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

REPORT NO. 37 - 2024 ACTIVITIES

Virtually

March 4 - 6, 2025

Photo Credit: Gretchen Ramlo

PREPARED FOR
U.S. SECTION TO NASCO

Cite As: USASAC (U. S. Atlantic Salmon Assessment Committee). 2025. Annual Report of the U.S. Atlantic Salmon Assessment Committee. Report Number 37 - 2024 activities. Virtual meeting. 192 pp.

Table of Contents

In Dedication:

Ruth Haas-Castro NOAA's Northeast Fisheries Science Center

The USASAC would like to thank and acknowledge Ruth Haas-Castro for over 30 years of work in support of the conservation of Atlantic salmon, both in the US and around the North Atlantic. She has been an active member of the USASAC for many years and her scale aging work for NOAA's Northeast Fisheries Science Center has provided thousands of adult and smolt ages, which have contributed to annual assessments and numerous scientific publications. Her contributions have helped inform salmon conservation and improve management through a better understanding of population dynamics. Thank you Ruth - good luck in retirement and bon voyage.

In Memoriam:

The United States Atlantic Salmon Program suffered a loss this past year.

Peter Burke - Biological Technician USFWS

Peter Burke, known as Pete to his colleagues, worked at the USFWS's Craig Brook National Fish Hatchery as a Biological Technician from 1970 until he retired in 2004. Pete was also a veteran of the U.S. Army, bringing his time as a civil servant to 36 years. His years of dedication to the USFWS's Atlantic salmon program was critical to advancing fish culture and bolstering the population of wild Atlantic salmon throughout the State of Maine. Pete worked diligently throughout his career and was always ready for something new. There were many changes to the hatchery protocols through the years and Pete would always do his best to achieve the goals of the program, follow the direction of his supervisors and share his knowledge with new fish culturists. Pete was always willing to put in a full day of hard work, whether it was spawning adult salmon into the night or delivering young salmon streamside to remote locations in Maine. And yet Pete also knew when the day was done and that home life was just as important as work. He had many diverse hobbies including painting, hiking, camping and square dancing with his wife Sandra. Pete will always be remembered as a kind and caring individual who loved his family of coworkers and in many ways shared his support for the salmon program through public outreach and community service.

Listed are primary contributors to the 2025 U.S. Atlantic Salmon Assessment Committee Report Sections.

Section	Section Title	Contributors
1	National Report for the United States	Jim Hawkes, John Kocik, Ernie Atkinson, John Sweka and Timothy Sheehan
2	Viability Assessment - Gulf of Maine Atlantic Salmon	John Kocik, Ernie Atkinson, John Sweka, Meredith Bartron
3	Gulf of Maine Distinct Population Segment Summary	Ernie Atkinson, Jason Valiere, Jen Noll, Paul Christman, Colby Bruchs, Danielle Frechette and Chris Fredrico
4	Non-Gulf of Maine Distinct Population Segment Summary	Steve Gephard and Ernie Atkinson

Copy editing - Marija Grange

1 U.S. Report Executive Summary

1.1 Abstract

Total returns to U.S. Rivers in 2024 were 1,520 salmon, which is the sum of documented returns to traps and returns estimated by redd counts. Returns to the United States rank 19th out of the 34-year time series (1991-2024) and 31st out of the full 58-year time series (1967-2024). Most returns (1,517; 99.8%) were to the Gulf of Maine Distinct Population Segment (GOM DPS), which includes the Penobscot, Ducktrap, Union, Kennebec, Androscoggin, Sheepscot and eastern Maine coastal rivers. There were only three returns documented outside of the GOM DPS. Documented returns to traps totaled 1,452 and returns estimated by redd counts totaled 68 adult salmon. Overall, 24.8% of the adult returns to the U.S. were 1SW salmon, 73.1% were 2SW salmon and 2.1% were 3SW or repeat spawners. Most (91.3%) returns were of hatchery smolt origin and the balance (8.7%) originated from either natural reproduction, hatchery fry, or planted eggs. Approximately 3,963,600 juvenile salmon (eggs, fry, parr, and smolt) and 3,312 adults were stocked into U.S. Rivers. Atlantic salmon at various origins and life-stages had marks applied during the year, with a total of 114,321 marked individuals released. In 2024, eggs for U.S. hatchery programs were taken from a total of 1,220 females consisting of 298 sea-run females and 922 captive/domestic and domestic females. Total egg take is still being calculated due to late spawning of fish within the hatchery.

1.2 Adult Returns to U.S. Rivers

Total returns to U.S. rivers were 1,520 (Table 1.2.1), which is a decrease from 2023 (1,854, Table 1.2.2). Returns are reported for three Distinct Population Segments (DPS; Figure 1.2.1): Long Island Sound (LIS, zero), Central New England (CNE, three), and Gulf of Maine (GOM, 1,517). The ratio of sea ages for fish sampled at traps and weirs was used to prorate the number of spawners by sea age for adults that weren't sampled (i.e. unsampled adults at traps or estimated via the redd counts). Overall, the majority of the 1,520 adult returns to the U.S. (documented and pro-rated) were 2SW (1,111; 73.1%), with 1SW (377; 24.8%), 3SW (27; 1.8%) and repeat spawners (5; 0.3%) making up the remainder of the total (Table 1.2.2). The percentage of 2SW returns in 2024 (73.1%) was nearly identical to the 10-year average of 73.4% (Figure 1.2.2).

Adult returns were well below conservation spawner requirements (i.e. conservation limit; CL). Returns to 14 monitored rivers represented only 7.6% of the U.S. 2SW CL in these populations. In monitored populations, the Kennebec River ranked the highest at 47.8% of the 2SW CL followed by the Penobscot (15.3%) and Dennys (7.5%; Table 1.2.3). It should be noted that the U.S. 2SW conservation limits were first reported by Baum (1995) and represent accessible habitat only. Only a small amount of habitat in the Kennebec River was accessible in 1995 and therefore the CL was estimated at 67 2SW spawners. In recent years, pre-spawned adult salmon captured at the lowermost main-stem dam have been trucked around barrier dams and released into the Sandy River, a tributary to the Kennebec, resulting in modest numbers of adult spawners. The Sandy River habitat is not considered within the existing estimated CL for the Kennebec, which is why the 'percent CL achieved' is so high for this system. Due to this and other evolving management activities and priorities, the U.S. is working to update our CLs based on the best available information. These updated CLs will be used to track attainment of CLs in the future.

Return Rates:

Marine return rate estimates are calculated based on known smolt migrants (estimated populations of naturally reared or hatchery stocked smolts) and corresponding adult returns. Until 2020, the return rate for Penobscot River hatchery-origin smolts was based on total smolts stocked and subsequent adult returns by sea age to generate a smolt-to-adult return rate (SAR). Beginning in 2021, the time series was revised by using the method proposed by Stevens et al. (2019) to decouple losses of smolts in the river and the estuary to provide an estimate of postsmolts entering the GOM. This method accounted for stocking location and subsequent natural mortality in the riverine and estuarine environments and flow-specific mortality related to dam passage. This postsmolt estimate and subsequent adult returns by sea age to generate a postsmolt-to-adult return rate (PSAR). The U.S. Atlantic Salmon Assessment Committee (USASAC) discussed the approach and agreed it would provide a better estimate of marine return rate by eliminating the impact of stocking location, dams and other river/estuary impacts. Other rivers reported continue to use the SAR to report return rate data.

Calculated return rates are presented in Figure 1.2.3 and Table 1.2.4. Return (PSAR) rates for two sea-winter Penobscot River salmon from the 2022 smolt cohort equaled 0.20%, which was a decrease from the 2021 estimate (0.26%) and greater than the previous five (0.17%) and 10 (0.15%) year means. The 2022 Narraguagus River SAR for the naturally-reared smolt population was 0.88%, which was lower than the previously reported SAR 2021 cohort (1.20%) and lower than the five (1.22%) and 10 (1.23%) year means.

1.3 Description of Fisheries and By-catch in U.S. Waters

All directed fisheries for Atlantic salmon in U.S. waters are closed. The current fishery management plan prohibits their possession as well as any directed fishery or incidental (bycatch) for Atlantic salmon in federal waters. Similar prohibitions exist in state waters. Atlantic salmon found in U.S. waters of the Northeast Shelf could be from four primary sources: 1) GOM DPS (endangered); 2) LIS or CNE DPSs (non-listed); 3) Canadian populations (many southern Canadian stocks are classified as Endangered by Canada); or 4) escaped fish from U.S. or Canadian aquaculture facilities. Bycatch and discard of Atlantic salmon are monitored annually by the Northeast Fisheries Science Center using the Standardized Bycatch Reporting Methodology. While bycatch is uncommon, observed events from 1989 through June 2023 were summarized using published reports and from July 2023 through September 2024 via supplemental data queries of audited unpublished data. Prior to 1993, observers recorded Atlantic salmon as an aggregate weight per haul. Therefore, no individual counts were available for these years, however eight observed interactions occurred. After 1993, observers recorded Atlantic salmon on an individual basis. Since 1993, monitoring has documented eight observed interactions, with a total count of eight individuals. In total, monitoring has detected Atlantic salmon bycatch and interactions across seven statistical areas in the GOM region, primarily in benthic fisheries. Five interactions were observed in bottom otter trawl gear and 11 interactions were observed in sink gillnet gear. Bycatch of Atlantic salmon is a rare event and monitoring has only detected 16 interactions in the 36-year time series (1989-2024) with the most recent detection occurring in February 2024.

1.4 Stock Enhancement Programs

During 2024, approximately 3,963,600 juvenile salmon were released into U.S. Rivers (Table 1.4.1). Of these, 2,151,100 were hatchery fry; 893,000 were planted eyed eggs; 201,400 were parr; and 718,100 were smolts. Most of these restoration stockings were within the GOM DPS with the Connecticut River (LIS) receiving limited allocations of fry (391,100), which continues the legacy program and Salmon-in-Schools programs. In 2024, there was again a significant reduction in parr stocked into the East Machias River due to Infectious Pancreatic Necrosis Virus (IPNV) at the Peter Gray Hatchery. These fish were destroyed once the disease was discovered. More details are presented in Section 1.6 of this report.

Adult salmon were also stocked into U.S. Rivers in 2024. A total of 3,312 adult salmon were released, all of which were stocked into the GOM (Table 1.4.2). The stocked adults were a mix of domestic captive reared and sea run broodstock and the majority were stocked as post-spawned fish (2,828) with the balance being pre-spawned (484).

1.5 Tagging and Marking Programs

Tagging and marking of individual Atlantic salmon of various life stages was used to facilitate a variety of research and assessment programs including identifying the life stage and location of stocking, evaluating juvenile growth and survival, monitoring instream adult and juvenile movement and estuarine smolt movement, etc. A total of 114,321 marked or tagged Atlantic salmon were released into U.S. waters in 2024. Tags and marks for smolts and adults included PIT, Radio, Floy, clips and punches. All releases occurred within the GOM (Table 1.5.1). Reported numbers should be considered estimates as some individuals receive multiple marks or tags and only primary marks and tags are reported here.

1.6 Aquaculture Production and Disease Reporting

Reporting an annual estimate of production of aquaculture reared Atlantic salmon has been discontinued due to confidentiality statutes in Maine Department of Marine Resources (MDMR) regulations since 2010 (Table 1.6.1). Production of aquaculture Atlantic salmon in 2024, is assumed to be similar as in recent decades given that the number of juvenile Atlantic salmon stocked in sea cages hasn't varied greatly over the past 20 years.

In 2024, there were no escapes of aquaculture salmon reported at marine net pen sites in Maine. However, in October 2024 a multi sea winter, possible aquaculture origin, Atlantic salmon (~ 80cm) was reported by Brookfield Power as being captured at the Ellsworth fish lift on the Union River. The fish could not be positively identified as an aquaculture origin fish and according to trap handling protocol, the fish was tagged and scale and fin samples were taken prior to release downriver. The tissue samples were sent to Cooke Aquaculture and the U.S. Fish and Wildlife Service (USFWS) Lamar Fish Technology Center and Northeast Fishery Center genetics lab for analysis. Parentage analysis conducted by Cooke confirmed the fish did not originate from their operations. Lab results from the USFWS to confirm whether the fish originated from the restoration program are still pending. The fish was recaptured several times throughout October and released downstream each time.

In September 2024, an interagency group met to discuss results from a recent routine annual fish health screening conducted on fish prior to stocking into State of Maine waters. Prior testing by the Maine Department of Inland Fisheries and Wildlife Fish Health Laboratory had detected the presence of a virus in Atlantic salmon sampled from the Downeast Salmon Federation (DSF) Peter Gray Hatchery in East Machias. The virus, which was identified as IPNV, has no cure and depopulation is the only means of eradication. Similar to last year, the strain seems to be A6/Canada1. The virus was detected in their East Machias and Narraguagus River stocks of Atlantic salmon, which are grown out at the Peter Grey facility for stock enhancement purposes in cooperation with the USFWS and MDMR. The hatchery was holding approximately 90,000 parr of Narraguagus and East Machias river strains.

Following eradication, the facility received a complete disinfection. The facility is looking into upgrading the current filtration/UV system, which was installed following the infection and depopulation in 2023. Prior to receiving eggs into the facility in 2024, the hatchery staff installed a UV disinfection gallery to their hatchery water intake line to prevent pathogens from entering the hatchery through the water supply. However, the system is undersized and is ineffective at reaching the sterilization levels needed to kill the pathogen.

Every year critically endangered adult Atlantic salmon returning to the Penobscot River are captured for broodstock and held at the Craig Brook National Fish Hatchery until spawning. All of these sea-run fish are screened for specific pathogens of concern. In 2024, there were two fish with HPRO positive detections, a non-pathogenic variant of Infectious Salmon Anemia virus, these fish were released back to the river in the fall.

1.7 Smolt Emigration

NOAA's National Marine Fisheries Service and the MDMR have conducted seasonal activities assessing Atlantic salmon smolt populations using Rotary Screw Traps (RSTs) in selected Maine rivers since 1996. Monitoring has focused on evaluating natural spawning and various restoration stockings by taking measures of length, weight, scale collection and enumerating individuals and/or estimating the population of emigrants via stratified mark-recapture methods (Figure 1.7.1, Table 1.7.1). RSTs are also used to facilitate access to smolts in support of tagging and other sample collection. In 2024, the Narraguagus River was the only river where smolt monitoring took place.

Narraguagus River:

On the Narraguagus River in 2024, MDMR operated smolt traps at two sites including an upper and lower river site to collect size data, scale samples and generate single site mark - recapture population estimates to identify smolt production within these portions of the drainage. Smolt sampling on the Narraguagus River was the 29th year of operation with 25 years of population estimates generated at the lower river site. Naturally-reared (natural spawning, fry stocking and egg planting) and hatchery (fall parr stocking) smolts stocked from the Peter Gray Hatchery (East Machias) in 2021 and 2022, were sampled during the 2024 trapping season.

