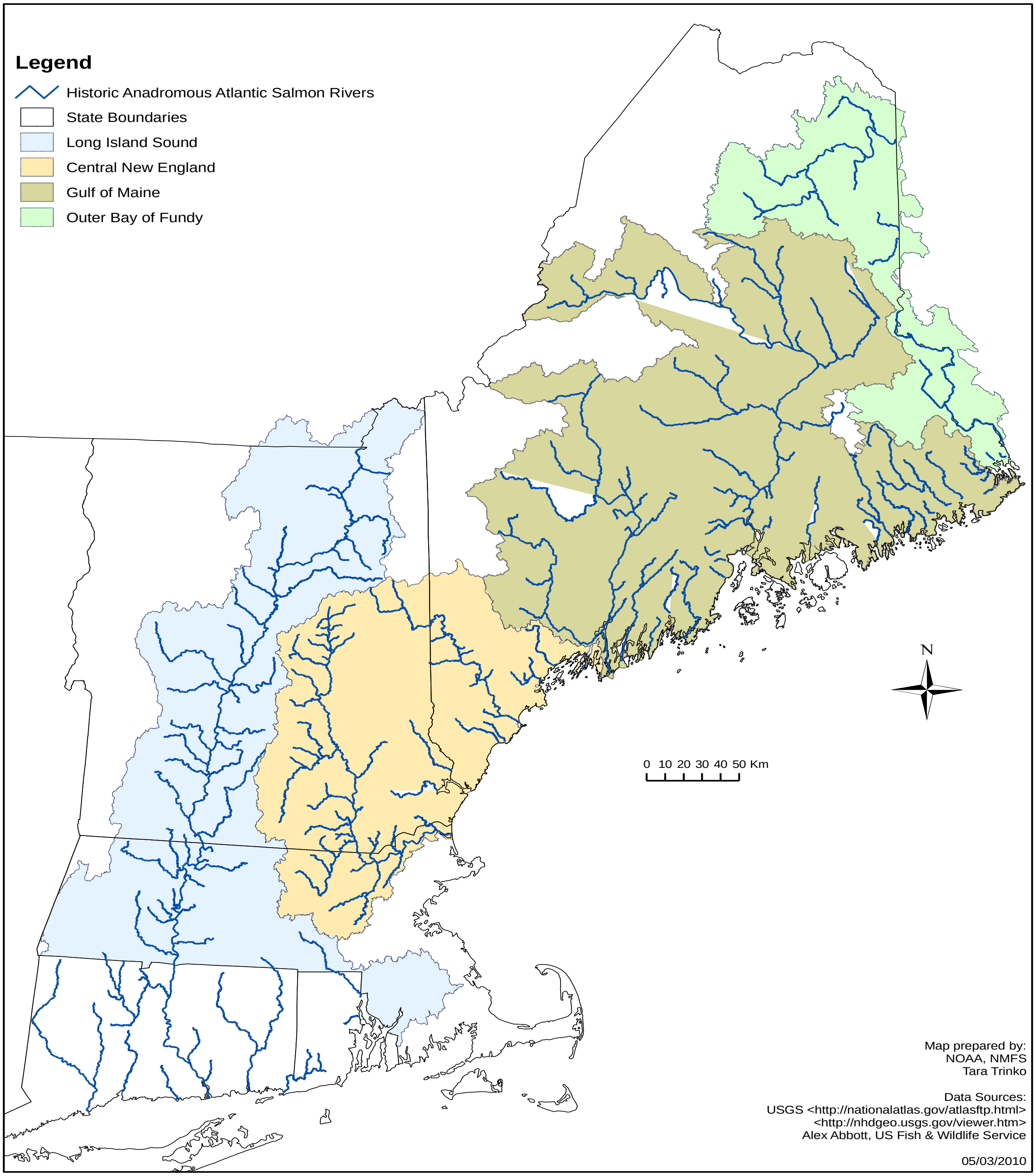

2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

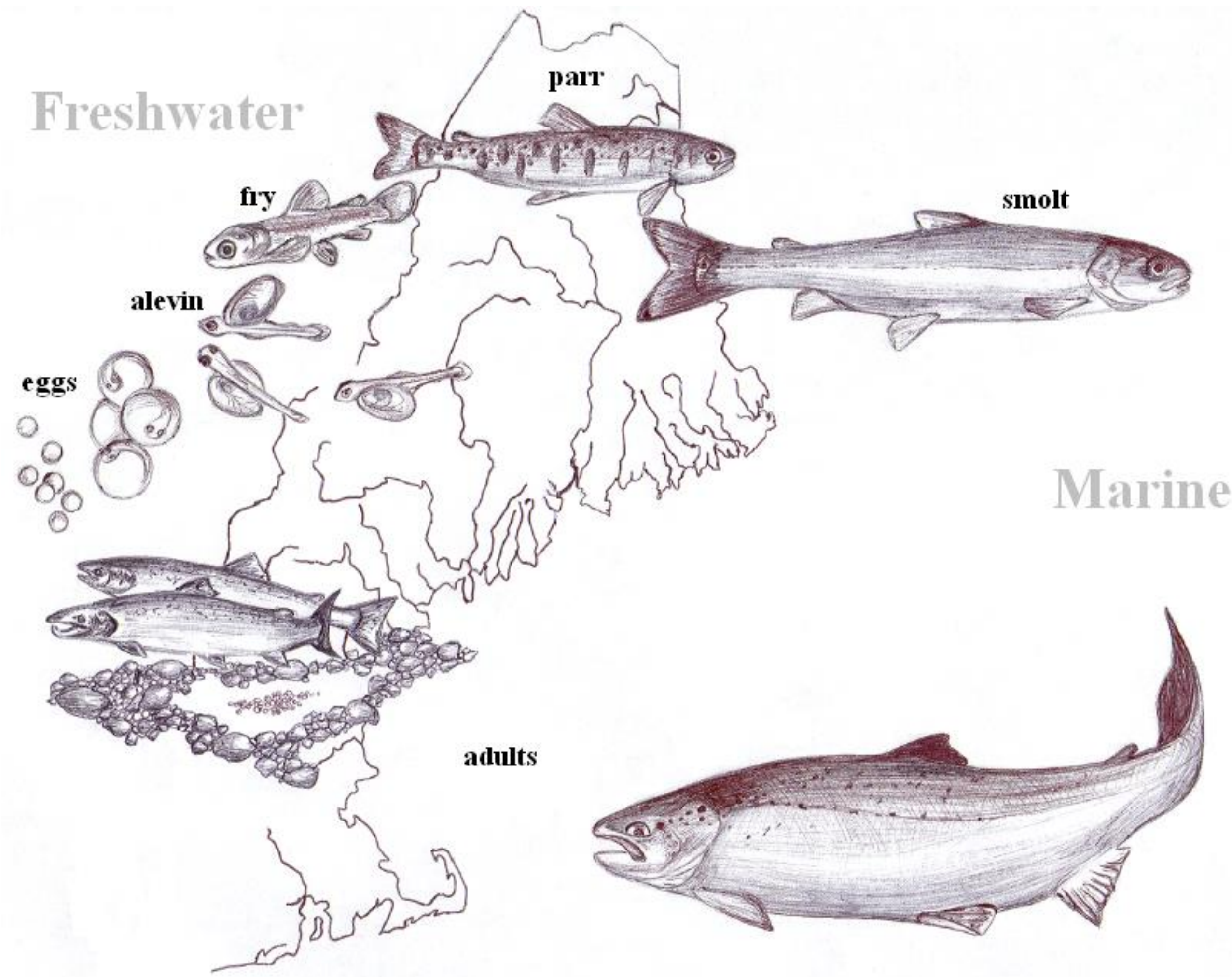

Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

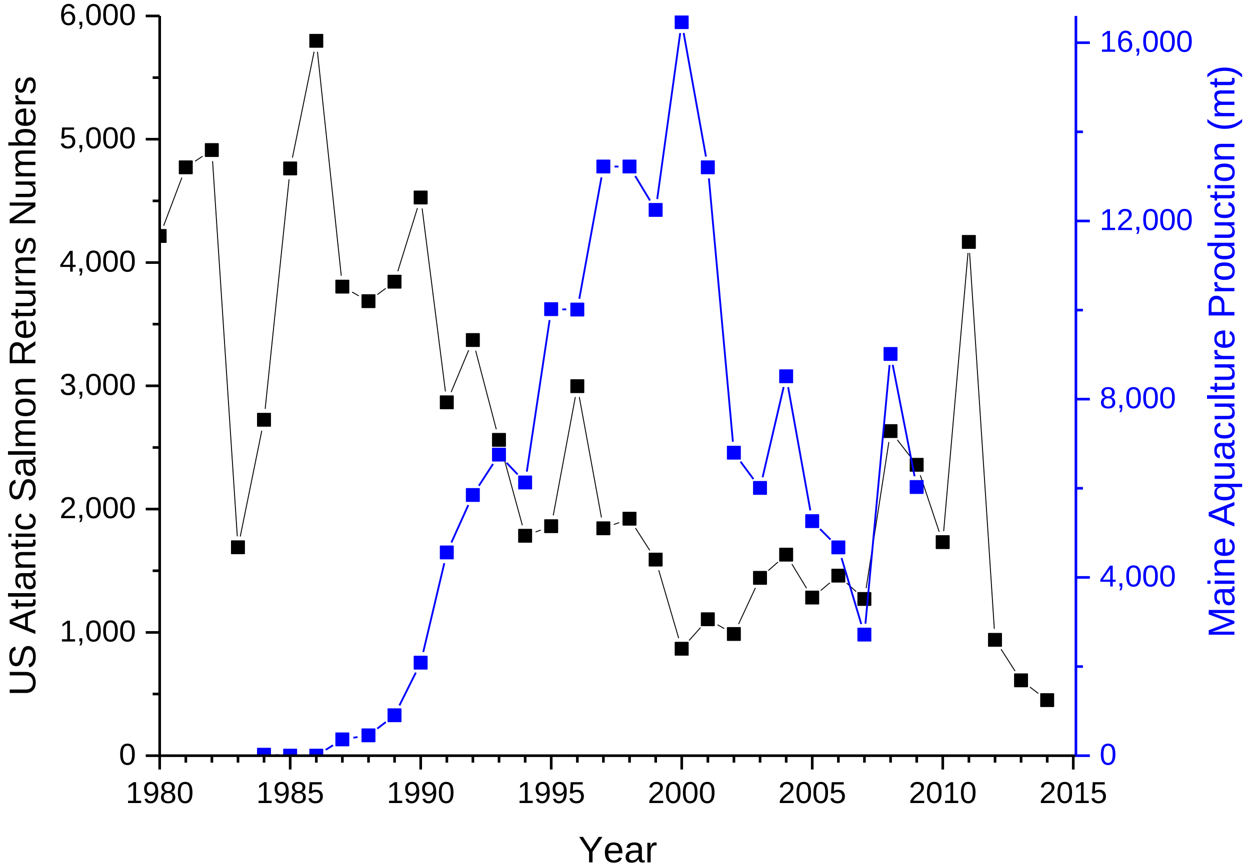

Figure 2.2.1.1 Time-series of New England Atlantic salmon returns (number of adults) and commercial Atlantic salmon aquaculture production (metric tons), with only one company reporting since 2010, confidentiality laws limit industry reporting.

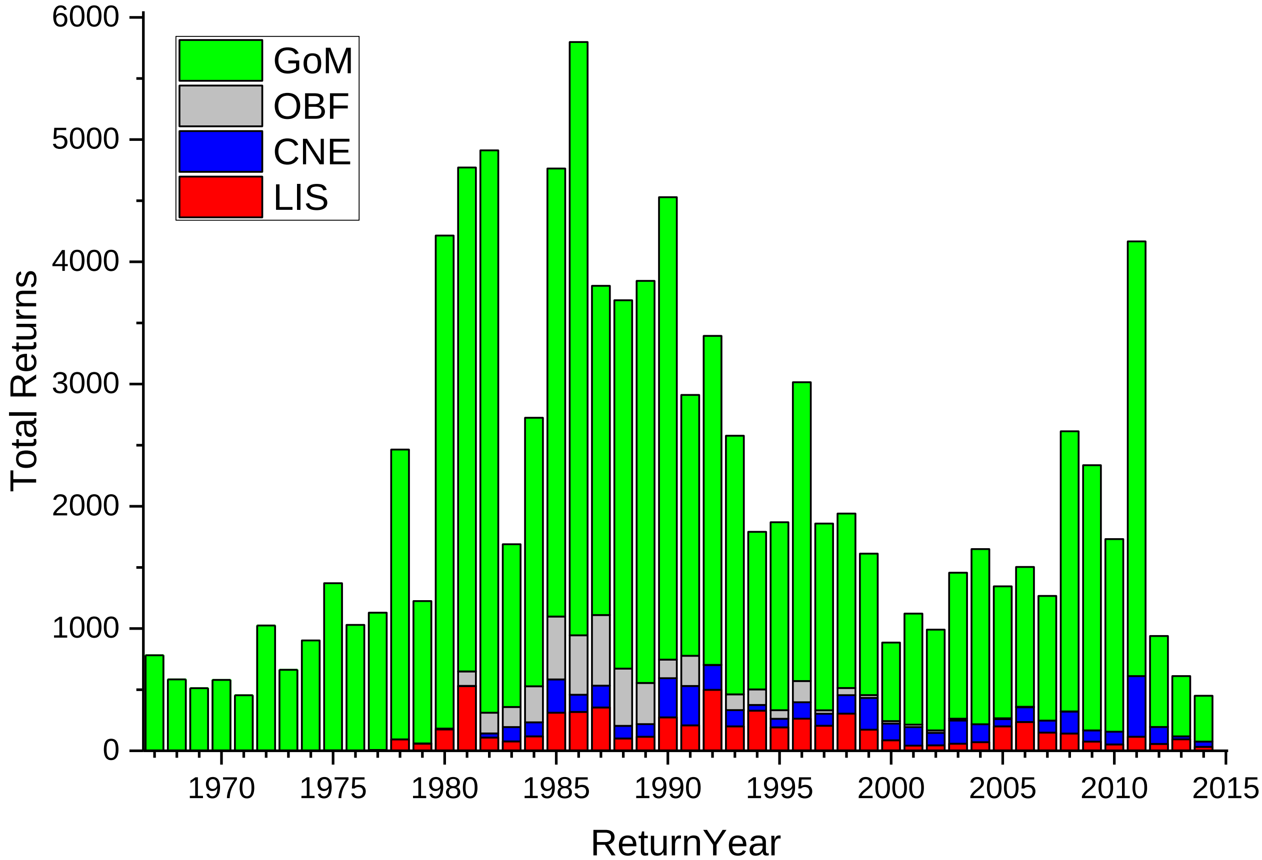

Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex from 1967 to present year.

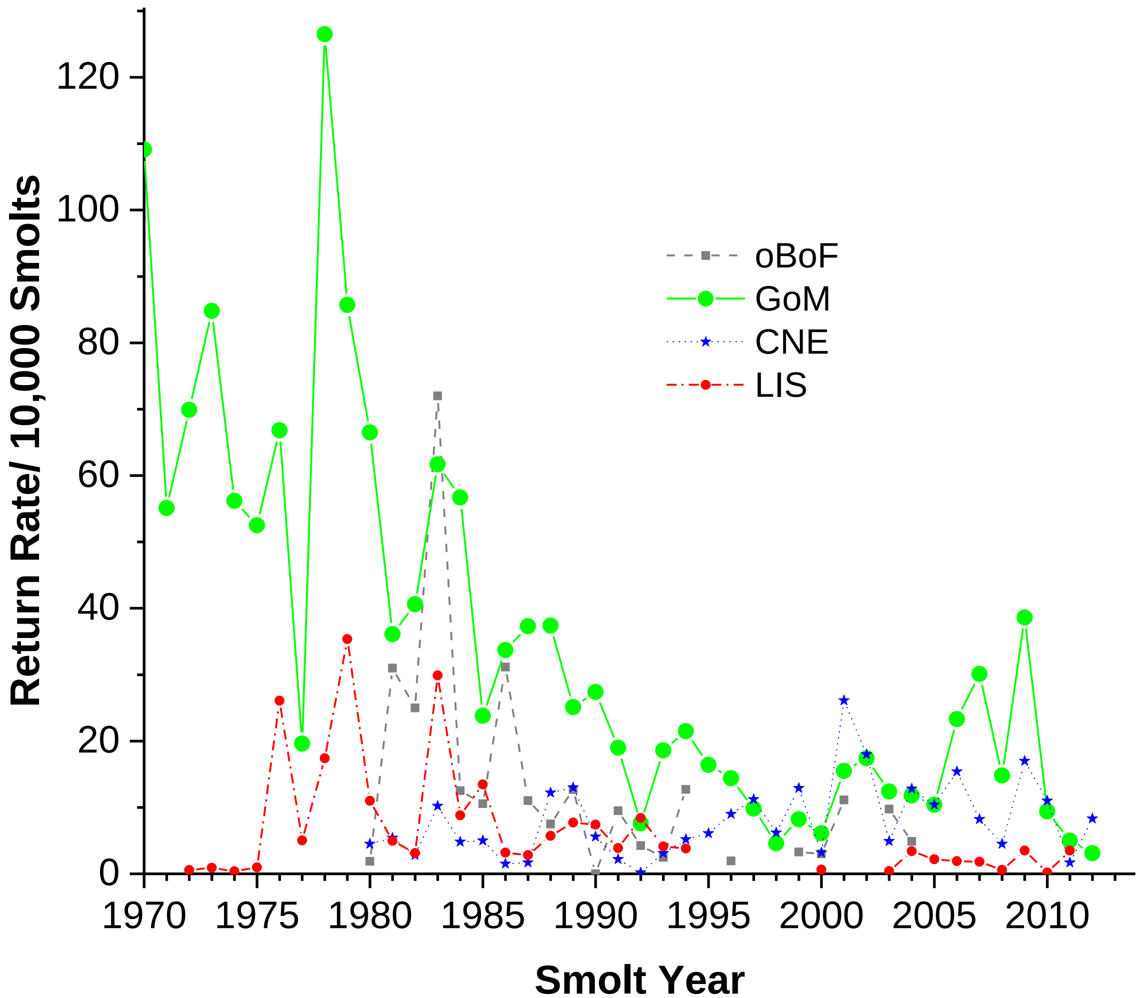

Figure 2.4.2.2 Hatchery return rates (#/10,000) of 2SW Atlantic salmon stocked as smolts in the Connecticut (LIS), Merrimack (CNE), Penobscot (GoM), and St. Croix (OBoF) Rivers.

