ANNUAL REPORT OF THE U.S ATLANTIC SALMON ASSESSMENT COMMITTEE

REPORT NO. 29 - 2016 ACTIVITIES

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PREPARED FOR
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1 Executive Summary

1.1 Abstract

Total return to USA rivers was 626; this is the sum of documented returns to traps and returns estimated by redd counts on selected Maine rivers, this year ranks 24 out of 26 years for the 1991-2016 time series, but represents a 164% increase over 2014 (the lowest in the time series) and only 15% of the recent high return number in 2011. Adult salmon returns to USA rivers with traps or weirs totaled 564 in 2016. Estimated return to Gulf of Maine small coastal rivers was 62 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 98% of the total return. Overall, 37.1% of the adult returns to the USA were 1SW salmon, 62.1% were 2SW salmon and 0.8% were 3SW or repeat spawners. Most (72 %) returns were of hatchery smolt origin and the balance (28%) originated from either natural reproduction or parr, hatchery fry and eggs. A total of 4,936,654 juvenile salmon (eggs, fry, parr, and smolts), and 3,757 adults were stocked in 2016. Of those fish 323,392 carried a variety of marks and/or tags. Eggs for USA hatchery programs were taken from 134 sea-run females and 1,620 captive/domestic and domestic females. Total egg take (5,426,096) was lower than the previous three years by nearly 1,000,000 eggs even with an increase of almost 200 spawners. Production of farmed salmon in Maine was not available, due to regulation concerning privacy.

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 626; (Table 1.3.1), a 32% decrease from 2015 returns and 15% of 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 2015 within areas were: LIS (-77%), CNE (-61%), GOM (-30%). 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. Starting in 2015, CNE rivers' sea ages are based on the estimates from 2009-2014, as fish are no longer handled at the trap.

At the 2017 meeting of the USASAC, updated Conservation Limit (CL) numbers were presented that calculated the CL in Maine using habitat values modeled by Wright et.al. 2008. Calculation of CL still uses 2.4 eggs per square meter and an average fecundity of 7,200 eggs to calculate the number of females needed. This number is doubled assuming a 1:1 female to male spawning ratio. This formula is described in a working paper submitted to the ICES Working Group on North Atlantic Salmon in 1995 by E. Baum (Baum 1995). In the 1995 working paper, it was noted that habitat values were incomplete for several drainages and the CL was likely underestimated. By using the Wright et.al. (2008) habitat model, estimates of Atlantic salmon habitat are available for entire drainages in Maine. These updated values are summarized in Table 1.3.3 and Table 1.3.4 (drainage values including OBoF within Maine) and are further explained in USASAC Working Paper WP17-03.

With the listing of Atlantic salmon populations in Maine as endangered under the US Endangered Species Act, there was a requirement to designate habitat critical which is critical for the recovery of the species (Critical Habitat, CH). As a result, not all habitat within a drainage was designated as CH as some tributaries were excluded for economic or geographical reasons (for more detail see the Federal Register 74:117 (June 19, 2009):29300–29341). However, for the sake of determining a CL for the US, all modeled values are included, including both critical and non-critical habitat. Conservation Limits for the US New England rivers are set at 84,655 2SW adults (Table 1.3.4). This is an increase from 29,198 2SW salmon as presented by Baum (1995). This increase is due to predicted habitat values in Maine as the Wright et.al. model only considers Maine drainages. If a similar habitat modeling exercise was applied to all of New England, the US CL would undoubtedly increase the CL further.

In the USA, using the new CL estimates, returns are well below conservation spawner requirements. Returns of 2SW fish from traps, weirs, and estimated returns were only 0.5% of the USA CL, with returns to the three areas ranging from 0 to 0.6 % of spawner requirements (Table 1.3.3). Out of select rivers the Dennys was the highest at about 6.3% of CL followed by the Penobscot (1.7%) and the Narraguagus (1.7%) (Table 1.3.5).

1.4 Stock Enhancement Programs

During 2016, about 4,936,654 juvenile salmon (67% fry) were released and 1,439,355 eggs were planted into 13 river systems (Table 1.4.1). The number of juveniles released was less than that in 2015. 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 the GOM into the Penobscot River (569,300) and the Narraguagus River (97,000). In addition to juveniles, 3,757 adult salmon were released into USA rivers (Table 1.4.2). A total of 687 of these were pre-spawn adults released into sub-drainages of the Merrimack River to provide a limited recreational opportunity.

1.5 Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 323,392 salmon released into USA waters in 2016 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).

1.6 Farm Production

Production of farmed salmon in Maine was not available. As only one company is currently in production we are unable to release information based on privacy concerns. Three aquaculture escapees were captured at traps or fishways in the USA. One AQS salmon was captured at the Milford trapping facility on the Penobscot River. This fish was sacrificed and confirmed to be aquaculture origin through DNA analysis. The other two were captured in the Dennys River, ME after reports of large numbers of salmon observed in the Dennys were received by MEDMR. In investigating the fish it was estimated that there were at least 100 adult salmon at large in the Dennys River. MEDMR staff attempted to capture several fish with large dip nets and a trap net deployed across the thalweg of the river. Two salmon were retained and subsequently sacrificed and confirmed aquaculture through DNA analysis.

1.7 Smolt Emigration

NOAA's National Marine Fisheries Service (NOAA) and the Maine Department of Marine Resources (DMR) have conducted seasonal field activities assessing Atlantic salmon smolt populations using Rotary Screw Traps (RSTs) in selected Maine rivers since 1996. In 2016, biologists trapped smolts on three rivers in an effort to continue the time series of abundance estimates using mark-recapture techniques.

DMR captured smolts using RSTs at two sites on the Narraguagus River from 14 April to 5 June, which continued smolt assessments for a 20th consecutive year. Nearly 100,000 unmarked age 1 hatchery smolts were stocked into the river in 2016. Six hundred and fifty-one (651) smolts of naturally-reared (product of spawning, and/or fry stocking) and 7,460 age 1 hatchery (stocked in 2016) origin smolts were handled at trap sites. Origin of capture smolts (hatchery or naturally reared) was assigned in the field. However, scale analysis back in the laboratory post-field season confirmed that the field assignments were less than 100% accurate. There was an attempt to calculate an abundance estimate but given the uncertainty in the catch statistics by origin, a reliable estimate could not be provided.

DMR operated three RSTs at one site on the Sheepscot River from 11 April to 30 May, which marked the 15th year of assessment on this river. Seven hundred and fifty one (751) smolts of naturally-reared (295) and parr stocked (456) origins were handled at trap sites. The Sheepscot River population estimates were comprised of 983 ± 113 naturally-reared smolts and 2,007 ± 257 parr stocked smolts (2,924 ± 262 combined estimate).

In partnership with the Downeast Salmon Federation (DSF), DMR operated two RSTs at one site on the East Machias River from 14 April to 7 June, which was the fourth consecutive year of trapping on this river. Staff captured 206 smolts of naturally-reared (27) and hatchery (179) origin. The East Machias population of naturally-reared fish was too small to estimate, while 946 ± 221 parr stocked smolts were estimated to exit the system (1,223 ± 297 combined estimate). A time series of estimates for the Narraguagus and Sheepscot Rivers are presented in Table 1.7.1.

Table 1.3.1 Estimated Atlantic salmon returns to USA by geographic area, 2016. "Natural" includes fish originating from natural spawning and hatchery fry or eggs. Some numbers are based on redds. Ages and origins are prorated where fish are not available for handling.

Areas	1SW		2SW		3SW		Repeat Spawners		Total
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	0	0	5	0	0	0	0	5
CNE	1	0	1	5	0	0	0	0	7
GOM	211	20	232	146	2	0	1	2	614
Total	212	20	233	156	2	0	1	2	626

Table 1.3.2 Estimated Atlantic salmon returns to the USA, 1967-2016. "Natural" includes fish originating from natural spawning and hatchery fry or eggs. 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
2015	150	761	9	1	921	739	182
2016	232	389	2	3	626	448	178

Table 1.3.3 Two sea winter (2SW) returns for 2016 in relation to spawner requirements (i.e. 2SW Conservation Limits) for USA rivers. Spawner limits represent the 2017 updated values as detailed in Section 1.3.

Area		Spawner Requirement	2SW returns 2016	Percentage of Requirement
Long Island Sound	LIS	17,785	5	0.0%
Central New England	CNE	5,516	6	0.1%
Gulf of Maine	GOM	61,355	378	0.6%
Total		84,656	389	0.5%

Table 1.3.4 Conservation Limits of Atlantic salmon in New England USA. Adults calculated on 7,200 egg fecundity and 1:1 M to F ratio. A unit of habitat = 100 m^2

Map Index #	DPS or SHRU	State	River	Habitat Units	Hectares	Eggs at 240 / unit	CL Number of Adults
1	OBoF	**Maine**	Aroostook	60,775	607.8	14,586,000	4,052
7	OBoF	**Maine**	Meduxnekeag	5,000	50.0	1,200,000	333
7	OBoF	**Maine**	Prestile	835	8.4	200,400	56
9	OBoF	**Maine**	St. Croix	29,260	292.6	7,022,400	1,951
11	OBoF	**Maine**	Boyden Stream	85	0.9	20,400	6
12	OBoF	**Maine**	Pennamaquan	85	0.9	20,400	6
13	DEC	**Maine**	Dennys	2,166	21.7	519,943	144
15	DEC	**Maine**	Hobart Stream	412	4.1	98,978	27
16	DEC	**Maine**	East Stream	337	3.4	80,880	22
16	DEC	**Maine**	Orange	321	3.2	77,146	21
17	DEC	**Maine**	East Machias	6,666	66.7	1,599,744	444
18	DEC	**Maine**	Machias	15,668	156.7	3,760,250	1,045
21	DEC	**Maine**	Chandler	1,212	12.1	290,976	81
22	DEC	**Maine**	Indian	445	4.4	106,730	30
23	DEC	**Maine**	Harrington	341	3.4	81,840	23
23	DEC	**Maine**	Pleasant	2,586	25.9	620,633	172
24	DEC	**Maine**	Narraguagus	7,174	71.7	1,721,820	478
26	DEC	**Maine**	Tunk Stream	1,029	10.3	246,919	69
26	DEC	**Maine**	Whitten Parritt	121	1.2	29,155	8
27	DEC	**Maine**	Patten Stream	972	9.7	233,198	65
27	DEC	**Maine**	Union	14,149	141.5	3,395,758	943
29	PEN	**Maine**	Orland River	1,775	17.7	425,885	118
30	PEN	**Maine**	Penobscot (Critical Hab.)	255,266	2,552.7	61,263,862	17,018
30	PEN.	**Maine**	Penobscot (Not Critical Hab)	152,772	1,527.7	36,665,388	10,185
60	PEN	**Maine**	Passagassawakeag	1,041	10.4	249,914	69
62	PEN	**Maine**	Ducktrap	996	10.0	238,949	66
63	MMB	**Maine**	St. George	7,132	71.3	1,711,726	475
64	MMB	**Maine**	Medomak	2,443	24.4	586,210	163
65	MMB	**Maine**	Pemaquid River	525	5.2	125,916	35
66	MMB	**Maine**	Sheepscot River	7,101	71.0	710,100	473
68	MMB	**Maine**	Kennebec (Critical Hab.)	91,240	912.4	21,897,600	6,083
68	MMB	**Maine**	Kennebec (Non-Critical Hab.)	230,454	2,304.5	55,308,905	15,364
78	MMB	**Maine**	Androscoggin (Critical Hab.)	16,757	167.6	4,021,620	1,117
78	MMB.	**Maine**	Androscoggin (Non-Critical Hab.)	99,226	992.3	23,814,334	6,615
83	CNE	**Maine**	Royal River	420	4.2	100,800	28
84	CNE	**Maine**	Presumpscot	85	0.9	20,400	6
87	CNE	**Maine**	Saco River	25,080	250.8	6,019,200	1,672
96	CNE	**Maine**	Kennebunk	85	0.9	20,400	6
100	CNE	**New Hampshire**	Merrimack	57,065	570.7	13,695,600	3,804
136	LIS	**Rhode island**	Pawcatuck	5,370	53.7	1,288,800	358
142	LIS	**Connecticut**	Connecticuit	261,400	2,614.0	62,736,000	17,427
			Grand Totals	**1,365,872**	**13,659**	**326,815,178**	**91,058**
			MMB SHRU only include CH	355,651	3,557	84,362,076	23,710
			PEN SHRU only include CH	259,078	2,591	62,178,610	17,272
			DEC SHRU	53,600	536	12,863,971	3,573
			GoM DPS only include CH	**668,328**	**6,683**	**159,404,657**	**44,555**
			Pen. = Not CH	152,772	1,528	36,665,388	10,185
			MMB. = Not CH	99,226	992	23,814,334	6,615
		Maine	**Total includes all Maine rivers**	**1,042,037**	**10,420**	**249,094,778**	**69,469**
			OBoF	96,040	960	23,049,600	6,403
			CNE	82,735	827	19,856,400	5,516
			LIS	266,770	2,668	64,024,800	17,785
			GoM	920,327	9,203	219,884,378	61,355

Table 1.3.5 Selection of US Rivers 2016 2SW Returns in relation to 2SW Conservation Limits.

Name	Longitude	Latitude	CL	Returns	% of CL Met
Connecticut	-72.374	41.593	17,427	5	0.03%
Dennys	-67.228	44.868	144	9	6.25%
Merrimack	-71.036	42.837	3,804	4	0.11%
Narraguagus	-67.783	44.654	478	8	1.67%
Pawcatuck	-71.133	41.937	358	0	0.00%
Penobscot	-68.82	44.769	17,018	285	1.67%
Pleasant	-67.5781	44.722	172	0	0.00%
Union	-68.474	44.643	943	0	0.00%

Table 1.4.1 Number of juvenile Atlantic salmon by lifestage stocked in USA, 2016.

Area	N	Rivers	Eyed Egg	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
LIS	2	Connecticut, Pawcatuck		71,009			1,200		72,209
CNE	2	Merrimack, Saco	34,818	374,985	4,000		12,000	106	425,909
GOM	8	Androscoggin to Dennys	1,404,355	1,889,581	478,253		666,453		4,438,642
OBF	1	Aroostook							0
Total	13		1,439,173	2,335,575	482,253		679,653		4,936,654

Table 1.4.2 Stocking summary for sea-run, captive reared domestic adult Atlantic salmon for the USA in 2016 by purpose and geographic area.

Area	Purpose	Captive Reared Domestic		Sea Run		Total
		Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	
Central New England	CNE Recreation	687				687
Gulf of Maine	GOM Restoration	489	2,303	0	278	3,070
Total for USA		1,176	2,303	0	278	3,757

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2016. Includes hatchery and wild origin fish.

Mark Code	Life History	GOM	LIS	Total
Adipose Clip	Adult	22		22
FLOY	Adult		7	7
Passive Integrated Transponder (PIT)	Adult	3,223	3	3,226
Radio	Adult	67		67
Adipose Clip	Parr	215,074		215,074
Acoustic Tag	Smolt	208		208
Passive Integrated Transponder (PIT)	Smolt	1,800		1,800
Radio	Smolt	748		748
Visual Implant Elastomer	Smolt	102,240		102,240
		323,382	10	323,392

Table 1.6.1 Aquaculture production (metric tonnes) in New England from 1997 to 2016. Production for 2011-2016 are unknown.

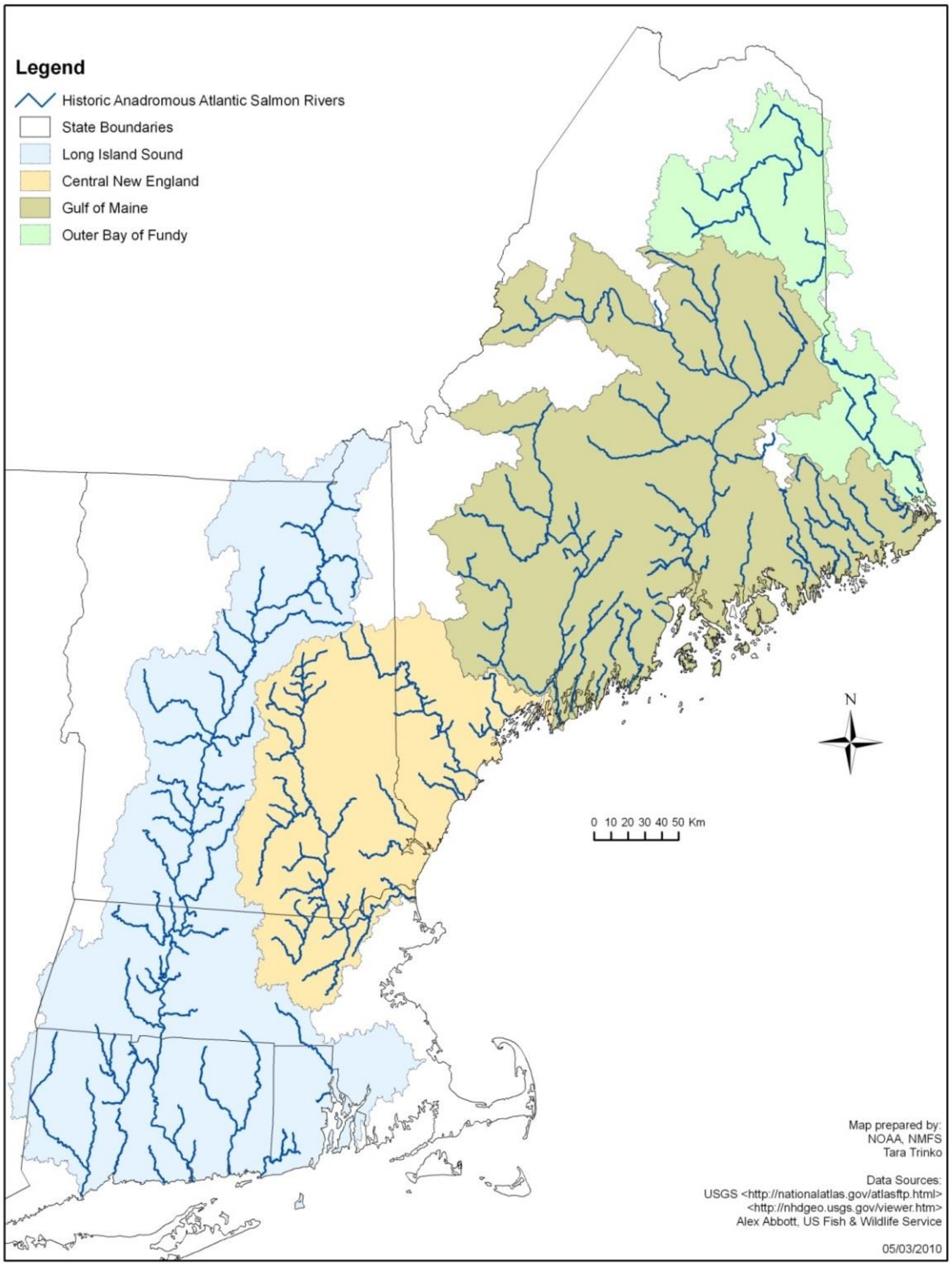
Year	MT
1997	13,222
1998	13,222
1999	12,246
2000	16,461
2001	13,202
2002	6,798
2003	6,007
2004	8,515
2005	5,263
2006	4,674
2007	2,715
2008	9,014
2009	6,028
2010	11,127
2011	*
2012	*
2013	*
2014	*
2015	*
2016	*

* not available for distribution

Table 1.7.1 Naturally reared smolt population estimate from rotary screw trap mark-recapture maximum likelihood estimates for the Narraguagus and Sheepscot Rivers, Maine USA.

	Narraguagus River			.	Sheepscot River		
Smolt Year	**Lower 95% CL**	**Pop Estimate**	**Upper 95% CL**	**.**	**Lower 95% CL**	**Pop Estimate**	**Upper 95% CL**
1997	1,940	2,749	3,558	.	N/A	N/A	N/A
1998	2,353	2,845	3,337	.	N/A	N/A	N/A
1999	3,196	4,247	5,298	.	N/A	N/A	N/A
2000	1,369	1,843	2,317	.	N/A	N/A	N/A
2001	1,835	2,562	3,289	.	N/A	N/A	N/A
2002	1,308	1,774	2,240	.	N/A	N/A	N/A
2003	995	1,201	1,407	.	N/A	N/A	N/A
2004	863	1,284	1,705	.	N/A	N/A	N/A
2005	846	1,287	1,728	.	N/A	N/A	N/A
2006	1,943	2,339	2,735	.	N/A	N/A	N/A
2007	954	1,177	1,400	.	N/A	N/A	N/A
2008	637	962	1,287	.	N/A	N/A	N/A
2009	1,000	1,176	1,352	.	1,243	1,498	1,753
2010	1,704	2,149	2,594	.	1,736	2,231	2,726
2011	657	1,404	2,151	.	916	1,639	2,363
2012	491	969	1,447	.	520	849	1,178
2013	722	1,237	1,752	.	566	829	1,091
2014	1,227	1,615	2,003	.	342	542	742
2015	729	1,201	1,673	.	431	572	713
2016	NA	NA	NA		762	983	1,204

Figure 1.3.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2016.