Lower Site (river km 11.16):

A total of 478 smolts was captured at the lower site (153 naturally reared, 325 hatchery-origin fall parr stocked classified as ambient parr). The estimate of naturally-reared smolts exiting the system was 541 (95% 462 to 620), hatchery origin 1,015 (95% 926 to 1,104) and a total estimate of 1,550 (95% 1,434 to 1,666, Figure 1.7.1, Table 1.7.1). For comparison, the total 2023 estimate was 1,421 (95% 1,252 to 1,590; Figure 1.7.1, Table 1.7.1).

Upper Site (river km 47.69):

Project SHARE, in partnership with MDMR, captured a total of 402 smolts (151 naturally-reared and 251 hatchery-origin smolts) at the upper site. The Upper Narraguagus River naturally-reared smolt population estimate was 352 (95% 304 to 400). The hatchery-origin population estimate was 574 (95% 522 to 626). The combined estimate (natural and hatchery reared) was estimated 914 (95% 852 to 976).

Table 1.2.1. Estimated Atlantic salmon returns to the United States by geographic area, 2024. Natural includes fish originating from natural spawning, stocked and hatchery fry or eggs and hatchery includes fish originating from parr or smolt stocking. Returns are composed of documented returns at traps and returns estimated by redd counts.

Area	1SW Hatchery	1SW Natural	2SW Hatchery	2SW Natural	3SW Hatchery	3SW Natural	Repeat Spawners Hatchery	Repeat Spawners Natural	Total
LIS	-	-	-	-	-	-	-	-	-
CNE	-	-	2	1	-	-	-	-	3
GOM	347	30	1,012	96	22	5	5	-	1,517
Total	347	30	1,014	97	22	5	5	-	1,520

Table 1.2.2. Estimated Atlantic salmon returns to the U.S., 1967-2024. "Natural" includes fish originating from natural spawning and hatchery fry or eggs. "Hatchery" includes Atlantic salmon that were stocked as parr or smolts. Starting in 2003, returns estimated by redd counts are included.

Year	Sea Age 1SW	Sea Age 2SW	Sea Age 3SW	Repeat Spawners	Total	Hatchery Origin	Natural Origin
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

Year	Sea Age 1SW	Sea Age 2SW	Sea Age 3SW	Repeat Spawners	Total	Hatchery Origin	Natural Origin
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
2017	363	663	13	2	1,041	806	235
2018	324	542	2	1	869	764	105
2019	398	1,131	3	3	1,535	1,162	373
2020	234	1,452	22	7	1,715	1,324	391
2021	235	434	7	4	680	521	159
2022	375	1,141	8	5	1,529	1,304	225
2023	130	1,714	8	2	1,854	1,608	246
2024	377	1,111	27	5	1,520	1,388	132

Table 1.2.3. 2024 Two sea winter (SW) returns against 2SW Conservation Limits (CL) for select U.S. Rivers. The adult return numbers include 26 multi sea winter returns (MSW) for the Penobscot River. Although the CL is a 2SW, these MSW fish do contribute eggs and are contributing to the total egg deposition in this system. Habitat units and corresponding CL data are taken from Baum et al. (1995). The U.S. is working to update our CLs based on the best available information and these updated CLs will be used to track attainment of CLs in the future.

DPS	River	Habitat (metric units)	CL	Returns	% CL
GOM	Dennys	2,415	161	12	7.5
GOM	East Machias	2,145	143	0	0.0
GOM	Machias	6,685	446	11	2.5
GOM	Pleasant	1,085	72	4	5.6
GOM	Narraguagus	6,015	401	9	2.2
GOM	Union	8,360	557	1	0.2
GOM	Penobscot	102,575	6,838	1,044	15.3
GOM	Ducktrap	585	39	2	5.1
GOM	Sheepscot	2,845	190	13	6.8
GOM	Kennebec	1,005	67	32	47.8
GOM	Androscoggin	3,175	212	4	1.9
CNE	Saco	12,540	836	1	0.1
CNE	Merrimack	38,980	2,599	2	0.1
LIS	Connecticut	145,900	9,727	0	0.0
	Totals	**334,310**	**22,288**	**1,135**	**7.6**

Table 1.2.4. Time series of 1SW and 2SW smolt-to-adult return rates (SAR) and postsmolt-to-adult return rates (PSAR) for monitored U.S. rivers since 1970. Estimated return rates for monitored rivers are identified as being derived from hatchery origin (Hat.) or naturally-reared origin (NR) and estimated as SAR or PSAR for the Penobscot (PN), Narraguagus (NG), Sheepscot (SHP), East Machias (EM), Sandy, Kennebec (KN), or Kennebec-Androscoggin (KN-AN) watersheds. Blank cells indicate that an estimate is not available due to smolt estimates not being calculated one or two years prior. The previous five and ten-year averages are included.

Smolt Year	PN (Hat/PSAR) 1SW	PN (Hat/PSAR) 2SW	NG (NR/SAR) 1SW	NG (NR/SAR) 2SW	SHP (NR/SAR) 1SW	SHP (NR/SAR) 2SW	EM (NR/SAR) 1SW	EM (NR/SAR) 2SW	Sandy (NR/SAR) 1SW	Sandy (NR/SAR) 2SW	KN (Hat/SAR) 1SW	KN (Hat/SAR) 2SW	KN-AN (Hat/SAR) 1SW	KN-AN (Hat/SAR) 2SW
1970	0.11%	1.56%												
1971	0.03%	0.82%												
1972	0.02%	1.23%												
1973	0.05%	1.58%												
1974	0.06%	0.72%												
1975	0.11%	0.84%												
1976	0.04%	1.30%												
1977	0.08%	0.39%												
1978	0.19%	2.34%												
1979	0.58%	2.13%												
1980	0.29%	1.52%												
1981	0.17%	0.60%												
1982	0.16%	1.11%												
1983	0.12%	1.26%												
1984	0.10%	1.34%												
1985	0.23%	0.61%												
1986	0.32%	0.88%												
1987	0.30%	0.85%												
1988	0.39%	1.14%												
1989	0.21%	0.52%												
1990	0.10%	0.69%												
1991	0.41%	0.55%												
1992	0.16%	0.29%												

1993	0.18%	0.70%

Smolt Year	PN (Hat/PSAR) 1SW	PN (Hat/PSAR) 2SW	NG (NR/SAR) 1SW	NG (NR/SAR) 2SW	SHP (NR/SAR) 1SW	SHP (NR/SAR) 2SW	EM (NR/SAR) 1SW	EM (NR/SAR) 2SW	Sandy (NR/SAR) 1SW	Sandy (NR/SAR) 2SW	KN (Hat/SAR) 1SW	KN (Hat/SAR) 2SW	KN-AN (Hat/SAR) 1SW	KN-AN (Hat/SAR) 2SW
1994	0.10%	0.75%												
1995	0.11%	0.22%												
1996	0.10%	0.33%												
1997	0.10%	0.25%	0.11%	0.90%										
1998	0.12%	0.15%	0.25%	0.28%										
1999	0.10%	0.29%	0.31%	0.53%										
2000	0.10%	0.18%	0.28%	0.17%										
2001	0.23%	0.53%	0.16%	0.85%										
2002	0.13%	0.61%	0.00%	0.46%										
2003	0.17%	0.41%	0.08%	1.01%										
2004	0.17%	0.41%	0.08%	0.98%										
2005	0.17%	0.28%	0.24%	0.73%										
2006	0.10%	0.60%	0.09%	0.78%										
2007	0.30%	0.71%	0.34%	1.72%										
2008	0.08%	0.36%	0.44%	0.65%										
2009	0.17%	0.90%	0.26%	1.80%	0.28%	0.84%								
2010	0.30%	0.23%	0.95%	0.61%	0.10%	0.33%								
2011	0.00%	0.12%	0.00%	0.72%	0.10%	0.26%								
2012	0.03%	0.10%	0.00%	0.68%	0.08%	0.83%								
2013	0.03%	0.20%	0.00%	2.35%	0.17%	0.33%	0.75%	2.07%						
2014	0.02%	0.05%	0.00%	0.57%	0.13%	0.44%	0.32%	1.37%						
2015	0.07%	0.15%	0.00%	0.62%	0.13%	0.98%	1.21%	2.83%						
2016	0.06%	0.09%			0.14%	0.14%	0.18%	1.10%						
2017	0.06%	0.16%			0.08%	0.83%	0.14%	2.23%						
2018	0.06%	0.22%	1.99%	3.31%	0.33%	0.72%	0.80%	2.01%						
2019	0.04%	0.06%	0.27%	0.40%	0.21%	0.64%	0.33%	1.31%						
2020	0.04%	0.17%									0.00%	0.01%	0.01%	0.02%
2021	0.06%	0.26%	0.49%	1.20%			0.36%	1.69%	0.05%	0.44%	0.03%	0.09%	0.04%	0.10%
2022	0.02%	0.20%	0.39%	0.88%					0.01%	0.10%	0.01%	0.02%	0.01%	0.03%
2023	0.07%		0.07%								0.02%		0.03%	

Table 1.3.1. Overview of Northeast Fisheries Observer Program and At-Sea Monitoring Program documentation of Atlantic salmon bycatch. A minimum of one fish is represented by each interaction count. Total weights for 1990 and 1992 may represent 1 or more fish, whereas post-1992 weights represent individual fish. Visual representation of the statistical areas can be referenced in Figure 1.3.1; below.

Year	Month	Statistical Area	Interaction Count	Total Weight (kg)
1990	June	512	1	0.5
1992	June	537	1	1.4
1992	November	537	6	10.4
2004	March	522	1	0.9
2005	April	522	1	1.8
2005	May	525	1	1.3
2009	March	514	1	4.1
2011	June	513	1	5.0
2013	April	515	1	4.1
2013	August	513	1	3.2
2024	February	515	1	1.4
		Totals	16	34.1

Table 1.4.1. Number of juvenile Atlantic salmon by life-stage stocked in U.S., 2024, by Distinct Population Segment (DPS) which includes: Central New England (CNE); Gulf of Maine (GOM); Long Island Sound (LIS) and drainage. Parr and smolt life stages broken out into age categories.

DPS	River	0 Parr	1 Parr	1 Smolt	2 Smolt	Eyed Egg	Fry	Total
LIS	Connecticut	-	-	-	-	-	391,100	391,100
GOM	Androscoggin	-	-	200	-	-	7,000	7,200
GOM	Dennys	-	-	-	-	-	228,000	228,000
GOM	East Machias	-	-	-	-	-	269,000	269,000
GOM	Kennebec	-	-	86,700	-	486,000	3,000	575,700
GOM	Machias	-	-	-	-	-	264,000	264,000
GOM	Narraguagus	-	-	-	-	-	306,000	306,000
GOM	Penobscot	185,600	-	631,200	-	197,000	370,000	1,383,800
GOM	Pleasant	-	-	-	-	100,000	208,000	308,000
GOM	Sheepscot	15,800	-	-	-	110,000	104,000	229,800
GOM	Union	-	-	-	-	-	1,000	1,000
		201,400	-	718,100	-	893,000	2,151,100	3,963,600

Table 1.4.2. Stocking summary for sea-run, captive reared domestic adult Atlantic salmon for the U.S. in 2024 by purpose and geographic area. Areas represented include: Long Island Sound (LIS), Central New England (CNE) and Gulf of Maine (GOM).

Area	Purpose	Captive Reared Domestic Pre-spawn	Captive Reared Domestic Post-spawn	Sea Run Pre-spawn	Sea Run Post-spawn	Total
LIS	-	-	-	-	-	0
CNE	-	-	-	-	-	0
GOM	Restoration	482	2,245	2	583	3,312
Total U.S.		482	2,245	2	583	3,312

Table 1.5.1. Summary of primary mark/tag applied for wild and hatchery origin Atlantic salmon released in the United States during 2024 by Distinct Population Segments (Long Island Sound (LIS), Central New England (CNE) and Gulf of Maine (GOM)). Reported numbers should be considered estimates as some individuals receive multiple marks or tags and only primary marks and tags are reported here.

Mark/Tag	Life Stage	CNE	GOM	LIS	Total
Adipose clip	Smolt	-	111,832	-	111,832
Radio Tag	Smolt	-	379	-	379
Adipose clip	Adult	-	1	-	1
Adipose punch	Adult	-	56	-	56
Upper Caudal Punch	Adult	-	15	-	15
Passive Integrated Transponder (PIT)	Adult	-	2,002	-	2,002
Radio Tag	Adult	-	33	-	33
Floy Tag	Adult	-	3	-	3
		-	114,321	-	114,321

Table 1.6.1. State of Maine U.S. commercial Atlantic salmon aquaculture production and suspected aquaculture captures to Maine rivers 2000 to 2024. Due to confidentiality statutes in Maine Department of Marine Resources (MDMR) regulations related to single producer, adult production rates are not available 2011 to 2024 because of confidentiality statutes in MDMR regulations, these years are represented by an "NA" designation.

Year	Total Salmon Stocked (smolt + fall parr + clips)	RV clipped fish stocked	Harvest total (metric tons)	Suspect aquaculture origin captures (Maine DPS Rivers)
2000	4,511,361		16,461	34
2001	4,205,161		13,202	84
2002	3,952,076		67,988	15
2003	2,660,620		6,007	4
2004	1,580,725		8,514	0
2005	294,544		5,263	12
2006	3,030,492	252,875	4,674	5
2007	2,172,690	154,850	2,715	0
2008	1,470,690		9,014	0
2009	2,790,428		6,028	0
2010	2,156,381	128,716	11,127	0
2011	1,838,642	45,188	NA	3
2012	1,947,799	137,207	NA	7
2013	1,329,371	170,024	NA	0
2014	2,285,000	0	NA	0
2015	1,983,850	446,129	NA	0
2016	1,892,511	262,410	NA	3
2017	2,224,348	211,043	NA	0
2018	2,035,690	45,000	NA	0
2019	1,996,662	60,480	NA	0
2020	2,225,000	40,000	NA	0
2021	2,080,309	31,140	NA	4
2022	1,983,106	54,174	NA	0

Year	Total Salmon Stocked (smolt + fall parr + clips)	RV clipped fish stocked	Harvest total (metric tons)	Suspect aquaculture origin captures (Maine DPS Rivers)
2023	1,965,852	3,023	NA	0
2024	1,168,801	2,285	NA	1

Table 1.7.1. Smolt population estimates ± Std. Error (SE) from maximum likelihood estimates for the Narraguagus (NG; 1997 - 2022: natural spawning, fry stocking, egg planting; 2023 - forward: includes ambient parr stocking), Sandy (LKB; egg planting), Sheepscot (SHP; natural spawning, fry stocking, egg planting and parr stocking), East Machias (EM; natural spawning, fry stocking, parr stocking) and Piscataquis (PI; natural spawning and fry stocking) rivers. Blank cells indicate that no population estimates were derived during a particular year. **Note: Starting in 2023, the NG population estimate includes both naturally reared fish and stocked ambient parr. Prior to 2023, the NG population estimate only included naturally reared fish. Specific lifestage/origin estimates have been generated for some rivers and can be found within annual Maine Smolts Update working papers**.