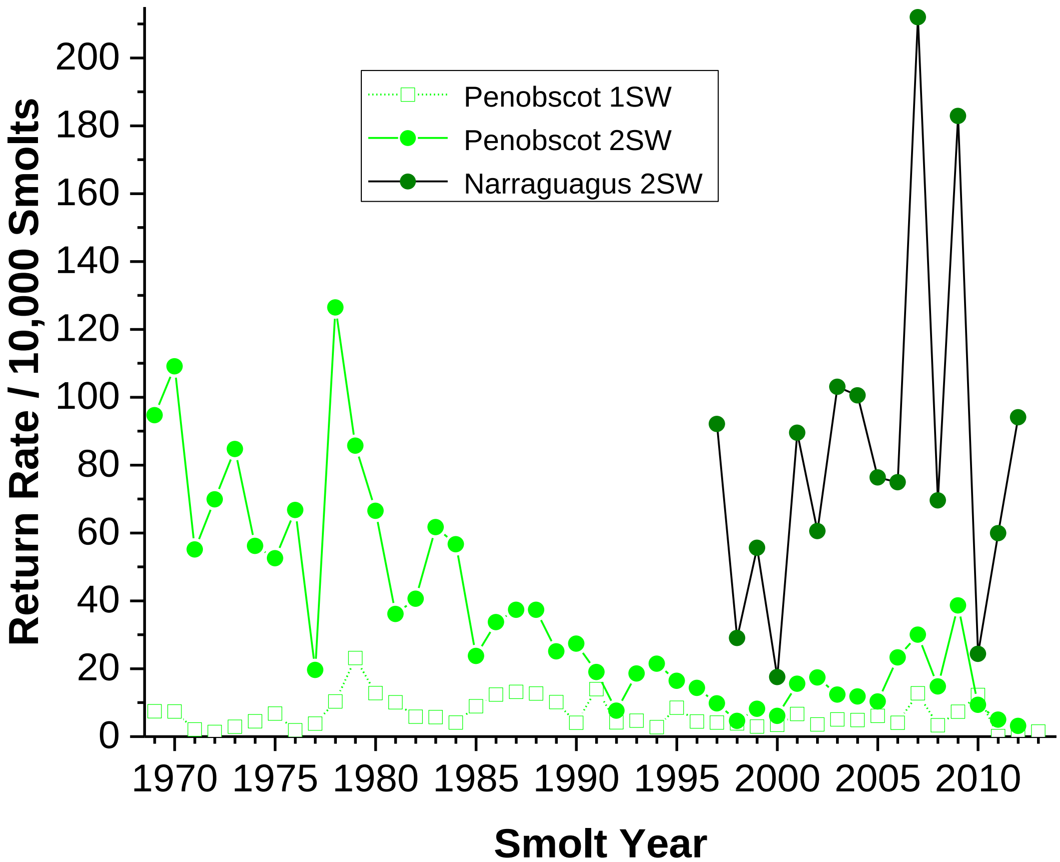

Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

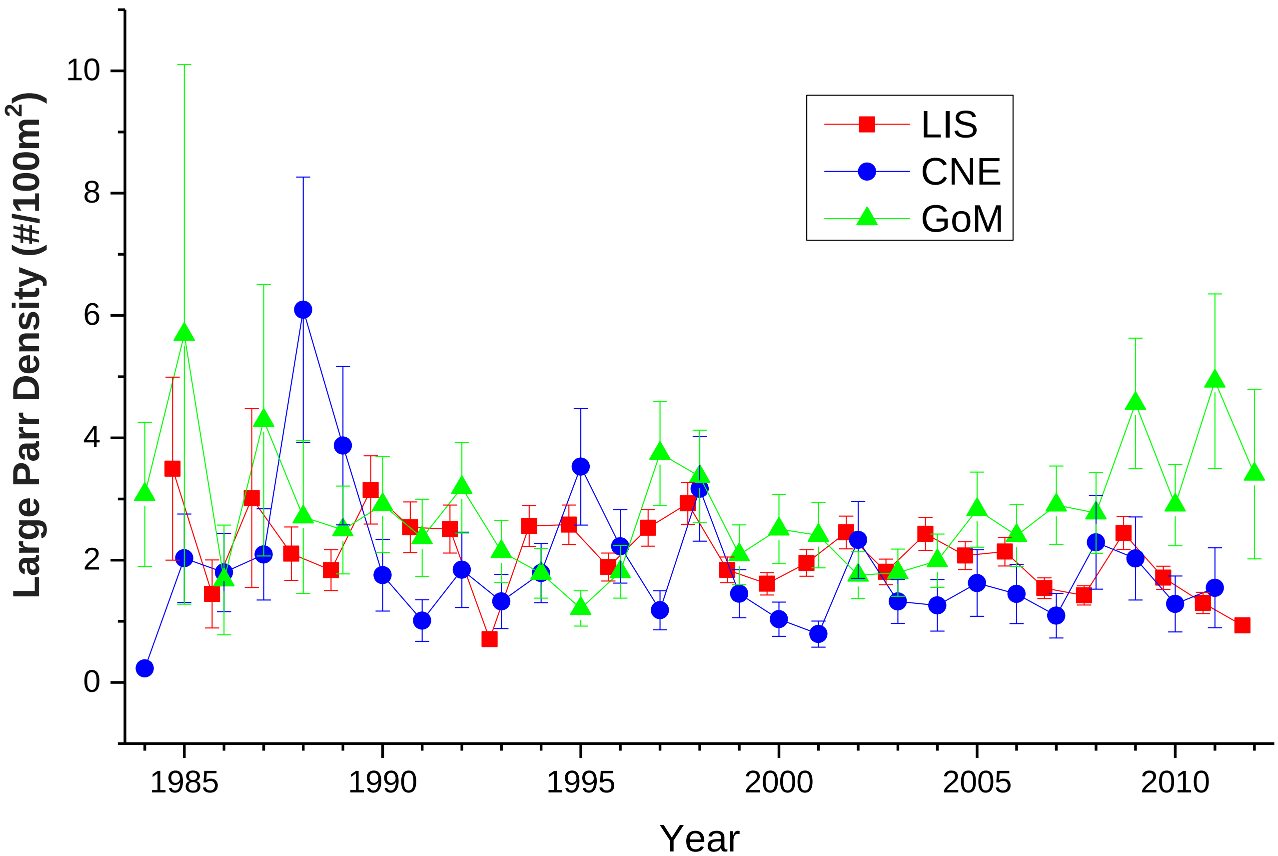

Figure 2.4.3.1 Index of large parr density from a mixed random effects model using electrofishing data from sites with > 10 years of data from 1984 through 2012 from USASAC databases for three stock complexes: Long Island Sound, Central New England, and in the Gulf of Maine DPS.

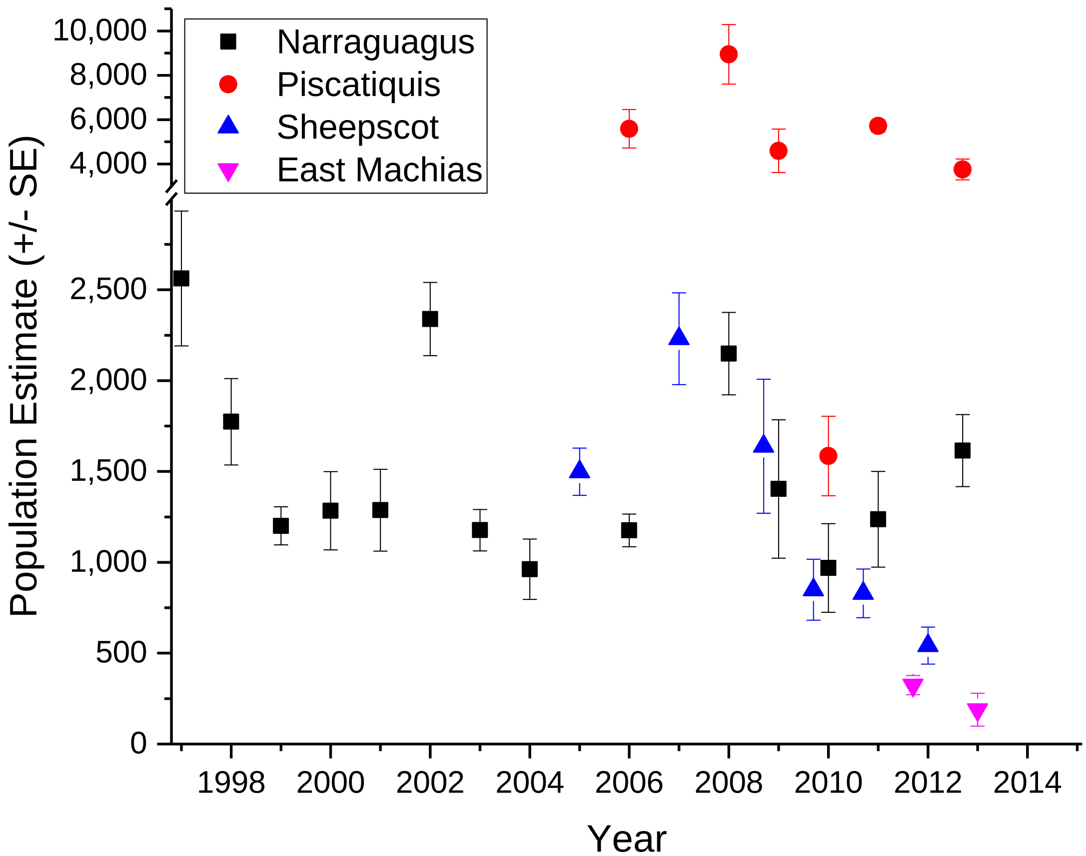

Figure 2.4.3.2 Mark-recapture population estimates of numbers of Atlantic salmon smolts emigrating from the Narraguagus, Piscatiquis, Sheepscot, and East Machias Rivers, Maine. See text for details of estimation methods.

3 Long Island Sound

3.1 Long Island Sound: Connecticut River

The Connecticut River Atlantic Salmon Restoration formally ceased in 2013 and in 2014 the new Atlantic Salmon Legacy Program was initiated by the Connecticut Department of Energy and Environmental Protection (CTDEEP). The Connecticut River Atlantic Salmon Commission (CRASC) maintained an Atlantic Salmon Sub-committee to deal with lingering issues of salmon throughout the watershed. Partner agencies other than the CTDEEP focused on operating fish passage facilities to allow upstream and downstream migrants to continue to access habitat but no further field work was conducted by other agencies. CRASC and its partners continued to work on other diadromous fish restoration in 2014. The following is a summary of work on Atlantic salmon.

3.1.1. Adult Returns

A total of 32 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 26 on the Connecticut River mainstem, three in the Farmington River, one in the Salmon River, and two in the Westfield River. No sea-run salmon were retained for broodstock at any facility. All returning salmon were released at fishways, except for the West Springfield Fishway (Westfield River) which required truck transport to upstream habitat. The intent was to handle, scale sample, and Floy-tag all salmon but one fish passed through the Holyoke Fishlift undetected and several others were intentionally not handled due to their physical condition and high water temperatures.

None of the adult salmon were of hatchery (smolt-stocked) origin. All were of wild (fry-stocked) origin. Two grilse were documented in 2014; all other returns were determined to be two sea-winter age fish. Not sampled fish (and fish with no readable scales) were assigned to age groups on a proportional basis. Including these assignments, the fresh-water age distribution of adult salmon was 1+ (31%), 2+ (66%) and 3+ (3%).

3.1.2. Hatchery Operations

Egg Collection
A total of 830,406 green eggs was produced in 2014, resulting in 568,405 eyed eggs (68% rate). Only the Kensington State Fish Hatchery (KSFH) in CT maintained domestic broodstock. Contributing broodstock included 103 females and 99 males, all 3+ year-old. Those eggs will be used for fry stocking for the Connecticut Legacy Program.

3.1.3. Stocking

Juvenile Atlantic Salmon Releases
A total of 198,957 juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2014. Selected stream reaches in the Farmington River received 119,737 fry and selected reaches in the Salmon River received 79,220 fry with the assistance of many

volunteers. Totals of 109,847 fed fry and 89,110 unfed fry were stocked into these tributary systems. Stocking was conducted out of KSFH, Tripps Streamside Incubation Facility, and Burlington State Trout Hatchery. Eggs at the latter two facilities were transferred from KSFH as eyed eggs.

Surplus Adult Salmon Releases
Domestic broodstock, surplus to program needs, from the KSFH were stocked into the Shetucket and Naugatuck rivers and two selected lakes in Connecticut to create sport fishing opportunities outside the Connecticut River basin.

3.1.4. Juvenile Population Status

Smolt Monitoring
TransCanada continued sampling of smolts at the Moore Dam, Littleton, NH. The trap operated from 30 April to 23 June, with 1,220 smolts collected. The highest collection occurred on 20 May (N=100). Over 80% of the catch was collected between 1 May and 31 May, and 95% was collected by 12 June. All smolts were captured and transported for release immediately downstream of the Vernon Dam, due to an agreement with the agencies. Mortality from the trap was 4% and resulted in a total of 1,171 smolts released. No other monitoring of smolts was conducted in 2014.

Index Station Electrofishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer and fall at index stations in Connecticut by CTDEEP. Electrofishing surveys in other states were not conducted in 2014. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production.

3.1.5. Fish Passage

<u>Hydropower Relicensing</u>- The licenses of five large hydropower projects (four main stem dams) will expire in 2018. These projects are Turners Falls, Vernon, Bellows Falls, and Wilder dams as well as the Northfield Mountain Pumped Storage facility, a project area spanning 175 river miles. State and Federal resource agencies have spent considerable time on FERC-related processes for these re-licensings. Many Study Requests have been submitted to FERC by the agencies. Due to the termination of the salmon restoration program, none of these requested studies involved Atlantic salmon.

<u>Fish Passage Monitoring</u>- 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.

<u>New Fishways</u>- The Manhan River fishway, a 4-foot wide Denil, in Easthampton, MA became operational for the first time in April of 2014. The Manhan River enters the Connecticut River in Easthampton, MA. One adult salmon was observed dropping back down the fishway at the video monitored fishway exit. Only a very limited analyses of the

video for counts has occurred to date. The Tiley-Pratt fishway, a small pool-and-weir, was constructed by The Nature Conservancy and the CTDEEP on the first dam on the Falls River, Essex, CT. The Falls River enters the Connecticut River in Essex, CT. This fishway will mostly benefit river herring.

3.1.6. Genetics

The genetics program previously developed for the Connecticut River program has been terminated. A 1:1 spawning ratio was used for domestic broodstock spawned at the KSFH.

Sea-run origin fry (7,423) were stocked in Pine Brook in CT in the spring of 2014 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 2014.

3.1.7. General Program Information

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-Schools program, providing eggs for 87 tanks in 61 schools in Connecticut.

3.1.8. Migratory Fish Habitat Enhancement and Conservation

There were two notable stream restoration projects in 2014. The Karp Family Dam Removal Project on Stony Brook in Suffield, CT was begun in late 2014 but not completed until early 2015.Cooperators included the CTDEEP, the USFWS, and the North Connecticut Conservation District. The Falls River Dam Removal Project on Falls River in Gill, MA was completed in late 2014. Various partners, including the USFWS and the State of Massachusetts, had been working on this project for many years.

3.2 Pawcatuck River

3.2.1. Adult Returns

Zero (0) adult salmon returned to the Pawcatuck River this year.

3.2.2. Stocking

Juvenile Atlantic Salmon Releases

The Salmon in the Classroom program was responsible for stocking approximately 5,000 fry into the Pawcatuck River and its tributaries. No other Atlantic salmon fry were stocked into the Pawcatuck River in 2014. No smolts were stocked in the Pawcatuck River in 2014.

3.2.3. Juvenile Population Status

Index Station Electrofishing Surveys
Parr assessments were not conducted in 2014 due to lack of personnel.

3.2.4. Smolt Monitoring

No work was conducted on this topic during 2014.

3.2.5. Tagging

In Rhode Island, all smolts are released with adipose fin clips, however, no smolts were released in 2014.

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 2014.

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 2014.

4 Central New England

Central New England: Merrimack River

4.1.1 Adult Returns

Forty (40) Atlantic salmon were counted in the Merrimack River at the Essex Dam, Lawrence, MA and additional one (1) fish passed with a floy tag present indicating it was from the broodstock fishery. Unlike past years, no salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Instead all fish were allowed to run the river. Thirty-four (34) fish were observed passing the Pawtucket Dam, Lowell, MA via a fish lift, with others were known to pass an unmonitored fishway at the dam. Only cursory morphometric data was collected, when possible at the viewing window at the Essex Dam. Twelve (12) of the sea-run returns had an adipose clip. The morphometric data was used to prorate the return age, all fish recorded under 26" estimate was estimated to be a 1 sea-winter return.

4.1.2 Hatchery Operations

The reduction of effort for the Merrimack Program has focus primary effort of Nashua National Fish Hatchery to the Saco River program. In 2014, the fish in the domestic broodstock were recorded as "Merrimack Stock". This nomenclature will continue when referring to fish stocked into the Saco River and recorded in the Merrimack River section of the report.

Egg Collection

Spawners provided an estimated 1,243,662 green eggs.

Sea-Run Broodstock

No sea-run fish were retained for broodstock.

Domestic Broodstock

A total of 293 female and over 295 male captive (F1 from sea-runs) broodstock spawned at Nashua NFH; 243 fish were non-spawners. Of the 293 females, 2 were four years old, 290 were three years old, and 1 was two years old. The captive broodstock spawning season began on November 7, 2014 and ended November 20, 2014, and only included 4 spawning events to reach target egg production. All eggs were retained at NNFH for incubation and eventual release to the Saco River watershed and the Adopt-A-Salmon educational programs

Stocking

Juvenile stocking is limited to educational salmon in schools program at about 12,500 eggs provided to schools to rear and release in the Merrimack River watershed.

4.1.3 Juvenile Population Status

Yearling Fry / Parr Assessment

In 2014, no parr assessment was conducted. Parr were occasionally collected in electrofishing surveys focused on other species, but are not reported here.

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.

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.

Fish have continued to be stocked that have restoration value. These include excess 232 gravid broodstock (in excess of the need under the Saco River agreement) and small amounts of fry stocked as part of the salmon in schools program. Some natural reproduction is likely occurring where fish can access suitable spawning habitat.

Atlantic Salmon Broodstock Sport Fishery

NHFG had their last planned stocking of Adult Atlantic salmon for their broodstock fishery in the spring of 2014. All 616 fish were excess broodstock from the Merrimack and Saco Programs.

Adopt-A-Salmon Family

The 2014 school year marked the twenty-second year of the Adopt-A-Salmon Family Program in central New England. In January and February, an estimated 12,500 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.