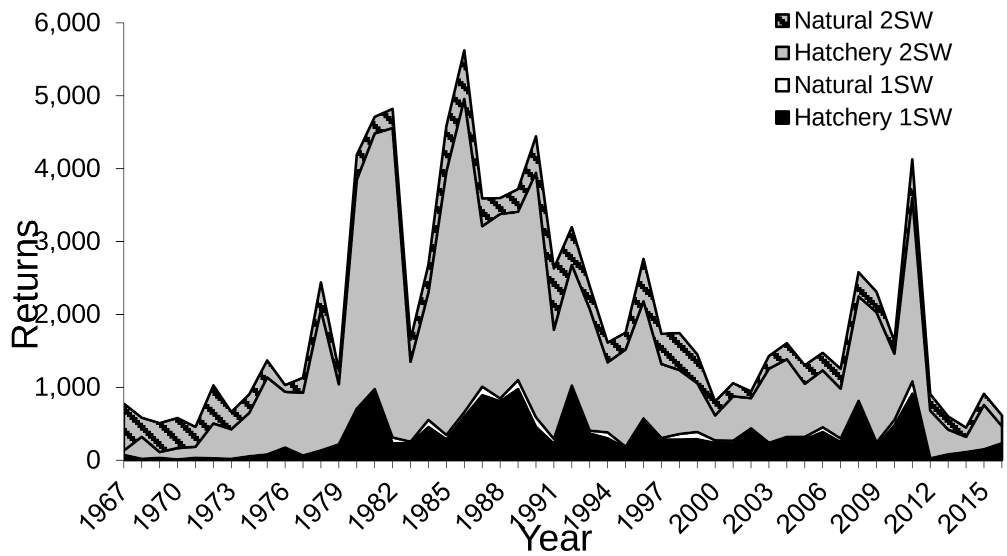


Figure 1.3.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2016.

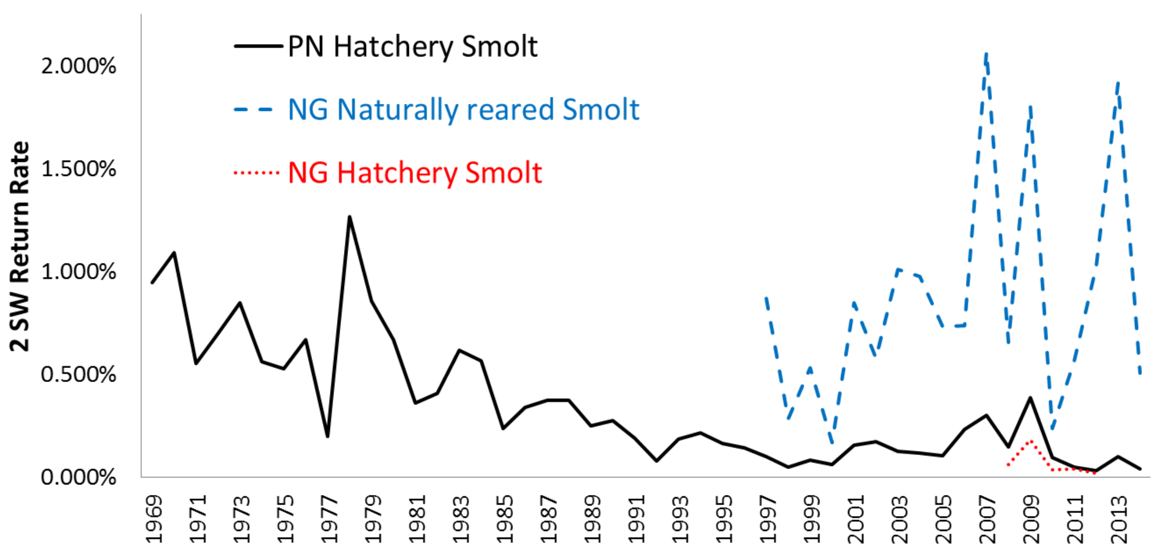


Figure 1.3.3 Return rate of 2SW adults to Gulf of Maine area rivers by smolt cohort year (1969 – 2014) of hatchery-reared Atlantic salmon smolts (Penobscot River solid line) and estimated wild smolt emigration (Narraguagus River blue dashed line), and hatchery-reared salmon smolts (Narraguagus River red dotted line) USA.

References:

Baum, E.T. 1995. Atlantic Salmon Spawner Targets for USA River. Working Paper for the US Atlantic Salmon Assessment Committee.

NOAA (National Oceanic and Atmospheric Administration) (2009) Endangered and threatened species; Designation of Critical Habitat for Atlantic salmon (Salmo salar) in the

Gulf of Maine Distinct Population Segment; Final Rule. Federal Register 74:117 (June 19, 2009):29300–29341. -link

Wright, J., J. Sweka, A. Abbott, and T. Trinko. 2008. GIS-Based Atlantic salmon habitat model. Appendix C of Critical habitat rule for GOM DPS for Atlantic salmon (74 FR 29300). -link

2 Status of Stocks

2.1 Distribution, Biology and Management

Atlantic salmon, *Salmo salar*, is a highly-prized game and food fish with a circumpolar distribution. In North America, the species originally ranged from the Ungava Bay southward to Long Island Sound, encompassing most coastal New England river basins (Figure 2.1.1). Because of human development, most native populations were extirpated (Fay et al. 2006). Salmon life history is complex because fish use both headwater streams and distant marine habitats (Figure 2.1.2). The life cycle for US Atlantic salmon begins with autumn spawning in rivers, 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 in the autumn, they typically develop into smolts, overwinter, and then migrate to the ocean the following 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 (<3%) and becoming rarer 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; 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. Biologists delineated US Atlantic salmon populations into four stock complexes that are managed discretely: (i) **Long Island Sound** complex; (ii) **Central New England** complex; (iii) **Gulf of Maine** distinct population segment (DPS), and (iv) the **Outer Bay of Fundy** designatable unit (Figure 2.1.1).

Restoration Areas. Native stocks in both the **Long Island Sound** and **Central New England** areas were extirpated in the 1800s (Parrish et al. 1998; Fay et. al 2006). Remnant native populations of Atlantic salmon in the US now persist only in Maine. Atlantic salmon stocks from the Penobscot River in Maine were primary donor stocks used to initiate restoration programs in the Connecticut and Pawcatuck rivers (Long Island Sound DPS) and in the Merrimack and Saco rivers (Central New England DPS). The Connecticut River program became independent of stocks from Maine and was able to sustain genetic diversity and facilitate local adaptation (Spidle et. al. 2004). 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 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 (Dennys, East Machias, Machias, Pleasant, Narraguagus), one Penobscot Bay (Penobscot), and one Merrymeeting Bay (Sheepscot) stocks 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 recovery strategy. In addition, these extant stocks represent potential donor populations for other watersheds. While at low levels, natural reproduction still represents a critical part of the management system, and redd surveys both document this contribution and facilitate management of stocked fish to protect naturally-spawned offspring.

Within Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses population structure and status and designates wildlife species are in peril. COSEWIC completed a species-level assessment of Atlantic salmon in eastern Canada in 2010. They 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 and recovery planning in ongoing US watersheds in the **Outer Bay of Fundy** DU 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 US tributaries are part of this DU and the St. Croix River is also in this DU.

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 home water fishery was finally closed in 1948, only 40 fish were harvested.

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 (Baum 1997). The dynamics of Atlantic salmon fishing are 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 but a catch-and-release fishery remained open. In 1999, when low salmon returns threatened sustainability of even hatchery populations, the remaining catch-and-release fishery was closed. In Maine, an experimental Penobscot River autumn (2006 and 2007) and spring (2008) catch-and-release fishery was authorized, but then closed again until populations rebuild. There was a small Atlantic salmon fishery in New Hampshire, where broodstock were reconditioned and released for angling in tributaries to the Merrimack River. There are no longer license sales for the fishery and stocking is no longer a formal program, but more of an opportunistic program. There remains a limited fishery for Atlantic salmon in New Hampshire, excess hatchery broodstock are released for angling in tributaries to the Merrimack River, which historically contained sea-run populations.

According to the Atlantic Salmon Fishery Management Plan (FMP) of the New England Fishery Management Council, the management unit for the 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 FMP covers: "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, Saint Pierre and Miquelon (France), 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.

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. Similar annual regulatory measures were adopted in 2004 and 2005. In 2006, multiannual regulatory measures covering the 2006-2008 fishing seasons were adopted as 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 2015, NASCO's West Greenland Commission adopted a regulatory measure for West Greenland Atlantic salmon fishery. The regulatory measure stated that any harvest above the established quota level would results in a reduction of the quota the following year. However, a quota level could not be agreed to by all Parties of the Commission and in the absence of a mutually-agreed quota, Denmark (in respect of the Faroe Islands and Greenland) unilaterally set a quota of 45 mt for all sectors of the fishery in 2015. This is the first time that a single quota had been applied to all sectors of the fishery for Atlantic salmon in Greenland

The reported landings for the 2015 fishery were approximately 58 mt; an exceedance of 13 mt. Consequently, Denmark (in respect of the Faroe Islands and Greenland) reduced the quota for the 2016 fishery to 32 mt. The 2016 Atlantic salmon fishery occurred from August 15, 2016 through October 31, 2016, but unfortunately official landings statics have not been reported to date. Officially statistics will be reported to the ICES Working Group on North Atlantic Salmon during their annual meeting, March 29 through April 7, 2017.

2.3 Aquaculture

Despite declining natural populations, the Atlantic salmon mariculture industry continues to develop worldwide. In eastern Maine and Maritime Canada, companies typically rear fish to smolt stage in private freshwater facilities, transfer them into anchored net pens or sea cages, feed them, and harvest the fish when they reach market size. In the Northwest Atlantic, 66% of production is based in Canada, with 99.4% of Canadian production in the Maritimes and 0.6% in Newfoundland. The balance (44%) of Northwest Atlantic production is in eastern Maine. US production trends for Maine facilities and areas occupied by marine cages grew exponentially for two decades. By 1998, there were at least 35 freshwater smolt-rearing facilities and 124 marine production facilities in eastern North America. Since the first experimental harvest of Atlantic salmon in 1979 of 6 mt, the mariculture industry in eastern North America has grown to produce greater than 32,000 mt annually since 1997. In Maine, production increased rapidly and peaked at about 16,500 mt in 2000, but abruptly declined to below 6,000 mt in 2005 because of a disease outbreak (infectious salmon anemia) that forced the destruction of large numbers of fish. Production practices also had to change due to a federal judge fining producers for violating the federal Clean Water Act through fouling the sea floor with excess feed, medications, feces, and other pollutants. With improved regulations targeting sustainable best management practices with innovative bay-area management creating fallowing areas, farmers have increased sustainability and production, and production has rebuilt. Maine production in 2010 was over 11,000 mt the 6th highest in the 27-year time series and valued at $73.6M. With one company in production since 2011, confidentiality policies preclude detailed reporting. The Industry projects that with new practices of fallowing production areas and rotations, annual production will vary depending upon areas occupied but should average 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 support commerce while protecting wild stocks and marine habitats.

2.4 Research Vessel Survey Indices

Atlantic salmon in the ocean are pelagic, highly surface–oriented, and of relatively limited abundance within a large expansive area; therefore, they are not typically caught in standard NEFSC bottom trawl surveys or midwater trawls used to calibrate hydroacoustic surveys. However, researchers in Canada and Norway have successfully sampled Atlantic salmon postsmolts using surface trawls. The NEFSC has experimented with these techniques in US waters to learn more about the distribution and ecology of Atlantic salmon in the marine environment. Between 2001 and 2005, NEFSC surface trawls sampled over 4,000 postsmolts, these assessments provided novel information on US salmon postsmolt ecology and status at sea (Sheehan et al. 2011).

2.5 Stock Assessment

Hatchery Inputs

A unique element of Atlantic salmon populations in New England is dependence on hatcheries. Since most US salmon are products of stocking, it is important to understand the background of these inputs to interpret salmon assessment results. US Atlantic salmon hatcheries are run by the US Fish and Wildlife Service and the state of Connecticut. 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. Connecticut hatcheries are restoration and Legacy Program hatcheries that 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 US populations.

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 the US 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 included retained fish from angling in the historical US time-series (pre-1996). 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 most 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 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 1,610. The time-series of data shows the rebuilding of US populations from critically low levels of abundance in the early part of the 20th century (Figure 2.4.2.1). Because many of the populations in Southern New England were extirpated and the Penobscot River was at very low levels, the salmon-returns graph illustrates the sequential rebuilding of the populations through restoration efforts in the 1970s, with increased abundance first in the Penobscot River and then in the Merrimack and Connecticut Rivers. Reductions 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 since 1967. 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 over 3,800 and recovery and restoration appeared within reach. Unfortunately, the trajectory of this recovery did not continue due to an overall reduction in marine survival that impacted most southern North American populations (Chaput et al. 2005). Median annual Atlantic salmon returns to US rivers from 1991 to the present is 1,610 fish, only 42% of the1977-1990 time-series median. There was 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 of lost freshwater productivity was insufficient, so US populations were at low absolute abundance when the period of lower marine survival began.

Returns to US waters in 2016 were only 626 fish, which ranks the 44th lowest in the 50 year time-series. Likewise, relative to the abundance in the current marine phase (1991–present, 26 years), returns were the 24th lowest on record. This is in stark contrast to returns as recent as 2011 that were the highest in the modern period and 7th highest in the 50 year records. Returns the last five years suggest high inter-annual variability in marine survival with some of the widest differences in inter-annual 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.

At the 2017 meeting of the USASAC, updated Conservation Spawning Escapement (CSE) numbers were presented that calculated the CSE in Maine using habitat values modeled by Wright et.al. 2008. Calculation of CSE still uses 2.4 eggs per square meter and an average fecundity of 7,200 eggs to calculate the number of females needed. This number is doubled assuming a 1:1 female to male spawning ratio. This formula is described in a working paper submitted to the ICES Working Group on North Atlantic Salmon in 1995 by E. Baum (Baum 1995). In the 1995 working paper, it was noted that habitat values were incomplete for several drainages and the CSE was likely underestimated. By using the Wright et.al. (2008) habitat model, estimates of Atlantic salmon habitat are available for entire drainages in Maine. These updated values are summarized in Table 2.4.2.1 and Table 2.4.2.2 (drainage values including OBoF within Maine) and are further explained in USASAC Working Paper WP17-03.

With the listing of Atlantic salmon populations in Maine as endangered under the US Endangered Species Act, there was a requirement to designate habitat which is critical for the recovery of the species (Critical Habitat, CH). As a result, not all habitat within a drainage was designated as CH as some tributaries were excluded for economic or geographical reasons (for more detail see the Federal Register 74:117 (June 19, 2009):29300–29341). However, for the sake of determining a CSE for the US, all modeled values are included, including both critical and non-critical habitat. Conservation Spawning Escapement for the US New England rivers are set at 84,655 2SW adults (Table 2.4.2.1). This is an increase from 29,198 2SW salmon as presented by Baum (1995). This increase is due to predicted habitat values in Maine as the Wright et.al. model only considers Maine drainages. If a similar habitat modeling exercise was applied to all of New England, the US CSE would undoubtedly increase the CSE further.

In the USA, using the new CSE estimates, returns are well below conservation spawner requirements. 2016 Returns of 2SW fish from traps, weirs, and estimated returns were only 0.5% of the USA CSE, with returns to the three areas ranging from 0 to 0.6 % of spawner requirements (Table 2.4.2.1). The average percent of the CSE target for the time-series

(1967 – 2016) was less than 2.43% of the CSE. In the last decade, average returns have accounted for 0.4% of this target for the Long Island Sound and 2.2% for the Central New England stock complexes. Salmon returns to the Gulf of Maine DPS have been as high as 5.8% of the CSE during this period during strong return years to the Penobscot River but average only 2.23%. In smaller rivers of the Gulf of Maine stock complex, the CSE ranged from 0 to 6.3%. Out of select rivers the Dennys was the highest at about 6.3% of CSE followed by the Penobscot (1.7%) and the Narraguagus (1.7%) (Table 2.4.2.3).

The Outer Bay of Fundy DU is assessed and reported 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 88% for the Gulf of Maine and 12% for both Central New England and Long Island Sound.

Return rates provide a standard indicator of marine survival. These estimates are calculated by dividing adult returns per numbers of smolts in that cohort and are reported as smolt-to-adult returns (**SAR**) per 10,000 hatchery smolts stocked. Previous assessments have shown that most US and North American SAR track each other over longer time-series. For a comprehensive look at return rates throughout New England see USASAC Report 2015 that completes the Central New England and Long Island Sound SAR smolt time series. Starting with this report only Gulf of Maine rates will be reported (all data are stored in USASAC databases).

Maine SAR provides both an index for naturally produced fish (fry stocked or wild spawned) in the Narraguagus River and for Penobscot River hatchery smolts. The Penobscot time series is the longest (starting in 1969) and least variable in release methods (Figure 2.4.2.3). Starting in 1997, NOAA began a program to estimate production of naturally-reared smolts in the Narraguagus River, Maine. Used in concert with adult assessments, SAR is calculated for this system as well. Penobscot average SAR for the last five years was 2 for 1SW salmon and 6 for 2SW fish. The average 2SW cohort SAR for naturally reared Narraguagus River smolt for the past five years was 85 (14 fold higher than the Penobscot 2SW hatchery cohort average).

In 2016, the SAR for 2SW hatchery smolts released in the Penobscot River was 3.9, ranking 45th in the 46-year record, while the 2016 return rate for 1SW hatchery grilse was 5.6 ranking 22nd in the 47-year record. The 2SW return rate in the Narraguagus River in 2016 was 50.7 (nearly 13-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.

Juvenile Abundance Metrics

In the past, USASAC used databases to develop regional-scale stock assessment products that assessed various life history stages. Examination of these data in further detail for such a long time-series provided insights into program-specific challenges and more general regional trends. These metrics monitored two life stages 1) pre-smolt large parr average densities (# per 100 m^2 habitat units) from 2008 to 2012 and 2) smolt production (1997 – Present). Changes in the overall Connecticut River and Merrimack River programs resulted in many fewer sites being electrofished by state and federal agencies and no smolt monitoring. In the past, these were summarized at regional level and generally showed higher pre-smolt densities in Gulf of Maine DPS (3.7) relative to the Central New England (1.7) and Long Island Sound (1.6) regions. Smolt production estimates were limited in New England, but two longer time-series of data were available and provided a good contrast: the Connecticut River basin-wide estimate and the Narraguagus River smolt assessment (USASAC 2013). With the scaling back of restoration activities and subsequently juvenile assessments no additional annual analyses will be presented for the southern New England areas. As such, juvenile metrics reported are now restricted to the Gulf of Maine DPS and have been updated. All historic data is still achieved in the USASAC databases and is available for research and analyses.

New approaches to monitor pre-smolt production are in progress in the Gulf of Maine. These will be summarized in future reports as the time series extends past 5 years. In brief, 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 decreased 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 that 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.

Natural 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 2.4.3.1). 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.

2.6 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 84,656. The strongest populations in the Gulf of Maine are at less than 0.6% of their target of 61,355 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.

2.7 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 Rivers, 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 1,610 fish, and returns in 2016 were only 626 fish. All stocks are at very low levels; only the Penobscot River population has been near 10% of its conservation spawning escapement and only because of an intensive smolt stocking program. Naturally-reared returns in the Penobscot are proportionally low. Most populations are still dependent on hatchery production and marine survival regimes since have been low, compromising the long-term prospects of even hatchery-supplemented populations. Returns since the 1991 phase shift have been depressed relative to the early stock rebuilding seen in the 50-year time series. The last 10 years can best be characterized as the most variable since the regime shift of 1991. Returns in 2011 exceeded the median by over 2,500 fish and returns in 2014 fell 1,100 fish below the median; these extremes represent the 26-year high and low return rates. Despite low but variable 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 2.4.2.1. Most current two-sea winter (2SW) conservation spawning escapement requirements for US river populations and 2SW returns (with % of CSE).