Smolt Year	NG SE Lower	NG Pop Est.	NG SE Upper	LKB SE Lower	LKB Pop Est.	LKB SE Upper	SHP SE Lower	SHP Pop Est.	SHP SE Upper	EM SE Lower	EM Pop Est.	EM SE Upper	PI SE Lower	PI Pop Est.	PI SE Upper
1997	2,429	2,869	3,309												
1998	2,594	2,845	3,096												
1999	3,711	4,247	4,783												
2000	1,601	1,843	2,085												
2001	2,191	2,562	2,933												
2002	1,536	1,774	2,012												
2003	1,096	1,201	1,306												
2004	1,069	1,284	1,499												
2005	1,062	1,287	1,512												
2006	2,137	2,339	2,541												
2007	1,063	1,177	1,291												
2008	796	962	1,128										4,213	5,851	7,489
2009	1,086	1,176	1,266				1,661	1,813	1,965				5,554	6,885	8,216
2010	1,922	2,149	2,376				3,572	3,944	4,316				8,438	9,667	10,896
2011	1,023	1,404	1,785				2,706	3,176	3,646				5,929	8,404	10,879
2012	725	969	1,213				2,132	2,507	2,882				1,513	1,732	1,951
2013	974	1,237	1,500				2,799	3,036	3,273	463	556	649	5,561	5,860	6,159
2014	1,417	1,615	1,813				1,416	1,650	1,884	814	1,019	1,224	3,185	3,538	3,891
2015	960	1,201	1,442				1,372	1,558	1,744	212	263	314	4,007	4,278	4,549
2016							2,662	2,924	3,186	916	1,210	1,504			
2017							2,149	2,758	3,367	1,248	1,501	1,754			
2018	483	604	725				1,295	1,652	2,009	863	1,049	1,235			
2019	627	829	1,031				1,244	1,442	1,640	1,056	1,289	1,522			
2020															
2021	1,334	1,426	1,518	11,935	13,229	14,523				714	881	1,048			

Smolt Year	NG SE Lower	NG Pop Est.	NG SE Upper	LKB SE Lower	LKB Pop Est.	LKB SE Upper	SHP SE Lower	SHP Pop Est.	SHP SE Upper	EM SE Lower	EM Pop Est.	EM SE Upper	PI SE Lower	PI Pop Est.	PI SE Upper
2022	949	1,031	1,113	9,080	9,694	10,308									
2023	1,252	1,421	1,590												
2024	1,434	1,550	1,666												

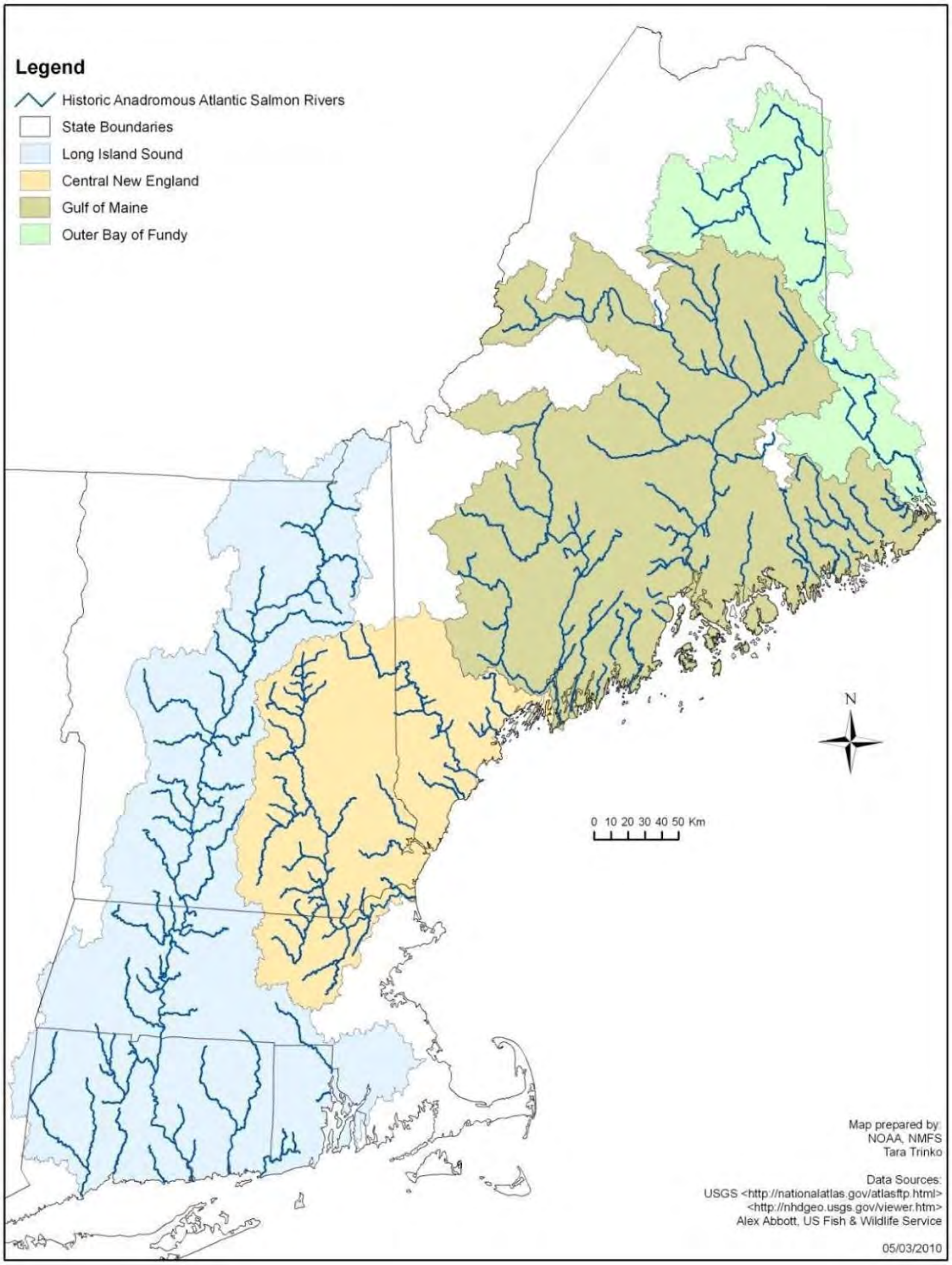


Figure 1.2.1. Map of Distinct Population Segments (DPS) used in summaries of United States data for returns, stocking, and marking in 2024.

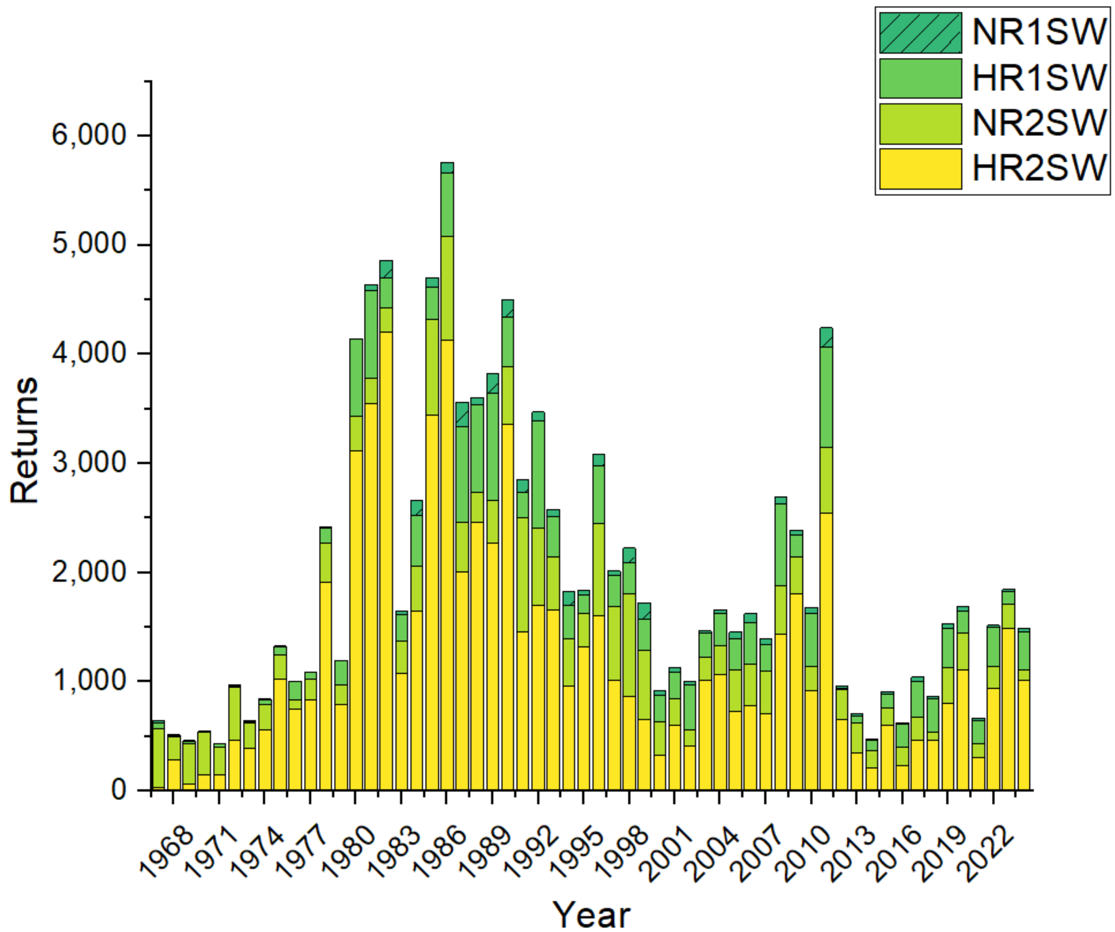
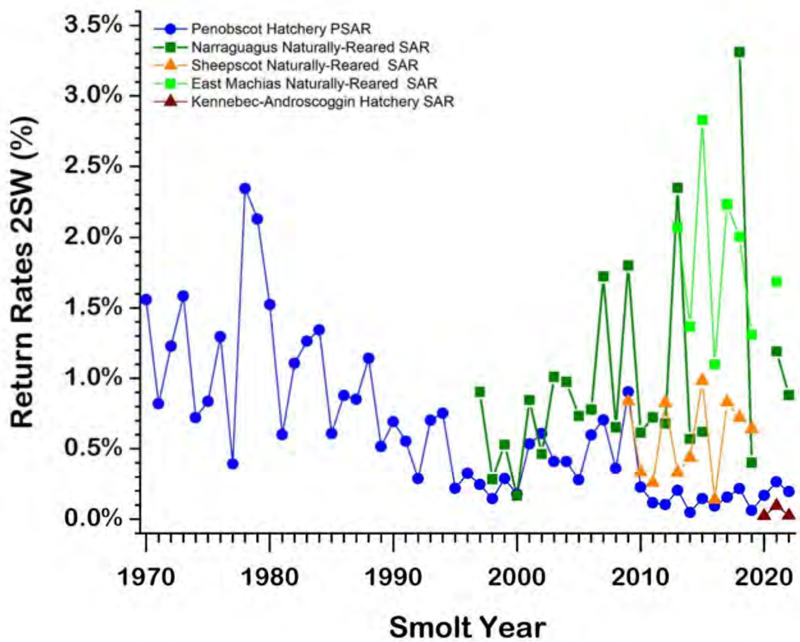


Figure 1.2.2. Origin and sea age (age 1 and 2 only) Atlantic salmon returning to U.S. rivers, 1967 to 2024 (NR1SW = Naturally Reared One Sea Winter; HR1SW = Hatchery Reared One Sea Winter; NR2SW = Naturally Reared Two Sea Winter; HR2SW = Hatchery Reared Two Sea Winter).



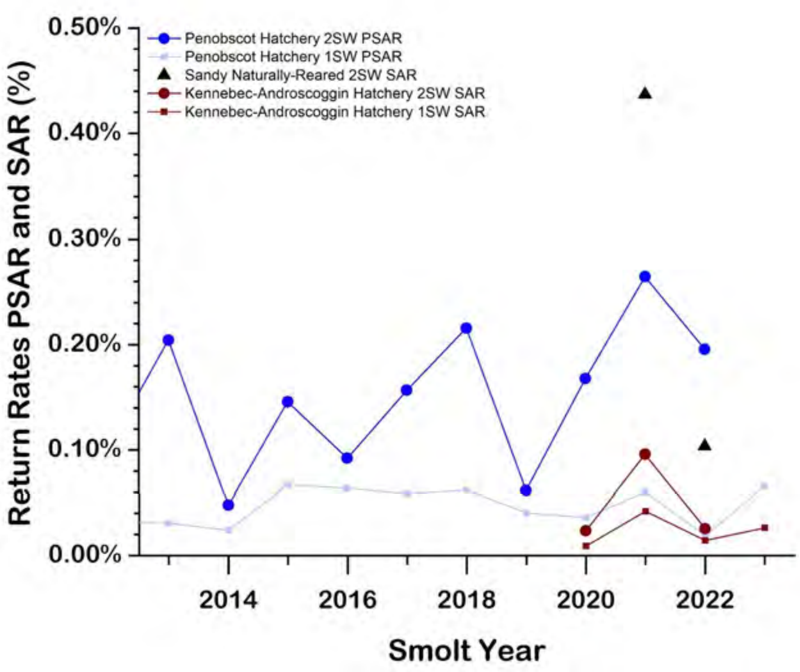


Figure 1.2.3. Top panel: time series since 1970 (top panel) smolt cohort for smolt-to-adult (SAR) and postsmolt-to-adult (PSAR) return rates for 2SW adults for monitored Maine Watersheds (and origins): Narraguagus (naturally-reared), Sheepscot (naturally-reared), East Machias (naturally-reared), Penobscot (hatchery), Kennebec-Androscoggin (hatchery). Lower panel: returns at 1SW and 2SW to larger rivers from Penobscot hatchery smolts (PSAR), Kennebec-Androscoggin hatchery smolts (SAR), and naturally reared smolts from the Sandy River in the Kennebec watershed (2SW only) by return year since 2013.