Central New England - Integrated ME/NH Hatchery Production

The FWS, Eastern New England Fishery Resources Complex has developed an agreement with MDMR to engage in planning and implementing an Atlantic salmon restoration and enhancement project in the Saco River watershed (see section 4.2.3). The agreement provides that NNFH and/or NANFH will produce juvenile Atlantic salmon for continued Saco River Salmon Club (Club) “grow-out” or release to the Saco River.

4.2 Central New England: Saco River

4.2.1 Adult Returns

Brookfield Renewable Energy Group 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 operated from 29 May to 31 October 2014. No salmon were observed moving upriver through these facilities. Three adult Atlantic salmon were captured at a third passage facility upriver at Skelton Dam, which operated from 1 June to 31 October 2014. The Saco River trapping facilities were not operated at the beginning May due to mechanical problems and safety issues associated with fixing the problems.

4.2.2 Hatchery Operations

Egg Collection

In 2014, 395,805 eyed eggs from Merrimack River origin broodstock were transferred from the Nashua National Fish Hatchery to the Saco River Salmon Hatchery. A portion of these were distributed to school programs (Fish Friends) and the remaining reared at the hatchery for release as fry.

Stocking

Juvenile Atlantic Salmon Releases

A total of 12,000 smolts raised at North Attleboro National Fish Hatchery (NANFH) were released to the river. In addition, 4,000 age 0 parr raised at NANFH were stocked in to the Saco. Approximately 366,000 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 2014.

Smolt Monitoring

No smolt monitoring was conducted in 2014.

Tagging

No salmon out planted into the Saco were tagged or marked in 2014.

4.2.4 Fish Passage

No fish passage improvements were made during 2014.

4.2.5 Genetics

No genetic samples were collected in 2014.

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 2014.

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 2014 were 375. Returns are the sum of counts at fishways and weirs (284) and estimates from redd surveys (92). 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 2014 was 211 (97 Penobscot [261 return – 162 broodstock and 2 DOA] + 114 other DPS). Because there was no rod catch, the escapement to the GOM DPS area was assumed to equal returns (estimated or released after capture) plus released pre-spawn captive broodstock (adults used as hatchery broodstock are not included).

Estimated replacement (adult to adult) of naturally reared returns to the DPS has varied since 1990 although the rate has been somewhat consistent since 1997 at or below 1 (Figure 5.1.1). Most of these were 2SW salmon that emigrated as 2 year old smolt, thus, cohort replacement rates were calculated assuming a five year lag. These were used to calculate the geometric mean replacement rate for the previous ten years (e.g. for 2000: 1991 to 2000) for the naturally reared component of the DPS overall and in each of three Salmon Habitat Recovery Units (SHRU). Despite an apparent increase in replacement rate since 2008, naturally reared returns are still well below 500 (Fig. 5.1.2).

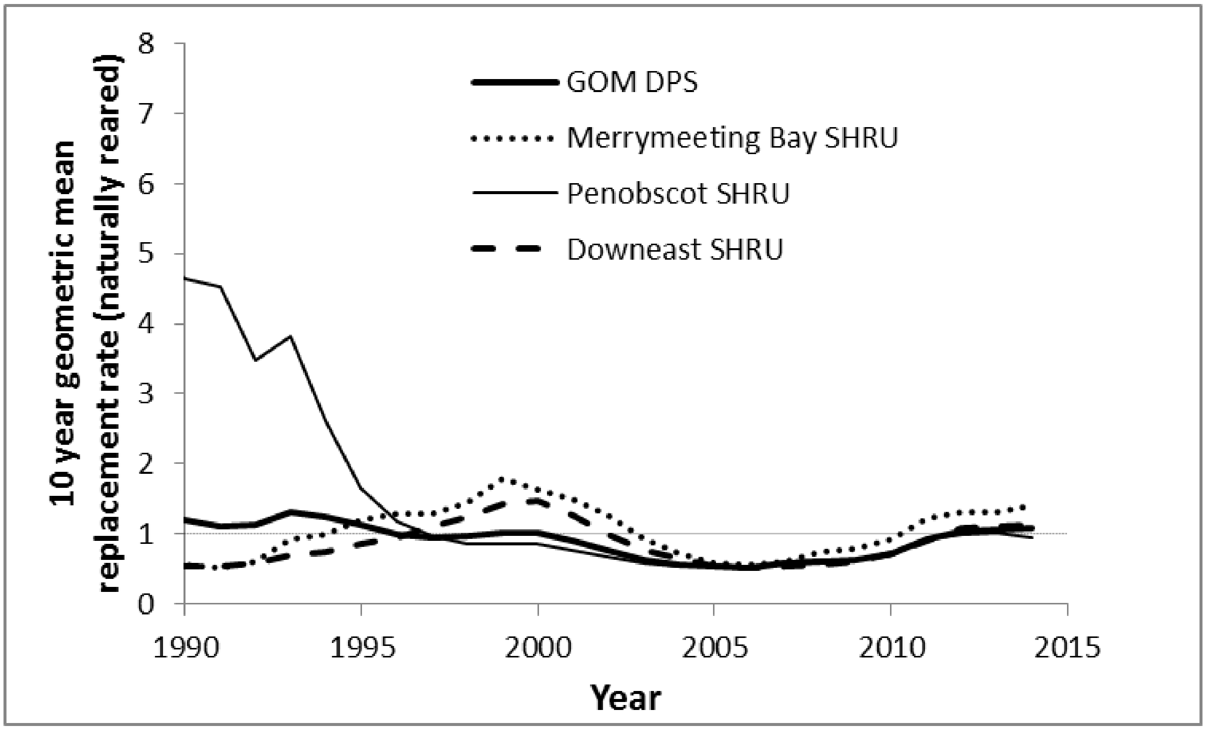

Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and the three Salmon Habitat Recovery Units (SHRU).

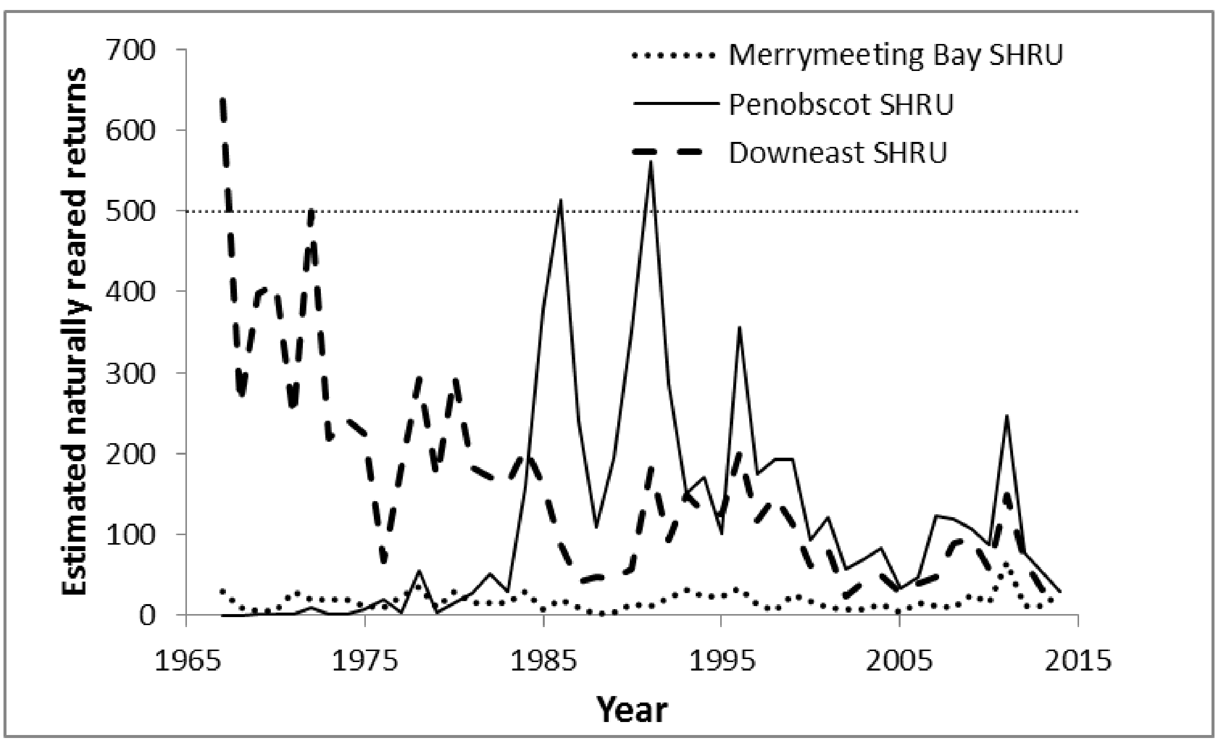

Figure 5.1.2 Estimated Naturally Reared Returns to the GOM

Small Coastal Rivers

Downeast Coastal SHRU

Dennys River
The weir in Dennysville has not been fished since 2011. At this time there are no plans to reactivate this site.

There was no spawning activity documented in the Denys River in 2014. However, due to high fall flows that limited visibility only Cathance Stream a major tributary was surveyed for redds.

East Machias River
Sixteen (16) redds attributed to wild returns were counted during the 2014 redd surveys in the East Machias River that included approximately 97% of known spawning habitat. No captive reared gravid adults were released into the East Machias because they were needed for egg production.

Machias River
A total of 11 redds were counted, covering only 40% of the known spawning habitat in the Machias drainage. Coverage was limited by high water and poor visibility.

There were 9 redds observed in Old Stream a highly productive tributary to the Machias. In 2013 only one redd had been observed, disappointing most since that was the first year true "wild" adults were to return. Since 2008 no hatchery product has been placed in Old Stream. These 9 redds can be attributed to 25 adult returns in 2010.

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 2014. 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 2SW returns from the 2011 stocked cohort were expected, as well as 1SW and MSW returns from fry stocking and natural reproduction. Staff captured two (2) 1SW hatchery origin and 1 naturally reared 2sw salmon in the fishway trap in 2014. Sea-age and origin were determined based on scale reading, marks and tags. Only 1 redd was noted in the Pleasant River during surveys that covered 85% of known spawning habitat area.

Narraguagus River
Returns to the fishway trap in 2014 (4) declined from last season (21) and remained far below the previous 10-year average (40 returns). It is important to note that high water conditions allow salmon to ascend Stillwater Dam in Cherryfield, bypassing the fishway trap. Of the four returns, 3 were two sea-winter (2SW) adults and one was a repeat spawner. In 2014, twenty redds were observed in the mainstem of the Narraguagus River. 82% of known spawning habitat was surveyed. Again as in other Downeast Rivers, high flows resulted in reduced coverage and poor visibility.

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 7 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 4 November.

Two female 2SW salmon were captured in the fishway trap on the Union River in 2014. One fish was trucked and released upstream to the West Branch of the Union, and the second salmon was returned to the river downstream of the Ellsworth Dam by Brookfield Renewable Energy Group. The second Atlantic salmon was not reported to MDMR until after the season had ended.

Penobscot SHRU

Ducktrap River
Three (3) redds were observed during surveys in late November that encompassed 73% of the spawning habitat area in the Ducktrap River watershed.

Cove Brook. No spawner surveys were conducted in 2014

Merrymeeting Bay SHRU

Sheepscot River
There were 26 total redds observed in the Sheepscot River in 2014. Of these 17 were in the West Branch and 9 were in the mainstem. 80% of known spawning habitat was surveyed. The number of redds observed was an increase from previous years and did not follow the trends observed in other rivers where the trend was a decrease. Factors influencing marine survival such as lifestage stocked may be responsible for the returns but data is not available yet to explain this year’s numbers.

Sandy River (Kennebec Drainage)

The Sandy River is a tributary to the Kennebec River. In 2014 80% of known spawning habitat was surveyed and 5 redds were observed. Origin of the redds observed in the Sandy River are from adult salmon trapped at the Lockwood fish lift (18) that were transported and placed in the Sandy River.

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 (Pleasant, Narraguagus and Union rivers) combined with redd count data from the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot 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 92 (90% CI = 38 - 218) (Table 5.1.1). Estimates include returns to the Union River.

Table 5.1.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 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
2014	38	92	218

5.1.3 Large Rivers

Penobscot River
2014 was the first year that the fish lift at the Milford Dam was operational. With removal of the Veazie Dam in 2013, Milford is now the first dam returning adult salmon encounter in the Penobscot River. The new fish lift at the Milford Hydro-Project owned by Brookfield Renewable Energy Group became operational in the spring of 2014. The Milford fish lift was operated daily by MDMR staff from 5 May through 12 November, 2014. The fish lift was also used to collect adult sea-run Atlantic salmon broodstock for the U.S. Fish and Wildlife Service (USFWS).

We captured 261 sea-run Atlantic salmon during the 2014 season (Table 5.1.2). This represents a 32% decrease from last year's catch of 381 sea-run salmon, and is considerably lower than the ten year average (2004-2013) of 1,379 fish. This year's median capture date was 29 June, seventeen days later than 2013.

Scales collected from 258 salmon captured at the Milford fish lift were analyzed to characterize the age and origin structure of the 2014 run. The origins of ten salmon captured at the fish lift 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 (174; 67%), along with 83 1SW salmon (32%), two (2) 3SW fish, and two (2) repeat spawners. Approximately 92% (239) of the salmon that returned were of hatchery origin and the remaining 8% (22) were of wild or naturally reared origin.

Only 2% of this year's run (6 salmon) were observed to have at least one mark applied (adipose clip or caudal punch) prior to being released as a hatchery smolt. A single MSW, long absence, repeat spawner male salmon was observed with an caudal punch and a passive integrated transponder (PIT) tag. The tag number indicates this male salmon was originally captured on June 12, 2012 as a 2SW and transported to the USFWS Craig Brook National Fish Hatchery in Orland (CBNFH) for broodstock and later released back to the river post spawn.

Additional data collected at the Milford fish lift included counts of other species present during each tending day. River herring (*Alosa spp.),* smallmouth bass (*Micropterus dolomieu*), American shad (*Alosa sapidissima*), and sea lamprey (*Petromyzon marinus*) were the most abundant species observed in 2014.

Androscoggin River
The Brunswick Dam fishway trap was operated from 16 May to 14 November, 2014 (Table 5.1.2). Four (4) 2SW adult Atlantic salmon were captured at the Brunswick fishway trap. Due to upstream passage study requirements each fish was tagged with radio transmitters. Two of the returning Atlantic salmon remained in the Androscoggin River upstream of Brunswick. One was of naturally reared origin and one was of hatchery reared origin. One of the tagged salmon was tracked into the Little River during the spawning season where it was observed spawning with another salmon. It is believed that the other salmon may have

been a non-tagged salmon that passed through the Brunswick fishway while being cleaned. That fifth salmon was not documented as an official return to Maine.

Two of the tagged salmon dropped back downstream below Brunswick. One of the salmon did return to the Brunswick trap only to drop back downstream a second time and was then captured at the Lockwood fish lift facility on the Kennebec River and trucked upstream to the Sandy River, where it remained throughout the spawning season. That salmon was not counted as a return to the Androscoggin River, but rather to the Kennebec River. Both of the Atlantic salmon that dropped out of the Androscoggin River System were of hatchery origin.

Table 5.1.2 Counts of sea-run, Atlantic salmon returns to Maine rivers in 2014 by gender and sea-age: (One sea-winter, 1SW; two sea-winter, 2SW; three sea-winter, 3SW; multi sea-winter, MSW; and repeat spawner, RPT). Also included are counts of aquaculture (AQS) and captive reared freshwater (CRF) adult captures. Drainages are grouped by Salmon Habitat Recovery Unit (SHRU).

				Male				Female				Unknown		Adult Counts		
River	Open Date	Median Catch Date	Close Date	1SW	2SW	3SW	RPT	1SW	2SW	3SW	RPT	1SW	MSW	Sea-run	AQS	CRF
Downeast Coastal SHRU																
Dennys River*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Narraguagus River	28 Apr	19 Jul	30 Oct	0	3	0	1	0	0	0	0	0	0	4	0	0
Pleasant River	12 May	13 Jul	22 Oct	2	0	0	0	0	1	0	0	0	0	3	0	0
Union River	07 May	23 Jun	04 Nov	0	0	0	0	0	2	0	0	0	0	2	0	0
Penobscot Bay SHRU																
Penobscot River	05 May	29 Jun	12 Nov	83	64	1	2	0	110	1	0	0	0	261	0	0
Merrymeeting Bay SHRU																
Lower Kennebec River	05 May	14 Jul	14 Nov	3	3	0	0	0	12	0	0	0	0	18	0	0
Lower Androscoggin R.	15 Apr	24 Jul	14 Nov	0	1	0	0	0	2	0	0	0	0	3	0	0
Sebasticook River	07 May	--	14 Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				88	71	1	3	0	127	1	0	0	0	291	0	0

* No trap was installed or operated at this facility in 2014.

Kennebec River

The Lockwood fish lift was operated by Brookfield Renewable Energy Group from 5 May to 14 November 2014 (Table 5.1.2). Eighteen (18) adult Atlantic salmon were captured at the Lockwood fish lift. Of those, fifteen (15) were 2SW and three (3) were 1SW. All 18 adult Atlantic salmon were trucked and released to the Sandy River.

Sebasticook River

The Benton Falls fish lift facility was operated by MDMR staff from 7 May to 14 August 2014 (Table 5.1.2). No Atlantic salmon were captured at Benton this year.

Survival Estimates

Atlantic salmon survival rates were calculated for marked hatchery stocks and naturally reared stocks for the Narraguagus and Penobscot Rivers (Table 5.1. 3). 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, 0.78%).

Table 5.1.3. 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 where all 2 sea-winter adult returns have been accounted for. Therefore, in some cases some 3 sea-winter adults may still be at large.

Cohort Year	Salmon Habitat Recovery Unit	Drainage	Source	Survival From	Survival To	Number Stocked or Estimated	Number of survivors	% Survival
2010	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	62,400	78	0.13
2010	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	2,376	25	1.05
2011	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	64,000	37	0.06
2011	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1,785	14	0.78
2012	Downeast Coastal	Narraguagus	Hatchery Smolts	Smolt	Adult	59,100	17	0.03
2012	Downeast Coastal	Narraguagus	Naturally Reared	Smolt	Adult	1,213	6	0.49
2008	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	512,500	1,007	0.20
2009	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	559,828	2,583	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	283	0.05
2012	Penobscot Bay	Penobscot	Hatchery Smolts	Smolt	Adult	555,200	230	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 4,447,793 million eggs for the Maine program in 2014: 775,100 thousand eggs from Penobscot sea-run broodstock; 1,653,293 million eggs from two domestic broodstock populations; 2,019,400 million eggs from six captive broodstock populations. Due to the continued low number of returning adults to the Penobscot, and corresponding reduction in available eggs, domestic-origin eggs produced at GLNFH will be incorporated into smolt production as for the 2014 cohort.