Area		Spawner Requirement	2SW returns 2016	Percentage of Requirement
Long Island Sound	LIS	17,785	5	0.0%
Central New England	CNE	5,516	6	0.1%
Gulf of Maine	GOM	61,355	378	0.6%
Total		84,656	389	0.5%

Table 2.4.2.2 Conservation Limits of Atlantic salmon in New England USA. Adults calculated on 7,200 egg fecundity and 1:1 M to F ratio. A unit of habitat = 100 m^2

Map Index #	DPS or SHRU	State	River	Habitat Units	Hectares	Eggs at 240 / unit	CL Number of Adults
1	OBoF	**Maine**	Aroostook	60,775	607.8	14,586,000	4,052
7	OBoF	**Maine**	Meduxnekeag	5,000	50.0	1,200,000	333
7	OBoF	**Maine**	Prestile	835	8.4	200,400	56
9	OBoF	**Maine**	St. Croix	29,260	292.6	7,022,400	1,951
11	OBoF	**Maine**	Boyden Stream	85	0.9	20,400	6
12	OBoF	**Maine**	Pennamaquan	85	0.9	20,400	6
13	DEC	**Maine**	Dennys	2,166	21.7	519,943	144
15	DEC	**Maine**	Hobart Stream	412	4.1	98,978	27
16	DEC	**Maine**	East Stream	337	3.4	80,880	22
16	DEC	**Maine**	Orange	321	3.2	77,146	21
17	DEC	**Maine**	East Machias	6,666	66.7	1,599,744	444
18	DEC	**Maine**	Machias	15,668	156.7	3,760,250	1,045
21	DEC	**Maine**	Chandler	1,212	12.1	290,976	81
22	DEC	**Maine**	Indian	445	4.4	106,730	30
23	DEC	**Maine**	Harrington	341	3.4	81,840	23
23	DEC	**Maine**	Pleasant	2,586	25.9	620,633	172
24	DEC	**Maine**	Narraguagus	7,174	71.7	1,721,820	478
26	DEC	**Maine**	Tunk Stream	1,029	10.3	246,919	69
26	DEC	**Maine**	Whitten Parritt	121	1.2	29,155	8
27	DEC	**Maine**	Patten Stream	972	9.7	233,198	65
27	DEC	**Maine**	Union	14,149	141.5	3,395,758	943
29	PEN	**Maine**	Orland River	1,775	17.7	425,885	118
30	PEN	**Maine**	Penobscot (Critical Hab.)	255,266	2,552.7	61,263,862	17,018
30	PEN.	**Maine**	Penobscot (Not Critical Hab)	152,772	1,527.7	36,665,388	10,185
60	PEN	**Maine**	Passagassawakeag	1,041	10.4	249,914	69
62	PEN	**Maine**	Ducktrap	996	10.0	238,949	66
63	MMB	**Maine**	St. George	7,132	71.3	1,711,726	475
64	MMB	**Maine**	Medomak	2,443	24.4	586,210	163
65	MMB	**Maine**	Pemaquid River	525	5.2	125,916	35
66	MMB	**Maine**	Sheepscot River	7,101	71.0	710,100	473
68	MMB	**Maine**	Kennebec (Critical Hab.)	91,240	912.4	21,897,600	6,083
68	MMB	**Maine**	Kennebec (Non-Critical Hab.)	230,454	2,304.5	55,308,905	15,364
78	MMB	**Maine**	Androscoggin (Critical Hab.)	16,757	167.6	4,021,620	1,117
78	MMB.	**Maine**	Androscoggin (Non-Critical Hab.	99,226	992.3	23,814,334	6,615
83	CNE	**Maine**	Royal River	420	4.2	100,800	28
84	CNE	**Maine**	Presumpscot	85	0.9	20,400	6
87	CNE	**Maine**	Saco River	25,080	250.8	6,019,200	1,672
96	CNE	**Maine**	Kennebunk	85	0.9	20,400	6
100	CNE	**New Hampshire**	Merrimack	57,065	570.7	13,695,600	3,804
136	LIS	**Rhode island**	Pawcatuck	5,370	53.7	1,288,800	358
142	LIS	**Connecticut**	Connecticuit	261,400	2,614.0	62,736,000	17,427
			Grand Totals	**1,365,872**	**13,659**	**326,815,178**	**91,058**
			MMB SHRU only include CH	355,651	3,557	84,362,076	23,710
			PEN SHRU only include CH	259,078	2,591	62,178,610	17,272
			DEC SHRU	53,600	536	12,863,971	3,573
			GoM DPS only include CH	**668,328**	**6,683**	**159,404,657**	**44,555**
			Pen. = Not CH	152,772	1,528	36,665,388	10,185
			MMB. = Not CH	99,226	992	23,814,334	6,615
		Maine	**Total includes all Maine rivers**	**1,042,037**	**10,420**	**249,094,778**	**69,469**
			OBoF	96,040	960	23,049,600	6,403
			CNE	82,735	827	19,856,400	5,516
			LIS	266,770	2,668	64,024,800	17,785
			GoM	920,327	9,203	219,884,378	61,355

Table 2.4.2.3 Selection of US Rivers 2016 2SW Returns in relation to 2SW Conservation Limits.

Name	Longitude	Latitude	CL	Returns	% of CL Met
Connecticut	-72.374	41.593	17,427	5	0.03%
Dennys	-67.228	44.868	144	9	6.25%
Merrimack	-71.036	42.837	3,804	4	0.11%
Narraguagus	-67.783	44.654	478	8	1.67%
Pawcatuck	-71.133	41.937	358	0	0.00%
Penobscot	-68.82	44.769	17,018	285	1.67%
Pleasant	-67.5781	44.722	172	0	0.00%
Union	-68.474	44.643	943	0	0.00%

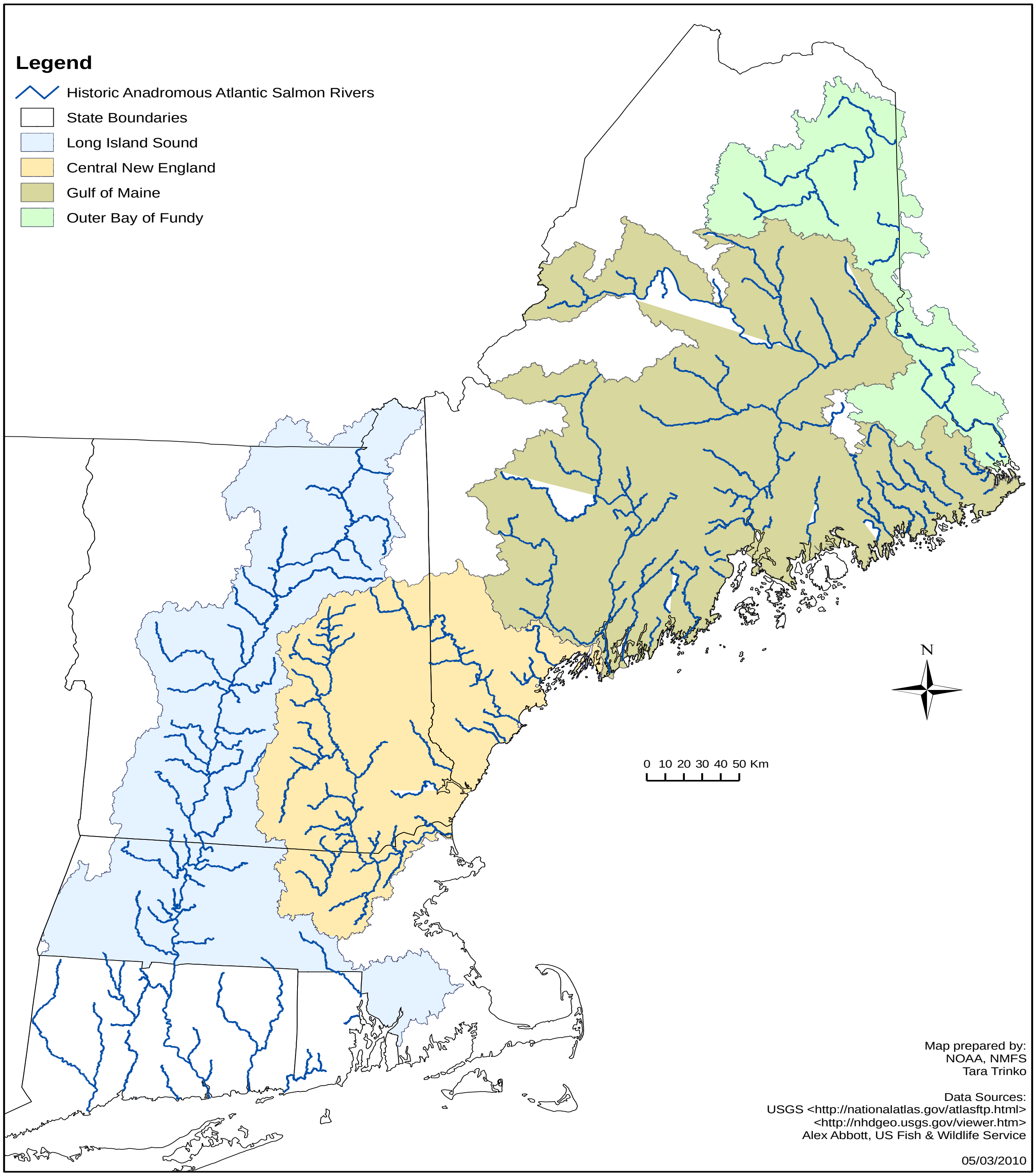


Figure 2.1.1 Map of New England Atlantic salmon management area by region from north to south: outer Bay of Fundy (OBF), Gulf of Maine DPS (GoM), central New England (CNE), and Long Island Sound (LIS) regions.

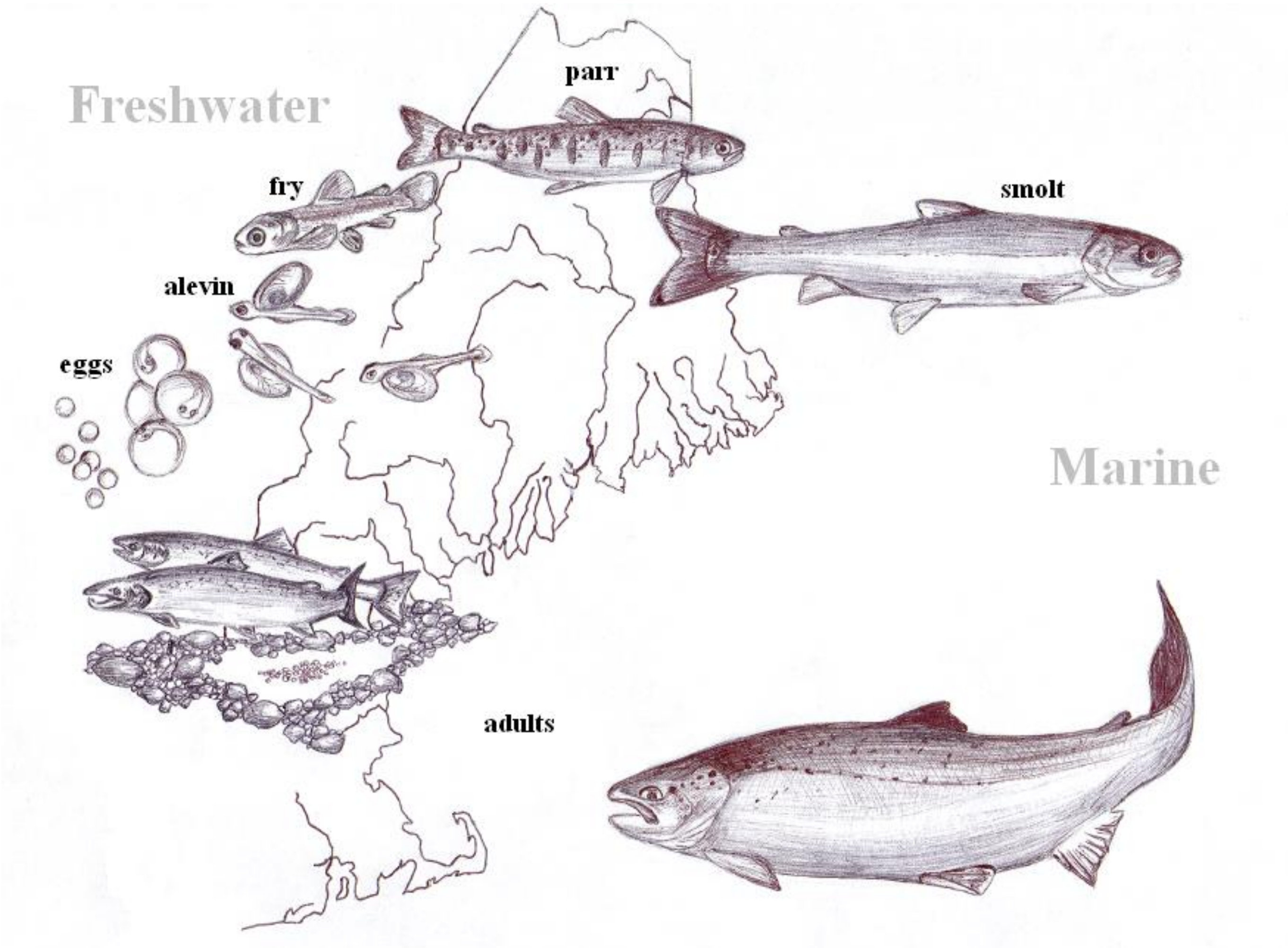


Figure 2.1.2 Life cycle of US Atlantic salmon illustrating marine and freshwater stages (Artwork by Katrina Mueller).

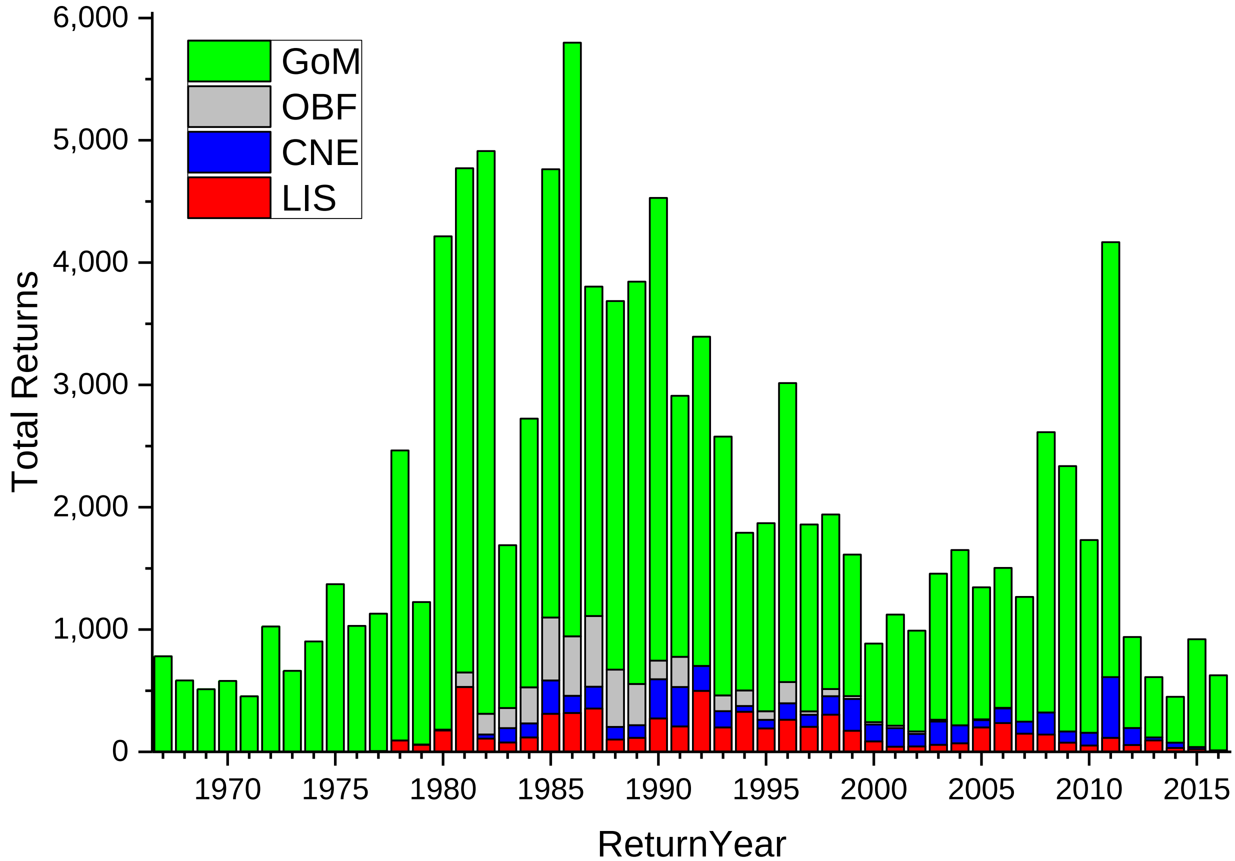


Figure 2.4.2.1 Time series of estimated total returns to New England from USASAC databases for outer Bay of Fundy (OBF) Designatable Unit, Gulf of Maine (GoM) Distinct Population Segment, central New England complex (CNE), and Long Island Sound (LIS) complex from 1967 to present year.

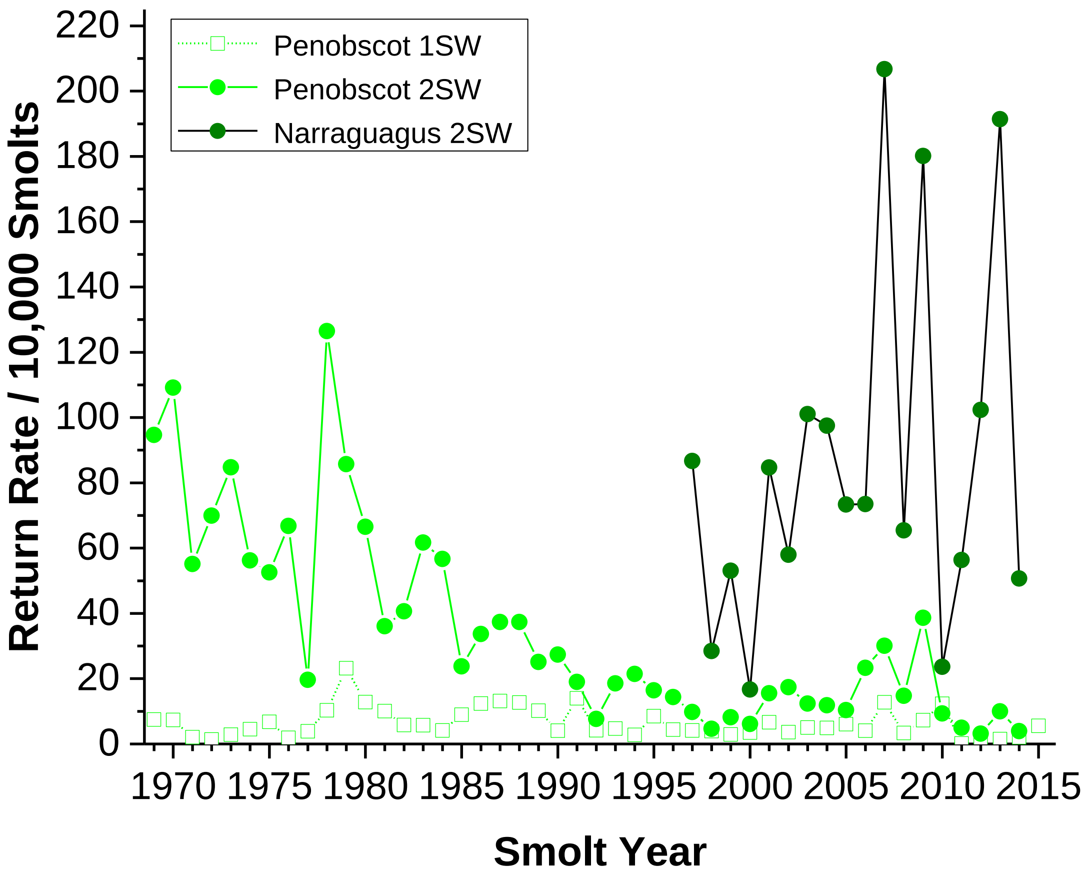


Figure 2.4.2.3 Return rates of Atlantic salmon per 10,000 smolts from the Narraguagus and Penobscot populations estimated from numbers of stocked smolts for the Penobscot and from estimated smolt emigration from the Narraguagus River population.

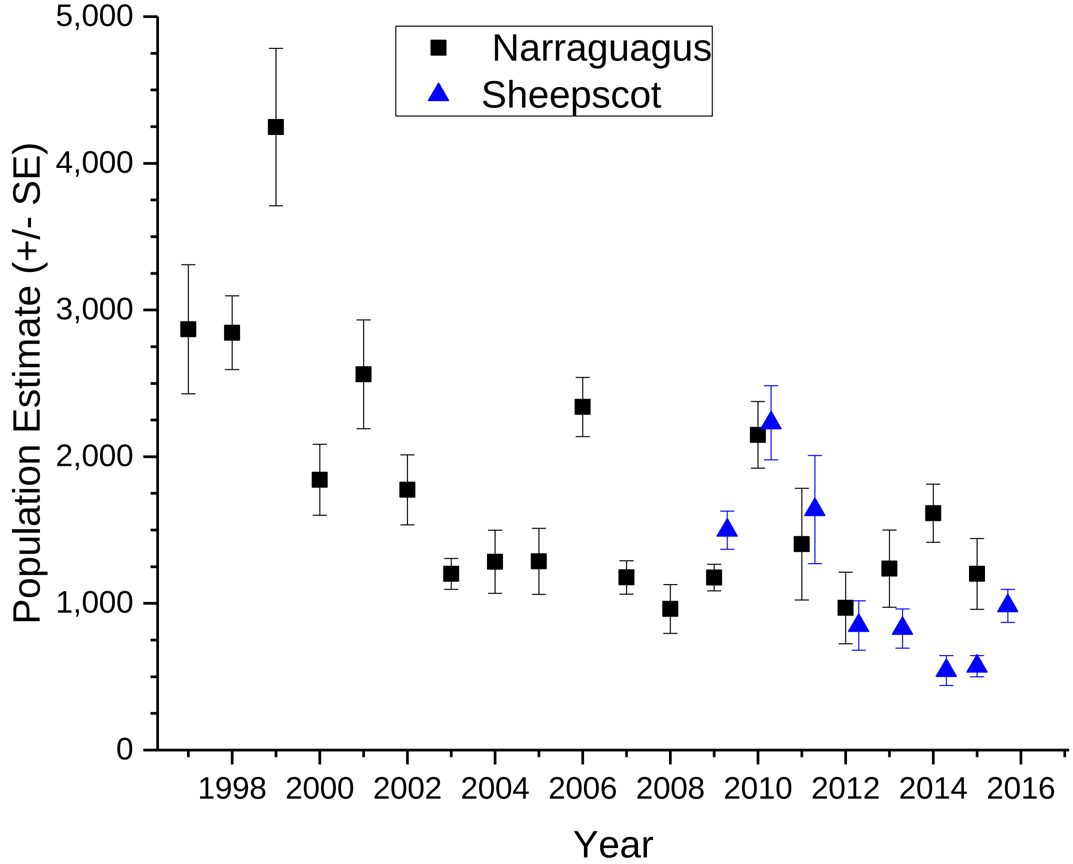


Figure 2.4.3.1 Mark-recapture population estimates of numbers of Atlantic salmon smolts emigrating from the Narraguagus and Sheepscot Rivers, Maine. See text for details of estimation methods.