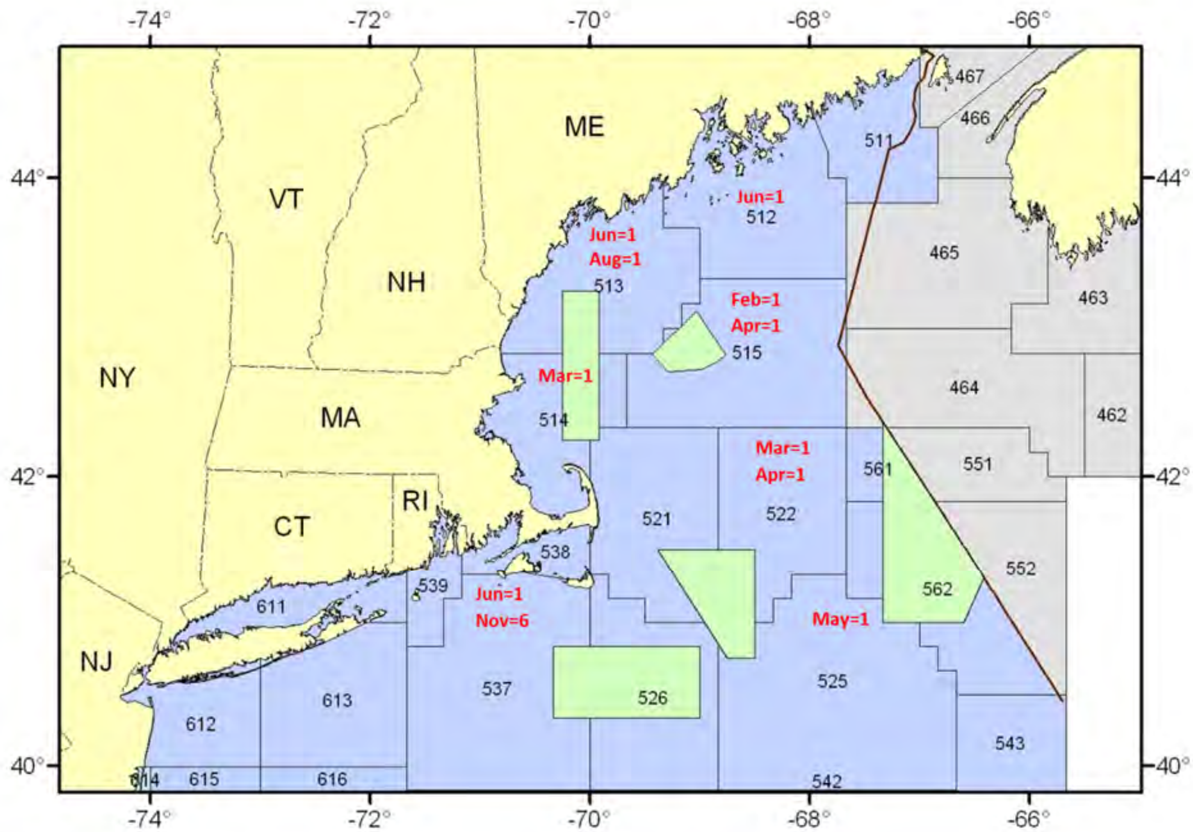


Figure 1.3.1. Map of Gulf of Maine region showing the month and number of Atlantic salmon interactions between 1993 and 2024. Blue polygons are U.S. statistical areas, grey zones are in Canada and green-shaded polygons represent regulated access areas. Red text highlights the month and number of individuals for each documented interaction within each statistical area. Location of the label within the statistical grid does not denote more specific locations. Summary data found within Table 1.3.1; above.

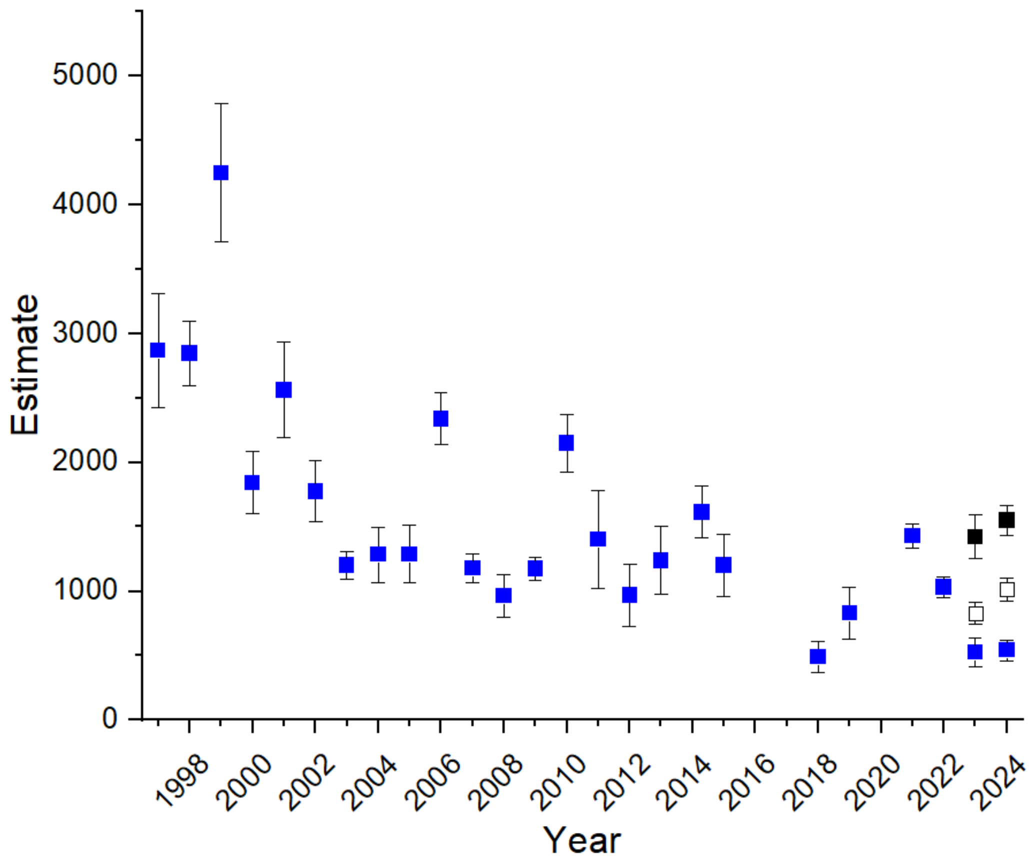


Figure 1.7.1. Population Estimates (± Std. Error) of emigrating smolts on the Narraguagus in Maine U.S. Blue boxes represent naturally reared smolts only (product of wild spawning, egg planting and fry stocking), open boxes represent parr only (stocked) and black boxes represent total estimate (naturally reared and ambient parr combined).

2 Viability Assessment - Gulf of Maine Atlantic Salmon

2.1 Executive Summary of DPS and Annual Viability Synthesis 2024

The adult Atlantic salmon **abundance** of the 2024 Gulf of Maine Distinct Population Segment (GOM DPS) spawning run (1,517 estimated adult returns) was ranked 13th out of 34 cohorts since 1991. Hatchery-origin adults (n = 1,386) represented 91% of the returns. Naturally-reared returns remained low across the GOM DPS (131) totaling 63 in Penobscot Bay (PNB), 44 in Downeast Coastal (DEC) and 24 in Merrymeeting Bay (MMB) Salmon Habitat Recovery Units (SHRUs). About 48% of all naturally-reared returns were documented in the PNB SHRU. However, abundance remains critically low relative to interim recovery targets of 500 naturally-reared returns per SHRU. The PNB SHRU was at 12.6% of this target, 2.6-fold higher than returns to the MMB SHRU (4.8%). Natural returns to the DEC SHRU estimated at 44 were only 8.8% of the target. In 2024, the Ducktrap River Population in the PNB SHRU remains at an elevated extirpation risk with only three estimated returns. In the past decade, biologists documented only 17 returns (average = 1.7) and in five of the last 10 years, there were no documented returns to the Ducktrap River. The variation in annual adult returns is primarily a function of return rates driven by both low marine survival and low natural spawner contributions with decreasing conservation hatchery supplementation. These populations remain spawner-limited due to overall adult abundance (returns and hatchery broodstock) remaining below conservation spawning escapement needs.

Population **growth** is monitored by 10-year geometric mean population growth rates of naturally-reared adults (USFWS & NMFS 2018). The GOM DPS rate for 2024 returns was 1.14% (95% confidence limits: 0.66 - 1.94). Error bounds around this rate overlap 1.0, so this indicates relative stability at the DPS level. This rate does not reflect the true wild population growth rates because naturally-reared salmon returns include not only individuals that are the product of wild reproduction but also products of the U.S. hatchery system (e.g., stocked fry and planted eggs). New methods to further evaluate the wild-reared population growth component are under development using Genetic Parentage Analysis

The **spatial structure** of juvenile populations represents a combination of wild production areas that are monitored for spawning activity and stream reaches that are stocked and produce naturally reared juveniles. Documented occupancy is summarized for the 2024 cohort from the four production sources: wild, egg planted, fry stocked, or parr stocked for core managed and surveyed HUC-12 units (USASAC 2023). Not all critical habitat is surveyed but this spatial structure is designed to document active management areas and those river reaches surveyed for spawners. Data are more complete for smaller coastal watersheds than the larger Penobscot and Kennebec watersheds. The trace network tool in Arc ProGIS software was used to enumerate HUC units that biologists stocked in 2024 or had documented redds in 2023. At minimum, 91 of 594 critical habitat HUC-12 units had documented wild spawning in 2023 or were stocked with eggs, fry and parr in 2024 contributing to the cohort. This analysis provides a general estimate of occupied habitat and qualitatively and visually summarizes available spatial data. With continued low freshwater abundance, expectations for reaching adult recovery targets should be scaled.

Genetic **diversity** of the GOM DPS was monitored through assessment of sea-run adults for the Penobscot River and juvenile parr collections for six other populations. Allelic diversity has remained relatively constant since the mid-1990s. All populations now possess more than 10 of 18 monitored loci. The Pleasant River population is consistently on the lower end and Penobscot sea-run and domestic has the most of the monitored loci. Estimates of the effective population size had increased to above 500 for the Penobscot River population in 2017 but have since fallen below 500. For the other rivers, effective population size estimates have remained either constant or slightly decreased but are often below 100. Conservation guidance in the broodstock management plan was based on the '50-500 rule' for small populations under short-term supplementation (Franklin 1980). More recently, Frankham et al. (2014) suggested that minimum populations should be greater than 100 to reduce the risk of inbreeding over the short term and greater than 1,000 to maintain evolutionary potential. The supplementation program for the Penobscot population has been river-specific since 1974, which equates to almost 10 generations (five-year generation time). Of the six coastal river-specific populations, most are nearing seven generations of hatchery intervention. As such, all exceed the definition of short term intervention (five generations). Given current freshwater and marine production, there is an increased urgency to revisiting broodstock collection, hatchery operations, and their impacts on conservation genetics and fish fitness. There is a pressing need to evaluate genetic rescue approaches that have been used successfully elsewhere for endangered salmonids.

2.2 Status Assessment Approach

This section summarizes general trends for the endangered GOM DPS in Maine. These populations represent the majority of US returns. This section of the report represents an annual viability assessment of the GOM DPS using a Viable Salmonid Populations (VSP) approach (McElhany et al. 2000). This approach allows U.S. stock assessment scientists to integrate the annual GOM DPS assessment within the overall U.S. assessment structure. This minimizes redundancies and leverages similar needs to optimize staff time. Four parameters form the key to evaluating population viability status: abundance, population growth rate, population spatial structure, and diversity. Integrating this annual VSP reporting (requested by the GOM DPS Collaborative Management Strategy) will also allow additional review of the GOM DPS viability assessment by a wider group of professionals assembled at the USASAC meeting. Benchmark assessments are scheduled to be produced and published every five years.

2.2.1 DPS Boundary Delineation

This section synthesizes data on the abundance, population growth, spatial distribution, and diversity to better characterize population viability (e.g., McElhany et al. 2000; Williams et al. 2016). These characterizations also represent metrics used to monitor progress for the Recovery Plan. There are three Major Population Groupings referred to as SHRU for the GOM DPS (NMFS 2009) based on watershed similarities and remnant population structure. The GOM DPS critical habitat ranges from the Dennys River southward to the Androscoggin River (NMFS 2009).

At the time of listing, nine populations were identified. In the DEC SHRU, there were five extant populations in the Dennys, East Machias, Machias, Pleasant, and Narraguagus Rivers. In the PNB SHRU, there were three: Cove Brook, Ducktrap River, and Penobscot River. In the MMB SHRU, there was one population in the Sheepscot River. Of these nine populations designated at listing, conservation hatchery programs propagate wild-exposed parr or returning adults (Penobscot) to supplement spawning in seven populations. There is no stocking in the Ducktrap River and Cove Brook, as native populations were extirpated in 2009.

Because conservation hatchery activities play a major role in fish distribution and recovery, a brief synopsis is included in the boundary delineation. The conservation hatchery strategy for six of these populations is to collect broodstock from wild-exposed or truly wild parr collections. These juveniles are then raised to maturity in a freshwater hatchery. All five extant DEC populations (Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers) are supported using this approach, as is the Sheepscot River population in the MMB SHRU. For the Penobscot River, the primary hatchery strategy is collection of sea-run adult broodstock that result from smolt stocking (85% or more of adult collections) or naturally-reared returns. In general, biologists stock these fish back into their natal rivers. However, because there are expansive areas of Critical Habitat that are both vacant and of high production quality, these seven populations (primarily the Penobscot River) can serve as donor stocks for other rivers reaches e.g., the Kennebec River within the MMB SHRU and Cove Brook within the PNB SHRU.

2.3 Population Targets and Annual Abundance

Comparing monitored adult abundance to management targets is an instructive metric of overall stock health. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed the Conservation Limit (CL). The CL for the GOM DPS is 29,198 adults (Baum 1995). A working paper provided an updated methodology to estimate the CL for U.S. populations with updated habitat estimates, sex ratios, and fecundity values. The updated estimate was delineated by DPS and critical versus non-critical habitat. The CL for GOM DPS critical habitat was estimated at 22,134 returns. However, given ongoing efforts to improve and update habitat area models, the CL value will remain unchanged in this document and remain 29,198 until habitat values are updated.

CL targets represent long-term goals for sustainable population sizes. Given the endangered status of the GOM DPS, the current recovery plan target for down listing from endangered to threatened is at least 1,500 adults originating from wild origin, or hatchery stocked eggs, fry, or parr spawning in the wild, with at least two of the three SHRUs having a minimum annual escapement of 500 naturally reared adults. The threshold of 2,000 wild spawners per SHRU, totaling 6,000 wild spawners annually for the GOM DPS, is one of the current recovery targets needed to consider delisting from endangered species listing. As such, adult returns are partitioned into hatchery returns (adult salmon that are a product of an accelerated smolt program or released as fall parr) or naturally-reared returns (products of natural spawning, egg planting, and fry stocking).

The goal of the GOM DPS Recovery Plan is a wild, self-sustaining population and therefore counts of wild fish are important to monitor progress toward the goal (USFWS & NMFS 2018). However, with extensive and essential conservation hatchery activities (planting eggs and stocking fry and parr), it is currently not feasible to distinguish all hatchery products from wild fish for such counts. All fish handled at traps are classified as to rearing origin by marks, fin condition and scale analysis. To partition naturally reared and stocked returns for redd based estimates, each population is pro-rated on an annual basis using the ratio of naturally-reared to stocked at the time of smolt emigration or other decision matrices (USASAC 2020).