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 2014 CBNFH used year class crosses as well as spawning optimization software to avoid spawning closely related individuals within captive broodstock populations

A total of 102 Penobscot sea-run origin females, 1 domestic female, and 519 captive females were spawned at CBNFH between the 28th of October and the 25th of November. At GLNFH, 354 age four and 203 age three domestic females were spawned to provide eggs for smolt production, fry production, and in-stream egg planting.

Egg Transfers

CBNFH transferred 290K Penobscot eyed eggs to GLNFH for age 1 smolt production, 396K 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 and 118K eyed Sheepscot eggs for egg planting in the Sheepscot River.

GLNFH transferred 1.18M eyed, Penobscot domestic origin eggs to DMR for egg planting in the Sandy River (1.15M) and for the Penobscot River (30K).

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 2014.

Wild Broodstock Collection and Domestic Broodstock Production

A total of 214 adult sea-run Atlantic salmon captured at the Milford Dam, on the Penobscot River, was 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. This increase was carried over in 2014. Given the low returns to the Penobscot River in 2012, 2013 and 2014, CBNFH and DMR personnel elected to collect parr for use as future broodstock in 2014 with a collection target of 1500 parr collected from throughout the basin.

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 2014, 2,393 wild parr (35, Dennys; 237, East Machias; 301, Machias; 306, Narraguagus; 1103, Penobscot; 202, Pleasant; 209, 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 2013 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 2014. Incoming adults were isolated in the screening facility to undergo sampling procedures and await the results of PCR testing. No suspects were identified in 2014.

Stocking

Stocking activities in Maine resulted in the release of over 4.75M Atlantic salmon in 2014. 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 (558K). Of the 558K, 92K were marked with adipose clips and visual implant elastomer (VIE) tags. No age 0 parr were released from GLNFH in 2014; due to the small number of sea-run origin eggs in 2013 all juveniles from that cohort are being retained at GLNFH for release in 2015.

Ambient age 0 parr reared at CBNFH released into the Sheepscot River totaled 15K; all CBNFH origin parr were marked with adipose fin clips. The Downeast Salmon Federation released 150K ambient age 0 parr reared by the East Machias Atlantic Salmon Resource Center; East Machias parr were adipose fin clipped.

The two federally operated hatcheries, CBNFH and GLNFH produced approximately 1.41 million unfed fry [Penobscot, 811K; Machias, 210K; Narraguagus, 263K; Sheepscot, 23K; Union, 22K], for release throughout the Distinct Population Segment (DPS).

Several privately operated hatcheries continued to support Atlantic salmon stocking efforts in 2014. Two hatcheries operated by the Downeast Salmon Federation released fry and age 0 parr into both the Pleasant (114K fry) and East Machias (16K fry and 150K 0 parr).

Adults

No gravid broodstock were released in 2014. Following spawning, 213 Penobscot sea-run broodstock were released from CBNFH back into the Penobscot River in 2014. 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 (38); East Machias (168); Machias (292), Narraguagus (202); Pleasant (168); Sheepscot (74). GLNFH released 1,220 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River. In addition, the USDA released 120 excess adults 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 2014. 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 2014 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

ME-DMR conducted electrofishing surveys to monitor spatial and temporal abundance of Atlantic salmon juveniles at 401 sites in 2014. Three hundred one (301) of the locations were sampled using a catch-per-unit-effort protocol, 12 sites were sampled using a multi-pass depletion protocol, and 8 locations were sampled to collect parr broodstock for the captive reared broodstock program. The sampling effort encompassed several projects including a juvenile abundance index, egg planting assessment, adult translocation study assessment, and large woody debris. DMR collected 436 scale samples and 1,101 fork length measurements from juvenile salmon in 2014.

2014 was the fourth 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 2014, a total of 125 sites were sampled; 59 for the Downeast SHRU, 26 for the Penobscot SHRU, and 40 for the Merrymeeting Bay SHRU

Two sampling methods are 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 (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.

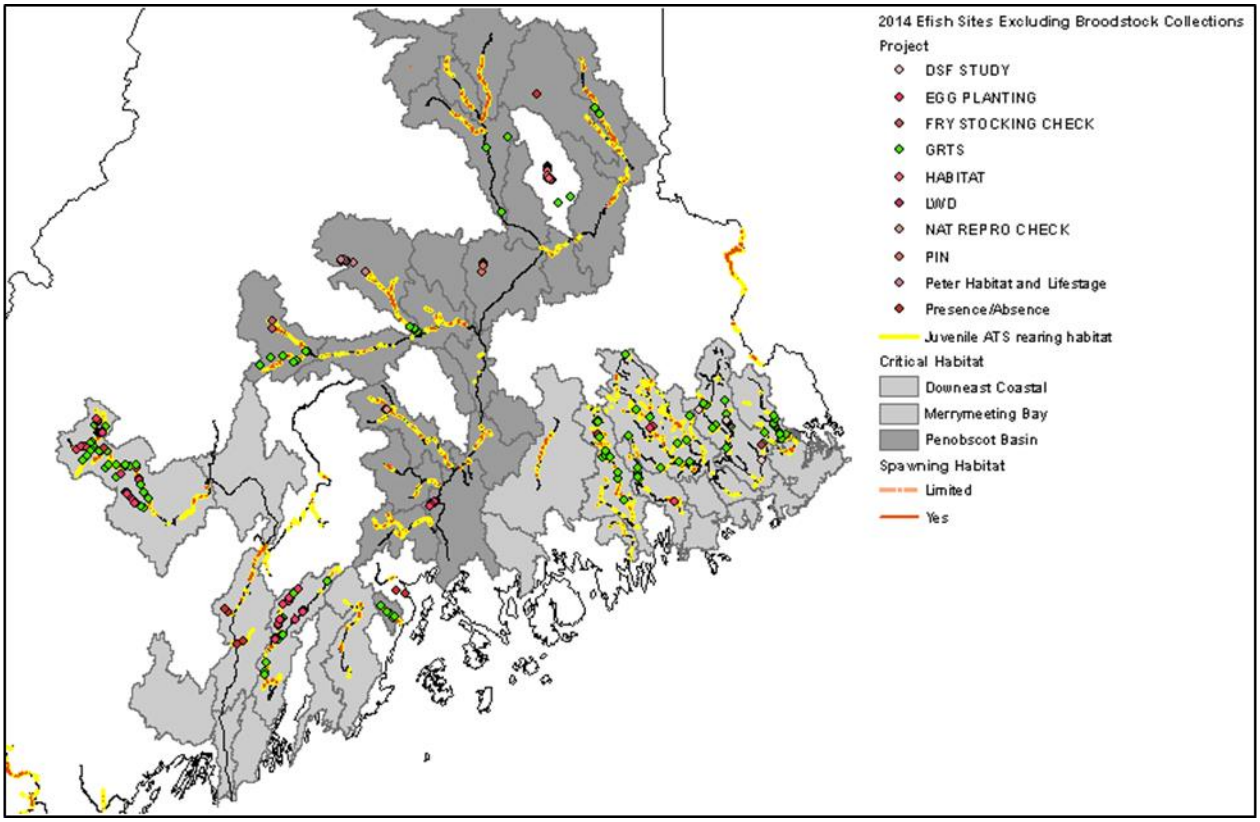

Figure 5.3.1. Locations of juvenile salmon assessments work performed in 2014.

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, 2014. Drainages are grouped by Salmon Habitat Recovery Unit (line).

		Parr				YOY			
Drainage	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Dennys	2014	2	0.45	0.48	0.51	2	6.46	9.25	12.05
East Machias	2014	2	4.43	10.56	16.69	2	0	0	0
Machias	2014	2	0	0.05	0.09	2	0	0.01	0.02
Narraguagus	2014	2	1.39	6.15	10.91	2	3.33	9.95	16.57
Pleasant	2014	2	1.87	3.49	5.11	2	0.7	6.23	11.76
Sheepscot	2014	11	0	4.76	34.96	11	0	8.83	60.64
Ducktrap	2014	1	0	0	0	1	0	0	0
Penobscot	2014	3	10.59	15.61	16.37	3	0	55.95	79.32
Piscataquis	2014	3	0.4	4.21	7.39	3	4.21	16.25	18.45

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, 2014. Drainages are grouped by Salmon Habitat Recovery Unit (line).

		Parr				YOY			
Drainage	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Dennys	2014	11	0	0	0.39	11	0	0.4	3.51
East Machias	2014	17	0	1.98	5.4	17	0	0	6.75
Machias	2014	23	0	0.55	2.71	23	0	0.2	9.34
Narraguagus	2014	21	0	0.8	3.37	21	0	2.6	12.98
Pleasant	2014	12	0	0.5	1.5	12	0	1.3	4.17
Sandy River	2014	65	0	0.59	2.19	65	0	0.39	7.5
Sheepscot	2014	30	0	0.2	2.8	30	0	0.5	5.4
Ducktrap	2014	6	0	0	0.19	6	0	0	0
East Branch Penobscot	2014	3	0	0	0.19	3	0	0	0
Mattawamkeag	2014	4	0	0.3	3.73	4	0	0	1.18
Penobscot	2014	25	0	1.17	3.53	25	0	0.71	10.06
Piscataquis	2014	20	0	0.36	3.46	20	0	1.22	7.19

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), 2007 to 2014.

		Density (fish / 100m^2)								CPUE (fish / minute)							
		Parr				YOY				Parr				YOY			
SHRU	**Year**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**	**N**	**Min**	**Median**	**Max**
Downeast Coastal	2007	55	0	2.88	22.32	53	0.42	7.33	58.85	139	0	0.56	5.05	139	0	1.79	15.31
	2008	43	0	3.55	20.15	43	0	7.02	73.83	20	0	0	2.4	20	0	0.59	8.75
	2009	56	0	3.75	32.53	56	0	7.66	36.54	58	0	0.75	5.45	58	0	1.62	15.37
	2010	29	0.54	5.17	28	29	0	8.03	89.09	109	0	1	8.84	109	0	1.4	15.54
	2011	19	0	2.83	94.58	19	0	3.41	65.74	162	0	0.8	8.74	162	0	0.6	6.32
	2012	9	0.56	2.75	11.36	9	0	0.72	19.88	73	0	0.44	3.19	73	0	0.37	5.4
	2013	6	0	1.48	2.49	6	0	1.17	13.59	85	0	0.6	8	85	0	0	8.4
	2014	10	0	1.63	16.69	10	0	2.02	16.57	84	0	0.6	5.4	84	0	0.88	12.98
Merrymeeting Bay	2007	33	0	0.28	50.27	33	0	4.03	69.76	34	0	0	2.6	34	0	0.23	5.03
	2008	26	0	1.64	21.65	27	0	2.17	38.85	20	0	0.36	0.77	20	0	0	1.4
	2009	17	0	6.01	21.74	17	0	3.12	28.07	48	0	0	3.27	48	0	0.19	9.35
	2010	22	0	2.14	16.57	21	0	3.03	109.94	112	0	0	2.94	112	0	0.8	29.4
	2011	17	0	8.65	44.45	17	0	1.89	43.26	56	0	0.2	4.37	56	0	0.2	9.8
	2012	20	0	2.25	16	20	0	6.65	77.48	108	0	0.2	4.92	108	0	0.4	12.97
	2013	15	0	4.92	41.11	15	0	8.86	61.68	103	0	0.2	2.8	103	0	0.4	6.6
	2014	11	0	4.76	34.96	11	0	8.83	60.64	95	0	0.4	2.8	95	0	0.4	7.5
Penobscot	2007	49	0	0	33.73	25	0	0	66.78	50	0	0.38	2.51	50	0	0	1.8
	2008	11	0	6.69	17.75	11	0	19.94	47.08	74	0	0	0.95	74	0	0	0.38
	2009	10	0	7.89	20.39	10	4.07	29.8	39.74	119	0	0	2.93	119	0	0.75	7.79
	2010	11	0	11.5	22.07	12	0	10.68	92.68	112	0	0	3.91	112	0	0.77	15.95
	2011	5	0	6.99	14.9	5	0	4.06	49.8	87	0	0	3.82	87	0	0	5.72
	2012	13	0	1.47	12.99	13	0	21.9	69.88	85	0	0	3.05	85	0	0.4	13.96
	2013	10	0	10.61	25	12	0	6.54	105.14	85	0	0.53	4.53	85	0	0.19	12.2
	2014	7	0	7.39	16.37	7	0	16.25	79.32	58	0	0.79	3.73	58	0	0.54	10.06

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.

Maine MDMR captured Atlantic salmon smolts using rotary screw traps (RST) in four Maine rivers (East Machias, Narraguagus, Piscataquis, and Sheepscot) to estimate smolt production and monitor migration timing in spring 2014. The East Machias River site was operated in partnership with the Downeast Salmon Federation (DSF). Additionally, Brookfield Renewable Energy Group captured smolts for downstream passage telemetry studies on the Sandy River a tributary of the Kennebec River. RST deployments occurred between 18 April and 13 June depending on river conditions and smolt captures at each assessment site (Table 5.3.4). A total of 2,035 smolts of hatchery and wild origin were captured in Maine rivers in 2014.

Table 5.3.4. Atlantic salmon smolt trap deployments, total captures, and capture timing by origin in Maine rivers, 2014.

River	Dates Deployed		Origin	Total Captures	First Capture	Median Capture Date	Last Capture
East Machias	30-Apr	13-Jun	H	123	4-May	21-May	11-Jun
			W	36	3-May	18-May	1-Jun
Narraguagus	23-Apr	3-Jun	W	523	1-May	15-May	2-Jun
Piscataquis	6-May	6-Jun	W	955	7-May	17-May	4-Jun
Sandy	18-Apr	12-Jun	W	83	23-May	26-May	2-Jun
Sheepscot	26-Apr	8-Jun	H	181	30-Apr	22-May	5-Jun
			W	134	29-Apr	10-May	5-Jun
			TOTAL	2,035			

A subsample of captured smolts undergo biological sampling including measurement of length (mm) and live weight (0.1g), observation of marks, fin condition, relative smolt development, and notation of any injury or mortality. Depending on site specific sampling plans, smolts were differentially marked or tagged to aide in mark and recapture or tracking. MDMR marked 1,465 smolts with a caudal punch in 2014 (Table 5.3.5). Scale samples and genetic tissue were collected for analysis from all rivers. No PIT tags were applied to smolts in 2014. Brookfield Renewable Energy Group marked 83 smolts with caudal clips. NOAA Fisheries and MDMR applied hydro acoustic “pinger” tags to 50 smolts from the Sandy River to study movements in Merrymeeting Bay.

Scale analysis indicated wild origin smolts were predominately age-2 (Table 5.3.5). The East Machias River had the highest proportion of age-3 smolts; a demographic shift driven by elimination of drainage-wide unfed fry stocking while transitioning to 0+ parr stocking. East Machias and Sheepscot River hatchery origin smolts were predominately age-1 (p8). However, older age-class hatchery origin smolts (p20 and p32) were found proportionally greater in the East Machias River. Sheepscot River smolts of both origins were larger at all ages compared to all rivers (Table 5.3.6). Both age-2 and age-3 wild smolts captured in the Piscataquis River were smaller than smolts in all rivers.

Table 5.3.5. Freshwater age distribution of Atlantic salmon smolts by origin captured in Maine rivers, 2014.

			Smolt Age						
River	Origin	n	1	2	3	4	p8	p20	p32
East Machias	H	116	--	--	--	--	64.1%	35.0%	0.9%
	W	36	0.0%	58.3%	41.7%	0.0%	--	--	--
Narraguagus	W	212	0.0%	83.5%	15.1%	1.4%	--	--	--
Piscataquis	W	562	0.0%	88.4%	11.6%	0.0%	--	--	--
Sandy	W	81	0.0%	75.3%	24.7%	0.0%	--	--	--
Sheepscot	H	158	--	--	--	--	84.8%	14.6%	0.6%
	W	133	0.0%	81.2%	18.8%	0.0%	--	--	--

Table 5.3.6. Mean length (mm ± s.d.) and weight (g ± s.d.) of Atlantic salmon smolts by age and origin captured in Maine rivers, 2014.

River	Origin	n	Age Code	Fork Length (mm)	Wet Weight (g)
East Machias	H	75	p8	162±17	38.9±13.5
	H	41	p20	183±18	55.2±17.0
	W	21	2	178±12	51.1±11.7
	W	15	3	190±18	63.3±16.6
Narraguagus	W	177	2	168±12	48.3±10.9
	W	32	3	181±17	55.8±15.7
Piscataquis	W	491	2	146±10	29.8±6.2
	W	65	3	159±9	36.0±5.9
Sandy	W	61	2	152±12	36.3±8.9
	W	20	3	160±12	41.3±9.4
Sheepscot	H	134	p8	167±10	52.4±10.0
	H	23	p20	193±14	75.0±17.1
	W	108	2	187±19	67.0±22.0
	W	25	3	193±18	73.9±24.0

Scientists generated population estimates (Table 5.3.7) using the 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. The East Machias, Piscataquis and Sheepscot River population estimates are based on a one site mark-recapture design. A two site mark-recapture design was used on the Narraguagus River to estimate the number smolts exiting the system for a seventeenth year. Obtaining a population estimate was not a sampling objective for the Sandy River. A more detailed report on smolt population enumeration and dynamics is included in Working Paper WP15-02- Smolts Update.

Table 5.3.7. Maximum likelihood mark-recapture population estimates for wild and hatchery origin Atlantic salmon smolts emigrating from Maine rivers, 2014.

River	Estimate Type	Origin	Population Estimate
East Machias	One site	Hatchery	852 ± 238
		Wild	189 ± 90
		Combined	1019 ± 205
Narraguagus	Two site	Wild	1,615 ± 198
Piscataquis	One site	Wild	3464 ± 336
Sheepscot	One site	Hatchery	1,294 ± 345
		Wild	542 ± 102
		Combined	1,650 ± 234

5.4 Fish Passage

Penobscot River PIT Network

Summary Compiled by George Maynard and Joe Zydlewski (USGS)

Starting in 2011, a cooperative effort between the MDMR, the University of Maine (UM), and the United States Geological Survey's Maine Cooperative Fish and Wildlife Research Unit (CFWRU), led to the installation of antennas to monitor movement of fish marked with passive integrated transponder (PIT) tags in the Penobscot River system. The original array consisted of antennas at eight dams (Veazie, Milford, West Enfield, and Weldon on the Penobscot River, Howland, Brown's Mill, and Guilford on the Piscataquis River, and Pumpkin Hill on the Passadumkeag River). This year's array is configured differently to reflect changes in hydropower management and monitoring efforts. Veazie Dam was removed, and is no longer part of the array. New antennas were installed at Milford to monitor the new fish lift. The old array is still operational at Milford, as the old Denil fishway was in operation for parts of the migration. Arrays upstream of Howland and West

Enfield were not deployed this year, as low salmon returns were anticipated and staff time was limited.