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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 2016. The following is a summary of work on Atlantic salmon.

3.1.1 Adult Returns

A total of 5 sea-run Atlantic salmon adults were observed returning to the Connecticut River watershed: 3 on the Connecticut River mainstem, one in the Salmon River, and one in the Westfield River. No sea-run salmon were retained for broodstock at any facility. Three salmon trapped at the Holyoke Fishlift were trucked to the Conte Lab for experimental trials prior to release (see section 3.1.7). One salmon captured at West Springfield Fishway (Westfield River) was transported by truck to suitable upstream habitat. One salmon netted in the Salmon River at a cold spring downstream of the Leesville Dam was transported and released in a deep pool above the dam. All salmon were given a Floy-tag.

None of the adult salmon were of hatchery (smolt-stocked) origin. All were of ‘wild’ (fry-stocked) origin. Only the fish from the Westfield River was scale-sampled and it was determine to be a W2:2. All other fish were multi-sea winter fish and assumed for the purposes of the database to be W2:2 because all past wild sea returns from the Connecticut River have been greatly dominated by 2:2 fish.

3.1.2 Hatchery Operations

Egg Collection
A total of 535,198 green eggs were produced in 2016. Only the Kensington State Fish Hatchery (KSFH) in CT maintained domestic broodstock. Contributing broodstock included 80 females and 78 males, all 3+ year-old. Those eggs will be used for fry stocking for the Connecticut Legacy Program including the Salmon in Schools program.

Stocking

Juvenile Atlantic Salmon Releases

A total of 64,003 juvenile Atlantic salmon was stocked into the Connecticut River watershed in 2016, all in Connecticut. Selected stream reaches in the Farmington River received 41,307 fry and selected reaches in the Salmon River received 22,696 fry with the assistance of many volunteers. Totals of 29,362 fed fry and 34,641 unfed fry were stocked into these tributary systems. These numbers were much lower than the approximately 391,000 fry stocked in 2015 because of extremely poor eye-up rates from the fall 2015 egg take at KSFH due to a non-functioning chiller. Stocking was conducted out of KSFH and Tripp Streamside Incubation Facility (TSIF). Eggs were transferred from KSFH to TSIF as eyed eggs. In addition, an estimated 13,600 fry were stocked in various approved locations within the Salmon and Farmington rivers by schools participating in the Salmon in Schools programs, in which they incubate eggs for educational purposes and stock surviving fry.

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.

3.1.3 Juvenile Population Status

Smolt Monitoring

No smolt migration monitoring was conducted anywhere in the basin in 2015. Smolt counts were made at the viewing window at the Rainbow Dam Fishway (Farmington River) but since the number of fish that passed down the fishway is an unknown percentage of the total fish descending the river and passing the dam by other routes, these data have limited value.

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 specific for salmon were not conducted in other states in 2016. However, routine electrofishing surveys documented

3+ year old parr in the Westfield River drainage (MA) originating from the last fry stocking in 2013.

3.1.4 Fish Passage

Hydropower Relicensing- The licenses of five large hydropower projects (four main stem dams) will expire in 2018. State and Federal resource agencies have spent considerable time on FERC-related processes for these re-licensings, including requesting numerous fish population, habitat, and fish passage studies. Due to the termination of the salmon restoration program, none of these requested studies involved Atlantic salmon. Many improvements to upstream and downstream fish passage are expected to result from the conditions placed on the new licenses but by the time they are implemented, very few salmon are expected to access that portion of the basin.

Fish Passage Monitoring- Salmonsoft® computer software was again used with lighting and video cameras to monitor passage at Turners Falls, Vernon, Bellows Falls, Wilder, Rainbow and Moulson Pond 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 – No new fishways were constructed in 2016.

Dam Removals- One dam was removed in the portion of the watershed stocked by the Legacy Program: the Norton Mill Dam (Jeremy River/Salmon River watershed). This project sponsored by The Nature Conservancy, opened 17 miles of high quality habitat including areas stocked with salmon fry as part of both the Legacy Program and the Salmon-in-School Program.

Planning continued on the removal of the Blackledge River Dam (Blackledge River/Salmon River watershed), which will also benefit salmon as part of the Legacy Program.

Two additional dams in the watershed were removed in Vermont but the affected habitat is no longer stocked with salmon.

Culvert Fish Passage Projects- There were many undertaken in the Basin but not of them will benefit Atlantic Salmon and therefore will not be listed here.

3.1.5 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.

3.1.6 General Program Information

The use of salmon egg incubators in schools as a tool to teach about salmon continued in Connecticut. The Connecticut River Salmon Association, in cooperation with CTDEEP, maintained its Salmon-in-Schools program, providing 16,400 eggs for 82 tanks in 61 schools in Connecticut.

Long-time manager of the KSFH, Al Sonski, retired from the CT DEEP after 35 years of state service.

Dr. Ted Castro-Santos (USGS) performed tests as part of the second year of a study on the sprinting performance and kinematics of adult Atlantic salmon at the Silvio Conte Anadromous Fish Research Center in Turners Falls, MA. Three salmon captured at Holyoke were taken to the lab and introduced into a test burst flume at the lab. After testing, and within two to seven days of capture, the fish were released back into the Connecticut River below the Turners Falls dam to resume their migration.

3.1.7 Migratory Fish Habitat Enhancement and Conservation There were many stream restoration projects in 2016 throughout the basin in 2016 but since most of them no longer impact Atlantic salmon habitat, they will not be listed here.

3.2 Long Island Sound: Pawcatuck River

The U.S. Fish and Wildlife Service no longer formally supports the effort to restore Atlantic Salmon to the Pawcatuck River watershed. Although a small portion of the watershed lies in Connecticut, all activities involving Atlantic Salmon have been conducted solely by Rhode Island Department of Environmental Management (RIDEM) within the state of Rhode Island. RIDEM still continues minimal efforts with salmon, mostly for public outreach purposes. Few details are available from RIDEM. The following is a summary of available information.

3.2.1 Adult Returns

No adult salmon were known to have returned to the river in 2016.

3.2.2 Hatchery Operations

Egg Collection

It is unclear if any state hatchery in Rhode Island is culturing Atlantic salmon or if any eggs were obtained from federal hatcheries.

Juvenile Atlantic salmon Releases

A total of 1,200 Atlantic salmon smolts were stocked into the watershed in 2016. It is not known where these fish were reared. A total of 7,000 fry was stocked into the watershed in 2016. It is possible that these fish were all stocked by schools participating in a salmon in the classroom program.

3.2.3 Juvenile Population Status

No information is available.

3.2.4 Fish Passage

<u>New Fishways</u> – No new fishways were constructed in 2016. Improvements to the Potter Hill Dam fishway, first on the river, are being planned.

<u>Dam Removals</u>- One dam (White Rock) was removed by The Nature Conservancy in 2015 and 2016 was the first year diadromous fish would have benefited from that removal. It

was a partially breached dam downstream of Potter Hill Dam. The removal of the third dam, Bradford Dam, is being planned for the future.

3.2.5 Genetics

No information is available.

3.2.6 General Program Information

No information is available.

3.2.7 Migratory Fish Habitat Enhancement and Conservation

No information is available.

4 Central New England

4.1 Central New England: Merrimack River

4.1.1 Adult Returns

Five (5) Atlantic salmon were counted in the Merrimack River at the Essex Dam, Lawrence, MA. Unlike past years, no salmon were transported to the Nashua National Fish Hatchery (NNFH), NH. Instead all fish were allowed to run the river. Five (5) 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. The fish could have been domestics stocking in the river or may have been sea-run fish. No morphometric data was collected, so all size and age estimations are based on stocking history and previous year's returns.

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 2016, 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 945,898 green eggs.

Sea-Run Broodstock

No sea-run fish were retained for broodstock.

Domestic Broodstock

A total of 363 female (F1 from sea-runs) broodstock spawned at Nashua NFH. Of the 363 females, 23 were two years old, and 340 were three years old. The captive broodstock spawning season began on November 9, 2016 and ended December 12, 2016, and included 10 spawning events to reach target egg production.

Stocking
Juvenile stocking is limited to educational salmon in schools program at about 3,985 eggs provided to schools to rear and release in the Merrimack River watershed. We report those eggs are stocked at fry with zero loss.

4.1.3 Juvenile population Status

Yearling Fry / Parr Assessment
In 2016, 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.

Fish have continued to be stocked that have restoration value. These include excess 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 directed stocking of Adult Atlantic salmon for their broodstock fishery in the spring of 2014. Additional adult fish were stocked in April, 2016; NHFG released 687 2+ and 3+ fish into the Merrimack.

Adopt-A-Salmon Family

The 2016 school year marked the twenty-fourth year of the Adopt-A-Salmon Family Program in central New England. In January and February, an estimated 3,985 salmon eggs were distributed from the NNFH to about 14 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.

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 Partners 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 1 May to 31 October, 2016. Two Atlantic salmon were observed moving upriver through these facilities. Only visual observations are recorded at Cataract, as the fish are never handled. No Atlantic salmon was captured at a third passage facility upriver at Skelton Dam, which operated from 8 May to 31 October, 2016. A total of two Atlantic salmon returned to the Saco River for the 2016 trapping season. However, the count could exceed two due to the possibility of adults ascending Cataract without passing through one of the counting facilities.

4.2.2 Hatchery Operations

Egg Collection

In 2016, 522,152 eyed eggs from Merrimack River origin broodstock were transferred from the Nashua National Fish Hatchery to the Saco Salmon Restoration Alliance. A portion of these were distributed to school programs (Fish Friends) and the remaining reared at the hatchery for release as fry.

4.2.3 Stocking

Juvenile Atlantic salmon Releases

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 371,000 fry, reared at the Saco Salmon Restoration Alliance, were released into one mainstem reach and 31 tributaries of the Saco River. In 2016 ME-DMR and the Saco Salmon Restoration Alliance planted 34,818 eyed-eggs in two tributaries to the Saco River.

Adult Salmon Releases

No adult Atlantic salmon were stocked into the Saco River.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

ME-DMR conducted five electrofishing surveys in the Saco River watershed in 2016. All five sites were directed at assessing juvenile Atlantic salmon production from the egg planting efforts conducted in the Saco River.

Smolt Monitoring

There was no smolt monitoring in 2016

Tagging
No salmon outplanted into the Saco were tagged or marked in 2016.

4.2.5 Fish Passage
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4.2.6 Genetics
No genetic samples were collected in 2016.

4.2.7 General Program Information
The US Fish and Wildlife Service and the Maine Department of Marine Resources continue to work with the Saco Salmon Restoration Alliance to adaptively manage Atlantic salmon in the Saco River.

4.2.8 Migratory Fish Habitat Enhancement and Conservation
No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2016**.**

5 Gulf of Maine

5.1 Adult Returns

A more detailed discussion of the following is provided in Working paper WP-2017- 01. Documented adult Atlantic salmon returns to rivers in the geographic area of the Gulf of Maine DPS (73 FR 51415-51436) in 2016 were 614. Returns are the sum of counts at fishways and weirs (552) and estimates from redd surveys (62). 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 marginal for adult dispersal throughout the rivers due to below normal discharge throughout much of Maine, and redd surveys were limited in some drainages.

Escapement to these same rivers in 2016 was 320; (213 Penobscot [507 returns – (291 broodstock + 3 DOA)] + 39 Kennebec + 6 Androscoggin + 62 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).

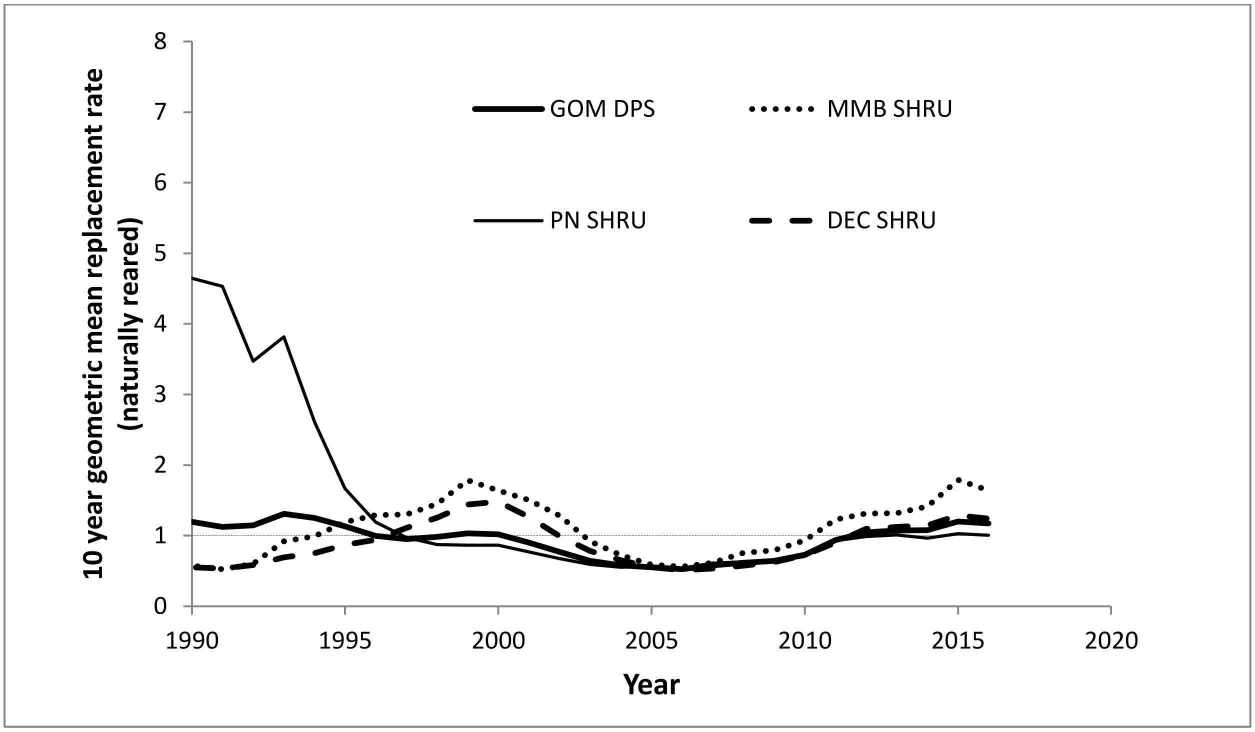

Figure 5.1.1. Ten year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and the three Salmon Habitat Recovery Units (SHRU).

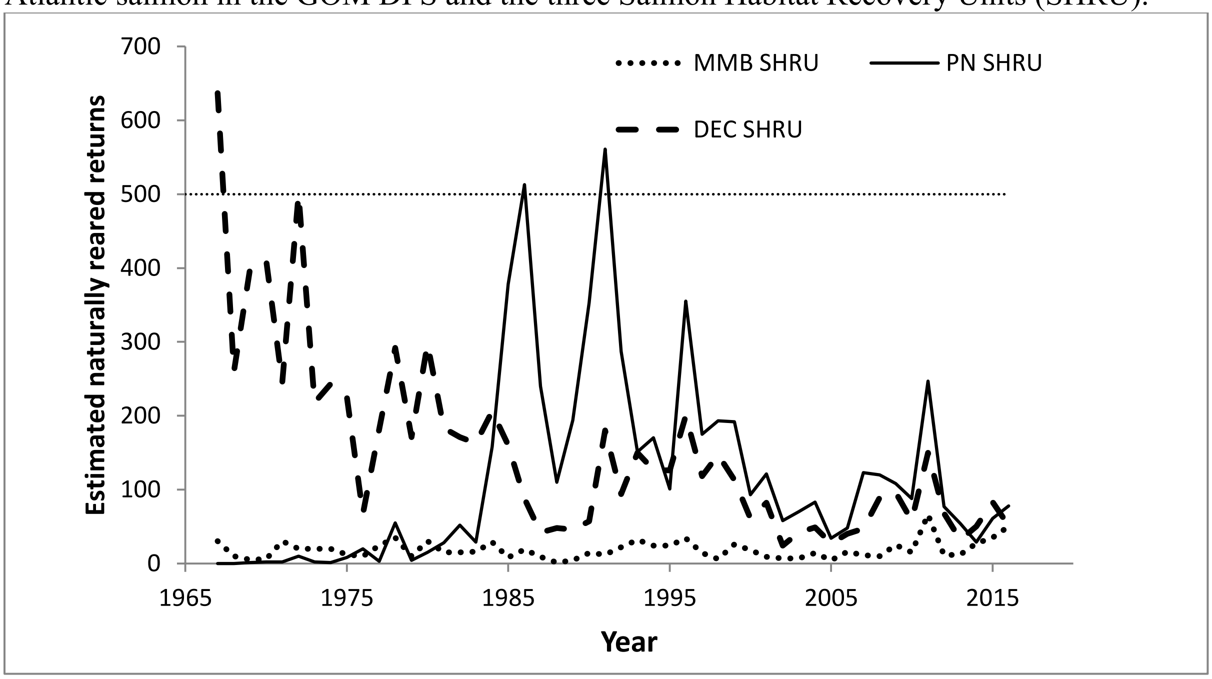

Figure 5.1.2 Estimated Naturally Reared Returns to the GOM

5.2 Small Coastal Rivers

Downeast Coastal SHRU

Dennys River
There were 6 redds surveyed in the Dennys River in 2016. Coverage was limited to only 85.2% of available habitat. Two aquaculture suspect salmon were captured in the Dennys in late September. MEDMR received notification of possible aquaculture adult salmon in the Dennys. Staff were able to observe around 100 salmon in pools and runs in reaches adjacent to tidewater. Staff deployed a trap net overnight and were able to collect two salmon that were determined in the field to be aquaculture in origin. Both fish were euthanized and a full work up including disease assay and tissue analysis was completed. Tissues sent both to the USFWS's genetic lab in Lamar, PA and the private aquaculture company confirmed both fish were escaped from a commercial site in Cobscook Bay. A hole was discovered at the site the fish originated from that had resulted from a predator strike.

East Machias River
Twelve (12) redds were counted during the 2016 redd surveys in the East Machias River that included approximately 98% of known spawning habitat. This was the first cohort of adult to return from fall parr outplanted as part of the Downeast Salmon Federation's project to raise and release fall parr. There were 53,215 parr associated with the adult cohort.

Machias River
A total of 14 redds were counted, covering only 58.9% of the known spawning habitat in the Machias drainage. Coverage was limited due to below average flows throughout the fall. Some surveys were done on foot high grading habitat based on stream survey data.

This year all of redds surveyed were observed in the mainstem reaches of the Machias River. Access was limited to tributary streams due to low flow. MEDMR personnel documented redds in locations where they had not been observed prior to this year, possibly due to normally higher water preventing salmon from using those shoals.

Pleasant River
There were no redds documented in the Pleasant River in 2016. Low flows and an abundance of beaver dams possibly prevented any upstream movement. Ironically, when flows were restored, the amount of precipitation was such that it made it impossible to see the river bottom in the lower reaches. A total of 45.9% of the habitat was surveyed in the Pleasant River.

Narraguagus River
Returns to the fishway trap in 2016 (3) were the same as 2015 (3) 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. However, this was a well below normal flow year with the Narraguagus setting new low flow levels. It is highly unlikely any salmon ascended the dam spill way. Of the three returns, all were two sea-winter (2SW) adults. Four (4) redds were observed in the mainstem of the Narraguagus River confirming that it was unlikely any salmon ascended the spillway. Spawner surveys covered 87.7% of known spawning habitat.

Union River
The fish trap at Ellsworth Dam on the Union River is operated by the dam owners, Brookfield Renewable Energy Group, under protocols established by the DMR. The trap was operated from 1 May to 31 October 2016. No salmon were captured during this period.

Penobscot SHRU

Ducktrap River
There were no redds observed during surveys in late November that encompassed 71.2% of the spawning habitat area in the Ducktrap River watershed.

Cove Brook
100% of spawning habitat in Cove Brook was surveyed. Zero redds were observed.

Merrymeeting Bay SHRU

Sheepscot River
There were 4 total redds observed in the Sheepscot River in 2016, all of which were in the mainstem. Only 52.2% of known spawning habitat was surveyed. The number of redds observed was a decrease from previous years.

Sandy River (Kennebec Drainage)
The Sandy River is a tributary to the Kennebec River. In 2016, 52% of known spawning habitat was surveyed and 33 redds were observed. Origin of the redds observed in the Sandy River are likely from adult salmon trapped at the Lockwood fish lift (39) that were transported and placed in the Sandy River. All adults returning to the Kennebec River are likely from the Sandy since only the Sandy is where fish are placed. The Sandy is also where eyed eggs have been planted since 2006.

5.3 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 118 (95% CI = 83 - 161) (Table 5.3.1). Estimates include returns to the Union River.

Table 5.3.1 Regression estimates and confidence intervals (90% CI) of adult Atlantic salmon in the small coastal GOM DPS rivers from 1991 to 2016. 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	65	95	133
2015	83	118	161
2016	26	62	156

5.4 Large Rivers

Penobscot River

The fish lift at the Milford Hydro-Project owned by Brookfield Renewable Energy Group was operated daily by MDMR staff from 15 April through 15 November, 2016. The fish lift was also used to collect adult sea-run Atlantic salmon broodstock for the U.S. Fish and Wildlife Service (USFWS).