2.3.1 Total Adult Returns

Total adult returns to the GOM DPS in 2024 were 1,517 adults with 1,386 hatchery-origin fish returning to the Narraguagus, Penobscot, Sheepscot, Kennebec, and Androscoggin rivers (Figure 2.3.1 and Table 2.3.1). Because of the abundance of the PNB SHRU smolt-stocked returns (1,321), this SHRU dominated (91%) total abundance with 1,386 returns (includes 63 naturally-reared returns). An additional 65 hatchery returns were documented from the DEC (3) and MMB SHRU (62).

Naturally reared returns were also highest in PNB at 63 (Table 2.3.1 and Figure 2.3.2). Of these, six adults returned to the Ducktrap River or lower Penobscot River tributaries below the Milford and Orono trapping sites. Elsewhere the DEC SHRU had 44 documented naturally reared returns across all six of monitored river systems while the Merrymeeting Bay SHRU had 24 natural returns to all three of monitored systems.

Table 2.3.1. Documented returns from trap and redd counts for the Gulf of Maine Distinct Population Segment (GOM DPS) Atlantic salmon by Salmon Habitat Recovery Unit (SHRU) for return year 2024 and percentage of naturally reared (Natural) fish relative to the interim 500 fish target (% of 500) by SHRU.

SHRU	Hatchery	Natural	Sub Totals	% NR of 500
Downeast Coastal	3	44	47	8.8%
Penobscot Bay	1,321	63	1,384	12.6%
Merrymeeting Bay	62	24	86	4.8%
GOM DPS	**1,386**	**131**	**1,517**	**-**

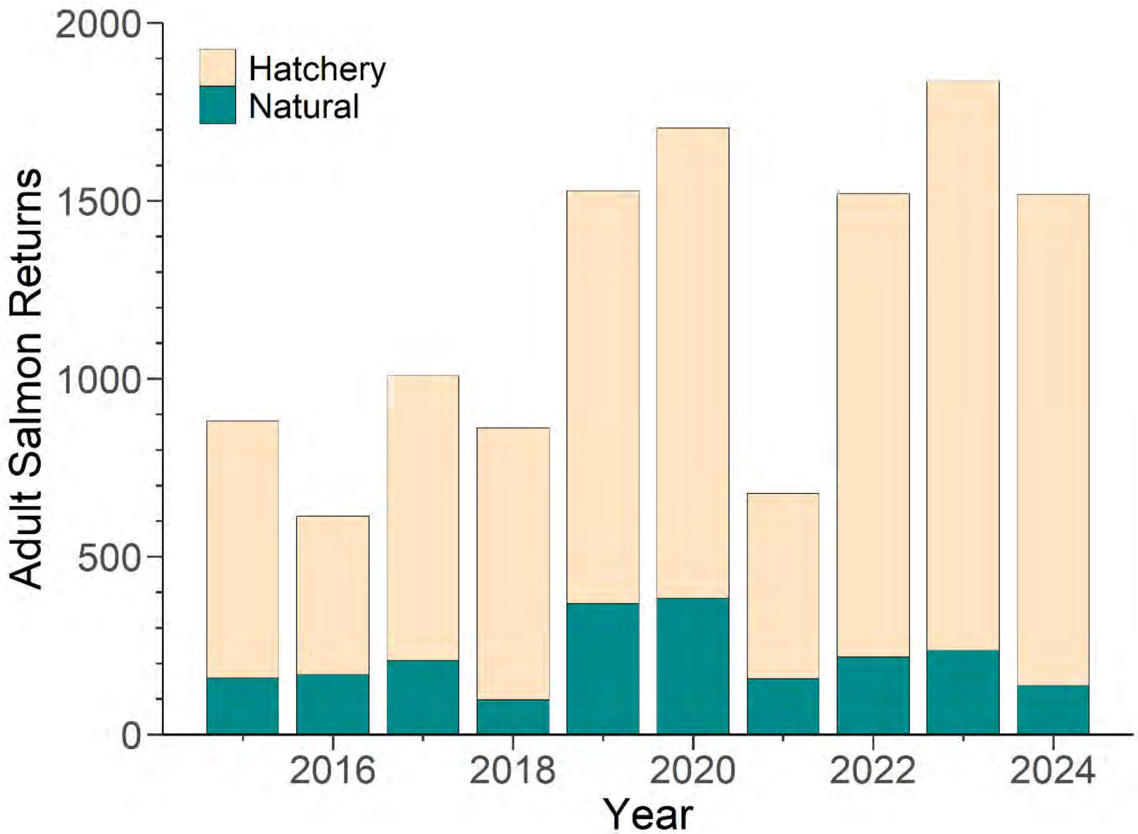


Figure 2.3.1. Recent 10-year time-series (2015 to 2024) of total estimated returns to the Gulf of Maine Distinct Population Segment of Atlantic salmon, illustrating the dominance of hatchery (parr or smolt stocked; tan bars) compared to natural (wild, egg stocked, fry stocked; teal bars) reared origin.

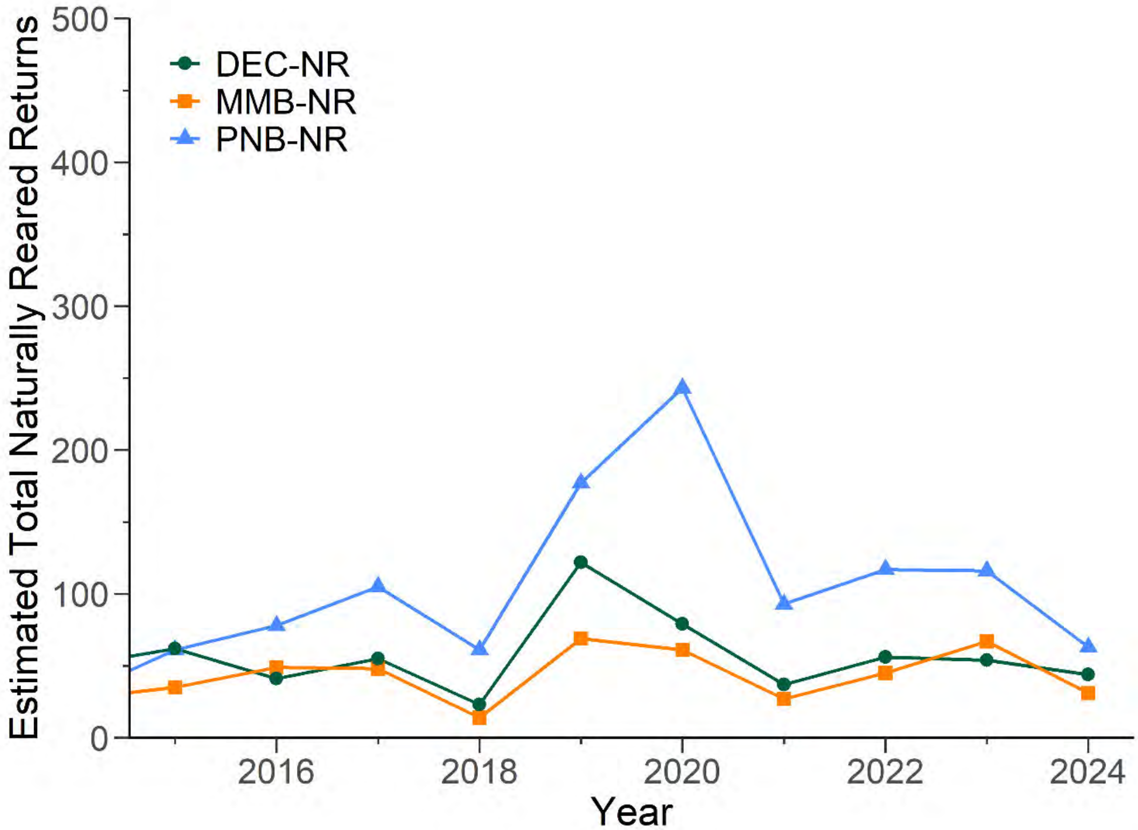


Figure 2.3.2. Recent 10-year time-series (2015 to 2024) time-series of naturally reared (NR) adult returns to the Merrymeeting Bay (MMB; Orange), Penobscot Bay (PNB; Blue), and Downeast Coastal (DEC; Green) Salmon Habitat Recovery Units. Note: The naturally reared interim target of 500 natural spawners is maximum axis value.

2.3.2 Adult Return Rates

The USASAC updated adult return rate metrics for Narraguagus River naturally reared smolts and Penobscot River hatchery reared smolts based on 2024 returns. These are the longest time series and core index populations for both domestic and international reporting (see Table 1.2.4; Appendix 17; Figure 2.3.2.1). The USASAC also updated return rates for naturally reared Sandy River 2021 and 2022 smolt cohorts and ongoing hatchery origin smolt releases in the Kennebec River. Shorter but complete time series are available for naturally reared smolts in the Sheepscot and East Machias Rivers (Table 1.2.4; Appendix 17; Figure 2.3.2.2).

Smolt emigration estimates and subsequent adult returns by sea age were used to generate a smolt-to-adult return rate (SAR) for Narraguagus and Sandy River populations. Naturally reared smolt abundance was the result of wild spawning, egg planting, fry stocking and stocking of ambient parr. The U.S. index population for naturally reared populations is the Narraguagus River starting with the 1997 smolt cohort. Adult return data for this population comes from trap counts of adults at the Cherryfield Dam or in years of high flow (salmon can bypass the trap), redd counts were used to estimate total returns. Sandy River naturally reared estimates are primarily from egg-planted fish. Returns are enumerated at census traps lower in the Kennebec watershed. For the Penobscot River, we used the methods of Stevens et al. (2019) to decouple losses of smolts in-river and in the estuary to provide an estimate of hatchery reared postsmolts entering the GOM. This method accounts for both stocking location and flow-specific mortality to generate a postsmolt to adult survival rate (PSAR) for the Penobscot. Estimates were adjusted from Stevens et al. (2019) to update improved passage with dam removals in 2012 and 2013.

The 1SW PSAR for the Penobscot 2024 returns was 0.07% and the SAR for the Narraguagus was also 0.07%. Trends in the last ten years (smolt cohorts 2014-2023) indicate Penobscot hatchery reared 1SW population PSAR averaged 0.05% while the Narraguagus River SAR averaged 0.46%, with only seven years available in the last 10 years because of incomplete smolt estimates in 2016, 2017, and 2020. Grilse (1SW fish) in Maine are typically a smaller component of annual returns and most commonly males (Figure 2.3.2.1).

Salmon predominantly return as 2SW (two sea-winter) in Maine. In 2024, the 2022 smolt cohort PSAR for the Penobscot was 0.20% (Figure 2.3.2.1). This rate was slightly higher than the ten-year average of 0.16% (Figure 2.3.2.2) but remained much lower than the 1970 to 1990 average of 1.12%. The average SAR for 2SW returns to the Narraguagus for the past decade averaged 1.33% over the seven monitored years and the 2024 SAR was lower at 0.88%. Time series for the Sheepscot and East Machias are presented graphically for completeness and data are available (Appendix 17). While the inter-annual variability is large in these smaller populations, these data indicate consistently better marine performance for naturally reared smolts (Figure 2.3.2.1). However, despite the higher rates for the Narraguagus and other naturally-reared populations, low smolt production results in lower number of adult returns.

Results from hatchery reared smolts stocked in the Kennebec and naturally reared smolts produced in the Sandy River provide preliminary insights into relatively new programs (Figure 2.3.2.2). Smolt stocking started in 2020; smolts were released downstream of all dams in 2020 - 2022, making Kennebec-Androscoggin 2SW SAR comparisons analogous to PSAR estimates in the Penobscot River for 2024.

Annual and time series averages for returns to the Kennebec River and the Kennebec-Androscoggin are presented because hatchery reared returns to the Androscoggin are likely strays from the nearby Kennebec. For hatchery smolts, the Kennebec 1SW SAR in 2024 (0.015%) was similar to the four-year average (0.016%). The Kennebec-Androscoggin 1SW SAR in 2024 was 0.026%, similar to the four-year average of 0.023%. For 2SW returns, Kennebec SAR in 2024 (0.023%) was lower than the three-year average (0.043%). The Kennebec-Androscoggin 2SW SAR in 2024 (0.026%) was also lower than the three year average (0.048%). All hatchery SAR values are lower than PSAR values for the Penobscot (Figure 2.3.2.2). In future years, analysis of SAR and PSAR metrics will be expanded to account for the longer time series and additional stocking locations.

For naturally reared smolts in the Sandy River, the estimates of 1SW SAR were 0.015% (2021) and 0% (2022); 2SW SAR estimates were 0.437% (2021) and 0.104% (2022). Rates were lower than comparable metrics in the Narraguagus River for the same cohorts.

Marine survival remains a primary threat to the recovery of all GOM DPS stocks. Reviews of marine survival indicate the best management strategy to address current ocean conditions is to maximize the production of wild or naturally reared smolts. Given the amount of vacant habitat across the DPS (Section 2.5), there is significant unused habitat capacity. Additional hatchery capacity would boost returns by stocking fish into more habitat to produce greater numbers of smolts. In the meantime, continued efforts to prioritize use of higher quality habitat, match life stages with habitat types, and explore expanding fry stocking will optimize the limited production capacity available at present (S. Gephard WP25-13 and emerging issues discussion). These efforts will be enhanced by ongoing work to further evaluate habitat quality (E. O'Regan WP25-16). Research and adaptive management changes could help close the marine performance gap for hatchery smolts and yield more spawners. Ongoing efforts to ensure safe downstream passage for both naturally reared and hatchery reared smolts remains essential and progress has been substantive in both the Penobscot and Kennebec Rivers.