Antenna deployments consist of a minimum of two antennas (custom built) to detect fish (at least one at the top and bottom of each fishway), a multiplexor (Digital Angel FS1001M) to decode and store detections, and a cellular modem (Verizon Raven XT) to transmit data to a central monitoring location. There, data are downloaded using PuTTY v0.62 (a free and open-source tel-net client) and stored as text files (*.txt). Text files include tag numbers detected along with timestamps and antenna numbers, as well as information on noise levels, which can be used to assess antenna efficiency.

This year the majority of multi-sea winter salmon (MSW) captured at the Milford Dam fish lift was trucked to the Craig Brook National Fish Hatchery (CBNFH) in Orland, Maine to be used as broodstock. A subset (n=64) were radio tagged (and PIT tagged) and released downstream of the Milford Dam as part of two telemetry studies to evaluate the efficiency of the new fish lift. Fifty-two (52) of these fish were subsequently recaptured at the Milford Dam and trucked to the CBNFH hatchery as broodstock. Five (5) escaped upstream of Milford, and seven (7) are still unaccounted for.

Three (3) of the MSW Atlantic salmon released to the Milford head pond were detected at the West Enfield fishway. PIT tag number EZ1501 was radio tagged and released at Ayer's Island boat ramp as part of a radio tag study on 19 May. It was detected at West Enfield on 9 June. Tags EZ1504 and EZ1505 were radio tagged and released at the Brewer boat ramp on 26 May and 27 May, respectively. Tag EZ1504 is known to have escaped the Milford fish lift facility on 5 June when it was inadvertently allowed to pass by the gates of the sorting facility. This fish was detected at West Enfield on 9 June. Fish EZ1505 was detected at West Enfield on 8 June. It is not clear how salmon EZ1501 or EZ1505 passed the Milford Dam, as MDMR staff did not observe any other MSW salmon escaping the fish lift facility back to the river. It may be possible that these fish were able to pass over the Milford Dam during high flows. On 27 August, two additional radio tagged MSW salmon were recaptured and released to the Milford Dam headpond. These fish were not detected at upstream PIT tag receivers.
Twenty-eight 1SW salmon (grilse) were released to the Milford Dam head pond with PIT tags. None of these fish were detected at upstream PIT tag receivers.

This year marks the second year of PIT monitoring of species other than Atlantic salmon. MDMR biologists tagged and released 58 sea lamprey, 646 river herring (blueback herring and alewife), and eleven (11) American shad. Thirty-seven (37) river herring were detected at West Enfield. They averaged 5.5 days of travel time between release at Milford and first detection at the West Enfield fishway. Of the 37 river herring detected, twenty (20) passed upstream of the facility. None of the sea lamprey or American shad were detected at upstream PIT tag receivers.

Souadabscook Stream – Gristmill Road Crossing

MDMR collaborated with the Atlantic Salmon Federation and US Fish and Wildlife Service to design and install fish passage (20 foot long Alaskan Steeppass Fishway) on Souadabscook Stream at the Grist Mill Road crossing in Carmel, Maine to allow anadromous alewives access to Etna Pond (362 acres). The crossing is at an historic mill site that is now in ruins. A ledge drop occurs under the bridge that was a result of both the historic mill development and the bridge construction. With fish passage restored Etna Pond will support a run of approximately 85,000 adult alewives annually.

Souadabscook Stream – Gristmill Road Crossing Project: Before, during and after construction

5.5 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick (3), the Lockwood fish lift on the Kennebec River (18), the Narraguagus River (4), The Pleasant River (3) and the Penobscot River (259). In total 287 genetic samples were collected in 2014 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 2014, DPS broodstock (collected in 2013) 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 (Salmon-in-Schools)

2014 marked the twentieth year of FWS' 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 many rivers within the DPS. In addition to educational facilities, local businesses are 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 (Service) and National Oceanographic and Atmospheric Administration - National Marine Fisheries Service (NMFS), in close collaboration with Maine Department of Marine Resources and the Penobscot Indian Nation. The draft was reviewed by the Department of Interior Office of the Regional Solicitor in late fall of 2012. Revisions are nearly complete to the draft plan in response to issues raised by the Regional Solicitor's Office. The Service and NMFS target date for publishing a notice of availability for public review in the Federal Register, in late spring of 2015. 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 2014, a number of small-scale habitat protection projects were completed in the Narraguagus and Pleasant River watersheds and large-scale projects are in development throughout the DPS.

Habitat Connectivity

Numerous studies have identified how stream barriers can disrupt ecological processes, 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 (MDIFW), Maine Department of Marine Resources (MDMR), Maine Forest Service (MFS), Maine Department of Transportation (MDOT), Maine Natural Areas Program (MNAP), Maine Coastal Program, Maine Audubon, The Nature Conservancy, Trout Unlimited, Atlantic Salmon Federation, Maine Rivers, National Oceanic and Atmospheric Agency (NOAA), USDA Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), Androscoggin Soil and Water Conservation District, and local land trusts.

After 8 years of fieldwork, well over half of the state's perennial stream crossings have been assessed (see Map 5.7.1). Almost 10,000 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 2015, stream barrier surveys will be completed in the St. Croix, Kennebec, West Branch Penobscot, Androscoggin, and numerous small Downeast and southern Maine watersheds.

Maine Barrier Survey Status Map

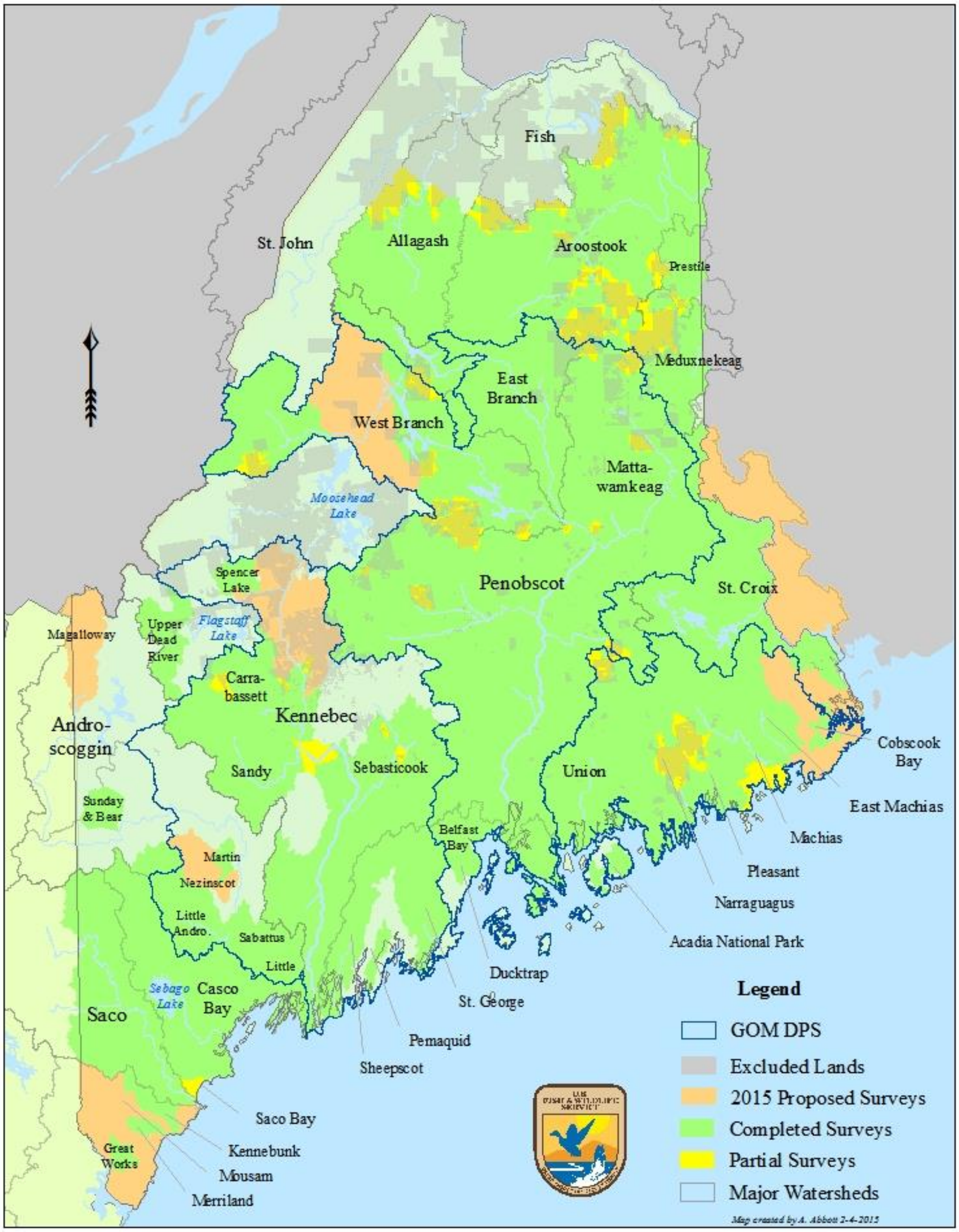

Figure 5.7.1 Extent of barrier surveys conducted in Maine to present. Almost 10,000 road-stream crossings have been assessed within the Gulf of Maine DPS since 2006.

Stream Smart training: In 2014 Maine Audubon continued to lead a statewide partnership to educate professionals responsible for road-stream crossings on how to improve stream habitat by creating better crossings. The partnership hosted 10 workshops around the state (in southern, central, and northern Maine) with over 200 attendees. Since 2012 over 700 people representing over 80 towns have attended Stream Smart workshops. Workshops 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, the Nature Conservancy, and US Army Corps.
One Stream Smart workshop was delivered specifically for Maine Department of Transportation staff at their request.

Of the 10 total workshops, 5 "train-the-trainer" workshops where delivered for the Maine Coast Heritage Trust land protection staff, regional land use and transportation planners and Soil and Water Conservation District and NRCS staff. The focus for these workshops was to provide information and training to professionals that work with communities at the local level to encourage community level outreach.

Figure 5.7.2: Stream Smart training provides instruction on culvert assessment and design methodologies.

Three of the workshops were Stream Assessment Field trainings targeting but not limited to prior Stream Smart workshop attendees. The focus of the field trainings provides 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

USFS Aquatic Organism Passage (AOP) Training: The Gulf of Maine Coastal Program and Project SHARE organized and hosted a five-day Advanced Stream Simulation Design Course this week. The workshop taught participants how to design road-stream crossing structures that provide unimpeded fish and other aquatic organism passage, restore natural channel processes through the structure, and maximize the long-term stability of the structure. The course was held at the Appalachian Mountain Club's lodge near Greenville, ME and was led by national experts including Bob Gubernick (USFS) and Dale Higgins (USFS). A diverse set of participants came from throughout New England and included private consulting engineers, staff from Maine Department of Transportation, USFWS, NGOs and NRCS. critical aquatic habitats in the Northeast.

Figure 5.7.3. Classroom and field instruction provide participants with advance Stream Simulation design instruction.

Online data viewer: 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

Stream Connectivity Projects

In 2014, 33 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 229 km of stream were 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, towns, 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 miles of stream habitat access.

Connectivity Activity	Watershed	Site Name	KM above
Log Dam Pull	Machias	Holmes Brook	5.9
Log Dam Pull	Machias	Thompson	9.5
Debris Pull	Machias	Fletcher 1	5.6
Log and Rock Dam Pull	Machias	Fletcher 2a	2.6
Debris Pull	Machias	Fletcher 2b	2.6
Log Dam Pull	Machias	Fletcher 2c	2.3
Rock Dam Pull	Machias	Elwell 1a	4.3
Rock Dam Pull	Machias	Elwell 1b	4.3
Log Dam Pull	Machias	Unknown 1a	21.7
Rock Dam Pull	Machias	Unknown 1b	21.3

Log Dam Pull	Machias	Dead 1	9.8
Log Dam Pull	Machias	Dead 2	3.3
Log Dam Pull	Machias	Dead 3	16.4
Log Dam Pull	Narraguagus	35 Brook #3a	12.8
Rock Dam Pull	Narraguagus	35 Brook #3b	12.5
Log Dam Pull	Narraguagus	35 Brook #4a	12.1
Log-Rock Dam Pull	Narraguagus	35 Brook #4b	11.5
Concrete Arch	St. Croix	Billy Brown	2.6
Open Arch	St. Croix	W.B. Amazon	10.8
Concrete Arch	Narraguagus	Sinclair Trib	2.3
Decommission	Narraguagus	Rocky Trib	1.3
Decommission	East Machias	Trib below Love Lake	6.2
Decommission	East Machias	Richardson Brk Trib 1	0.3
Decommission	East Machias	Richardson Brk Trib 2	0.3
Metal Arch	East Machias	Richardson Brk Trib 3	1.0
Concrete Arch	East Machias	Creamer Trib	1.0
Metal Arch	East Machias	RB trib to Northern	3.0
Metal Arch	East Machias	Meadow Brook	2.6
Embedded Box	Kennebec	Warm Brook	22.3
Bridge	West Branch Pleasant	Henderson Brook	3.3
Bridge	Sebec	Salmon Stream	2.3
Bridge	Sebec	Salmon Stream	5.2
		Total	229.3

Figure 5.7.4. Stream Simulation design replacement culvert in Kennebec River watershed.

Figure 5.7.5. Culvert replacement in East Machias River watershed.

Pleasant River Focus Area Initiative

Project goals: To restore runs of **diadromous** fish that include but are not limited to the federally endangered Atlantic salmon, to selectively restore geomorphic characteristics and functions of Maine's rivers and streams, and to enhance in-stream habitat complexity and aquatic connectivity to benefit **resident and diadromous** fish, eastern brook trout, and other native aquatic species at a landscape scale.

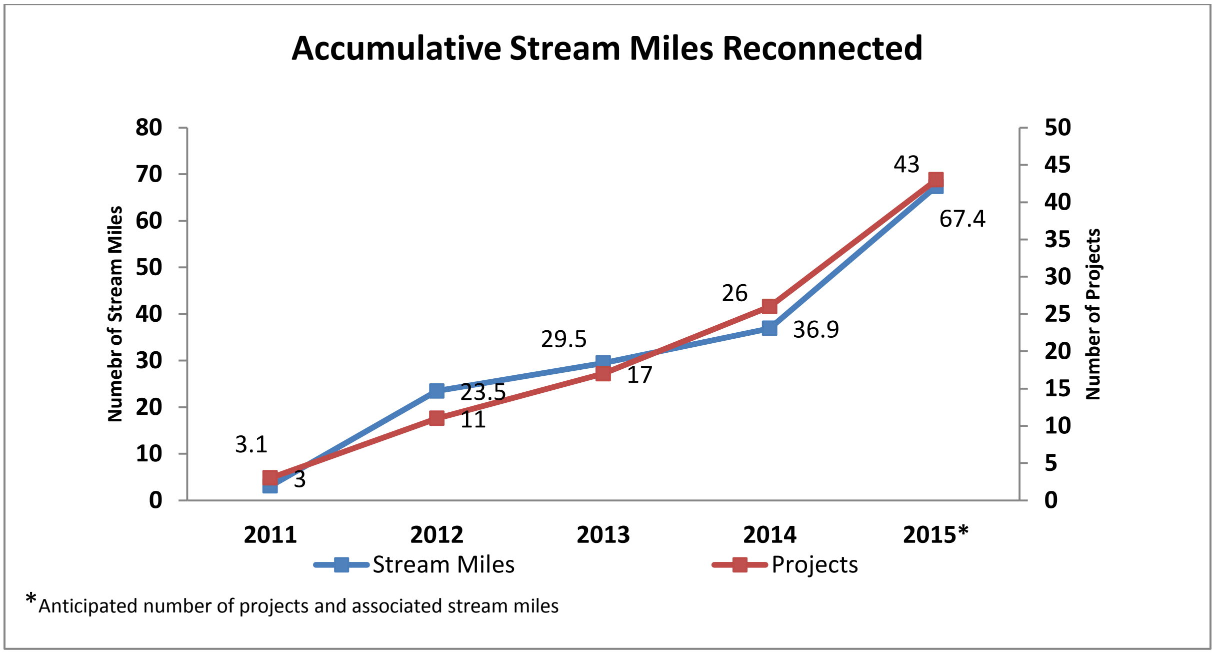

Figure 5.7.6. Summary of reconnected stream reaches within the Pleasant River a tributary of the Penobscot River.

Stream connectivity progress to date: Extensive outreach and education with specific focus on road-stream crossings that occurred during the first two years of the focused partnership stream restoration effort has helped pave the way for collaborative on-the-ground restoration. Currently close to 37 stream miles have been re-connected. All 37 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 7.4 stream miles from 9 projects reconnected during 2014, 2.6 miles will directly benefit Atlantic salmon by allowing juvenile salmon to freely migrate to historic rearing habitat and to access cold water thermal refugia. Photos and site descriptions of 2014 completed projects can be found in Appendix I. Projects included in this report are projects for which Ben Naumann has provided significant assistance including, but not limited to: project identification, planning, coordination, engineering surveys, endangered species consultations, electrofishing, and oversight during project implementation. It is anticipated that 17 projects will be completed during 2015 that will re-connect a total of 30.5 miles of streams, 15.4 miles benefiting Atlantic salmon and brook trout, 13 benefiting just brook trout and 2.1 stream and 5975 lake acres benefiting alewives. Currently one project is planned for 2016 and more are likely to be added.

2014 Upper Penobscot River restoration effort: Stream connectivity efforts have broadened to include projects throughout the state; however the upper Penobscot Basin remains a focus area. Six of the nine projects completed in 2014 were in the Penobscot basin reconnecting 5.3 stream miles. In the Penobscot basin alone a total of 8 projects are anticipated to be complete in 2015.

5.7.4 Habitat Complexity

Narraguagus Focus Area Restoration

Project SHARE has identified the Upper Narraguagus Watershed as a high-priority focus area for salmonid habitat restoration. The Narraguagus River is located in Maine's Downeast, region within the geographic range of the federally listed-endangered Atlantic salmon. Other native fish species include Eastern brook trout (identified in steep decline throughout its range by the Eastern Brook Trout Joint Venture), American eel, alewife, shad, and sea lamprey.