A total of 507 sea-run Atlantic salmon were captured during the 2016 season (Table 5.4.1). Scale samples were collected from 387 salmon captured at the Milford fish lift and analyzed to characterize the age and origin structure of the run. The origins of the remaining Atlantic salmon not scale sampled were prorated based on the observed proportions, taking into account the presence of tags or marks observed and dorsal fin deformity. The majority of returning salmon were age 2SW (286; 56%), along with 218 1SW salmon (43%), two (2) 3SW fish, and one (1) repeat spawners. Approximately 85% (4300) of the salmon that returned were of hatchery origin and the remaining 15% (77) were of wild or naturally reared origin. One aquaculture suspect salmon was captured and removed from the river.

Additional data collected at the Milford fish lift included counts of species other than Atlantic salmon present during each tending day. River herring (*Alosa spp.),* American shad (*Alosa sapidissima*), smallmouth bass (*Micropterus dolomieu*), and sea lamprey (*Petromyzon marinus*) were the most abundant species observed in 2016. It is worth noting two alosine species that have made significant recoveries. There were 1,349,722 river herring counted at Milford. Additionally, there were 7,870 American shad. While river herring have been stocked throughout the Penobscot shad have not.

Androscoggin River

The Brunswick fishway trap was operated from 15 April to 31 October, 2016 (Table 5.4.1). Six adult Atlantic salmon were captured at the Brunswick fishway trap. Biological data was collected from all returning Atlantic salmon in accordance with MDMR protocols, and the presence of marks and tags observed were recorded.

Table 5.4.1. Counts of sea-run, Atlantic salmon returns to Maine rivers in 2015 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.

				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	01 Sep	02 Sep	02 Sep	0	0	0	0	0	0	0	0	0	0	0	2	0
Narraguagus River	30 Apr	21 Jun	27 Oct	0	1	0	0	0	2	0	0	0	0	3	0	0
Union River	01 May	--	31 Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
Penobscot Bay SHRU																
Penobscot River	15 Apr	19 Jun	15 Nov	217	107	1	0	1	172	1	1	0	7	507	1	0
Merrymeeting Bay SHRU																
Lower Kennebec River	01 May	10 Jun	31 Oct	1	14	0	0	0	24	0	0	0	0	39	0	0
Lower Androscoggin R.	15 Apr	31 May	31 Oct	0	1	0	0	0	3	0	0	0	2	6	0	0
Sebasticook River	25 Apr	--	18 Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
Outside the Gulf of Maine DPS																
Aroostook River	27 Jun	28 Aug	08 Nov	0	1	0	0	5	1	0	0	0	0	7	0	0
Saco River	01 May	13 Jun	31 Oct	0	0	0	0	0	0	0	0	0	2	2	0	0
St. Croix River	14 Apr	--	11 Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				218	124	1	0	6	202	1	1	0	11	564	3	0

Kennebec River
The Lockwood fish lift was operated by Brookfield staff from 1 May to 31 October, 2016 (Table 5.4.1). Thirty-nine adult Atlantic salmon were captured at the Lockwood fish lift facility in 2016. Biological data was collected from all returning Atlantic salmon in accordance with MDMR protocols, and the presence of marks and tags observed were recorded. Of the thirty-none returning Atlantic salmon, thirty-eight were 2SW and one was a grilse (1SW) (Table 5.4.1). All salmon were naturally reared in origin. All 39 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 25 April to 18 July, 2016. No Atlantic salmon were captured at the Benton Fall fish lift in 2016 (Table 5.4.1).

5.5 Survival Estimates
Atlantic salmon survival rates were calculated for marked hatchery stocks and naturally reared stocks for the Narraguagus and Penobscot Rivers (Table 5.5.1). 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 (0.957%). Penobscot SAR rates of hatchery smolt are slightly higher, (0.158%) compared to the Narraguagus hatchery smolts (0.066%) but not significant ($p > 0.05$).

Table 5.5.1. Summary table of Atlantic salmon survival rates from the Penobscot and Narraguagus Rivers. All rates for stocked origin stocks were based on marked groups. Data represent only 2 sea-winter adult returns. Therefore, in some cases some 3 sea-winter adults may still be at large. There were no smolts stocked in the Narraguagus for the 2013 cohort year.

Cohort Year	Origin of Smolt Number	Number of Smolts	Number of Survivors	% Survival
Narraguagus River Naturally Reared SAR				
2008	Estimate	962	8	0.654%
2009	Estimate	1,176	25	1.801%
2010	Estimate	2,149	25	0.237%
2011	Estimate	1,404	14	0.563%
2012	Estimate	969	6	1.023%
2013	Estimate	1,237	22	1.914%
2014	Estimate	1,615	8	0.507%
			Mean	**0.957%**
Narraguagus River Hatchery Reared SAR				
2008	Stocked	54,100	33	0.061%
2009	Stocked	52,800	96	0.182%
2010	Stocked	62,400	21	0.034%
2011	Stocked	64,000	25	0.039%
2012	Stocked	59,100	10	0.017%
			Mean	**0.066%**
Penobscot River Hatchery Reared SAR				

2008	Stocked	554,600	1,007	0.182%
2009	Stocked	561,100	2,583	0.460%
2010	Stocked	567,100	1,230	0.217%
2011	Stocked	554,000	283	0.051%
2012	Stocked	555,200	237	0.043%
2013	Stocked	553,000	631	0.114%
2014	Stocked	557,700	218	0.039%
			Mean	**0.158%**

5.6 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 3,945,000 eggs for the Maine program in 2016: 885,000 eggs from Penobscot sea-run broodstock; 1,530,000 eggs from Penobscot domestic broodstock population; 1,530,000 eggs from six captive broodstock populations.

Spawning protocols for domestic and captive broodstock at CBNFH and GLNFH give priority to first time spawners and utilize 1:1 paired matings. Spawning protocols for Penobscot sea run broodstock also utilize 1:1 paired matings. In 2016 CBNFH used year-class crosses as well as spawning optimization software to avoid spawning closely related individuals within captive broodstock populations.

A total of 134 Penobscot sea-run origin females and 552 captive females were spawned at CBNFH between October 31st and November 17th. Eggs produced at CBNFH are used for in-stream egg planting, fry stocking, age 0+ parr stocking and educational programs. Additionally, Penobscot sea-run eggs and Narraguagus captive eggs produced at CBNFH are transferred to GLNFH for parr and smolt production.

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. Above-optimal water temperatures during early egg development affect egg survival, embryonic deformities and fry survival. CBNFH uses a photoperiod treatment to re-set the biological clock in the sea-run broodstock, delaying the onset of spawning into early November, using artificial light. Filtered ambient light is still available; extra light is administered via overhead lighting using a predetermined schedule and time clocks. The 2016 treatment extended the light available during the summer solstice [June 21] for ten days which allowed eggs to be collected in favorable water temperatures.

At GLNFH, 635 Penobscot-origin domestic females were spawned to provide eggs for in-stream egg planting, to supplement smolt production, domestic brood production and educational programs.

Egg Transfers

CBNFH eyed-egg transfers from the 2015 spawn year included: 930K Penobscot eggs to GLNFH; 475K eggs to two facilities operated by the Downeast Salmon Federation (Pleasant: 129K and East Machias: 346K); 473K Penobscot sea-run origin eggs to DMR for planting; 209K Sheepscot eggs to DMR for planting; 113K Narraguagus eggs to GLNFH; 40K Machias eggs to DMR for planting. DMR received 63K eyed eggs from the Downeast Salmon Federation Pleasant facility for egg planting.

GLNFH transferred 619K eyed, Penobscot domestic origin eggs to DMR for egg planting in the Sandy River drainage.

Broodstock Collection

A total of 293 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 2016.

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 2016, 1,583 wild parr (292, Dennys; 237, East Machias; 322, Machias; 312, Narraguagus; 210, Pleasant; 210, Sheepscot) were collected by CBNFH and DMR personnel. All parr were transported to CBNFH for captive rearing.

Pedigree and Domestic Broodstock Production

Pedigree Broodstock

Current restoration efforts of the Maine Atlantic salmon program focus on the release of hatchery products [as eggs, fry or age 0+ parr] and the recapture of those products as age 1+ parr. This effort is undertaken to incorporate some natural selection into the life history of Atlantic salmon brood populations. When recovery of stocked individuals is low or unevenly distributed the potential for reducing genetic diversity within the broodstock and increasing the potential of inbreeding is increased. One method to minimize with these risks is to implement a "pedigree broodstock".

Pedigree broodstocks are comprised of two components originating from the same cohort of eggs. The domestic component, comprised an equal number of offspring per 1:1 mating [typically 4-12 eyed eggs per], is raised entirely in at the hatchery. The captive component is released into its natal river system, recaptured at age 1+ and then reared to sexual maturity at the hatchery.

Recaptured hatchery products exposed to some natural selection in the wild [captive component] are used preferentially for spawning. The domestic component provides a genetic resource from which representatives can be drawn to supplement the captives. Parentage analysis for each component ensures retention of representatives from the entire cohort.
In addition to domestic and captive parr, the progeny of naturally spawning adults may be identified during genetic analysis. These parr are also incorporated in the spawning population.

The guidelines for implementation of pedigree broodstock at CBNFH are when:

- The number of new captive broodstock for a population is low.
- There is a threat of either few or no hatchery-origin or naturally-spawned parr being recaptured.
- If loss of family variation through general parr collection practices is projected to cause appreciable losses in local population diversity in the near future.

CBNFH is currently developing two year classes of pedigree broodstock for both the Dennys and Narraguagus populations.

Domestic Broodstock

GLNFH retained approximately 1,200 fish from the 2015 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 2016. Incoming adults were isolated in the screening facility to undergo sampling procedures and await the results of PCR testing. No suspects were identified in 2016.

Stocking

Stocking activities within the GOM DPS [no data included for Saco River or Aroostook River releases] resulted in the release of approximately 4,441,712 Atlantic salmon in 2016. 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 released into the Penobscot Basin (569K) and the Narraguagus River (97K). Of the Penobscot total, 102K were marked with adipose clips and visual implant elastomer (VIE) tags.

Age 0+ parr were released into the Penobscot Basin by GLNFH (263K), the Sheepscot River by CBNFH (15K) and East Machias River by the Downeast Salmon Federation (200K). Sheepscot and East Machias parr were adipose fin clipped prior to release.

Two federal hatcheries, two private hatcheries and two educational programs released approximately 1.889M fry throughout the GOM DPS in 2016: Androscoggin, 2K; Dennys, 343K; East Machias, 12K; Kennebec, 3K; Machias, 186K; Narraguagus, 219K; Penobscot, 1.025M; Pleasant, 53K; Sheepscot, 20K; Union, 26K.

Adult Stocking

In May 2016 a group of 489 captive Penobscot River brood were released into Kenduskeag Stream. The brood had been collected as age 1+ parr in 2014 from throughout the Penobscot River drainage. Due to insufficient rearing space at CBNFH the fish were released.

Following spawning, 278 Penobscot sea-run broodstock were released by CBNFH back into the Penobscot River in 2016. 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 (73); East Machias (223); Machias (256), Narraguagus (268); Pleasant (138); Sheepscot (202). GLNFH released 1,143 excess adults, comprised of age 3 and 4 domestic broodstock, into the Penobscot River.

5.7 Juvenile Population Status

Juvenile abundance estimates

Juvenile population assessments were performed using 241 sampling locations to evaluate annual population variation or specific studies of interest i.e. egg planting. Of these 241 sites, 94 were selected using the Generalized Random Tessellated Stratified (GRTS) design. GRTS sites were selected for the Narraguagus (12), the East Machias (12), The Sandy River (30), the Sheepscot (12), the Mattawamkeag (10), Cove Brook (6) and the Piscataquis (12).The remaining 73 sites were focused on specific project questions like egg planting follow up or follow up on natural spawning (Table 5.7.1 and Figure 5.7.1). There were 12 Parr broodstock trips performed by DMR staff in 2017 with the majority of these (12) conducted in the Sheepscot River. The USFWS staff from CNBNFH performed the majority of brood stock collection in the Downeast Region with planning and logistical support provided by DMR. Also in 2016, two sites were surveyed in the Dennys River for the purpose of collecting tissues on YOY. Staff from NOAA Fisheries and DMR collected 50 samples of YOY suspected of being from AQS origin. These samples were forwarded to the USFWS Lamar Lab for analysis. The samples have been processed but the data has not been analyzed.

During annual juvenile surveys scale samples, lengths, and weights were collected on large parr with no scales taken from YOY. In addition to Atlantic salmon, counts are made during the first pass of all other species encountered.

Sampling sites continue to be selected using the GRTS design outlined in previous reports.

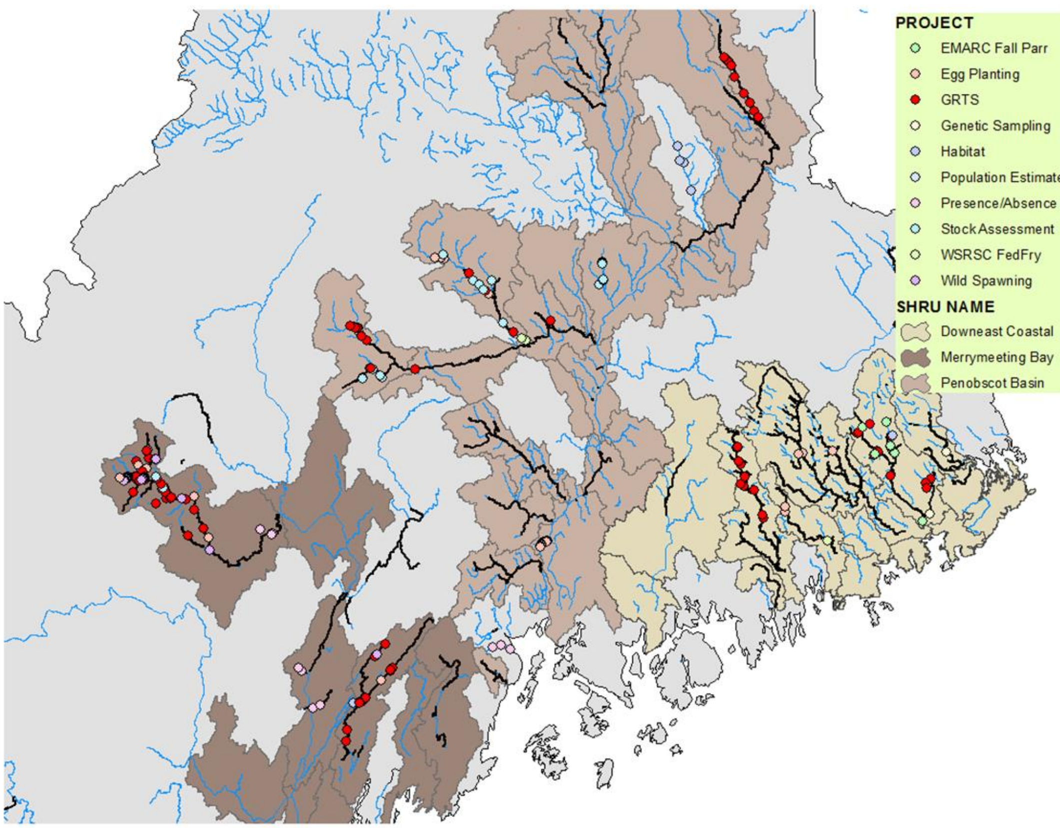

Figure 5.7.1. Distribution of electrofishing survey sites throughout the GOM DPS in 2016. Survey objectives are noted by project color. Purple dots are GRTS sites.

Median parr and YOY CPUE are presented in Table 5.7.1.

Table 5.7.1. 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, 2016. Drainages are grouped by Salmon Habitat Recovery Unit (line).

		Parr				YOY			
Drainage	**Year**	**n**	**Min**	**Median**	**Max**	**n**	**Min**	**Median**	**Max**
Dennys	2016	2	1.46	1.88	2.29	2	2.43	2.79	3.15
East Machias	2016	24	0	3	11.6	24	0	0	3.8
Machias	2016	3	0.39	2.76	3	3	3.2	8.49	9.94
Narraguagus	2016	12	0	0.1	3.16	12	0	0.4	3.36
Pleasant	2016	6	0.19	0.6	2.4	6	0	1	3.18
Sandy River	2016	39	0	0.2	1.97	39	0	0.2	9.4
Sheepscot	2016	24	0	0.2	3.58	24	0	0.5	10.13
Mattawamkeag	2016	15	0	0.33	1.68	15	0	0.98	6.45
Penobscot	2016	32	0	1.12	3.2	32	0	1.71	18.33
Piscataquis	2016	31	0	0.9	4.63	31	0	1.84	10.59

Smolt Abundance

The following is a summary of activities intended to obtain an abundance of smolt out-migration at several sites within the GOM. A more detailed report on smolt population enumeration and dynamics is included in Working Paper WP16-02- Smolts Update.

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. These include the East Machias, Narraguagus, and Sheepscot Rivers. The Piscataquis was not fished in 2016 and there are no immediate plans to renew this sampling site. A total of 9,181 smolts were trapped at all sites in 2016. Deployment dates ranged from 11 April to 7 June. A hatchery component is included in the Narraguagus due to 97,000 1-smolts released in late April.

Maine DMR scientists calculated population estimates using Darroch Analysis with Rank Reduction (DARR) 2.0.2 for program R (Bjorkstedt 2005; Bjorkstedt 2010) for each RST site (Table 5.7.3). The East Machias and Sheepscot River population estimates are based on a one site mark-recapture design. The total population estimate for all smolts exiting the East Machias River (hatchery 0+ parr origin and wild/naturally reared origin) was 1,223 ± 297. The hatchery population estimate was calculated 946 ± 221. Insufficient recaptures prohibited calculation of the wild origin population estimate. The total population estimate for all smolts exiting the Sheepscot River (hatchery 0+ parr origin and wild/naturally reared origin) was 2,924 ± 262. The hatchery population estimate was calculated 2,007 ± 257. The wild population estimate was 983 ± 113. A two site mark-recapture design was used on the Narraguagus River to estimate the number smolts exiting the system for the twentieth year. The Narraguagus River naturally reared smolt population was estimated 2,453 ± 387 and the hatchery component was 37,978 +- 2,276. Further details on age, origin, and other data are presented in *Working Paper WP17-02- Smolts Update*.

Table 5.7.2. Atlantic salmon smolt trap deployments, total captures, and capture timing by origin in Maine rivers, 2016.

River	Dates Deployed		Origin	Total Captures	First Capture	Median Capture Date	Last Capture
East Machias	14-Apr	7-Jun	H	179	25-Apr	14-May	27-May
			W	27	25-Apr	12-May	2-Jun
Narraguagus	14-Apr	5-Jun	H	7,460	22-Apr	19-May	31-May
			W	651	22-Apr	19-May	31-May
Sheepscot	11-Apr	30-May	H	465	20-Apr	9-May	27-May
			W	295	20-Apr	9-May	27-May
Total				9,077			

Table 5.7.3. Maximum likelihood mark-recapture population estimates for wild and hatchery origin
Atlantic salmon smolts emigrating from Maine rivers, 2015.

River	Estimate Type	Origin	Population Estimate
East Machias	One site	Hatchery	946 ± 221
		Wild	n/a
		Both	1,223 ± 297
Narraguagus	Two site	Hatchery	37,978 ± 2,276
		Wild	2,453 ± 387
Sheepscot	One site	Hatchery	2,007 ± 257
		Wild	983 ± 113
		Both	2,924 ± 262

5.8 Fish Passage

The USGS Cooperative Fisheries and Wildlife Unit (CFWRU) continued to monitor passive integrated transponder tag (PIT tags) detections at several locations in the Penobscot Drainage. In addition, the CFWRU has been radio tagging adult Atlantic salmon captured at the Milford fish lift and monitoring their movements past the former Veazie and Great Works dam sites, the confluence of the mainstem Penobscot River with the Stillwater branch, the Milford tailrace, and above the Milford dam. MDMR has assisted the CFWRU as needed with the radio tagging.

MDMR assisted USGS in tagging 47 adult Atlantic salmon captured at the Milford Dam Fish lift with 22 mm passive integrated tags (PIT) and radio tags for an ongoing salmon movement study. MDMR PIT tagged a total of 491 adult Atlantic salmon at the Milford Dam Fish lift.

The MDMR, Brookfield White Pine Hydro and NOAA Fisheries collaborated on an upstream passage study on the Kennebec River. As was outlined in the Interim Species Protection Plan for the Lockwood Hydro Project, the project owner committed to assessing upstream passage for adult Atlantic salmon to document passage effectiveness of existing project conditions. In the summer of 2016 the Brookfield crews captured and radio tagged 20 naturally-reared adult Atlantic salmon with Lotek MCFT2-3EM transmitter (12 mm x 53 mm) tags at the Lockwood Project. After tagging they were allowed to recover and were trucked down river 2.21 river kilometers to the Waterville boat launch (Rkm 99.71) for release. In order to determine behavior in the project area, stationary receivers were deployed above and below the release site. The data from this study is still being analyzed but does indicate that 88.9% of the salmon were able to find the passage facility after considerable time searching. Overall almost all of the adults were recaptured and moved upstream into nursery habitat.

5.9 Genetics

Tissue samples were collected from salmon handled at the Androscoggin River fishway in Brunswick (4), the Lockwood fish lift on the Kennebec River (39), the Narraguagus River (3), and the Penobscot River (495). Additionally, 2 samples were collected from adult salmon captured in the Dennys River suspected to be aquaculture in origin. In total 543 genetic samples were collected in 2016 from adult trapping facilities. All tissue samples were preserved in 95% ethanol.