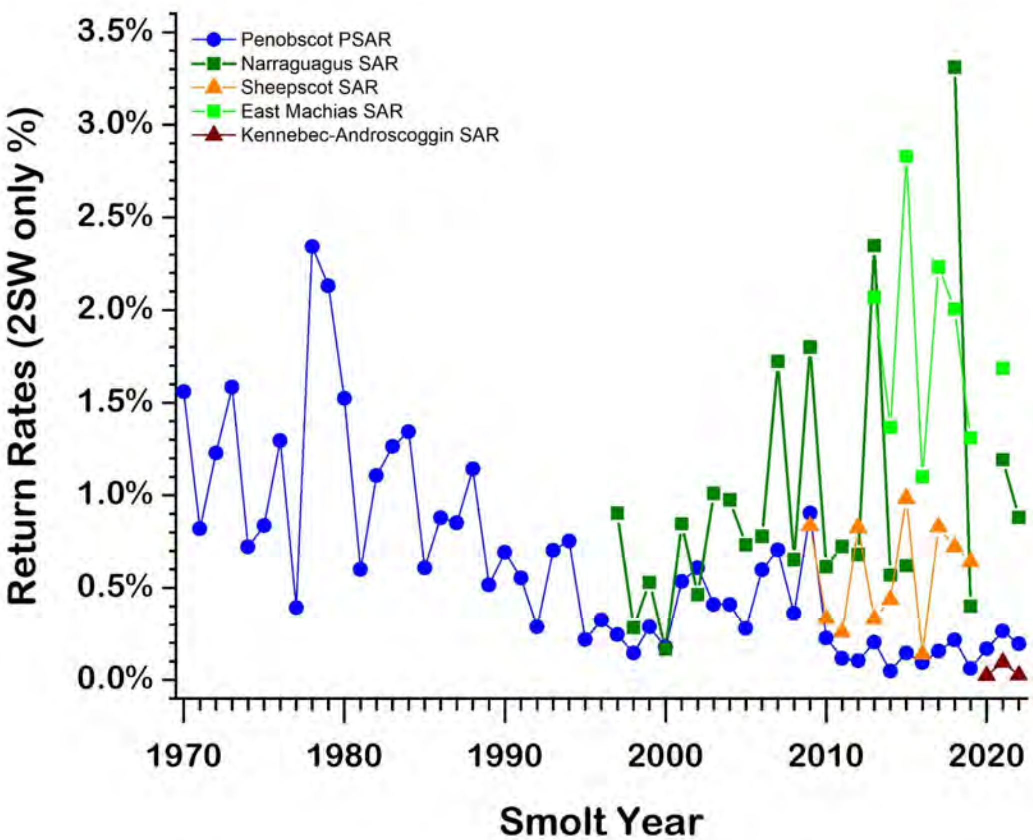


Figure 2.3.2.1. Complete time series of 2SW adult return rates for: 1) Penobscot River hatchery smolts postsmolt-to-adult return (PSAR; blue circles); 2) naturally reared smolt-to-adult return rates (SAR) for the Narraguagus (olive squares), Sheepscot (orange triangle), East Machias (green squares); and Kennebec-Androscoggin watershed SAR for hatchery stocked smolts (maroon triangle).

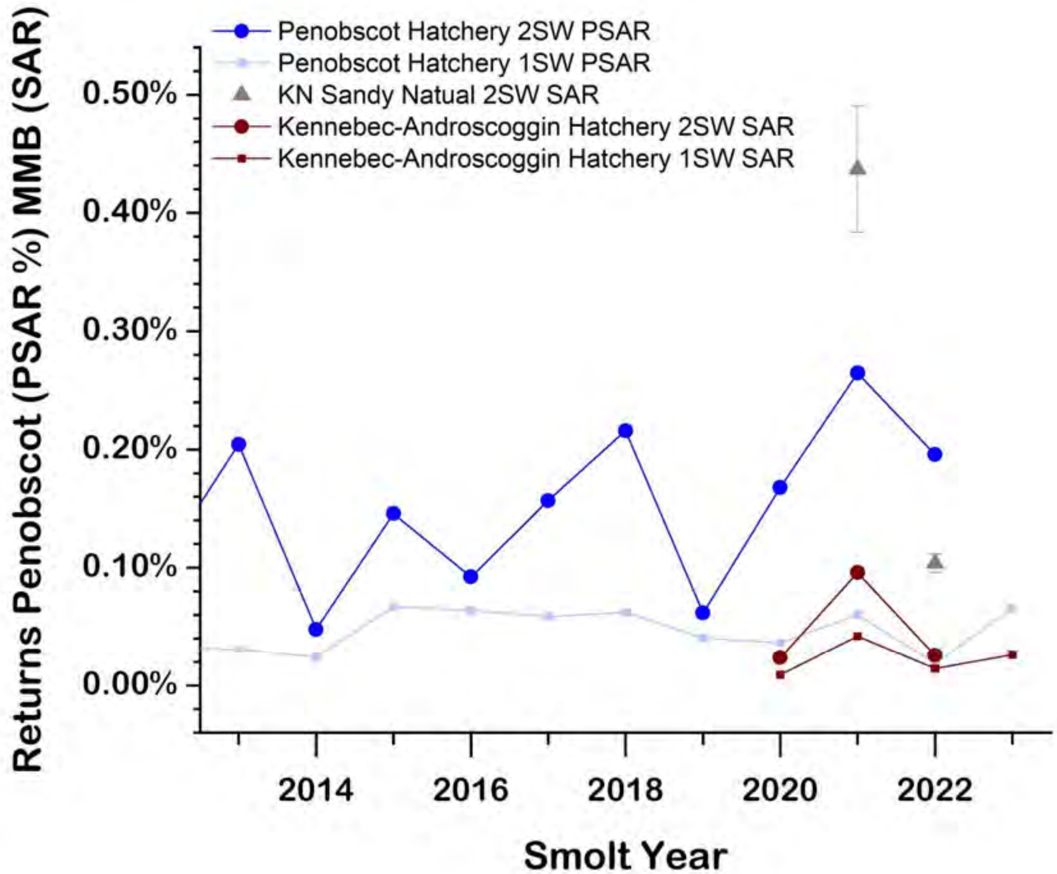


Figure 2.3.2.2. Ten year time series of adult return rates to large watersheds of Maine. Penobscot hatchery smolts 2SW postsmolt-to-adult return (PSAR; blue circles) and 1SW PSAR (light blue rectangles) and Merrymeeting Bay (Kennebec stocked and Kennebec-Androscoggin returns) Hatchery Smolts 2SW smolt-to-adult return (SAR; maroon circles) and 1SW (maroon rectangles). Two years of naturally reared smolt to adult return rates are available for the Sandy River, only 2SW returns (grey triangles) are presented graphically (see text for details).

2.4 Population Growth Rate

Another metric of recovery progress in each SHRU is a sustained population growth rate indicative of an increasing population. The mean life span of Atlantic salmon is five years; therefore, consistent population growth must be observed for at least two generations (10 years) to show sustained improvement. If the geometric mean population growth rate of the most recent 10-year period is greater than 1.0, this provides assurance that recent population increases are not random population fluctuations but more likely are a reflection of true positive population growth. The geometric mean population growth rate is calculated as:

$$GM_{\underline{R}} = exp(mean[R_t, R_{t-1}, R_{t-2}, \dots, R_{t-9}])$$

where GMR is the geometric mean population growth rate of the most recent 10-year period and Rt is the natural log of the five-year replacement rate in year t. The five-year replacement rate in year t is calculated as:

$$R_t = ln\left(\frac{N_t}{N_{t-5}}\right)$$

where N_t is the number of adult returns in year *t* and N_{t-5} is the number of adult returns five years prior. Naturally-reared adult returns are counted in the calculation of population growth rate in the objectives of the current recovery phase (reclassification to threatened). In the future, only wild adult returns will be used in assessing progress toward delisting objectives. As described in the 2009 Critical Habitat rule, a recovered GOM DPS must represent the natural population where the adult returns must originate from natural reproduction that has occurred in the wild.

In a future when the GOM DPS is no longer at risk of extinction and eligible for reclassification to threatened status, an updated hatchery management plan will detail how hatchery supplementation should be phased out. This plan would include population benchmarks that trigger decreasing hatchery inputs. The benchmarks should be based upon improved PVA models that incorporate contemporary demographic rates and simulate various stocking scenarios to assess the probability of achieving long-term demographic viability.

The geometric mean population growth rate based on estimates of naturally-reared returns fell below 1.0 for all SHRUs during the mid-2000s due to declining numbers of returning salmon (USASAC 2009). In more recent years, the population in each SHRU has stabilized at low numbers and the geometric mean population growth rate increased to approximately 1.0 for all SHRUs by 2012 (Figure 2.4.1). In 2024, error bounds around this rate overlap 1.0, indicative of relative stability. The MMB SHRU had the highest growth rate (1.46). The DEC SHRU had the lowest median growth rate (0.91) and was below 1. The PNB SHRU had an intermediate growth rate of 1.22 (Table 2.4.1).

Table 2.4.1. 10-year geometric mean replacement rates (GM_R) for Gulf of Maine Distinct Population Segment (GOM DPS) Atlantic Salmon as calculated for 2024 return year with 95% confidence limits (CL). SHRU = Salmon Habitat Recovery Unit.

SHRU	**GM_R**	**Lower 95% CL**	**Upper 95% CL**
Downeast Coastal	0.91	0.55	1.51
Penobscot	1.22	0.63	2.38
Merrymeeting Bay	1.46	0.80	2.64
GOM DPS	**1.14**	**0.66**	**1.94**

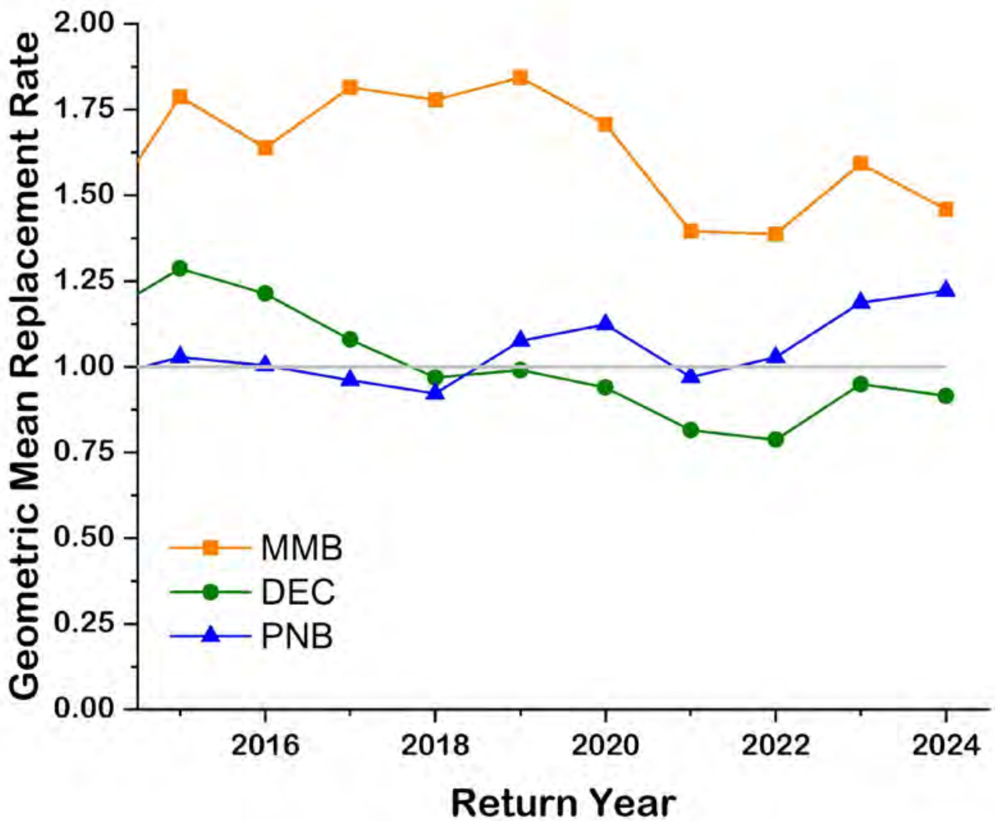


Figure 2.4.1. Annually calculated 10-year geometric mean replacement rates for the GOM DPS of Atlantic salmon for Merrymeeting Bay (MMB; orange), Penobscot Bay (PNB; blue), and Downeast Coastal (DEC; green) for each Salmon Habitat Recovery Unit individually over the last decade.

The geometric mean population growth rate based on the five-year replacement rate does not completely reflect the true population growth rate because naturally-reared salmon returns include individuals that are the product of natural reproduction in the wild as well as individuals that are products of the hatchery system (e.g., stocked fry and planted eggs). The inclusion of hatchery products in the 10-year geometric mean replacement rate gives an overestimate of the true wild population growth rate. Improved and alternative approaches to understand population growth of wild populations such as Genetic Parentage Analysis of broodstock from both stream collections and adult returns are under development to further inform recovery efforts (USASAC 2024).

2.5 Documented Spatial Structure of DPS

The spatial structure of juvenile production at the USGS Hydrologic Unit Codes (HUC)-12 level was evaluated to better visualize the contributions of both wild spawners and stock enhancement efforts. The HUC-12 level provides a useful index of observed occupancy where wild spawning or stocking with eggs, fry, or parr contribute to documented Atlantic salmon occupancy. For Age-0 salmon, documented occupancy begins with Alvin still in the gravel on 1 January that were a product of redds documented the previous November. Managers supplement occupancy by: 1) planting eggs directly in the gravel in January and February, 2) stocking fry in May, and 3) stocking parr in October. These four sources contribute to a naturally-reared cohort of the GOM DPS. To summarize these contributions, georeferenced redd and stocking data are used to produce a series of maps that show the percent of habitat where juvenile salmon are likely rearing in river nursery areas (termed “documented occupancy”) at the HUC-12 level within each SHRU. These maps illustrate not only documented occupancy but also illustrate areas where surveyed habitat is thought to be underutilized and areas where information is limited. Combined, these georeferenced documented occupancy data can: 1) prevent/minimize redd superimposition with egg planting, 2) reduce interaction of stocked fish with wild fish by buffering wild production reaches, and 3) allow spatial planning of stocking to optimize stocking locations. Additionally, these occupancy maps provide a tool for managers to evaluate most likely salmon presence and compare to critical habitat maps or the atlas of juvenile rearing habitat for 2-3 cohorts.

All input data were georeferenced and a documented occupancy model was developed using standard dispersal distances. These dispersal distances were from point locations of redds, egg planting sites, or from stocking spatial references for fry and parr (upstream and downstream points). From these points, dispersal was standardized at 500 m upstream and 1,500 m downstream from a source point using the Utility Network Analyst extension and the Trace Network Tool in Arc Pro 2.9. This method allows estimation of fish dispersal with these standard dispersal metrics to estimate documented occupied habitat as a function of stream length and habitat area (Figure 2.5.1). The documented occupancy does not estimate relative density only linear distribution expectations scaled by habitat area. The line segments will attach to existing stream network segments and the entire segment will be selected as occupied. These segments are variable in length but provide a reasonable estimate until a finer resolution stream network is available (expected in 2025- E. O’Regan WP 25-16). The trace algorithm highlights the reaches where fish would disperse on the primary river reach for the point and tributaries within the dispersal distance. These lengths are measured in km but the underlying salmon habitat area in metric units is used to calculate the occupancy category from 0 to 100% (Figure 2.5.1)

An important characteristic of GOM DPS Atlantic salmon populations is their dependence on conservation hatcheries (Legault 2005). Because most U.S. salmon are products of stocking, it is important to understand the magnitude, types, and distribution of stocking inputs to understand juvenile spatial structure throughout Critical Habitat. Atlantic salmon hatcheries are operated by USFWS and the Downeast Salmon Federation (DSF). All egg takes occur at USFWS facilities operating as conservation hatcheries. Fish are collected from remnant local stocks within the GOM DPS, grown to maturity at the hatchery, and produce eggs or juveniles to stock back into their natal rivers. In some cases, donor populations are used to stock vacant Critical Habitat in the GOM DPS range to re-establish populations. For example, the Sandy River in the MMB SHRU has received donor stocking from the Penobscot and Dennys rivers. From a management perspective, rebuilding Atlantic salmon populations will require increasing natural production of smolts throughout all Critical Habitat. Examining the spatial contributions of multiple recruitment sources provides insights into 1) both spatial density of freshwater production and 2) occupied/unoccupied areas of the watershed. This approach also provides an information base to examine fish dispersal, optimal production areas, and site-specific stocking targets. Ultimately, these data should help facilitate management at a more refined spatial scale than an entire watershed and facilitate management actions at a sub-drainage (HUC12 or finer) level.