Over the last thirteen years SHARE, in collaboration with state and federal agencies, landowners, and nonprofit organizations, has developed a habitat restoration program with principal focus on the five Downeast Maine Atlantic salmon watersheds. The group has identified threats to habitat connectivity and function and opportunities to restore cold water refugia and rearing habitat, and conducted cooperative projects that have removed those threats and/or restored connectivity and natural stream function. Watershed-scale threat assessments of the Narraguagus River have documented summer water temperatures in main stem river reaches above sub-lethal stress levels, approaching acute lethal levels. Remnant dams and associated legacy reservoirs are identified heat sinks contributing to warmer temperatures. Undersized culverts at road/stream crossings present stream connectivity threats and are barriers to upstream coldwater refugia.

Climate change predictions present threats in addition to legacy effects of past land use. Stream temperatures are expected to rise in most rivers; the threat to salmon recovery is high where temperatures are near sub-lethal or lethal thresholds for salmon (Beechie et al. 2013). Average air temperatures across the Northeast have risen 1.5˚ F since 1970, with winter temperatures rising most rapidly, 4˚ between 1970 and 2000 (NECIA 2007). However, increased water temperature is not the only threat associated with climate change. Precipitation and timing of significant aquatic events (intense rain, ice-out, spring flooding, and drought, among them) are "master variables" that influence freshwater ecosystems and are predicted to change, according to all climate model predictions. Jacobson et. al. (2009) provide a preliminary assessment summarizing impacts to Maine's freshwater ecosystems, predicting a wetter future, with more winter precipitation in the form of rain and increased precipitation intensity. Although it is not possible to predict specific changes at a given location, several 100- to 500-year precipitation events have occurred in recent years.

Climate change will affect the inputs of water to aquatic systems in Maine, and temperature changes will affect freezing dates and evaporation rates, with earlier spring runoff and decreased snow depth. Stream gauges in Maine show a shift in peak flows to earlier in spring, with lower flows later in the season. New England lake ice-out dates have advanced by up to two weeks since the 1800s. Water levels and temperatures cue migration of sea-run fish such as alewives, shad, and Atlantic salmon into our rivers, and the arrival or concentration of birds that feed on these fish. Lower summer flows will reduce aquatic habitats like coldwater holding pools and spawning beds. This complex interplay of climate effects, restoration opportunities, and potential salmonid responses poses a considerable challenge for effectively restoring salmon populations in a changing climate (Beechie et al. 2013). However, past land use practices often have degraded habitats to a greater degree than that predicted from climate change, presenting substantial opportunities to improve salmon habitats more than enough to compensate for expected climate change over the next several decades (Battin et al., 2007).

Process-based habitat restoration provides a holistic approach to river restoration practices that better addresses primary causes of ecosystem degradation (Roni et al., 2008). Historically, habitat restoration actions focused on site-specific habitat characteristics designed to meet perceived “good” habitat conditions (Beechie et al. 2010). These actions favored engineering solutions that created artificial and unnaturally static habitats, and attempted to control process and dynamics rather than restore them. By contrast, efforts to reestablish system process promote recovery of habitat and biological diversity. Process restoration focuses on critical drivers and functions that are the means by which the ecosystem and the target species within it can be better able to adapt to future events, such as those predicted associated with climate change.

SHARE is collaborating in this project with a team of scientists in a 5- to 7-year applied science project taking a holistic, natural process-based, approach to river and stream restoration in an 80-square-mile area in Hancock and Washington Counties. The vision, from the perspective of restoration of Atlantic salmon as an endangered species, is to restore the return of spawning adult Atlantic salmon from the sea to the Upper Narraguagus River sub-watershed to escapement levels that are self-sustaining. The work will be guided by a team of scientists and restoration actions will be based on the four principles of process-based restoration of river systems:

- Restoration actions should address the root causes of degradation;
- Actions should be consistent with the physical and biological potential of the site;
- Actions should be at a scale commensurate with environmental problems; and
- Actions should have clearly articulated expectations for ecosystem dynamics.

This project, a collaboration with the National Oceanographic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the University of Maine, Maine’s Department of Marine Resources, Boston College, Connecticut College, and the Canadian Rivers Institute, will test the hypothesis that reconnecting river and stream habitat, improving habitat suitability, and reintroducing salmon to unoccupied habitat, will increase the number of salmon smolts leaving the sub-watershed en route to the ocean.

Water Temperature

A Water Temperature Working Group was established in Maine to begin developing a coordinated stream temperature monitoring array that can be integrated with regional and national efforts. The Group recently met in order to standardize protocols, discuss the use of the Spatial Hydro-Ecological Decision Support (SHEDS) web application, and to coordinate locations and equipment needs for the coming field season. Under the guidance of the Group, USFWS personnel deployed four temperature loggers within the Casco Bay watershed; others are currently planning deployments for the 2015 field season. In addition, the Group plans to host a state-wide protocol workshop in early spring of 2015, in order to standardize this technique throughout Maine.
Goals of the group are to:

- Conduct a comprehensive inventory of existing data for current and past water temperature monitoring efforts.
- Identify a central database for locations and water temperature data.
- Create a distribution network for stream temperature data loggers.

The group is working with Dan Isaak (USFS) and Ben Letcher (USGS) to use water temperature data to model and identify catchments that may be more resilient to temperature increases in the future. The work will be using previous and current data sets from all over the state to develop a model to predict future stream temperature conditions and identify resilient sub-watersheds.

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6 Outer Bay of Fundy

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

Adult Returns

Aroostook River

The Tinker fishway trap on the Aroostook River was operated by Algonquin Power Company from 4 August to 31 October. One Atlantic salmon was captured and released upstream in 2014. The salmon was a wild 2SW female.

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.

6.2 Stocking

Juvenile Atlantic Salmon Releases

Aroostook River

ASNM stocked a total of 569,000 non-feeding fry into the Aroostook River in under the supervision of DMR biologists.

Adult Salmon Releases

Aroostook River

No adults were stocked in 2014.

6.2 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed in 2014.

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 stream temperature modeling. 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).

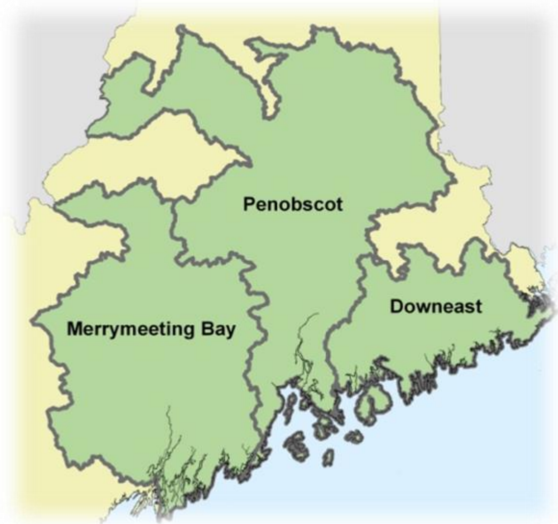

Figure 7.1.1 Recovery units for the Gulf of Maine DPS.

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 2012-2014 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.

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 2014 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 2014 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 2015.

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 and PN (Kocik, Atkinson)
            1. age-structured adult return numbers (add 1SW and 3SW)
        iii. Fry rr for GoM, BoF (Sweka, Atkinson) - continuing work on fry equivalents (FE) see below

2) Re-development of model in R to facilitate broader use that @Risk Version (Kocik, Sweka)

3) GRTS investigation (Atkinson)
    a. What we have learned
    b. Is it working for us
    c. Ad hoc 1 person pers shru

4) Penobscot smolt studies and retrospective lessons learned (Kocik)

5) Emerging Issues Identified Intercession or at Annual Meeting –

6) Potential Theme 2015– 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
Rory	Saunders	Rory.Saunders@noaa.gov	NOAA	Orono, ME
John	Sweka*	John_Sweka@fws.gov	FWS	Lamar, PA
Peter	Lamothe	Peter_Lamothe@fws.gov	FWS	East Orland, ME
Jason	Overlock	jason.overlock@maine.gov	ME	Hallowell, ME
Paul	Christman	paul.christman@maine.gov	ME	Hallowell, ME
Michael	Bailey	michael_bailey@fws.gov	FWS	Nashua, NH
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT	Old Lyme, CT

*via conference call

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	Steve Gephard	Steve.Gephard@po.state.ct.us	Connecticut River Update (PPT)
PS14-03	Michael Bailey	michael_bailey@fws.gov	Merrimack River Update (PPT)
PS14-04	Ernie Atkinson	ernie.atkinson@maine.edu	Saco, DPS, OBF Updates (PPT)
PS14-05	John Sweka	john_sweka@fws.gov	Database Update
PS14-06	Rory Saunders	rory.saunders@noaa.gov	ICES/NASCO Update (PPT)
WP14-01	Colby Brucks, Chrsitine Lipsky, Ernest Atkinson, James Hawkes, Ruth Hass-Castro, Randy Spencer, Paul Christman, and Kyle Winslow	Christine.Lipsky@noaa.gov	Update on Maine River Atlantic Salmon Smolt Studies:2014
WP14-02	Graham Goulette, James Hawkes, John Kocik, and Paul Christman	james.hawkes@noaa.gov	Update on NOAA Fisheries Service Coastal Maine Atlantic Salmon Smolt Telemetry Studies: 2014
WP14-03	David Bean, Chris Vonderweidt, Jon Lewis, and Marcy Nelson	David.Bean@noaa.gov	Maine and neighboring Canadian Commercial Aquaculture Activities and Production
WP14-04	Ruth Haas-Castro	ruth.haas-castro@noaa.gov	Review of Image Analysis Studies: 2013 (PART 1) and Work Plan for 2014 (PART 2)

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 culture 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. This can refer to a number or just as a group of fish.
Egg Deposition	Salmon eggs that are deposited in gravelly reaches of the river. This can refer to the action of depositing eggs by the fish, a group of unspecified number of eggs per event, or a specific number of eggs.
Fecundity	The reproductive rate of salmon represented by 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	Adults produced from naturally reared 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.

8.4.2 Life History related

Green Egg	Life stage from spawning until faint eyes appear.
Eyed Egg	Life stage from the appearance of faint eyes until hatching.
Sac Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Feeding Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Fed Fry	Fry subsequent to being fed an artificial or natural diet. Often used interchangeably with the term “feeding fry” and most often associated with stocking activities.
Unfed Fry	Fry that have not been fed an artificial diet or natural diet. Most often associated with stocking activities.
Parr	Life stage immediately following the fry stage until the commencement of migration to the sea as smolts.
Age 0 Parr	Life stage occurring during the period from August 15 to December 31 of the year of hatching, often referring to fish that are stocked from a hatchery during this time. The two most common hatchery stocking products are (1) parr that have been removed from an accelerated growth program for smolts and are stocked at lengths >10 cm and (2) parr that have been raised to deliberately produce more natural size-at-age fish and are stocked at lengths ≤10 cm.
Age 1 Parr	Life stage occurring during the period from January 1 to December 31 one year after hatching.
Age 2 Parr	Life stage occurring during the period from January 1 to December 31 two years after hatching.
Parr 8	A parr stocked at age 0 that migrates as 1 Smolt (8 months spent in freshwater).

Parr 20	A parr stocked at age 0 that migrates as 2 Smolt (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	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	Life stage occurring during the period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	Life stage occurring during the period from July 1 to December 31 of the year the salmon became a smolt. Typically encountered in the ocean.
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 (MSW) 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	Life stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to home waters to spawn again.

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

8.5 Appendicies

Appendix 1. Estimated Atlantic salmon returns to the USA, 1967-2014. "Natural" includes fish originating from natural spawning and hatchery fry. Starting in 2003 estimated returns based on redds are included.

Year	Sea age					Origin	
	1 SW	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
2014	110	334	3	3	450	304	146

Appendix 2. Two sea winter (2SW) returns for 2014 in relation to spawner requirements for USA rivers.

Area		Spawner Requirement	2SW returns 2013	Percentage of Requirement
Long Island Sound	LIS	10,094	30	0.3%
Central New England	CNE	3,435	38	1.1%
Gulf of Maine	GOM	15,670	266	1.7%
Total		29,199	334	1.1%

Appendix 3. Number of juvenile Atlantic salmon stocked in USA, 2014. 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		204,000					204,000
CNE	2	Merrimack, Saco		379,000	16,000		12,100		407,100
GOM	8	Androscoggin to Dennys	1,509,000	1,553,000	165,230		557,656		3,784,886
OBF	1	Aroostook		569,000					569,000
Total	13		1,509,000	2,705,000	181,230	0	569,756	0	4,964,986

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2014 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	616				616
Central New England	CNE	Restoration	232				232
Gulf of Maine	GOM	Restoration		2,282		213	2,495
Total for USA			848	2,282		213	3,343

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2014. Includes hatchery and wild origin fish.

Mark Code	Life History	CNE	GOM	Total
AD	Parr		164,815	164,815
AD	Smolt			0
FLOY	Adult	616		616
PING	Smolt		282	282
PIT	Adult		2,526	2,526
PIT	Smolt			0
VIE	Smolt		92,354	92,354
RAD	Adult		16	16
RAD	Smolt		1,795	1,795
Total		616	261,788	262,404

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

Appendix 6. Aquaculture production (metric tonnes) in New England from 1997 to 2014. Production for 2012-2014 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
2014	2,173 to 8,205

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2014.

United States

No. of fish stocked by lifestage

River	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	0	199,000	0	0	0	0	0	199,000
Total for Connecticut Program								**199,000**
Androscoggin	0	1,000	0	0	0	0	0	1,000
Aroostook	0	569,000	0	0	0	0	0	569,000
Dennys	0	84,000	0	0	0	0	0	84,000
East Machias	0	16,000	149,800	0	0	0	0	165,800
Kennebec	1,151,000	2,000	0	0	0	0	0	1,153,000
Machias	27,000	210,000	400	0	0	0	0	237,400
Narraguagus	79,000	263,000	0	0	0	0	0	342,000
Penobscot	89,000	815,000	0	0	0	557,700	0	1,461,700
Pleasant	46,000	114,000	0	0	0	0	0	160,000
Saco	0	366,000	16,000	0	0	12,100	0	394,100
Sheepscot	118,000	23,000	15,000	0	0	0	0	156,000
Union	0	24,000	0	0	0	0	0	24,000
Total for Maine Program								**4,748,000**
Merrimack	0	12,000	0	0	0	0	0	12,000
Total for Merrimack Program								**12,000**
Pawcatuck	0	5,000	0	0	0	0	0	5,000
Total for Pawcatuck Program								**5,000**
Total for United States								**4,964,000**
Grand Total								**4,964,000**

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 2014.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	38	0	0	38
East Machias	Restoration	0	168	0	0	168
Machias	Restoration	0	292	0	0	292
Merrimack	Restoration	232	0	0	0	232
Merrimack	Recreation	616	0	0	0	616
Narraguagus	Restoration	0	202	0	0	202
Penobscot	Restoration	0	1,340	0	213	1,553
Pleasant	Restoration	0	168	0	0	168
Sheepscot	Restoration	0	74	0	0	74
Total		848	2,282	0	213	3,343

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.

Appendix 9.1. Atlantic salmon marking database for New England; marked fish released in ***2014***.

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
DMR		Adult	H	Androscoggin	RAD	3	AP	June	Androscoggin
DMR		Adult	H	Androscoggin	RAD	1	AP	Aug	Androscoggin
USFWS	4	Adult	H	Dennys	PIT	38	PUNCH	Dec	Dennys
EMARC	0	Parr	H	East Machias	AD	149,815		Oct	East Machias
USFWS	3	Adult	H	East Machias	PIT	14	PUNCH	Nov	East Machias
USFWS	4	Adult	H	East Machias	PIT	70	PUNCH	Nov	East Machias
USFWS	5	Adult	H	East Machias	PIT	84	PUNCH	Nov	East Machias
NOAA		Smolt	W	Kennebec	PING	50		May	Kennebec
USFWS	5	Adult	H	Machias	PIT	127	PUNCH	Dec	Machias
USFWS	3	Adult	H	Machias	PIT	99	PUNCH	Dec	Machias
USFWS	4	Adult	H	Machias	PIT	66	PUNCH	Dec	Machias
NHFGD	3+	Adult	H	Merrimack	FLOY	616		May	Merrimack
USFWS	3	Adult	H	Narraguagus	PIT	92	PUNCH	Nov	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	58	PUNCH	Nov	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	52	PUNCH	Nov	Narraguagus
Brookfield	1	Smolt	H	Penobscot	RAD	257		May	Androscoggin
Brookfield	1	Smolt	H	Penobscot	RAD	1,323		May	Penobscot
Brookfield	1	Smolt	H	Penobscot	RAD	49		June	Penobscot
DMR		Adult	H	Penobscot	PIT	1		Aug	Penobscot
DMR		Adult	H	Penobscot	RAD	7	PIT	June	Penobscot
DMR		Adult	H	Penobscot	RAD	4	PIT	May	Penobscot
DMR		Adult	H	Penobscot	PIT	28		July	Penobscot
DMR		Adult	H	Penobscot	RAD	1	PIT	Sept	Penobscot
DMR		Adult	H	Penobscot	PIT	1		Oct	Penobscot
Miller Hydro	1	Smolt	H	Penobscot	RAD	10		June	Androscoggin

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
Miller Hydro	1	Smolt	H	Penobscot	RAD	156		May	Androscoggin
USDA		Adult	H	Penobscot	PIT	121	PUNCH	Dec	Penobscot
USFWS		Adult	H	Penobscot	PIT	213	PUNCH	Nov	Penobscot
USFWS	3	Adult	H	Penobscot	PIT	483	PUNCH	Dec	Penobscot
USFWS	4	Adult	H	Penobscot	PIT	737	PUNCH	Dec	Penobscot
USFWS	1	Smolt	H	Penobscot	VIE	46,405	AD	April	Penobscot
USFWS	1	Smolt	H	Penobscot	VIE	45,949	AD	May	Penobscot
USGS	1	Smolt	H	Penobscot	PING	232		May	Penobscot
USFWS	3	Adult	H	Pleasant	PIT	57	PUNCH	Nov	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	55	PUNCH	Nov	Pleasant
USFWS	5	Adult	H	Pleasant	PIT	56	PUNCH	Nov	Pleasant
USFWS	3	Adult	H	Sheepscot	PIT	14	PUNCH	Dec	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	30	PUNCH	Dec	Sheepscot
USFWS	5	Adult	H	Sheepscot	PIT	30	PUNCH	Dec	Sheepscot
USFWS	0	Parr	H	Sheepscot	AD	15,000		Sept	Sheepscot

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

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2014.