In the fall of 2015, 16 redds were surveyed in the Dennys River. Due to a history of aquaculture escapes into the drainage and normally low to no spawning activity in the preceding years, it was decided to attempt capture of YOY in the vicinity of these 2015 redds during the late summer of 2016. At two locations 50 tissue samples were collected from YOY. These samples were sent to the Lamar, PA USFWS laboratory for analysis. At the time of this writing the samples had been processed but the data had not been analyzed.

Also in 2016 for very much the same reason as in the Dennys River, 50 YOY tissue samples were collected from Chase Mill Stream a tributary of the East Machias River. These were also forwarded to the Lamar Lab but the results were not ready at the time of this writing. Chase Mill Stream is of a concern due to a commercial hatchery that outflows into this stream.

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 2016, DPS broodstock (collected in 2014) were PIT tagged, sampled for future genetic characterization, and moved from the CBNFH Receiving Building to broodstock modules.

5.10 General Program Information

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 2016. 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. As of this writing a Draft of the Recovery Plan has been presented to the public at several forums but a final version has not been made available.

Hatchery Management Plan

Representatives from NOAA –Fisheries, USFWS, and ME DMR have been working on updating the Brood Stock Management Plan (Bartron 2005) to reflect the guidance and structure of the Draft Atlantic salmon Recovery Plan. This plan will not only define standard practices in maintaining Atlantic salmon but will include decision making tools for future discussion and situations. The plan should be available by the fall of 2017.

U. S. Fish & Wildlife Service Schools Programs

2016 marked the twenty-second 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, annually a local business is annually invited to participate in the program to broaden exposure to the general public.

CBNFH and GLNFH provide Atlantic salmon eggs for the Atlantic Salmon Federation [Maine Council] program “Fish Friends”. Fish Friends offers educational opportunities in Maine schools reaching thousands of students, cooperating teachers and parents annually. The two programs, working in partnership, reach over 3,600 people each school year.

Migratory Fish Habitat Enhancement and Conservation

Habitat Assessment

MDMR staff conducted habitat surveys in five streams in 2016 (Table 5.10.1). Staff surveyed approximately 24 km of stream length documenting over 1,845 units of rearing habitat. Additionally, staff documented 883 units of spawning habitat. Data are currently being entered in the DMR Habitat database for use in GIS. The new dataset will be appended to the current habitat database and a new GIS dataset will be issued in March 2017. Surveys in the Downeast Coastal SHRU focused on streams that received recent connectivity improvements and/or potential expanded stocking. New surveys occurred in the Merrymeeting Bay SHRU in 2016 were focused in the Carrabasset River.

Table 5.10.1 Summary of 2016 Stream Surveys in the GOM

SHRU	Drainage	Stream	Survey Length (km)	Rearing Units ($100m^2$)	Spawning Units ($100m^2$)	Comments
Downeast Coastal						
	East Machias	Grey Brook	0.36	10.8	-	New survey
	East Machias	Northern Inlet	0.54	33.4	-	New survey
	East Machias	Scott Brook	0.82	19.9	-	New survey
	Narraguagus	West Branch Brook	3.30	122.7	42.5	Survey extension
Merrymeeting Bay						
	Carrabassett	Carrabassett River	18.90	1659.2	840.7	Survey extension
		TOTAL	**23.92**	**1846.0**	**883.2**	

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 Nature Conservancy, Maine Audubon, USDA Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), 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, Trout Unlimited, Atlantic Salmon Federation, Maine Rivers, National Oceanic and Atmospheric Agency (NOAA), and the Androscoggin Valley and Oxford County Soil and Water Conservation Districts.

After 10 years of fieldwork, about two-thirds of the state's perennial stream crossings have been assessed (see Map 1). About 10,000 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 2017, stream barrier surveys will be completed in the Kennebec, West Branch Penobscot, Androscoggin, St. John, and small coastal Maine watersheds on Mount Desert Island and Downeast.

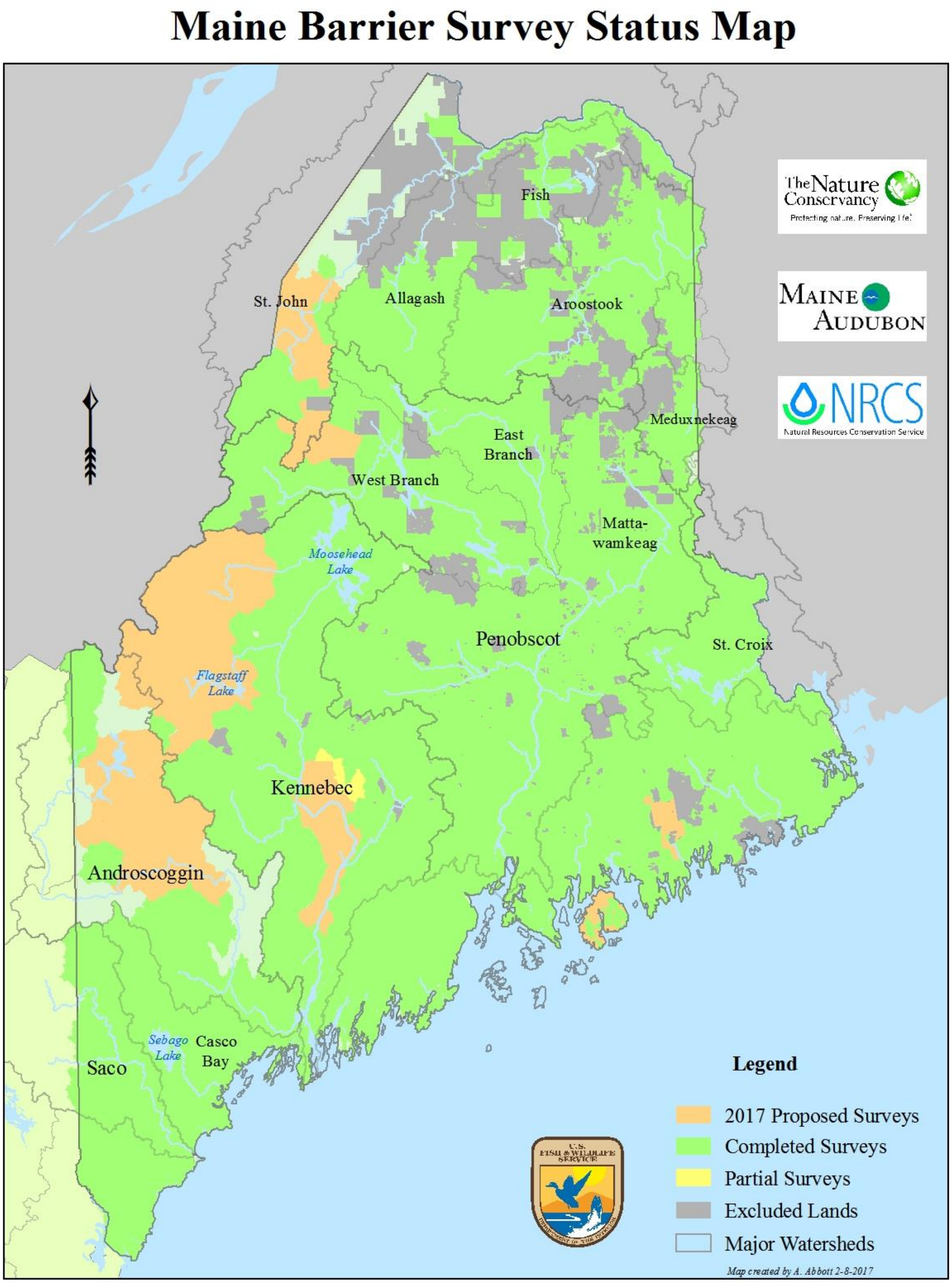

Figure 5.10.1. Status of Maine Barrier Survey showing completed, partial and proposed survey to be completed.

Penobscot Habitat Blueprint Barrier Prioritization Tool

As part of the NOAA-funded Penobscot Habitat Blueprint effort The Nature Conservancy (TNC) is developing a stream barrier prioritization and an associated custom analysis tool. This prioritization will help planners and managers identify the stream barriers (culverts, dams) where fish passage improvements, via upgrades or other mitigation efforts, can have the greatest ecological impact.

Following similar methodologies to TNC's Northeast Aquatic Connectivity project (https://tnc.box.com/s/l50rfnkeztmcvqa53ikr), Chesapeake Fish Passage Prioritization (http://maps.tnc.org/EROF_ChesapeakeFPP), and Southeast Aquatic Connectivity Assessment Project (http://maps.tnc.org/seacap), a suite metrics are calculated for each stream barrier in a GIS. Each metric assesses a quality that is relevant to understanding the impacts of a barrier on aquatic organism passage. The can include metrics that are derived from the river network (e.g. upstream miles that would be opened by the mitigation of a barrier), habitat data (e.g. salmon parr productivity in a barriers upstream connected network), or any number of other data types and sources (e.g. invasive species presence, geology, alewife spawning ponds, etc). These metrics can then be subset and weighted to develop a prioritized result that is reflective of a user's objective. For example, a prioritization that seeks to identify barriers whose mitigation would most benefit salmon might heavily weight metrics which assess the length of habitat that would be opened by each barrier's mitigation and the parr productivity of that habitat. Conversely, a prioritization that seeks to identify priority barriers for brook trout might most heavily weight whether each barrier is within an Eastern Brook Trout Joint Venture (EBTJV) Wild Brook Trout Patch, and how much of the reconnected habitat is considered 'High' or 'Very High' quality brook trout habitat by Maine's Department of Inland Fish and Wildlife.

TNC is working with the Penobscot Habitat Blueprint Workgroup to identify two "consensus scenarios." This multi-stakeholder group includes representatives from state and federal agencies and other NGOs which are active in fish passage issues in Maine. The consensus scenarios, developed by weighting a subset of metrics as described above, will reflect the Workgroup's priority barriers for diadromous fish and resident fish, respectively, and will provide a clear set of priorities that can be used by partners to inform planning decisions.

Additionally, a custom-prioritization tool will be available so users can develop their own prioritizations based on a user-defined subset of metrics and weights. This tool, which will be hosted in a web map along with the consensus scenarios, will provide a "menu" of the universe of metrics which are available for use in the prioritization. Beyond the ability to prioritize barriers, the tool will also allow users to model the removal or mitigation of a barrier and assess the impacts of that removal on the remaining priorities. For example, if a given barrier is potentially slated for removal / upgrade, the prioritization tool can be run as if that barrier were no longer a barrier thereby revealing, perhaps, that the next upstream barrier which had previously been a low priority has become a higher priority. An intermediate step to running the "barrier removal" functionality is a re-calculation of all of the metrics for the barriers surrounding the removed barrier. Thus, in addition to a prioritization run as if the barrier did not exist, the tool produces metric values which, in and of themselves, may be of interest to the user.

As of February 8, 2016, an initial draft of the geoprocessing service that underlies the prioritization tool is functional, including the barrier removal functionality and summary statistics functionality. Further, a development version of the web map and tool is operational. The map interface and functionality will continue to be built out from the core functionality that is currently operational.

Stream Smart training: In 2016, 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 4 workshops around the state (in southern, central, and northern Maine). Since 2012, 800 people representing 111 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.

Figure 5.10.2: Stream Smart training provides instruction on culvert assessment and design methodologies.

Four 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

Online data viewer – Online data viewer – The Maine Stream Habitat Viewer provides easy access to habitat and barrier datasets (http://www.maine.gov/dacf/mcp/environment/streamviewer/index.htm), and was being completely revised in 2016. The viewer previously hosted by the Maine Office of GIS will shift to its new Maine Department of Agriculture, Conservation and Forestry host in early 2017. The Viewer contains Atlantic salmon spawning and rearing habitat, and modeled rearing datasets along with dams, natural barriers and public road-stream crossings. The Viewer was created to enhance statewide stream restoration and conservation efforts, and 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 areas of interest.
- Contact experts for technical assistance and funding information.

2016 Highlighted Connectivity Projects

Stream Connectivity Projects

In 2016, several aquatic connectivity projects were completed across the Gulf of Maine DPS (Table 5.7.2) 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 51 miles 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 5.10.2: Partial List of projects restoring stream connectivity in Maine Atlantic salmon watersheds, indicating project type, stream and watershed name and kilometers of stream habitat access.

Project Type	**Watershed**	**Stream**	**KM**
Concrete Box/Bridge	Kennebec	Warm Brook Tributary	2.4
Concrete Arch	Sheepscot	Finn Brook	1.0
Arch	Penobscot	Crystal Brook	2.5
Total			**5.9**

Figure 5.10.3: Stream Simulation design replacement culvert in Kennebec/Sandy River watershed (credit Alex Abbott)

Figure 5.10.4: Stream Simulation design replacement culvert in Sheepscot River watershed (credit Alex Abbott)

Figure 5.10.5: Stream Simulation design replacement culvert in Penobscot River watershed (credit Alex Abbott)

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 coldwater 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 usage. 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.

Figure 5.10.6: Coarse wood jam in the Narraguagus River, Maine.

In 2015, two pilot wood placement projects were implemented in the mainstem Narraguagus. Crews placed wood jams in the mainstem of the river in order to force development of more complex multiple thread (anabranching) channels. It is hoped that such channels will provide greater riparian shading, greater edge effects and be more productive for juvenile Atlantic salmon. The structures were surveyed using CHaMP (https://www.champmonitoring.org/) protocols. Unfortunately, the wood became mobile under high flows soon after placement. The group is now investigating alternative placement techniques.

Water Temperature

The Maine Stream Temperature Monitoring Network was developed in 2014 to facilitate a coordinated stream temperature monitoring effort in Maine that will be integrated with regional and national efforts. The Network is being implemented by the Stream Temperature Working Group (STWG), composed of multiple state agencies, academic institutions, NGOs, tribes and federal agencies.

In 2015, the STWG collected historical temperature data from more than 1200 locations and deployed over 220 stream temperature sensors in every watershed, with many more to come in the following seasons. The group held a protocol workshop in early spring to teach logger deployment methods and continue to build capacity throughout the state. The web-based database, SHEDS, is now operational and organizations across the state are uploading their continuous stream temperature data into one, centralized repository. Additionally, the public may view and download any stream temperature data in the database not flagged as "private." SHEDS also hosts a module for predictive catchment modeling, as well as other stream temperature modeling tools.   Researchers and fisheries managers plan to use this robust data repository for fish occupancy modeling, habitat restoration prioritization, and regional climate studies.

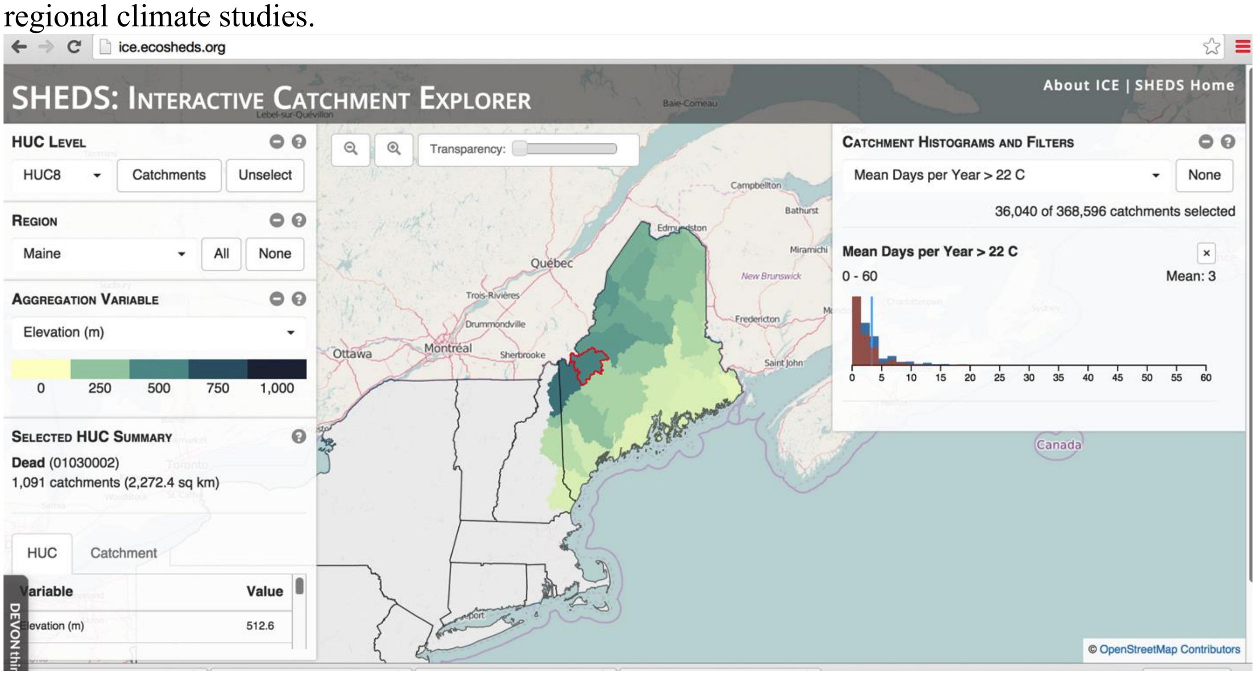

Figure 5.10.7: View of the Interactive SHEDS portal for view modeled temperature data in New England.

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6 Outer Bay of Fundy

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

6.1 Adult Returns

The Tinker fishway trap on the Aroostook River was operated by Algonquin Power Company from 27 June to 28 August, 2016. Seven Atlantic salmon were captured and released upstream in 2016. All seven salmon (1 male and 6 female) were reported as wild origin.

6.2 Hatchery Operations

Stocking

No juvenile lifestages were stocked in 2016.

Adult Salmon Releases

No adults were stocked in 2016.

6.3 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed in 2015.

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 projects or updates.

6.6 Genetics
No tissue samples were collected.

6.7 General Program Information
No updates or information.

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 three 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 are developed (7.3).

7.1 USASAC Regional Assessment Product Progress Update

The following will serve as an update for TOR's identified during the 2016 meeting of the USASAC. Several of these projects support the concepts laid down in previous reports that the USASAC will 1) make sure that the core needs of the ICES working group are met, 2) that the annual USASAC report delivers programmatic data that can serve as "one-stop" data repository for New England and NASCO managers for US Atlantic salmon data, 3) keep making progress toward providing data for the Gulf of Maine for each Salmon Habitat Recovery Unit and associated metrics of progress, and 4) making sure that data and cutting edge science are given to New England managers as tools for rebuilding Atlantic salmon stocks. Many of the updates discussed below involve data organization and collation like progress on a database containing historical Atlantic salmon stocking data within Maine. Other attempting to update a suitable Conservation Spawning limit for New England based on updated habitat data. While not in the realm of analyses, this progress helps to simplify the core stock assessment data sourcing in the same way that updates and changes to the USASAC database did in 2008. These needs are especially urgent as habitat connectivity and in-stream improvements are increasing regionally, conservation of genetic diversity goals are moving to the forefront and the scope and impact of stocking programs is changing.

7.1.1 Escapement- stocking database integration – include midterm meeting report on the status of the data - hatchery (July 2016 in Nashua) – Domina, Atkinson, Lamothe, Saunders, Kocik, Bailey, Sheehan, FWS PL-GL.

Special session trends in hatchery production

- Age structures
- Egg planting
- What are stocking targets?
- Other changes to hatchery protocols

Update: The Maine Atlantic salmon stocking data base took a huge step forward in 2016. A general audit was performed and spatial data updated. These data should be available for use by summer 2017. No work has been done on integrating escapement to stocking data.

7.1.2 Integration of USASAC (dbase) and Recovery Criteria (intersection between hatchery #s and stock assessment). Atkinson, Lamothe, Saunders, Kircheis, FWS PL-ES.

Update: The US Atlantic salmon recovery plan is still in review. No work has been completed on the TOR.

7.1.3 Conservation Limits and Escapement (Atkinson, Kocik, Sheehan, Kircheis, Saunders).

Update: A new table has been created. Results of this work and a discussion on it creation are presented in USASAC Working paper 2017-003 “Conservation Limits within the Gulf of Maine”.

7.1.4 Lower PN redd counts- and how to integrate into PN SHRU – using redd counts (maybe integrate CV, DT, Kenduskeag). Simpson, Kocik, Atkinson.

Update: This is an ongoing task. Work will continue in 2017.

7.1.5 Review of 5-year stock status report from NOAA in VSP –type format- it is possible this will be done intercessional to get USASAC review prior to publication. (Kircheis, Kocik- SAAT,GDAT).

Update: No work performed on this TOR in 2016.

7.1.6 CSL needed for this ICES meeting- number on a by river basis should be published as a table with documentation. Monitored rivers and proportion of CL met is what goes through ICES. Short term- of 43 US rivers reported to NASCO how many monitored and how many meeting CL). All

Update: This work has been completed and is summarized in WP17-03 and in Chapter 1 of this report

7.2 USASAC Draft Terms of Reference 2017 Meeting.

The purpose of this section is to outline potential terms of reference identified at the USASAC annual meeting in February and to start an outline for refinement at our summer teleconference tentatively scheduled for mid-July 2017. This will be refined further prior to the 2018 Assessment Meeting.

7.2.1 Addressing the loss of physical samples i.e. scale, tissues, or carcasses from historical Atlantic salmon Fisheries. As agencies work to clean up archives or involvement in Atlantic salmon management decreases biological samples may be discarded. A discussion will be had regarding storage of these samples as well as the time frame to be kept. Additionally, it would be good to consider analyses that could be completed using these samples. Sheehan, Gephard, Atkinson, Sweka

7.2.2 The USASAC will revisit data collection and reporting based on which rivers are currently managed. This will be an examination of the list of reported rivers in the USASAC database.