To document Wild Production Areas (WPAs), the geolocation of redds was used to delineate distributions. For this metric, the occupancy model assumes an upstream distribution of juveniles of 0.5 km upstream and 1.5 km downstream from each redd or cluster of redds - including adjacent tributary streams (Beall et al. 1994; Eisenhauer et al. 2021). Mapped WPAs are excluded from egg planting and stocking in the following year to minimize competition between wild and hatchery-origin juveniles. Additionally, in two years, these areas will be targeted for broodstock collection during electrofishing efforts to bring components of wild spawning into the captive reared brood program.

To document Hatchery Production Areas (HPAs), distributions were calculated for all hatchery products using the occupancy model assumption of juvenile dispersal from each egg planting location or stocking start/end locations. Egg-Planted Production Areas (EPA) are based on point positions of artificial redds and the standard diffusion model as used for WPA. Fry and parr stocked production areas (FPA or PPA) were based on linear distances stocked and dispersion from both the upstream and downstream apex of a stocking effort.

By combining the three hatchery production types and documented wild production, a useful visualization of overall documented occupancy and relative intensity of habitat occupancy in a monitored unit of rearing habitat can be visualized (see Figure 2.5.2.3). These values should be considered minimal documented occupancy areas because: 1) not all redds are counted; 2) assumptions on dispersion (although well supported in literature and with local data) need additional study; and 3) additional redd survey coverage is needed in larger watersheds. That is, redd counts do not account for total quantified escapement in the Penobscot and Kennebec watershed. However, given the relatively high proportion of spawning habitat surveyed in active management areas and numeric and spatial demographic scope of hatchery products, these production areas are informative and meaningful metrics at the HUC-12 scale for managed areas. Additionally, the areas where spawner monitoring is not logistically possible and hatchery production capacity is insufficient to supplement critical habitat are also visualized.

Table 2.5.1. Summary of number of HUC-12 units in 2024 where occupancy was documented for Wild Production Areas (WPA - 2023 spawning) and hatchery production areas for each hatchery product that results in natural production in a river. Note: because sources overlap in some HUC-12 units, the total below (70) exceeds the aggregate total (45) described above. Abbreviations: CH = Critical Habitat, EPA = Egg-Planted Production Area, FPA = Fry Stocked Production Area and PPA = Parr Stocked Production Area, SHRU = Salmon Habitat Recovery Unit, GOM DPS = Gulf of Maine Distinct Population Segment.

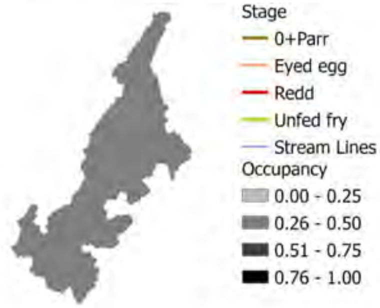
SHRU	CH Totals for SHRU	WPA	EPA	FPA	PPA
Downeast Coastal	142	14	1	21	0 36/142
Penobscot Bay	291	18	2	7	0 27/291
Merrymeeting Bay	161	11	12	3	2 28/161
GOM DPS	**594**	**43**	**15**	**31**	2 91/594

Salmon Stream-Piscataquis River

Fry	KM	Habitat
Occupied	8.2	155.7
Total	92.6	2,081.1
Percent	9%	**7%**

Clary Lake-Sheepscot River

Aggregate	KM	Habitat
Occupied	13.0	599.1
Total	158.9	1,365.4
Percent	8%	**44%**



Upper Sandy River

Egg	KM	Habitat
Occupied	41.3	2,058.7
Total	137.0	3,658.1
Percent	30%	**56%**

Cathance Stream

Fry	KM	Habitat
Occupied	20.7	475.5
Total	26.8	492.2
Percent	77%	**97%**

Figure 2.5.1 Visualization of the use of the Utility Network Analyst extension and the Trace Network Tool in Arc Pro 2.9 to visualize and summarize fish dispersal and documented occupancy. A visualization of individual HUC-12 watersheds illustrates total river kilometers and dispersal model outputs from known spawning or stocking locations. Each row includes a watershed map outlining stream length and documented occupied length, a table with documented occupancy metrics: and a shaded watershed outline, proportional to documented habitat occupancy.

2.5.1 Wild Production Areas – Redd Distributions in 2023 and 2024 Cohort Production

Redd survey coverage included 43 HUC-12s in the autumn of 2023 with redds observed in 39 HUC-12s (Figure 2.5.1.1). In PNB redds were observed in 16 of the 17 HUC-12s surveyed containing a total of 175 redds. Estimated dispersal from these redds occupied 18 HUC-12s seeding an average of 17% of available rearing habitat (10,497 units). In DEC, 13 out of 13 HUC-12s surveyed contained a total of 95 redds. Estimated dispersal from these redds occupied 14 HUC-12s (redds from Chase Mills stream dispersed into East Machias River) seeding an average of 11% of the habitat (4,227 units). In MMB, a total of 88 redds were found in 10 of the 13 HUC-12s surveyed. Estimated dispersal from these redds occupied 11 HUC-12s seeding an average of 20% of the available habitat (5,810 units).

In PNB, redd surveys were focused only on the Piscataquis and East Branch Penobscot Rivers and Kenduskeag and Mattamiscontis Streams (Figure 2.5.1.1). In DEC SHRU, where redd surveys consistently exceed 80% of mapped spawning habitat area annually, estimates of wild production areas are most representative for overall production in the SHRU. In MMB, redd surveys were conducted in the Sheepscot and only in actively managed areas of Sandy River watershed and lower Kennebec River tributaries (Figure 2.5.1.1). In PNB SHRU, escapement is more variable spatially due to a broad distribution of egg planting and fry stocking and smolt stocked return imprinting. The large area creates challenges to monitoring natural production across four large sub-basins. As such, while provided for context, the PNB occupancy may under-represent wild production and more work is needed to understand better potential wild contributions and survey capacity versus documented escapement.

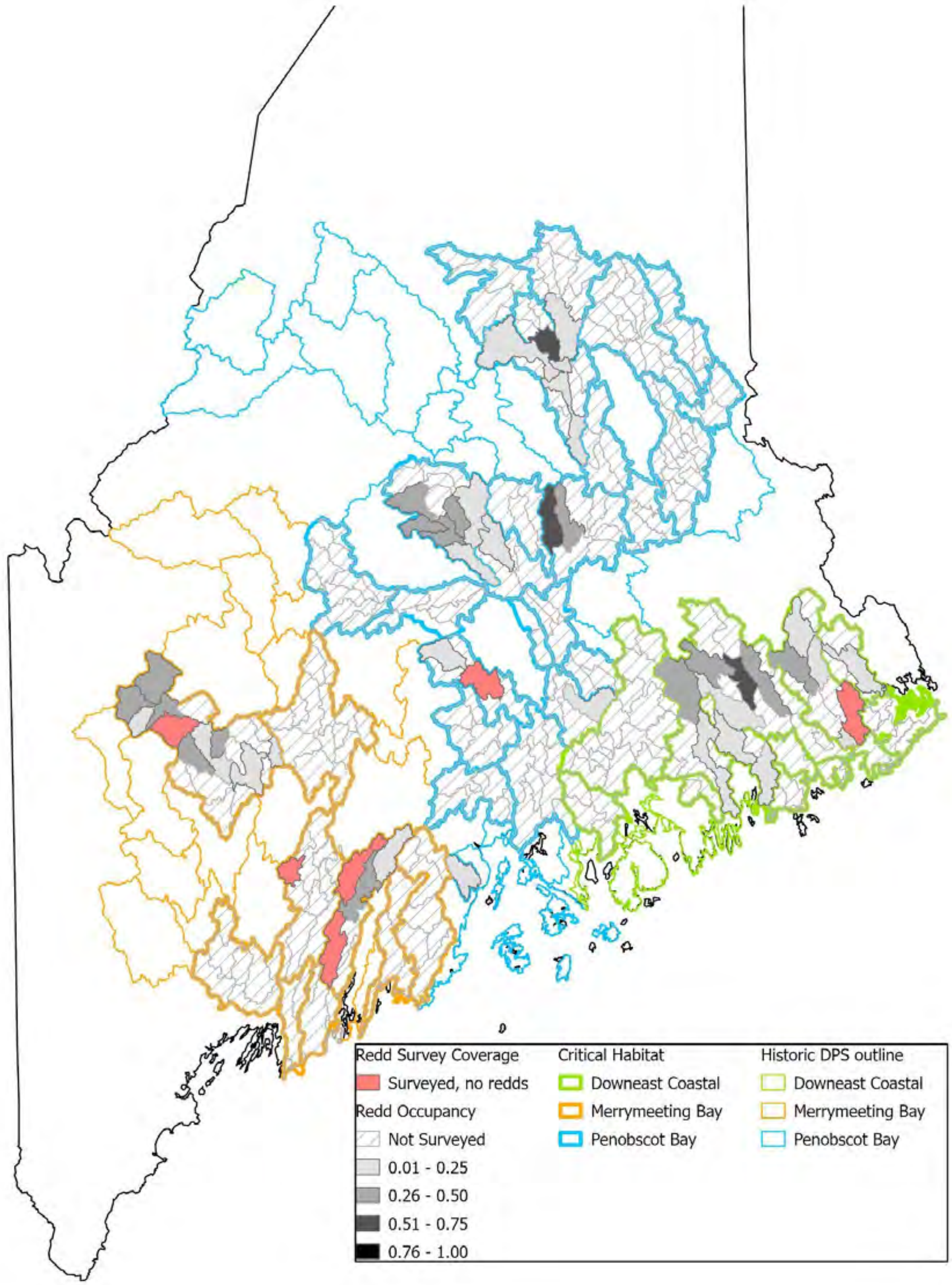


Figure 2.5.1.1. Wild Production Areas for 2024 cohort. Map highlighting known spawning activity in 2023 and dispersion from redd visualized at a HUC-12 watershed summary level to visualize occupancy in HUC-12 units where redd surveys were conducted. Redds observed (shading is % documented occupancy) and areas surveyed with no observed redds (light red; see Table 2.5.1).

2.5.2 Freshwater 2024 Cohorts from Hatchery Production

Egg planting occurred in 15 HUC-12s in 2024, 12 of which were in MMB, 2 in PNB, and 1 in DEC. In MMB, three HUC-12s were in the Sheepscot and the remaining nine HUC-12s were in the Sandy River (Figure 2.5.2.1; Table 2.5.1). The occupancy in the Sheepscot averaged 5% across the three areas planted (279 units) and the Sandy averaged 15% (1,640 units). In the Pleasant, one HUC-12 was egg planted occupying 10% (331 units). Fry stocking occurred in all three SHRUs (Figure 2.5.2.2) across 31 HUC-12s (Table 2.5.1). In the DEC area, 21 HUC-12s were stocked (6,298 units) with an average occupancy of 25% (Figure 2.5.2.2). In PNB, seven HUC-12s were fry stocked (3,813 units) with an occupancy averaging 5%. The PNB stocking focused mostly in the Piscataquis or lower Penobscot sub-drainages (Figure 2.5.2.2). In MMB, all fry stocking was in the Sheepscot River across three HUC-12s (444 units) with an average density of 3%. About 13,500 0+ parr were stocked in the Sheepscot River across two HUC-12s, supplementing 455 units at average occupancy of 1%.

In aggregate, 91 HUC-12 units had documented wild production or hatchery supplementation. Thirty-three HUC-12 units had only one source of production (sources are wild, egg planted, fry stocked or parr stocked). HUC-12s with more than one source numbered 24 with two, two with three, and only one HUC-12 (Clary Lake-Sheepscot River) had all four strategies used. These stocking efforts are designed to have minimal spatial overlap with each other and wild production. For example, in the Sheepscot River parr stocking is spatially distant from other reaches within a HUC-12.

By organizing these data spatially, the USASAC is providing a resource to refine occupancy assessments to targeting areas to conduct juvenile assessments to increase efficiency and lead to a better understanding of dispersion metrics. The next steps of spatial stock assessment would work towards integrating density based on redd densities, stocking rates, juvenile abundance, and other sources. Independent efforts to look at climate resilience could then be merged with a spatial assessment to manage Atlantic salmon habitat, hatchery supplementation, and passage priorities to support salmon conservation now and in the future.