	1SW		2SW		3SW		Repeat			2010-2014
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	0	0	2	1	0	0	0	0	**3**	15
Connecticut	0	2	0	30	0	0	0	0	**32**	68
Kennebec	0	3	2	13	0	0	0	0	**18**	20
Merrimack	4	0	25	10	1	0	0	0	**40**	135
Narraguagus	0	0	2	1	0	0	0	1	**4**	63
Pawcatuck	0	0	0	0	0	0	0	0	**0**	2
Penobscot	82	1	153	21	2	0	2	0	**261**	1,141
Pleasant	2	0	0	1	0	0	0	0	**3**	2
Saco	0	0	3	0	0	0	0	0	**3**	26
Union	0	0	1	1	0	0	0	0	**2**	1
Total	**88**	**6**	**188**	**78**	**3**	**0**	**2**	**1**	**366**	**1,473**

Note: The origin/age distribution for returns to the Merrimack River in 2014 were based on observed distributions over the previous 10 years because fish were not handled in 2014.

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2014.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	103	830,000
Merrimack	Domestic	293	1,244,000
Penobscot	Domestic	557	1,653,000
Dennys	Captive	40	148,000
East Machias	Captive	99	452,000
Machias	Captive	141	640,000
Narraguagus	Captive	112	355,000
Pleasant	Captive	74	259,000
Sheepscot	Captive	56	164,000
Total	**Captive/Domestic**	**1,475**	**5,745,000**
Penobscot	Sea Run	102	775,000
Total	**Sea Run**	**102**	**775,000**
Grand Total for Year	**2014**	**1,577**	**6,520,000**

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															
1993-2004	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															
1977-2004	1,475	16,853,000	7,900	21,749	140,646,000	5,900	0	0		1,950	24,262,000	10,100	25,174	181,761,000	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
2014	0	0		103	830,000	8,100	0	0		0	0		103	830,000	8,100
Total Connecticut	2,071	21,264,000	7,400	33,662	208,352,000	6,100	0	0		2,395	28,934,000	9,700	38,128	258,550,000	6,300
Dennys															
1939-2004	26	214,000	7,600	0	0		868	3,552,000	4,100	40	330,000	7,700	934	4,096,000	5,000
2005	0	0		0	0		85	386,000	4,500	0	0		85	386,000	4,500
2006	0	0		0	0		96	400,000	4,200	0	0		96	400,000	4,200
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300

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

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

Note: Connecticut data are preliminary prior to 1990.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
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
2014	0	0		0	0		40	148,000	3,700	0	0		40	148,000	3,700
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,410	5,937,000	4,267	40	330,000	7,700	1,601	7,168,000	4,500
East Machias															
1995-2004	0	0		0	0		817	3,385,000	4,200	0	0		817	3,385,000	4,200
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
2014	0	0		0	0		99	452,000	4,600	0	0		99	452,000	4,600
Total East Machias	0	0		0	0	0	1,565	6,413,000	4,055	0	0		1,565	6,413,000	4,100
Kennebec															
1979-2004	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
1992-2004	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															
1941-2004	456	3,263,000	7,300	0	0		1,433	5,890,000	4,200	8	52,000	6,400	1,897	9,205,000	6,200
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
2014	0	0		0	0		141	640,000	4,500	0	0		141	640,000	4,500
Total Machias	456	3,263,000	7,300	0	0	0	2,764	11,319,000	4,018	8	52,000	6,400	3,228	14,634,000	4,200
Merrimack															
1983-2004	1,166	8,935,000	7,900	8,985	47,361,000	5,000	0	0		222	2,161,000	10,400	10,373	58,458,000	6,200
2005	13	111,000	8,500	191	691,000	3,600	0	0		65	697,000	10,700	269	1,499,000	5,600
2006	42	377,000	9,000	269	1,097,000	4,100	0	0		49	582,000	11,900	360	2,056,000	5,700
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
2009	48	369,000	7,700	516	2,380,000	4,600	0	0		55	577,000	10,500	619	3,326,000	5,400
2010	28	201,000	7,200	135	721,000	5,300	0	0		57	669,000	11,700	220	1,591,000	7,200
2011	107	935,000	8,700	103	408,000	4,000	0	0		0	0		210	1,343,000	6,400

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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
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
2014	0	0		293	1,244,000	4,200	0	0		0	0		293	1,244,000	4,200
Total Merrimack	1,582	12,306,000	8,000	11,980	59,106,000	4,000	0	0		540	5,708,000	11,100	14,102	77,121,000	5,200
Narraguagus															
1962-2004	0	1,303,000		0	0		1,411	5,140,000	3,700	0	0		1,411	6,443,000	3,700
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
2014	0	0		0	0		112	355,000	3,200	0	0		112	355,000	3,200
Total Narraguagus	0	1,303,000		0	0	0	2,851	11,059,000	4,100	0	0		2,851	12,362,000	4,100
Orland															
1967-2004	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															
1992-2004	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			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
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															
1871-2004	18,282	156,885,000	7,900	6,212	15,970,000	2,600	0	0		0	0		24,494	172,855,000	7,400
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
2014	102	775,000	7,600	557	1,653,000	3,000	0	0		0	0		659	2,428,000	3,700
Total Penobscot	20,935	178,707,000	8,100	9,741	28,291,000	3,400	329	1,400,000	4,300	0	0		31,005	208,398,000	5,600
Pleasant															
2001-2004	0	0		0	0		66	401,000	6,000	0	0		66	401,000	6,000
2005	0	0		0	0		99	304,000	3,100	0	0		99	304,000	3,100
2006	0	0		0	0		54	240,000	4,400	0	0		54	240,000	4,400
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400

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
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
2014	0	0		0	0		74	259,000	3,500	0	0		74	259,000	3,500
Total Pleasant	0	0		123	469,000	5,900	642	2,421,000	3,827	0	0		765	2,889,000	4,100
Sheepscot															
1995-2004	18	125,000	6,900	0	0		666	2,722,000	3,900	45	438,000	9,900	729	3,285,000	4,500
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
2014	0	0		0	0		56	164,000	2,900	0	0		56	164,000	2,900
Total Sheepscot	18	125,000	6,900	0	0	0	1,427	5,410,000	3,555	45	438,000	9,900	1,490	5,973,000	3,600
St Croix															
1993-2004	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															
1974-2004	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	33,662	208,351,000	6,100	0	0		2,395	28,935,000	9,700	38,128	258,550,000	6,300
Dennys	26	214,000	7,600	125	687,000	4,600	1,410	5,937,000	4,300	40	330,000	7,700	1,601	7,168,000	4,400
East Machias	0	0		0	0		1,565	6,413,000	4,100	0	0		1,565	6,413,000	4,100
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		2,764	11,319,000	4,000	8	52,000	6,400	3,228	14,634,000	4,200
Merrimack	1,582	12,306,000	8,000	11,980	59,105,000	4,000	0	0		540	5,709,000	11,100	14,102	77,121,000	5,200
Narraguagus	0	1,303,000		0	0		2,851	11,059,000	4,100	0	0		2,851	12,362,000	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	20,935	178,707,000	8,100	9,741	28,290,000	3,400	329	1,400,000	4,300	0	0		31,005	208,398,000	5,600
Pleasant	0	0		123	468,000	5,900	642	2,420,000	3,800	0	0		765	2,889,000	4,100
Sheepscot	18	125,000	6,900	0	0		1,427	5,409,000	3,600	45	438,000	9,900	1,490	5,973,000	3,600
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	**25,800**	**222,614,000**	**8,600**	**56,187**	**296,909,000**	**5,300**	**10,988**	**43,957,000**	**4,000**	**3,041**	**35,540,000**	**11,700**	**96,016**	**599,024,000**	**6,200**

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							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin								
2001-2004	0	6,000	0	0	0	0	0	6,000
2005	0	0	0	0	0	0	0	0
2006	0	1,000	0	0	0	0	0	1,000
2007	0	1,000	0	0	0	0	0	1,000
2008	0	1,000	0	0	0	0	0	1,000
2009	0	2,000	0	0	0	0	0	2,000
2010	0	1,000	0	0	0	0	0	1,000
2011	0	1,000	0	0	0	0	0	1,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	1,000	0	0	0	500	0	1,500
2014	0	1,000	0	0	0	0	0	1,000
Totals:Androscoggin	**0**	**16,000**	**0**	**0**	**0**	**500**	**0**	**16,500**
Aroostook								
1978-2004	0	2,122,000	317,400	38,600	0	32,600	29,800	2,540,400
2005	0	133,000	0	0	0	0	0	133,000
2006	0	324,000	0	0	0	0	0	324,000
2007	0	854,000	0	0	0	0	0	854,000
2008	0	365,000	0	0	0	0	0	365,000
2009	0	458,000	0	0	0	0	0	458,000
2010	0	527,000	0	0	0	0	0	527,000
2011	0	237,000	0	0	0	0	0	237,000
2012	0	731,000	0	0	0	0	0	731,000
2013	0	580,000	0	0	0	0	0	580,000
2014	0	569,000	0	0	0	0	0	569,000
Totals:Aroostook	**0**	**6,900,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**7,318,400**
Cocheco								
1988-2004	0	1,958,000	50,000	10,500	0	5,300	0	2,023,800
Totals:Cocheco	**0**	**1,958,000**	**50,000**	**10,500**	**0**	**5,300**	**0**	**2,023,800**
Connecticut								
1967-2004	0	100,402,000	2,830,600	1,812,800	0	3,769,700	1,197,900	110,013,000
2005	0	7,805,000	0	0	0	0	85,100	7,890,100
2006	0	5,848,000	3,700	0	12,600	1,000	52,100	5,917,400
2007	0	6,345,000	0	600	2,300	600	99,000	6,447,500
2008	0	6,041,000	0	0	2,400	0	50,000	6,093,400
2009	0	6,476,000	3,900	0	14,400	0	49,100	6,543,400
2010	0	6,009,000	0	6,300	19,000	0	42,700	6,077,000
2011	0	6,010,000	5,200	9,500	10,000	0	81,700	6,116,400
2012	0	1,733,000	3,100	7,500	4,000	0	71,000	1,818,600
2013	0	1,857,000	3,200	0	0	600	99,500	1,960,300
2014	0	199,000	0	0	0	0	0	199,000
Totals:Connecticut	**0**	**148,725,000**	**2,849,700**	**1,836,700**	**64,700**	**3,771,900**	**1,828,100**	**159,076,100**

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Dennys								
1975-2004	0	1,619,000	176,100	7,300	0	363,000	29,200	2,194,600
2005	0	215,000	21,700	0	0	56,700	0	293,400
2006	0	295,000	27,600	0	0	56,500	0	379,100
2007	0	257,000	0	0	0	56,500	0	313,500
2008	0	292,000	0	0	0	0	200	292,200
2009	0	317,000	0	0	0	0	600	317,600
2010	0	430,000	0	0	0	0	0	430,000
2011	0	539,000	0	0	0	0	0	539,000
2014	0	84,000	0	0	0	0	0	84,000
Totals:Dennys	**0**	**4,048,000**	**225,400**	**7,300**	**0**	**532,700**	**30,000**	**4,843,400**
Ducktrap								
1986-2004	0	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**0**	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias								
1973-2004	0	2,076,000	7,500	42,600	0	108,400	30,400	2,264,900
2005	0	216,000	0	0	0	0	0	216,000
2006	0	199,000	0	0	0	0	0	199,000
2007	0	245,000	0	0	0	0	0	245,000
2008	0	261,000	0	0	0	0	0	261,000
2009	0	186,000	0	0	0	0	0	186,000
2010	0	266,000	0	0	0	0	0	266,000
2011	0	180,000	0	0	0	0	0	180,000
2012	0	88,000	53,200	0	0	0	0	141,200
2013	0	20,000	77,600	0	0	0	0	97,600
2014	0	16,000	149,800	0	0	0	0	165,800
Totals:East Machias	**0**	**3,753,000**	**288,100**	**42,600**	**0**	**108,400**	**30,400**	**4,222,500**
Kennebec								
2001-2004	0	104,000	0	0	0	0	0	104,000
2005	0	34,000	0	0	0	0	0	34,000
2006	40000	8,000	0	0	0	0	0	47,598
2007	34000	20,000	0	0	0	0	0	53,878
2008	246000	3,000	0	0	0	0	0	249,331
2009	159000	2,000	0	0	0	200	0	161,609
2010	600000	147,000	0	0	0	0	0	746,849
2011	810000	2,000	0	0	0	0	0	811,500
2012	921000	2,000	0	0	0	0	0	922,888
2013	654000	2,000	0	0	0	600	0	656,682
2014	1151000	2,000	0	0	0	0	0	1,153,330
Totals:Kennebec	**4,615,000**	**326,000**	**0**	**0**	**0**	**800**	**0**	**4,941,665**
Lamprey								
1978-2004	0	1,592,000	427,700	58,800	0	201,400	32,800	2,312,700
Totals:Lamprey	**0**	**1,592,000**	**427,700**	**58,800**	**0**	**201,400**	**32,800**	**2,312,700**

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Machias								
1970-2004	0	2,850,000	96,900	118,100	0	191,300	44,100	3,300,400
2005	0	476,000	0	200	0	0	0	476,200
2006	0	638,000	2,000	1,500	0	0	0	641,500
2007	0	470,000	0	2,200	0	0	0	472,200
2008	0	585,000	100	400	0	0	0	585,500
2009	0	291,000	300	0	0	0	0	291,300
2010	0	510,000	0	0	0	0	0	510,000
2011	0	347,000	0	500	0	0	0	347,500
2012	0	231,000	0	1,400	0	0	0	232,400
2013	0	172,000	800	1,400	0	59,100	0	233,300
2014	27000	210,000	400	0	0	0	0	237,387
Totals:Machias	**27,000**	**6,780,000**	**100,500**	**125,700**	**0**	**250,400**	**44,100**	**7,327,687**
Merrimack								
1975-2004	0	32,345,000	231,200	597,700	0	1,469,000	638,100	35,281,000
2005	0	962,000	1,400	400	0	50,000	0	1,013,800
2006	0	1,011,000	0	0	0	50,000	0	1,061,000
2007	0	1,140,000	0	0	0	50,000	0	1,190,000
2008	0	1,766,000	3,400	9,600	0	88,900	0	1,867,900
2009	0	1,051,000	0	0	0	91,100	0	1,142,100
2010	0	1,481,000	80,000	9,300	0	72,900	0	1,643,200
2011	0	892,000	93,800	0	0	34,900	0	1,020,700
2012	0	1,016,000	22,000	0	0	33,800	0	1,071,800
2013	0	111,000	0	41,200	0	40,900	0	193,100
2014	0	12,000	0	0	0	0	0	12,000
Totals:Merrimack	**0**	**41,787,000**	**431,800**	**658,200**	**0**	**1,981,500**	**638,100**	**45,496,600**
Narraguagus								
1970-2004	0	2,970,000	62,900	14,600	0	107,800	84,000	3,239,300
2005	0	352,000	0	0	0	0	0	352,000
2006	0	478,000	17,500	0	0	0	0	495,500
2007	0	346,000	15,700	0	0	0	0	361,700
2008	0	485,000	21,000	0	0	54,100	0	560,100
2009	0	449,000	0	0	0	52,800	0	501,800
2010	0	698,000	0	0	0	62,400	0	760,400
2011	0	465,000	0	0	0	64,000	0	529,000
2012	0	389,000	0	0	0	59,100	0	448,100
2013	0	288,000	0	0	0	0	0	288,000
2014	79000	263,000	0	0	0	0	0	342,145
Totals:Narraguagus	**79,000**	**7,183,000**	**117,100**	**14,600**	**0**	**400,200**	**84,000**	**7,878,045**
Pawcatuck								
1979-2004	0	5,382,000	1,209,200	263,200	0	76,400	500	6,931,300
2005	0	5,000	0	0	0	16,600	0	21,600
2006	0	85,000	0	0	0	12,800	0	97,800
2007	0	115,000	0	4,900	0	6,400	0	126,300
2008	0	313,000	0	0	0	6,000	0	319,000

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2009	0	86,000	0	0	0	5,400	0	91,400
2010	0	290,000	0	0	0	3,900	0	293,900
2011	0	6,000	0	0	0	0	0	6,000
2012	0	6,000	0	0	0	0	0	6,000
2013	0	8,000	0	0	0	0	0	8,000
2014	0	5,000	0	0	0	0	0	5,000
Totals:Pawcatuck	**0**	**6,301,000**	**1,209,200**	**268,100**	**0**	**127,500**	**500**	**7,906,300**
Penobscot								
1970-2004	0	15,747,000	4,272,800	1,394,400	0	12,710,200	2,508,200	36,632,600
2005	0	1,899,000	295,400	0	0	555,500	0	2,749,900
2006	0	1,509,000	293,500	0	0	555,200	0	2,357,700
2007	0	1,606,000	337,800	0	0	559,900	0	2,503,700
2008	0	1,248,000	216,600	0	0	554,600	0	2,019,200
2009	0	1,023,000	172,200	0	0	561,100	0	1,756,300
2010	0	999,000	258,800	0	0	567,100	0	1,824,900
2011	0	952,000	298,000	0	0	554,000	0	1,804,000
2012	353000	1,073,000	325,700	0	0	555,200	0	2,306,679
2013	233000	722,000	214,000	0	0	553,000	0	1,722,193
2014	89000	815,000	0	0	0	557,700	0	1,461,360
Totals:Penobscot	**675,000**	**27,593,000**	**6,684,800**	**1,394,400**	**0**	**18,283,500**	**2,508,200**	**57,138,532**
Pleasant								
1975-2004	0	287,000	16,000	1,800	0	57,500	26,900	389,200
2005	0	76,000	0	0	0	5,900	0	81,900
2006	0	284,000	0	0	0	0	15,200	299,200
2007	0	177,000	0	0	0	0	0	177,000
2008	0	171,000	0	0	0	0	0	171,000
2009	0	97,000	0	0	0	0	300	97,300
2010	0	142,000	0	0	0	0	0	142,000
2011	0	124,000	0	0	0	61,000	0	185,000
2012	0	40,000	0	0	0	60,200	0	100,200
2013	0	180,000	0	0	0	62,300	0	242,300
2014	46000	114,000	0	0	0	0	0	159,500
Totals:Pleasant	**46,000**	**1,692,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**2,044,600**
Saco								
1975-2004	0	4,810,000	438,700	201,200	0	344,100	9,500	5,803,500
2005	0	340,000	0	18,000	0	1,700	0	359,700
2006	0	106,000	0	0	0	0	0	106,000
2007	0	576,000	0	0	0	0	0	576,000
2008	0	358,000	9,100	0	0	0	0	367,100
2009	0	1,000	0	0	0	0	0	1,000
2010	0	302,000	0	0	0	26,500	0	328,500
2011	0	238,000	16,000	0	0	12,000	0	266,000
2012	0	396,000	0	12,800	0	11,900	0	420,700
2013	0	319,000	10,100	0	0	12,100	0	341,200
2014	0	366,000	16,000	0	0	12,100	0	394,100

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Totals:Saco	**0**	**7,812,000**	**489,900**	**232,000**	**0**	**420,400**	**9,500**	**8,963,800**
Sheepscot								
1971-2004	0	2,058,000	100,400	20,600	0	92,200	7,100	2,278,300
2005	9000	201,000	15,900	0	0	0	0	225,700
2006	9000	151,000	16,600	0	0	0	0	176,600
2007	0	198,000	0	0	0	0	0	198,000
2008	0	218,000	13,000	0	0	0	0	231,000
2009	0	185,000	17,900	0	0	0	0	202,900
2010	9000	114,000	14,500	0	0	0	0	137,500
2011	0	129,000	15,000	0	0	0	0	144,000
2012	70000	50,000	15,700	0	0	0	0	136,069
2013	122000	18,000	14,000	0	0	0	0	154,476
2014	118000	23,000	15,000	0	0	0	0	155,668
Totals:Sheepscot	**337,000**	**3,345,000**	**238,000**	**20,600**	**0**	**92,200**	**7,100**	**4,040,213**
St Croix								
1981-2004	0	1,268,000	470,400	158,300	0	808,000	20,100	2,724,800
2006	0	0	27,600	0	0	0	0	27,600
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0
Totals:St Croix	**0**	**1,268,000**	**498,000**	**158,300**	**0**	**808,000**	**20,100**	**2,752,400**
Union								
1971-2004	0	436,000	371,400	0	0	379,700	251,000	1,438,100
2005	0	2,000	0	0	0	0	0	2,000
2006	0	2,000	0	0	0	0	0	2,000
2007	0	22,000	0	0	0	0	0	22,000
2008	0	23,000	0	0	0	0	0	23,000
2009	0	28,000	0	0	0	0	0	28,000
2010	0	19,000	0	0	0	0	0	19,000
2011	0	19,000	0	0	0	0	0	19,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	2,000	0	0	0	0	0	2,000
2014	0	24,000	0	0	0	0	0	24,000
Totals:Union	**0**	**578,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,580,100**
Upper StJohn								
1979-2004	0	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
Totals:Upper StJohn	**0**	**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.