7.2.3 Continue refinement of Conservation Limits especially within the Gulf of Maine DPS. Review and update the number of rivers with conservation limits and the monitored time series. Atkinson, Kocik, Sheehan

7.2.4 Following feedback from ICES, finalize and present the CL working paper to address concerns over the dramatic increase in adult spawner numbers. Atkinson, Kocik, Sheehan.

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	MEDMR	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	USFWS	Lamar, PA
Colby	Bruchs	Colby.W.B.Bruchs@maine.gov	MEDMR	Jonesboro, ME
Mitch	Simpson	Mitch.Simpson@maine.gov	MEDMR	Bangor, ME
Tim	Sheehan	Tim.Sheehan@noaa.gov	NOAA	Woods Hole, MA
James	Hawkes	james.hawkes@noaa.gov	NOAA	Orono, ME
Paul	Christman	paul.christman@maine.gov	MEDMR	Augusta, ME
Michael	Bailey	michael_bailey@fws.gov	USFWS	Nashua, NH
Steve	Gephard	Steve.Gephard@po.state.ct.us	CT-DEEP	Old Lyme, CT
Oliver	Cox	Oliver_cox@fws.gov	USFWS	Ellsworth, ME
Carl	Wilson	Carl.wilson@maine.gov	MEDMR	Boothbay, ME
Felix	Massiot-Ganier		GoMRI	Portland, ME

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

Number	Authors	Title
PS17-01	Steve Gephard	Pawcatuck River Update (PPT)
PS17-02	Steve Gephard	Connecticut River Update (PPT)
PS17-03	Michael Bailey	Merrimack River Update (PPT)
PS17-04	Ernie Atkinson	Saco, GOM, OBF Updates (PPT)
PS17-05	John Sweka	Database Updates
PS17-06	Tim Sheehan	ICES WGNAS Meeting Summary - review and preview
PS17-07	Steve Gephard	NASCO Classification Process and next steps
PS17-08	Ernie Atkinson and John Kocik	Review CSE table
PS17-09	Colby Bruchs, Jim Hawkes, and Christine Lipsky	Maine Smolt Summary (PPT)
PS17-10	Mitch Simpson	Maine Adult Returns Summary

PS17-11	Ernie Atkinson	Update on GRTS
PS17-12	Colby Bruchs	East Machias Parr Project: Juvenile Data Analysis Discussion (PPT)
WP17-01	Mitch Simpson, Colby Bruchs, Jason Overlock, Ernie Atkinson, Peter Ruksznis, Paul Christman	Update on Maine River Adult Salmon Stock Assessment 2016
WP17-02	Colby Bruchs, Ernie Atkinson, James Hawkes, Christine Lipsky, Ruth Hass-Castro, Paul Christman, Zach Sheller, Justin Stevens, Graham Goullette	Update on Maine River Atlantic Salmon Smolt Studies: 2016
WP17-03	Ernie Atkinson, John Kocik	Conservation Limits within the Gulf of Maine
WP17-04	Ruth Haas-Castro, Graham Goullette	Review of Image Analysis:2016 (Part 1) and Work Plan for 2017 (Part 2)
WP17-05	Graham Goullette, James Hawkes, and Paul Christman	Evaluation of an Atlantic Salmon restoration product in the Kennebec River, ME
WP17-06	David Bean and Marcy Nelson	Maine and Neighboring Canadian Commercial Aquaculture Activities and Production
WP17-07	John F. Kocik, Christopher Tholke, and Daniel Kircheis	Annual Bycatch Update Atlantic Salmon though December 2016

8.3 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

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.

8.5 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.

9 Appendices

Appendix 1. Estimated Atlantic salmon returns to the USA, 1967-2016. "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
2015	150	761	9	1	921	739	182
2016	232	389	2	3	626	448	178

Appendix 2. Two sea winter (2SW) returns for 2016 for USA rivers.

Area	1SW		2SW		3SW		Repeat Spawners		TOTAL
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	0	0	5	0	0	0	0	5
CNE	1	0	1	5	0	0	0	0	7
GOM	211	20	232	146	2	0	1	2	614
Total	212	20	233	156	2	0	1	2	626

Appendix 3. Number of juvenile Atlantic salmon stocked in USA, 2016.

Area	N	Rivers	Eyed Egg	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
LIS	2	Connecticut, Pawcatuck		71,009			1,200		72,209
CNE	2	Merrimack, Saco	34,818	374,985	4,000		12,000	106	425,909
GOM	8	Androscoggin to Dennys	1,404,355	1,889,581	478,253		666,453		4,438,642
OBF	1	Aroostook							0
Total	13		1,439,173	2,335,575	482,253		679,653		4,936,654

Appendix 4. Stocking summary for sea-run, captive, and domestic adult Atlantic salmon and egg planting summary for the USA in 2016 by geographic area.

Area		Purpose	Captive Reared Domestic		Sea Run		Total
			Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	
Central New England	CNE	Recreation	687				687
Gulf of Maine	GOM	Restoration	489	2,303	0	278	3,070
Total for USA			1,176	2,303	0	278	3,757

Appendix 5. Summary of tagged and marked Atlantic salmon released in USA, 2016. Includes hatchery and wild origin fish.

Mark Code	Life History	GOM	LIS	Total
Adipose Clip	Adult	22		22
FLOY	Adult		7	7
Passive Integrated Transponder (PIT)	Adult	3,223	3	3,226
Radio	Adult	67		67
Adipose Clip	Parr	215,074		215,074
Acoustic Tag	Smolt	208		208
Passive Integrated Transponder (PIT)	Smolt	1,800		1,800
Radio	Smolt	748		748
Visual Implant Elastomer	Smolt	102,240		102,240
		323,382	10	323,392

Appendix 6. Aquaculture production (metric tonnes) in New England from 1997 to 2016. Production for 2011-2016 are unknown.

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	*
2012	*
2013	*
2014	*
2015	*
2016	*

* not available for distribution

Appendix 7. Juvenile Atlantic salmon stocking summary for New England in 2016.

United States

River	No. of fish stocked by lifestage Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	0	64,000	0	0	0	0	0	64,000
Total for Connecticut Program								**64,000**
Androscoggin	0	2,000	0	0	0	0	0	2,000
Dennys	0	343,000	0	0	0	0	0	343,000
East Machias	0	12,000	199,700	0	0	0	0	211,700
Kennebec	619,000	3,000	0	0	0	0	0	622,000
Machias	40,000	186,000	0	0	0	0	0	226,000
Narraguagus	0	219,000	0	0	0	97,100	0	316,100
Penobscot	473,000	1,025,000	263,200	0	0	569,300	0	2,330,500
Pleasant	63,000	53,000	0	0	0	0	0	116,000
Sheepscot	209,000	20,000	15,400	0	0	0	0	244,400
Union	0	26,000	0	0	0	0	0	26,000
Total for Maine Program								**4,437,700**
Merrimack	0	4,000	0	0	0	0	100	4,100
Total for Merrimack Program								**4,100**
Pawcatuck	0	7,000	0	0	0	1,200	0	8,200
Total for Pawcatuck Program								**8,200**
Total for United States								**4,514,000**
Grand Total								**4,514,000**

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 .2016

Drainage	Purpose	Captive/Domestic Pre-Spawn	Post-Spawn	Sea Run Pre-Spawn	Post-Spawn	Total
Dennys	Restoration	0	73	0	0	73
East Machias	Restoration	0	223	0	0	223
Machias	Restoration	0	256	0	0	256
Merrimack	Restoration/Recreation	687	0	0	0	687
Narraguagus	Restoration	0	268	0	0	268
Penobscot	Restoration	489	1,143	0	0	1,632
Pleasant	Restoration	0	138	0	0	138
Sheepscot	Restoration	0	202	0	0	202
Total		1,176	2,303	0	0	3,479

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 2016.

Agency	Age	Marking Stage	H/W	Life Origin	Stock Mark or Tag	Primary Marked	Number Mark or Tag	Secondary Date	Release Location	Release
DMR		Adult	H	Androscoggin	AD	4		June	Androscoggin	
CONTE	4	Adult	W	Connecticut	PIT	2		June	Connecticut	
CONTE	4	Adult	W	Connecticut	PIT	1		May	Connecticut	
CTDEEP	4	Adult	W	Connecticut	FLOY	6		July	Connecticut	
MADFW	4	Adult	W	Connecticut	FLOY	1		June	Connecticut	
CBNFH	3	Adult	H	Dennys	PIT	6	AP	Nov	Dennys	
CBNFH	4	Adult	H	Dennys	PIT	24	AP	Nov	Dennys	
CBNFH	5	Adult	H	Dennys	PIT	43	AP	Nov	Dennys	
CBNFH	4	Adult	H	East Machias	PIT	56	AP	Nov	East Machias	
CBNFH	5	Adult	H	East Machias	PIT	89	AP	Nov	East Machias	
CBNFH	3	Adult	H	East Machias	PIT	77	AP	Nov	East Machias	
CBNFH	6	Adult	H	East Machias	PIT	1	AP	Nov	East Machias	
EMARC	0	Parr	H	East Machias	AD	199,674		Oct	East Machias	
CBNFH	3	Adult	H	Machias	PIT	84	AP	Nov	Machias	
CBNFH	4	Adult	H	Machias	PIT	77	AP	Nov	Machias	
CBNFH	5	Adult	H	Machias	PIT	95	AP	Nov	Machias	
CBNFH	6	Adult	H	Narraguagus	PIT	1	AP	Nov	Narraguagus	
CBNFH	3	Adult	H	Narraguagus	PIT	84	AP	Nov	Narraguagus	
CBNFH	4	Adult	H	Narraguagus	PIT	83	AP	Nov	Narraguagus	
CBNFH	5	Adult	H	Narraguagus	PIT	100	AP	Nov	Narraguagus	
NMFS	1	Smolt	H	Narraguagus	PIT	1,800	AD	April	Narraguagus	
Brookfield		Adult	H	Penobscot	RAD	20		June	Kennebec	
Brookfield	1	Smolt	H	Penobscot	RAD	568		May	Penobscot	
Brookfield	1	Smolt	H	Penobscot	PING	60		May	Union	
Brookfield	1	Smolt	H	Penobscot	RAD	180		May	Union	

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Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
CBNFH	3	Adult	H	Penobscot	PIT	489	AP	May	Penobscot
CBNFH		Adult	H	Penobscot	PIT	278	AP, VIE	Dec	Penobscot
DMR		Adult	H	Penobscot	AD	18		June	Kennebec
DMR		Adult	H	Penobscot	PIT	153	AD	June	Penobscot
GLNFH	4	Adult	H	Penobscot	PIT	702	AP	Dec	Penobscot
GLNFH	3	Adult	H	Penobscot	PIT	441	AP	Dec	Penobscot
GLNFH	1	Smolt	H	Penobscot	VIE	54,446	AD	April	Penobscot
GLNFH	1	Smolt	H	Penobscot	VIE	47,794	AD	May	Penobscot
USGS		Adult	H	Penobscot	RAD	47	AD, PIT	June	Penobscot
USGS	1	Smolt	H	Penobscot	PING	148	AD	April	Penobscot
CBNFH	5	Adult	H	Pleasant	PIT	86	AP	Nov	Pleasant
CBNFH	4	Adult	H	Pleasant	PIT	8	AP	Nov	Pleasant
CBNFH	3	Adult	H	Pleasant	PIT	44	AP	Nov	Pleasant
CBNFH	3	Adult	H	Sheepscot	PIT	64	AP	Nov	Sheepscot
CBNFH	4	Adult	H	Sheepscot	PIT	39	AP	Nov	Sheepscot
CBNFH	5	Adult	H	Sheepscot	PIT	99	AP	Nov	Sheepscot
CBNFH	0	Parr	H	Sheepscot	AD	15,400		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

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Appendix 9.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2016.

Origin	Total External	Total Adipose	Total Marked
Hatchery Adult	2,967	175	3,312
Hatchery	319,262	319,262	320,070
Wild Adult	7		10
Total			**323,392**

Appendix 10. Documented Atlantic salmon returns to New England rivers in 2016.

	1SW		2SW		3SW		Repeat			2012-2016
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total	Average
Androscoggin	0	0	0	6	0	0	0	0	**6**	2
Connecticut	0	0	0	5	0	0	0	0	**5**	41
Kennebec	0	1	0	38	0	0	0	0	**39**	20
Merrimack	1	0	1	3	0	0	0	0	**5**	41
Narraguagus	0	0	0	3	0	0	0	0	**3**	10
Pawcatuck	0	0	0	0	0	0	0	0	**0**	1
Penobscot	208	11	218	67	2	0	1	0	**507**	501
Saco	0	0	0	2	0	0	0	0	**2**	5
Total	**209**	**12**	**219**	**124**	**2**	**0**	**1**	**0**	**567**	**621**

Note: The origin/age distribution for returns to the Merrimack River after 2013 were based on observed distributions over the previous 10 years because fish were not handled.

Appendix 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2016

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	70	535,000
Merrimack	Domestic	363	946,000
Penobscot	Domestic	635	1,530,000
Dennys	Captive	27	155,000
East Machias	Captive	113	473,000
Machias	Captive	114	165,000
Narraguagus	Captive	112	393,000
Pleasant	Captive	53	235,000
Sheepscot	Captive	133	109,000
Total	**Captive/Domestic**	**1,620**	**4,541,000**
Penobscot	Sea Run	134	885,000
Total	**Sea Run**	**134**	**885,000**
Grand Total for Year 2016		**1,754**	**5,426,000**

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															
1993-2006	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															
1977-2006	1,693	18,508,000	7,800	24,913	159,716,000	5,900	0	0		2,034	25,106,000	10,100	28,640	203,329,000	6,400
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
2015	0	0		60	534,000	8,900	0	0		0	0		60	534,000	8,900
2016	0	0		70	535,000	7,600	0	0		0	0		70	535,000	7,600
Total Connecticut	2,071	21,265,000	7,300	33,792	209,421,000	6,500	0	0		2,395	28,934,000	9,600	38,258	259,619,000	6,700
Dennys															
1939-2006	26	214,000	7,600	0	0		1,049	4,338,000	4,200	40	330,000	7,700	1,115	4,882,000	5,000
2007	0	0		0	0		84	425,000	5,100	0	0		84	425,000	5,100
2008	0	0		0	0		105	450,000	4,300	0	0		105	450,000	4,300
2009	0	0		38	91,000	2,400	61	360,000	5,900	0	0		99	451,000	4,600
2010	0	0		87	596,000	6,900	25	105,000	4,200	0	0		112	701,000	6,300

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		
	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
Year															
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
2015	0	0		0	0		78	447,000	5,700	0	0		78	447,000	5,700
2016	0	0		0	0		27	155,000	5,700	0	0		27	155,000	5,700
Total Dennys	26	214,000	7,600	125	687,000	4,600	1,515	6,539,000	4,578	40	330,000	7,700	1,706	7,770,000	4,800
East Machias															
1995-2006	0	0		0	0		987	3,994,000	4,100	0	0		987	3,994,000	4,100
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
2015	0	0		0	0		110	468,000	4,300	0	0		110	468,000	4,300
2016	0	0		0	0		113	473,000	4,200	0	0		113	473,000	4,200
Total East Machias	0	0		0	0	0	1,788	7,354,000	4,164	0	0		1,788	7,354,000	4,200
Kennebec															
1979-2006	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.

	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
1992-2006	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															
1941-2006	456	3,263,000	7,300	0	0		1,753	7,287,000	4,200	8	52,000	6,400	2,217	10,602,000	6,100
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
2015	0	0		0	0		108	354,000	3,300	0	0		108	354,000	3,300
2016	0	0		0	0		114	165,000	1,400	0	0		114	165,000	1,400
Total Machias	456	3,263,000	7,300	0	0	0	2,986	11,838,000	3,655	8	52,000	6,400	3,450	15,153,000	3,800
Merrimack															
1983-2006	1,221	9,423,000	8,000	9,445	49,149,000	4,800	0	0		336	3,441,000	10,600	11,002	62,013,000	6,100
2007	35	299,000	8,600	687	2,587,000	3,800	0	0		45	511,000	11,400	767	3,398,000	4,400
2008	66	533,000	8,100	275	1,018,000	3,700	0	0		47	511,000	10,900	388	2,062,000	5,300
2009	48	369,000	7,700	516	2,380,000	4,600	0	0		55	577,000	10,500	619	3,326,000	5,400
2010	28	201,000	7,200	135	721,000	5,300	0	0		57	669,000	11,700	220	1,591,000	7,200
2011	107	935,000	8,700	103	408,000	4,000	0	0		0	0		210	1,343,000	6,400
2012	72	510,000	7,100	231	746,000	3,200	0	0		0	0		303	1,255,000	4,100
2013	5	36,000	7,200	295	853,000	2,900	0	0		0	0		300	889,000	3,000

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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.

	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
Year															
2014	0	0		293	1,244,000	4,200	0	0		0	0		293	1,244,000	4,200
2015	0	0		234	761,000	3,300	0	0		0	0		234	761,000	3,300
2016	0	0		363	946,000	2,600	0	0		0	0		363	946,000	2,600
Total Merrimack	1,582	12,306,000	7,800	12,577	60,813,000	3,900	0	0		540	5,709,000	11,000	14,699	78,828,000	4,700
Narraguagus															
1962-2006	0	1,303,000		0	0		1,722	6,291,000	3,700	0	0		1,722	7,594,000	3,700
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
2015	0	0		0	0		124	447,000	3,600	0	0		124	447,000	3,600
2016	0	0		0	0		112	393,000	3,500	0	0		112	393,000	3,500
Total Narraguagus	0	1,303,000		0	0	0	3,087	11,899,000	4,073	0	0		3,087	13,202,000	4,100
Orland															
1967-2006	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															
1992-2006	16	143,000	8,900	6	6,000	1,100	0	0		9	61,000	6,600	31	210,000	7,100
2007	2	9,000	4,500	0	0		0	0		0	0		2	9,000	4,500
2008	0	0		0	0		0	0		2	10,000	5,000	2	10,000	5,000

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		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	600	0	0		13	76,000	4,700	589	241,000	3,800
Penobscot															
1871-2006	18,903	162,377,000	7,900	6,571	17,283,000	2,700	329	1,400,000	4,300	0	0		25,803	181,061,000	7,400
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
2015	348	2,640,000	7,600	381	780,000	2,000	0	0		0	0		729	3,420,000	4,700
2016	134	885,000	6,600	635	1,530,000	2,400	0	0		0	0		769	2,415,000	3,100
Total Penobscot	21,417	182,232,000	7,800	10,757	30,600,000	3,200	329	1,400,000	4,300	0	0		32,503	214,233,000	5,200
Pleasant															
2001-2006	0	0		0	0		219	945,000	5,300	0	0		219	945,000	5,300
2007	0	0		0	0		77	275,000	3,600	0	0		77	275,000	3,600
2008	0	0		14	66,000	4,700	47	139,000	3,000	0	0		61	205,000	3,400
2009	0	0		3	20,000	6,500	54	230,000	4,200	0	0		57	249,000	4,400
2010	0	0		30	186,000	6,200	12	42,000	3,500	0	0		42	228,000	5,400
2011	0	0		4	35,000	8,800	26	124,000	4,800	0	0		30	159,000	5,300
2012	0	0		68	133,000	2,000	55	145,000	2,600	0	0		123	278,000	2,300

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.

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	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
Year															
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
2015	0	0		0	0		63	214,000	3,400	0	0		63	214,000	3,400
2016	0	0		0	0		53	235,000	4,400	0	0		53	235,000	4,400
Total Pleasant	0	0		123	469,000	5,900	758	2,870,000	3,791	0	0		881	3,338,000	4,000
Sheepscot															
1995-2006	18	125,000	6,900	0	0		819	3,249,000	3,800	45	438,000	9,900	882	3,813,000	4,300
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
2015	0	0		0	0		85	317,000	3,700	0	0		85	317,000	3,700
2016	0	0		0	0		133	109,000	800	0	0		133	109,000	800
Total Sheepscot	18	125,000	6,900	0	0	0	1,645	5,835,000	3,327	45	438,000	9,900	1,708	6,399,000	3,400
St Croix															
1993-2006	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															
1974-2006	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Total Union	600	4,611,000	7,900	0	0	0	0	0		0	0		600	4,611,000	7,900

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.
Note: Totals of eggs/female includes only the years for which information on number of females is available. It is a simple ratio of eggs/female and should not be used as an age specific fecundity measure because this can vary with age composition and broodstock type. Note: Connecticut data are preliminary prior to 1990.

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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	7,300	33,792	209,421,000	6,500	0	0		2,395	28,935,000	9,600	38,258	259,620,000	6,700
Dennys	26	214,000	7,600	125	687,000	4,600	1,515	6,539,000	4,600	40	330,000	7,700	1,706	7,770,000	4,700
East Machias	0	0		0	0		1,788	7,354,000	4,200	0	0		1,788	7,354,000	4,200
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		2,986	11,838,000	3,700	8	52,000	6,400	3,450	15,153,000	3,800
Merrimack	1,582	12,306,000	7,800	12,577	60,812,000	3,900	0	0		540	5,709,000	11,000	14,699	78,827,000	4,700
Narraguagus	0	1,303,000		0	0		3,087	11,899,000	4,100	0	0		3,087	13,202,000	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	500	0	0		13	76,000	4,700	589	241,000	3,800
Penobscot	21,417	182,232,000	7,800	10,757	30,600,000	3,200	329	1,400,000	4,300	0	0		32,503	214,232,000	5,200
Pleasant	0	0		123	468,000	5,900	758	2,869,000	3,800	0	0		881	3,337,000	4,000
Sheepscot	18	125,000	6,900	0	0		1,645	5,835,000	3,300	45	438,000	9,900	1,708	6,399,000	3,400
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	**26,282**	**226,139,000**	**8,600**	**57,930**	**301,996,000**	**5,200**	**12,108**	**47,734,000**	**3,900**	**3,041**	**35,540,000**	**11,700**	**99,361**	**611,410,000**	**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								
2001-2006	0	7,000	0	0	0	0	0	7,000
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
2015	0	2,000	0	0	0	0	0	2,000
2016	0	2,000	0	0	0	0	0	2,000
Totals: Androscoggin	**0**	**20,000**	**0**	**0**	**0**	**500**	**0**	**20,500**
Aroostook								
1978-2006	0	2,579,000	317,400	38,600	0	32,600	29,800	2,997,400
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
2015	0	1,000	0	0	0	0	0	1,000
Totals: Aroostook	**0**	**6,901,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**7,319,400**
Cocheco								
1988-2006	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								
1967-2006	0	114,055,000	2,834,300	1,812,800	12,600	3,770,700	1,335,100	123,820,500
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
2015	0	391,000	0	0	0	0	0	391,000
2016	0	64,000	0	0	0	0	0	64,000
Totals: Connecticut	**0**	**149,180,000**	**2,849,700**	**1,836,700**	**64,700**	**3,771,900**	**1,828,100**	**159,531,100**

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Number of fish stocked by life stage

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Dennys								
1975-2006	0	2,129,000	225,400	7,300	0	476,200	29,200	2,867,100
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
2015	0	110,000	0	0	0	0	0	110,000
2016	0	343,000	0	0	0	0	0	343,000
Totals: Dennys	**0**	**4,501,000**	**225,400**	**7,300**	**0**	**532,700**	**30,000**	**5,296,400**
Ducktrap								
1986-2006	0	68,000	0	0	0	0	0	68,000
Totals: Ducktrap	**0**	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias								
1973-2006	0	2,491,000	7,500	42,600	0	108,400	30,400	2,679,900
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
2015	0	11,000	192,000	0	0	0	0	203,000
2016	0	12,000	199,700	0	0	0	0	211,700
Totals: East Machias	**0**	**3,776,000**	**679,800**	**42,600**	**0**	**108,400**	**30,400**	**4,637,200**
Kennebec								
2001-2006	40,000	146,000	0	0	0	0	0	185,598
2007	34,000	20,000	0	0	0	0	0	53,878
2008	246,000	3,000	0	0	0	0	0	249,331
2009	159,000	2,000	0	0	0	200	0	161,609
2010	600,000	147,000	0	0	0	0	0	746,849
2011	810,000	2,000	0	0	0	0	0	811,500
2012	921,000	2,000	0	0	0	0	0	922,888
2013	654,000	2,000	0	0	0	600	0	656,682
2014	1151,000	2,000	0	0	0	0	0	1,153,330
2015	275,000	2,000	0	0	0	0	0	276,587
2016	619,000	3,000	0	0	0	0	0	622,364
Totals: Kennebec	**5,509,000**	**331,000**	**0**	**0**	**0**	**800**	**0**	**5,840,616**
Lamprey								
1978-2006	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**

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Number of fish stocked by life stage

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Machias								
1970-2006	0	3,964,000	98,900	119,800	0	191,300	44,100	4,418,100
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	27,000	210,000	400	0	0	0	0	237,387
2015	49,000	503,000	500	0	0	0	0	552,732
2016	40,000	186,000	0	0	0	0	0	226,348
Totals: Machias	**116,000**	**7,469,000**	**101,000**	**125,700**	**0**	**250,400**	**44,100**	**8,106,767**
Merrimack								
1975-2006	0	34,318,000	232,600	598,100	0	1,569,000	638,100	37,355,800
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
2015	0	4,000	0	0	0	0	0	4,000
2016	0	4,000	0	0	0	0	100	4,100
Totals: Merrimack	**0**	**41,795,000**	**431,800**	**658,200**	**0**	**1,981,500**	**638,200**	**45,504,700**
Narraguagus								
1970-2006	0	3,800,000	80,400	14,600	0	107,800	84,000	4,086,800
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	79,000	263,000	0	0	0	0	0	342,145
2015	0	165,000	0	0	0	0	0	165,000
2016	0	219,000	0	0	0	97,100	0	316,100
Totals: Narraguagus	**79,000**	**7,567,000**	**117,100**	**14,600**	**0**	**497,300**	**84,000**	**8,359,145**
Pawcatuck								
1979-2006	0	5,472,000	1,209,200	263,200	0	105,800	500	7,050,700
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
2009	0	86,000	0	0	0	5,400	0	91,400
2010	0	290,000	0	0	0	3,900	0	293,900

Number of fish stocked by life stage

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
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
2015	0	7,000	0	0	0	0	0	7,000
2016	0	7,000	0	0	0	1,200	0	8,200
Totals: Pawcatuck	**0**	**6,315,000**	**1,209,200**	**268,100**	**0**	**128,700**	**500**	**7,921,500**

Penobscot

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
1970-2006	0	19,155,000	4,861,700	1,394,400	0	13,820,900	2,508,200	41,740,200
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	353,000	1,073,000	325,700	0	0	555,200	0	2,306,679
2013	233,000	722,000	214,000	0	0	553,000	0	1,722,193
2014	89,000	815,000	0	0	0	557,700	0	1,461,360
2015	89,000	518,000	257,800	0	0	375,600	0	1,240,580
2016	473,000	1,025,000	263,200	0	0	569,300	0	2,330,673
Totals: Penobscot	**1,237,000**	**29,136,000**	**7,205,800**	**1,394,400**	**0**	**19,228,400**	**2,508,200**	**60,709,785**

Pleasant

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
1975-2006	0	647,000	16,000	1,800	0	63,400	42,100	770,300
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	46,000	114,000	0	0	0	0	0	159,500
2015	0	183,000	0	0	0	0	0	183,000
2016	63,000	53,000	0	0	0	0	0	115,700
Totals: Pleasant	**109,000**	**1,928,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**2,343,300**

Saco

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
1975-2006	0	5,256,000	438,700	219,200	0	345,800	9,500	6,269,200
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
2015	0	702,000	25,000	0	0	11,700	0	738,700
Totals: Saco	**0**	**8,514,000**	**514,900**	**232,000**	**0**	**432,100**	**9,500**	**9,702,500**

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Number of fish stocked by life stage

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Sheepscot								
1971-2006	18,000	2,410,000	132,900	20,600	0	92,200	7,100	2,680,600
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	9,000	114,000	14,500	0	0	0	0	137,500
2011	0	129,000	15,000	0	0	0	0	144,000
2012	70,000	50,000	15,700	0	0	0	0	136,069
2013	122,000	18,000	14,000	0	0	0	0	154,476
2014	118,000	23,000	15,000	0	0	0	0	155,668
2015	118,000	19,000	14,200	0	0	0	0	150,868
2016	209,000	20,000	15,400	0	0	0	0	244,170
Totals: Sheepscot	**664,000**	**3,384,000**	**267,600**	**20,600**	**0**	**92,200**	**7,100**	**4,435,251**
St Croix								
1981-2006	0	1,268,000	498,000	158,300	0	808,000	20,100	2,752,400
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
2015	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								
1971-2006	0	440,000	371,400	0	0	379,700	251,000	1,442,100
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
2015	0	25,000	0	0	0	0	0	25,000
2016	0	26,000	0	0	0	0	0	26,000
Totals: Union	**0**	**629,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,631,100**
Upper St. John								
1979-2006	0	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
Totals: Upper St. John	**0**	**2,165,000**	**1,456,700**	**14,700**	**0**	**5,100**	**27,700**	**3,669,200**

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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	19,000	0	0	0	500	0	**19,900**
Aroostook	0	6,901,000	317,400	38,600	0	32,600	29,800	**7,319,400**
Cocheco	0	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	0	149,179,000	2,849,700	1,836,700	64,800	3,771,900	1,828,200	**159,465,200**
Dennys	0	4,501,000	225,400	7,300	0	532,800	30,000	**5,296,800**
Ducktrap	0	68,000	0	0	0	0	0	**68,000**
East Machias	0	3,774,000	679,800	42,600	0	108,400	30,400	**4,635,600**
Kennebec	5,509,000	331,000	0	0	0	900	0	**5,840,900**
Lamprey	0	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	117,000	7,470,000	100,900	125,600	0	250,400	44,100	**8,107,300**
Merrimack	0	41,795,000	431,700	658,100	0	1,981,400	638,300	**45,504,600**
Narraguagus	79,000	7,568,000	117,100	14,600	0	497,400	84,000	**8,360,200**
Pawcatuck	0	6,314,000	1,209,200	268,100	0	128,700	500	**7,920,700**
Penobscot	1,237,000	29,135,000	7,205,800	1,394,400	0	19,228,400	2,508,200	**60,708,600**
Pleasant	108,000	1,929,000	16,000	1,800	0	247,000	42,400	**2,344,200**
Saco	0	8,514,000	514,800	232,000	0	432,000	9,500	**9,702,500**
Sheepscot	664,000	3,385,000	267,500	20,600	0	92,200	7,100	**4,435,800**
St Croix	0	1,270,000	498,000	158,300	0	808,000	20,100	**2,754,200**
Union	0	628,000	371,400	0	0	379,700	251,000	**1,630,500**
Upper StJohn	0	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**278,498,000**	**16,739,200**	**4,882,800**	**64,800**	**28,704,100**		**5,584,000**	**342,121,400**

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									
1983-2006	37	532	6	2	6	84	0	1	**668**
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**
2012	0	0	0	0	0	0	0	0	**0**
2013	0	1	0	0	0	1	0	0	**2**
2014	0	2	0	0	0	1	0	0	**3**
2015	0	0	0	0	0	1	0	0	**1**
2016	0	0	0	0	0	6	0	0	**6**
Total for Androscoggin	57	602	6	2	10	115	0	1	**793**
Cocheco									
1992-2006	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1974-2006	49	3,540	28	2	95	1,777	12	1	**5,504**
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**
2015	0	0	0	0	4	18	0	0	**22**
2016	0	0	0	0	0	5	0	0	**5**
Total for Connecticut	58	3,612	28	2	140	2371	14	3	**6,228**
Dennys									
1967-2006	37	316	0	1	32	745	3	31	**1,165**
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**

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	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									
1985-2006	0	0	0	0	3	30	0	0	**33**
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-2006	21	250	1	2	12	329	1	10	**626**
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-2006	16	195	5	1	3	11	0	0	**231**
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**
2015	0	2	0	0	3	26	0	0	**31**
2016	0	0	0	0	1	38	0	0	**39**
Total for Kennebec	24	260	6	7	16	158	0	0	**471**
Lamprey									
1979-2006	10	17	1	0	13	16	0	0	**57**
Total for Lamprey	10	17	1	0	13	16	0	0	**57**
Machias									
1967-2006	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									
1982-2006	324	1,300	22	8	127	999	26	0	**2,806**
2007	8	52	0	0	1	12	1	0	**74**
2008	6	77	0	0	5	29	1	0	**118**
2009	4	41	2	0	1	28	2	0	**78**
2010	29	40	0	0	7	7	1	0	**84**
2011	128	155	12	1	11	90	5	0	**402**
2012	0	81	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**

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	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2015	0	8	1	0	0	3	1	0	**13**
2016	1	1	0	0	0	3	0	0	**5**
Total for Merrimack	504	1,786	53	12	153	1220	40	0	**3,768**
Narraguagus									
1967-2006	92	650	19	54	93	2,420	71	155	**3,554**
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**
2015	0	0	0	0	0	3	0	0	**3**
2016	0	0	0	0	0	3	0	0	**3**
Total for Narraguagus	185	804	23	56	123	2495	72	160	**3,918**
Pawcatuck									
1982-2006	2	148	1	0	1	17	1	0	**170**
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**
2015	0	0	0	0	0	0	0	0	**0**
2016	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot									
1968-2006	11,070	43,838	288	709	691	3,754	35	99	**60,484**
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**
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**

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	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2015	110	552	7	1	9	52	0	0	**731**
2016	208	218	2	1	11	67	0	0	**507**
Total for Penobscot	13,762	52,106	313	746	858	4503	37	102	**72,427**
Pleasant									
1967-2006	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									
1985-2006	125	598	3	7	28	77	3	0	**841**
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**
2015	1	4	0	0	0	0	0	0	**5**
2016	0	0	0	0	0	2	0	0	**2**
Total for Saco	180	711	5	7	50	121	6	0	**1,080**
Sheepscot									
1967-2006	6	38	0	0	30	358	10	0	**442**
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
Union									
1973-2006	274	1,841	9	28	1	16	0	0	**2,169**
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	115	0	1	**793**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,612	28	2	140	2,371	14	3	**6,228**
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	260	6	7	16	158	0	0	**471**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	504	1,786	53	12	153	1,220	40	0	**3,768**
Narraguagus	185	804	23	56	123	2,495	72	160	**3,918**
Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot	13,762	52,106	313	746	858	4,503	37	102	**72,427**
Pleasant	7	13	0	0	14	231	3	2	**270**
Saco	180	711	5	7	50	121	6	0	**1,080**
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 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
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 2011 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	0	0	3	97	0	0
2010	425	20	0.047	0	25	0	5	70	0	0	0	0	0	0	30	70	0	0
2011	438	12	0.027	0	83	0	17	0	0	0	0			0	100	0	0	
2012	85	3	0.035	0	0	0	0	100		0				0	0	100		
2013	62	0	0.000	0	0		0							0	0			
Total	**10,161**	**1,693**																
Mean			**0.483**	**0**	**6**	**0**	**3**	**70**	**3**	**0**	**3**	**0**	**0**	**0**	**9**	**70**	**7**	**0**

Means includes year classes with complete return data (year classes of 2011and 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 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
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 2011 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	0	0	4	95	1	0
2010	601	29	0.048	0	28	0	7	66	0	0	0	0	0	0	35	66	0	0
2011	601	29	0.048	3	34	0	7	55	0	0	0			3	41	55	0	
2012	173	10	0.058	0	20	0	30	50		0				0	50	50		
2013	186	1	0.005	100	0		0							100	0			
2014	20	0	0.000	0										0				
Total	**14,860**	**2,525**																
Mean			**0.380**	**0**	**12**	**0**	**4**	**68**	**1**	**0**	**4**	**0**	**0**	**0**	**15**	**68**	**6**	**0**

Means includes year classes with complete return data (year classes of 2011and 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 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
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 2011and 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	0	0	100	0	0
2010	85	4	0.047	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
2011	76	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2012	35	0	0.000	0	0	0	0	0		0				0	0	0		
2013	56	0	0.000	0	0		0							0	0			
2014	12	0	0.000	0										0				
Total	**2,373**	**373**																
Mean			**0.263**	**0**	**23**	**0**	**4**	**59**	**0**	**0**	**7**	**0**	**0**	**0**	**28**	**59**	**7**	**0**

Means includes year classes with complete return data (year classes of 2011and later). Page 6 of 16 for Appendix 18.

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 2011and 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	0	0	8	92	0	0
2010	148	8	0.054	0	0	0	0	88	12	0	0	0	0	0	0	88	12	0
2011	89	6	0.067	0	50	0	0	50	0	0	0			0	50	50	0	
2012	102	3	0.030	0	0	0	0	100		0				0	0	100		
2013	11	0	0.000	0	0		0							0	0			
2014	1	0	0.000	0										0				
Total	**4,183**	**1,413**																
Mean			**2.093**	**0**	**1**	**0**	**10**	**65**	**4**	**2**	**8**	**0**	**0**	**0**	**11**	**67**	**13**	**1**

Means includes year classes with complete return data (year classes of 2011and later).

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

Means includes year classes with complete return data (year classes of 2011and later).

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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	0	0	0	0	0	0
2011	1	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2012	1	0	0.000	0	0	0	0	0		0				0	0	0		
2013	1	0	0.000	0	0		0							0	0			
2014	0	0	0.000	0										0				
Total	**631**	**27**																
Mean			**0.130**	**0**	**4**	**1**	**1**	**35**	**0**	**0**	**5**	**0**	**0**	**0**	**5**	**36**	**5**	**0**

Means includes year classes with complete return data (year classes of 2011 and later).Page 10 of 16for Appendix 18.

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 2011and 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	0	0	100	0	0
2010	28	4	0.143	0	50	0	25	25	0	0	0	0	0	0	75	25	0	0
2011	24	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2012	15	1	0.069	0	0	0	0	100		0				0	0	100		
2013	21	0	0.000	0	0		0							0	0			
2014	8	0	0.000	0										0				
Total	**551**	**121**																
Mean			**0.243**	**0**	**19**	**0**	**5**	**59**	**0**	**0**	**0**	**0**	**0**	**0**	**24**	**59**	**0**	**0**

Means includes year classes with complete return data (year classes of 2011 and later). Page 12 of 16 for Appendix 18.

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

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

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
1988	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	11	1	0.095	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1990	27	4	0.146	0	25	0	0	75	0	0	0	0	0	0	25	75	0	0
1991	81	8	0.099	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
1992	40	15	0.373	0	0	0	0	93	0	0	7	0	0	0	0	93	7	0
1993	66	37	0.559	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	67	44	0.652	0	0	0	2	91	0	0	7	0	0	0	2	91	7	0
1995	88	17	0.192	0	0	0	18	82	0	0	0	0	0	0	18	82	0	0
1996	71	12	0.170	0	0	0	8	92	0	0	0	0	0	0	8	92	0	0
1997	91	6	0.066	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	102	8	0.078	0	0	0	25	62	0	0	12	0	0	0	25	62	12	0
1999	71	4	0.056	0	0	0	0	75	0	0	25	0	0	0	0	75	25	0
2000	84	11	0.131	0	9	0	0	73	0	0	18	0	0	0	9	73	18	0
2001	107	20	0.188	0	5	0	5	90	0	0	0	0	0	0	10	90	0	0
2002	89	34	0.381	0	15	0	6	79	0	0	0	0	0	0	21	79	0	0
2003	81	23	0.284	0	17	0	9	70	0	0	4	0	0	0	26	70	4	0
2004	93	36	0.389	0	11	0	0	86	0	0	3	0	0	0	11	86	3	0
2005	84	1	0.012	0	0	0	100	0	0	0	0	0	0	0	100	0	0	0
2006	73	5	0.069	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2007	57	5	0.088	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
2008	63	9	0.143	0	0	0	44	44	0	0	11	0	0	0	44	44	11	0

Means includes year classes with complete return data (year classes of 2011and 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	0	0	9	82	9	0
2010	60	2	0.033	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2011	59	1	0.017	100	0	0	0	0	0	0	0			100	0	0	0	
2012	39	1	0.026	0	0	0	0	100		0				0	0	100		
2013	47	0	0.000	0	0		0							0	0			
Total	**1,717**	**315**																
Mean			**0.190**	**0**	**4**	**0**	**9**	**75**	**0**	**0**	**7**	**0**	**0**	**0**	**13**	**75**	**7**	**0**

Means includes year classes with complete return data (year classes of 2011and 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 2011and 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	0	0	10	88	2	0
2010	100	27	0.270	0	0	0	11	74	0	4	11	0	0	0	11	78	11	0
2011	95	55	0.578	0	0	0	0	89	0	4	7			0	0	93	7	
2012	107	73	0.681	0	0	0	10	86		4				0	10	90		
2013	72	8	0.111	0	0		100							0	100			
2014	82	0	0.000	0										0				
Total	**2,747**	**4,922**																
Mean			**4.951**	**0**	**0**	**0**	**17**	**72**	**1**	**3**	**7**	**0**	**0**	**0**	**17**	**75**	**8**	**0**

Means includes year classes with complete return data (year classes of 2011and 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

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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	0.054	0.000	0.048	0.047	0.143	0.047	0.033	0.270
2011	0.067	0.000	0.048	0.027	0.000	0.000	0.017	0.578
2012	0.030	0.000	0.058	0.035	0.069	0.000	0.026	0.681
2013	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.111
2014	0.000	0.000	0.000		0.000	0.000		0.000
Mean	**2.151**	**0.137**	**0.389**	**0.495**	**0.247**	**0.270**	**0.197**	**5.112**
StDev	**5.276**	**0.415**	**0.455**	**0.709**	**0.266**	**0.304**	**0.173**	**6.459**

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).

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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	79	4	0	4	0	0	0	13	79	8	0
Connecticut (basin)	3	13	0	5	75	2	0	5	0	0	3	18	75	6	0
Farmington	0	25	0	5	62	0	0	7	0	0	0	29	63	8	0
Merrimack	0	3	0	10	71	4	2	9	0	0	0	13	73	13	1
Pawcatuck	0	8	2	2	78	0	0	10	0	0	0	10	80	10	0
Penobscot	0	0	0	19	73	1	3	7	0	0	0	19	76	8	0
Salmon	0	22	0	6	72	0	0	0	0	0	0	28	72	0	0
Westfield	4	4	0	9	76	0	0	7	0	0	4	13	76	7	0
Overall Mean:	**1**	**11**	**0**	**7**	**73**	**1**	**1**	**6**	**0**	**0**	**1**	**18**	**74**	**7**	**0**

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