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Androscoggin	0	16,000	0	0	0	500	0	**16,300**
Aroostook	0	6,900,000	317,400	38,600	0	32,600	29,800	**7,318,500**
Cocheco	0	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	0	148,724,000	2,849,700	1,836,700	64,800	3,771,900	1,828,200	**159,010,500**
Dennys	0	4,048,000	225,400	7,300	0	532,800	30,000	**4,843,600**
Ducktrap	0	68,000	0	0	0	0	0	**68,000**
East Machias	0	3,751,000	288,100	42,600	0	108,400	30,400	**4,220,700**
Kennebec	4,615,000	326,000	0	0	0	900	0	**4,941,500**
Lamprey	0	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	27,000	6,780,000	100,400	125,600	0	250,400	44,100	**7,327,900**
Merrimack	0	41,787,000	431,700	658,100	0	1,981,400	638,100	**45,496,500**
Narraguagus	79,000	7,184,000	117,100	14,600	0	400,300	84,000	**7,878,600**
Pawcatuck	0	6,300,000	1,209,200	268,100	0	127,500	500	**7,905,500**
Penobscot	675,000	27,592,000	6,684,800	1,394,400	0	18,283,500	2,508,200	**57,138,000**
Pleasant	46,000	1,693,000	16,000	1,800	0	247,000	42,400	**2,045,500**
Saco	0	7,812,000	489,800	232,000	0	420,300	9,500	**8,963,300**
Sheepscot	337,000	3,346,000	238,000	20,600	0	92,200	7,100	**4,040,700**
St Croix	0	1,270,000	498,000	158,300	0	808,000	20,100	**2,754,000**
Union	0	577,000	371,400	0	0	379,700	251,000	**1,579,100**
Upper StJohn	0	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**273,890,000**	**15,771,500**	**4,882,800**	**64,800**	**27,649,200**	**5,583,900**		**333,555,400**

Summaries for each river vary by length of time series.

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

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

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin									
1983-2004	30	523	6	2	6	84	0	1	**652**
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**
2014	0	2	0	0	0	1	0	0	**3**
Total for Androscoggin	57	602	6	2	10	108	0	1	**786**
Cocheco									
1992-2004	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2004	36	3,503	28	2	52	1,471	12	0	**5,104**
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**
2014	0	0	0	0	2	30	0	0	**32**
Total for Connecticut	58	3,612	28	2	136	2348	14	3	**6,201**
Dennys									
1967-2004	35	314	0	1	31	744	3	31	**1,159**
2006	2	2	0	0	1	1	0	0	**6**
2007	1	1	0	0	0	1	0	0	**3**
2008	0	1	0	0	1	3	0	3	**8**
2009	0	0	0	0	0	6	1	1	**8**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
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									
1985-2004	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2004	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2004	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**
2014	0	2	0	0	3	13	0	0	**18**
Total for Kennebec	24	258	6	7	12	94	0	0	**401**
Lamprey									
1979-2004	10	17	1	0	11	16	0	0	**55**
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									
1967-2004	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									
1982-2004	307	1,211	21	8	121	989	26	0	**2,683**
2005	8	25	0	0	0	1	0	0	**34**
2006	9	64	1	0	6	9	0	0	**89**
2007	8	52	0	0	1	12	1	0	**74**
2008	6	77	0	0	5	29	1	0	**118**
2009	4	41	2	0	1	28	2	0	**78**
2010	29	40	0	0	7	7	1	0	**84**
2011	128	155	12	1	11	90	5	0	**402**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	**Total**
2012	0	81	15	0	1	27	3	0	**127**
2013	0	6	0	3	0	12	0	0	**21**
2014	4	25	1	0	0	10	0	0	**40**
Total for Merrimack	503	1,777	52	12	153	1214	39	0	**3,750**
Narraguagus									
1967-2004	92	650	19	54	89	2,396	71	155	**3,526**
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**
2014	0	2	0	0	0	1	0	1	**4**
Total for Narraguagus	185	804	23	56	123	2489	72	160	**3,912**
Pawcatuck									
1982-2004	2	148	1	0	1	15	1	0	**168**
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**
2014	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot									
1968-2004	10,463	42,507	287	697	670	3,699	35	97	**58,455**
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**
2010	410	819	0	11	23	53	0	0	**1,316**
2011	696	2,167	3	12	45	201	1	0	**3,125**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2012	8	531	6	2	5	69	0	3	**624**
2013	54	275	3	2	3	44	0	0	**381**
2014	82	153	2	2	1	21	0	0	**261**
Total for Penobscot	13,444	51,336	304	744	838	4384	37	102	**71,189**
Pleasant									
1967-2004	5	12	0	0	14	228	3	2	**264**
2012	0	0	0	0	0	2	0	0	**2**
2013	0	1	0	0	0	0	0	0	**1**
2014	2	0	0	0	0	1	0	0	**3**
Total for Pleasant	7	13	0	0	14	231	3	2	**270**
Saco									
1985-2004	112	571	3	7	23	67	3	0	**786**
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**
2014	0	3	0	0	0	0	0	0	**3**
Total for Saco	179	707	5	7	50	119	6	0	**1,073**
Sheepscot									
1967-2004	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2004	274	1,841	9	28	1	16	0	0	**2,169**
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**
2014	0	1	0	0	0	1	0	0	**2**
Total for Union	274	1,842	9	28	1	18	0	0	**2,172**

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	602	6	2	10	108	0	1	**786**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,612	28	2	136	2,348	14	3	**6,201**
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	258	6	7	12	94	0	0	**401**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	503	1,777	52	12	153	1,214	39	0	**3,750**
Narraguagus	185	804	23	56	123	2,489	72	160	**3,912**
Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot	13,444	51,336	304	744	838	4,384	37	102	**71,189**
Pleasant	7	13	0	0	14	231	3	2	**270**
Saco	179	707	5	7	50	119	6	0	**1,073**
Sheepscot	6	38	0	0	30	358	10	0	**442**
Union	274	1,842	9	28	1	18	0	0	**2,172**

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 2009 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	0	0	39	59	2	0
2009	472	61	0.129	0	3	0	0	97	0	0	0			0	3	97	0	
2010	425	20	0.047	0	25	0	5	70		0				0	30	70		
2011	438	12	0.027	0	83		17							0	100			
2012	85	0	0.000	0										0				
Total	**10,099**	**1,690**																
Mean			**0.505**	**0**	**6**	**0**	**3**	**69**	**3**	**0**	**4**	**0**	**0**	**0**	**9**	**69**	**7**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	39	59	2	0
2009	648	79	0.122	0	4	0	0	95	0	0	1			0	4	95	1	
2010	601	29	0.048	0	28	0	7	66		0				0	35	66		
2011	601	13	0.022	8	77		15							8	92			
2012	173	0	0.000	0										0				
Total	**14,654**	**2,498**																
Mean			**0.397**	**0**	**11**	**0**	**4**	**67**	**2**	**0**	**4**	**0**	**0**	**0**	**15**	**67**	**6**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	38	62	0	0
2009	82	4	0.049	0	0	0	0	100	0	0	0			0	0	100	0	
2010	85	4	0.047	0	25	0	0	75		0				0	25	75		
2011	76	0	0.000	0	0		0							0	0			
2012	35	0	0.000	0										0				
Total	**2,305**	**373**																
Mean			**0.278**	**0**	**24**	**0**	**5**	**57**	**0**	**0**	**7**	**0**	**0**	**0**	**29**	**57**	**8**	**0**

Means includes year classes with complete return data (year classes of 2009 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 2009 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	0	0	22	78	0	0
2009	105	13	0.124	0	0	0	8	92	0	0	0			0	8	92	0	
2010	148	7	0.047	0	0	0	0	100		0				0	0	100		
2011	89	3	0.034	0	100		0							0	100			
2012	102	0	0.000	0										0				
Total	**4,171**	**1,406**																
Mean			**2.211**	**0**	**2**	**0**	**10**	**63**	**4**	**2**	**9**	**0**	**0**	**0**	**12**	**66**	**13**	**1**

Means includes year classes with complete return data (year classes of 2009 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	0	0	33	67	0	0
2009	9	2	0.234	0	0	0	0	100	0	0	0			0	0	100	0	

Means includes year classes with complete return data (year classes of 2009 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		0				0	0	0		
2011	1	0	0.000	0	0		0							0	0			
2012	1	0	0.000	0										0				
Total	**630**	**27**																
Mean			**0.132**	**0**	**4**	**1**	**1**	**34**	**0**	**0**	**5**	**0**	**0**	**0**	**5**	**35**	**5**	**0**

Means includes year classes with complete return data (year classes of 2009 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 (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	12	2	0.165	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1988	4	3	0.693	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	11	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	4	0.322	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
1993	11	2	0.190	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	24	4	0.166	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1995	24	1	0.041	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1996	25	15	0.607	0	20	0	33	47	0	0	0	0	0	0	53	47	0	0
1997	22	3	0.134	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
1998	26	1	0.039	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	13	6	0.454	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2000	28	3	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
2001	25	4	0.160	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	26	21	0.799	0	10	0	24	67	0	0	0	0	0	0	34	67	0	0
2003	25	13	0.526	8	38	0	8	46	0	0	0	0	0	8	46	46	0	0
2004	28	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	26	2	0.076	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2006	25	3	0.119	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
2007	28	5	0.178	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0

Means includes year classes with complete return data (year classes of 2009 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	0	0	36	64	0	0
2009	24	2	0.085	0	0	0	0	100	0	0	0			0	0	100	0	
2010	28	4	0.143	0	50	0	25	25		0				0	75	25		
2011	24	0	0.000	0	0		0							0	0			
2012	15	0	0.000	0										0				
Total	**522**	**120**																
Mean			**0.254**	**0**	**19**	**0**	**5**	**58**	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**58**	**0**	**0**

Means includes year classes with complete return data (year classes of 2009 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 (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1988	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	62	0	0	12	0	0	0	25	62	12	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3	0	0	0	11	86	3	0
2005	84	1	0.012	0	0	0	100	0	0	0	0	0	0	0	100	0	0	0
2006	73	5	0.069	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2007	57	5	0.088	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2008	63	9	0.143	0	0	0	44	44	0	0	11	0	0	0	44	44	11	0

Means includes year classes with complete return data (year classes of 2009 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	11	0.170	0	9	0	0	82	0	0	9			0	9	82	9	
2010	60	2	0.033	0	0	0	0	100		0				0	0	100		
2011	59	1	0.017	100	0		0							100	0			
2012	39	0	0.000	0										0				
Total	**1,670**	**314**																
Mean			**0.199**	**0**	**4**	**0**	**10**	**74**	**0**	**0**	**7**	**0**	**0**	**0**	**14**	**74**	**7**	**0**

Means includes year classes with complete return data (year classes of 2009 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 .

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 2009 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	0	0	42	58	0	0
2009	102	50	0.489	0	0	0	10	88	0	0	2			0	10	88	2	
2010	100	24	0.240	0	0	0	12	83		4				0	12	87		
2011	95	0	0.000	0	0		0							0	0			
2012	107	0	0.000	0										0				
Total	**2,593**	**4,783**																
Mean			**5.277**	**0**	**0**	**0**	**17**	**72**	**1**	**3**	**7**	**0**	**0**	**0**	**17**	**74**	**8**	**0**

Means includes year classes with complete return data (year classes of 2009 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	0.122	0.129	0.085	0.049	0.170	0.489
2010	0.047	0.000	0.048	0.047	0.143	0.047	0.033	0.240
2011	0.034	0.000	0.022	0.027	0.000	0.000	0.017	0.000
2012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean	**2.273**	**0.134**	**0.404**	**0.517**	**0.227**	**0.284**	**0.201**	**5.442**
StDev	**5.414**	**0.436**	**0.464**	**0.724**	**0.244**	**0.310**	**0.182**	**6.580**

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).

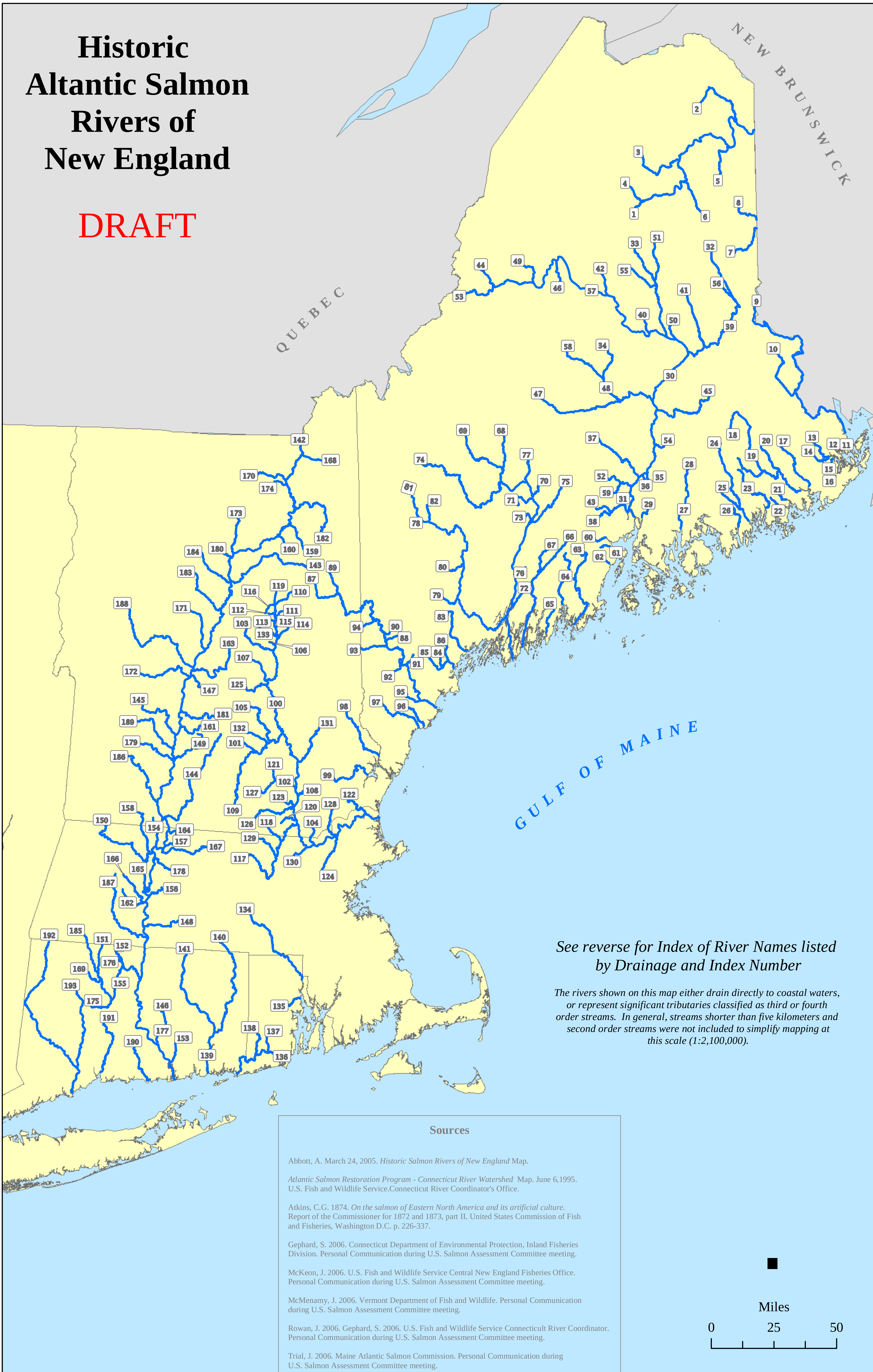
Appendix 20. Summary of age distributions of adult Atlantic salmon that were stocked in New England as fry.

	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)	0	15	0	4	76	2	0	5	0	0	0	19	76	7	0
Farmington	0	25	0	5	62	0	0	7	0	0	0	29	63	8	0
Merrimack	0	4	0	10	71	4	2	9	1	0	0	15	73	14	1
Pawcatuck	0	8	2	2	78	0	0	10	0	0	0	10	80	10	0
Penobscot	0	0	0	17	73	1	3	7	0	0	0	17	75	8	0
Salmon	0	23	0	6	70	0	0	0	0	0	0	29	70	0	0
Westfield	4	4	0	9	79	0	0	8	0	0	4	13	79	8	0
Overall Mean:	**1**	**11**	**0**	**7**	**74**	**1**	**1**	**6**	**0**	**0**	**1**	**18**	**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).

Sources

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