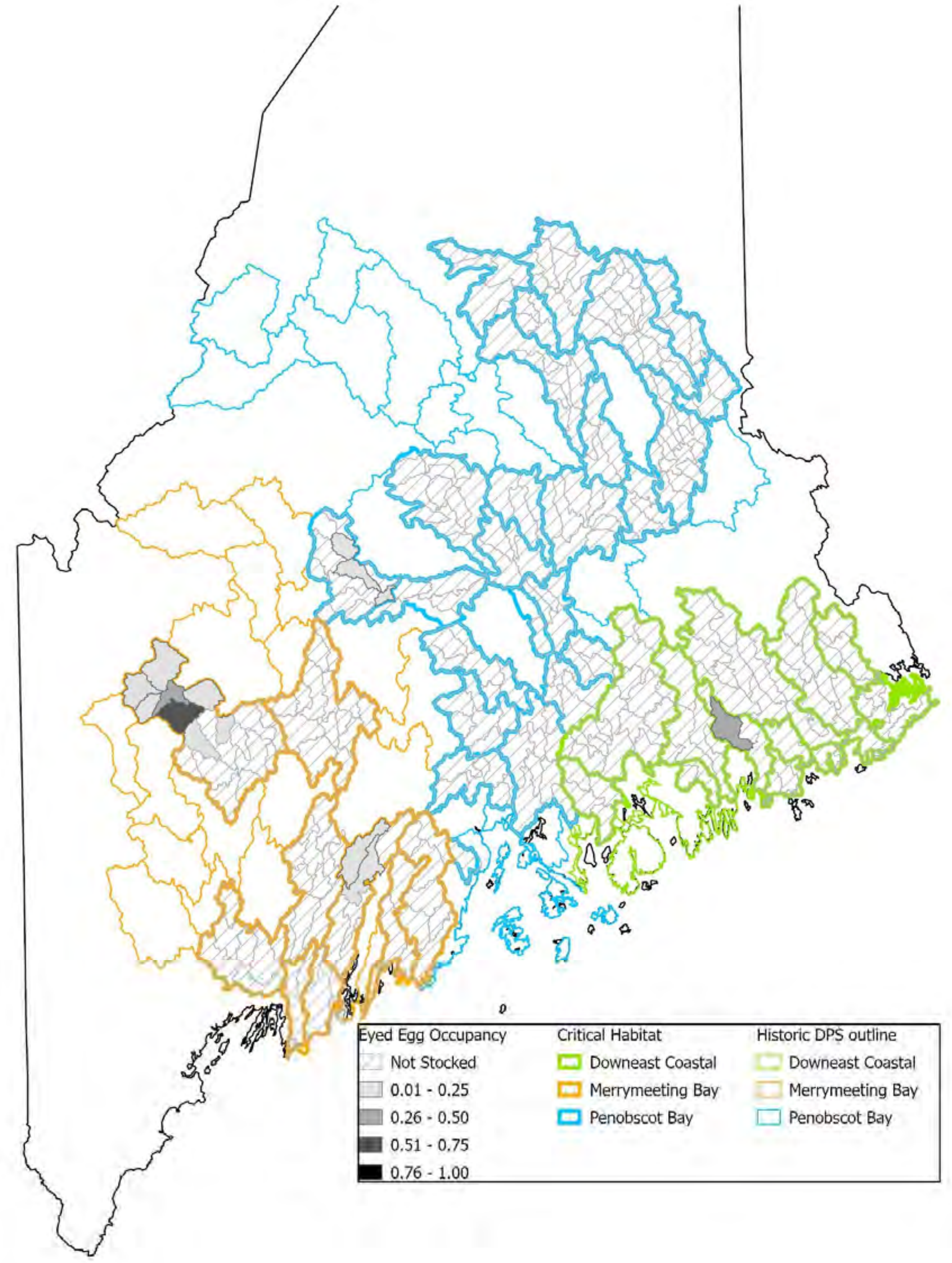


Figure 2.5.2.1 Egg Production Areas. Map highlighting HUC-12 watershed to visualize where egg planting was used and the intensity of occupancy within each HUC-12 of this life stage in the 2024 year class.

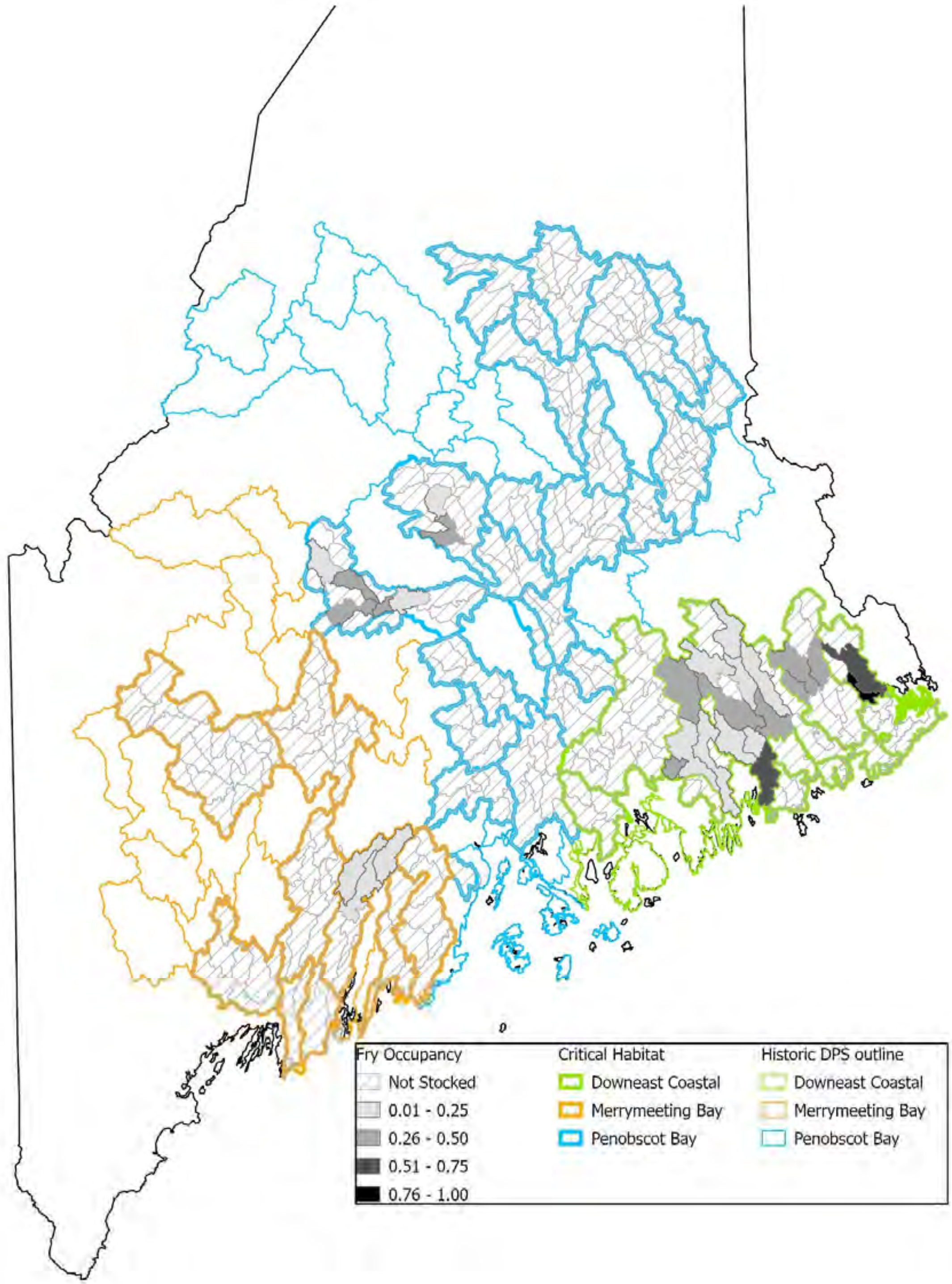


Figure 2.5.2.2 Fry Production Areas. Map highlighting HUC-12 watershed to visualize where fry stocking was used and the intensity of occupancy within each HUC-12 of this life stage in the 2024 year class (see Table 2.5.1).

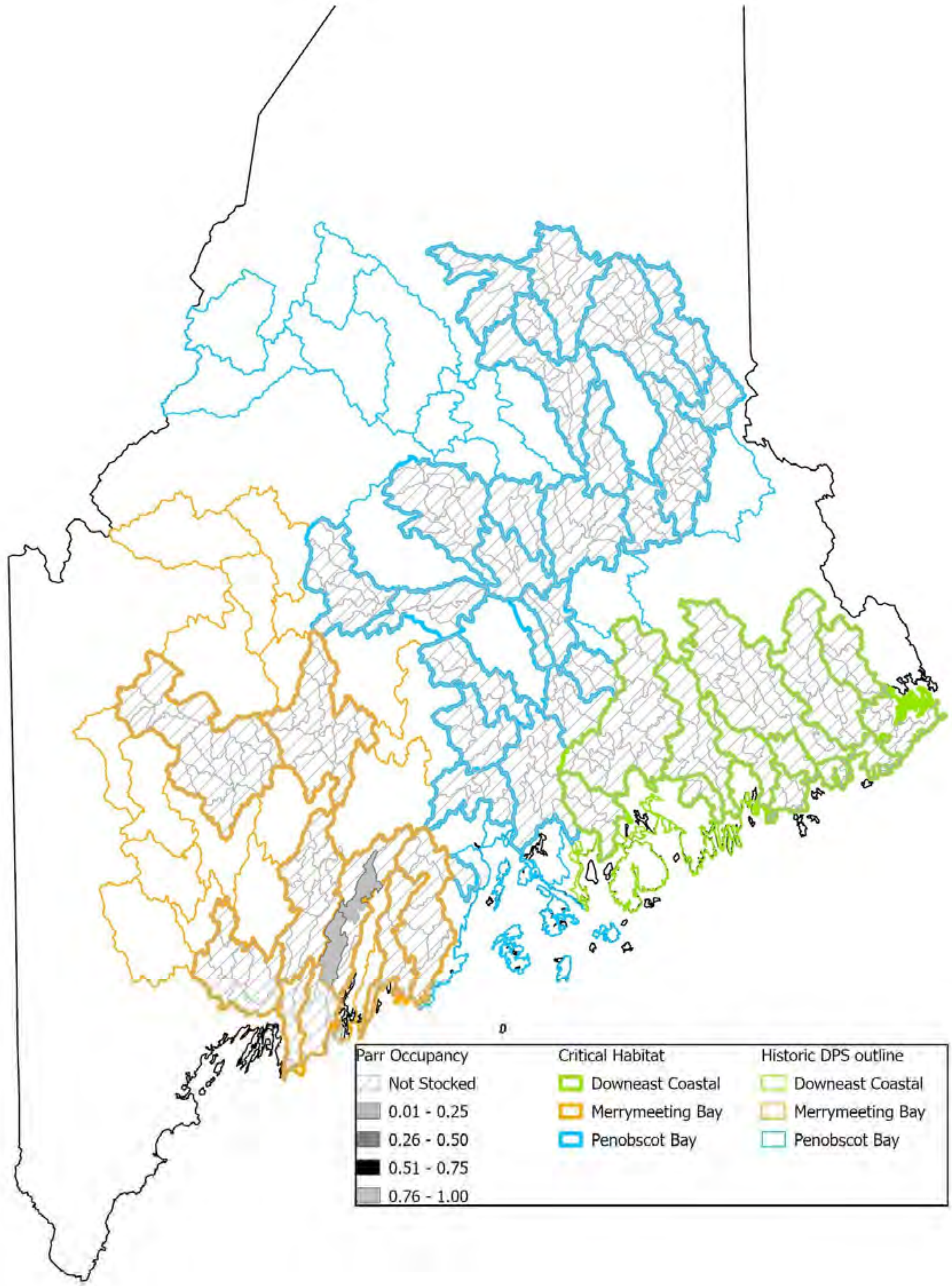


Figure 2.5.2.3 Parr Production Areas. Map highlighting HUC-12 watershed to visualize where parr stocking was used and the intensity of occupancy within each HUC-12 of this life stage in the 2024 year class (see Table 2.5.1).

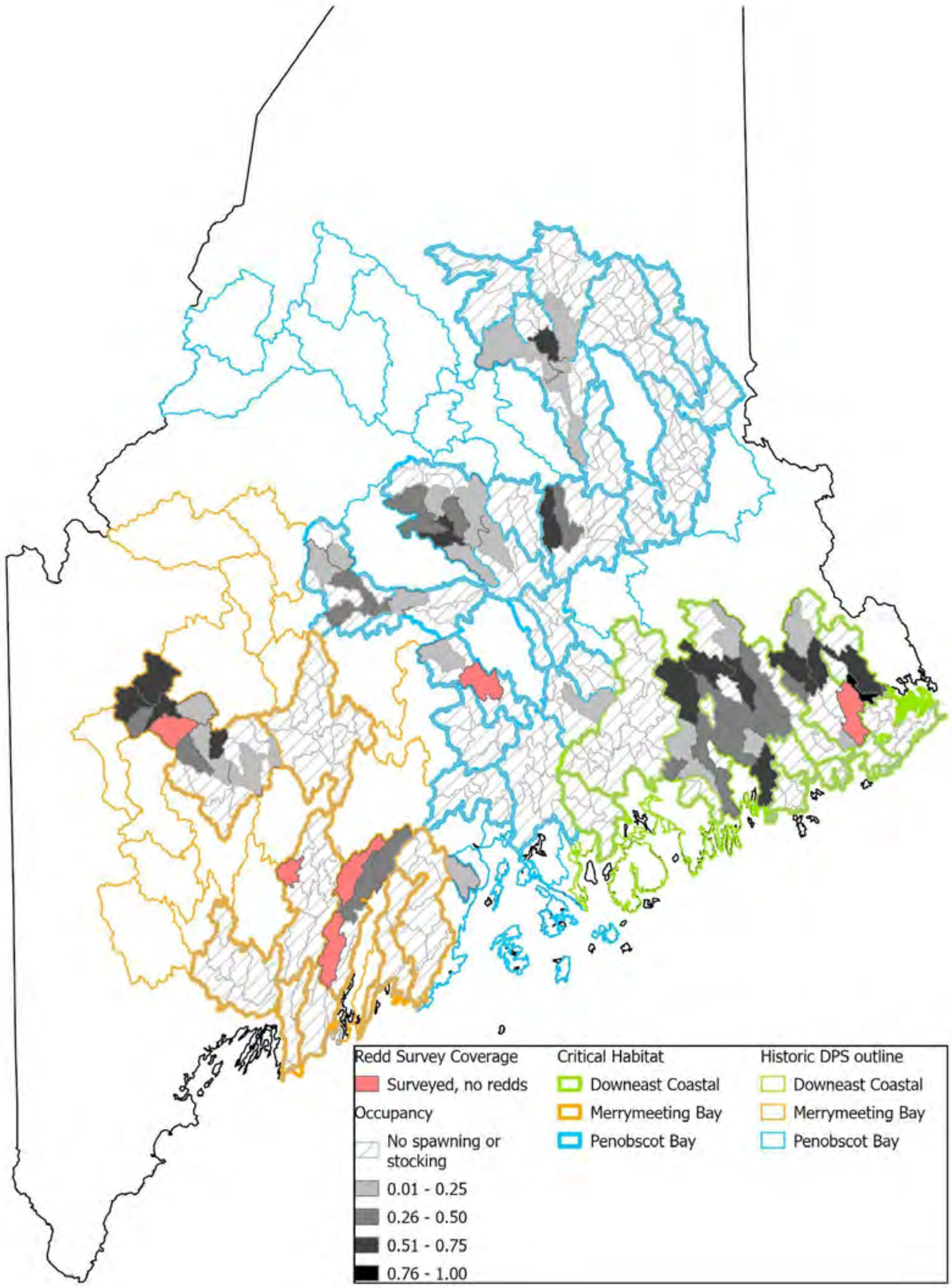


Figure 2.5.2.4 Total documented occupied production area for the 2024 cohort visualized at HUC-12 watershed resolution. Unsampled units are represented by white/grey hash fill. The five categories for censused and/or stocked areas are 0.01-25%; >25-50%, >50-75%, and > 75%) in composite of wild production areas, egg planting and fry or parr stocking that contributed to the 2024 year class, e.g. Table 2.5.1. Pink areas are where stocking did not occur and surveys found no redds but coverage documented.

2.5.3 Redd Surveys- 2025 Wild Cohort - 2024 Redd Surveys

Redd surveys were conducted in 49 HUC-12s in 2024 (Figure 2.5.3.1; Section 3). This coverage increased from previous years with biologists continuing to focus on actively managed HUCs. Redds were found in 27 of the 49 HUC-12s surveyed. These data will inform all stocking activities in 2025 to minimize interactions with stocked fish and optimize production from both natural and stocked sources.

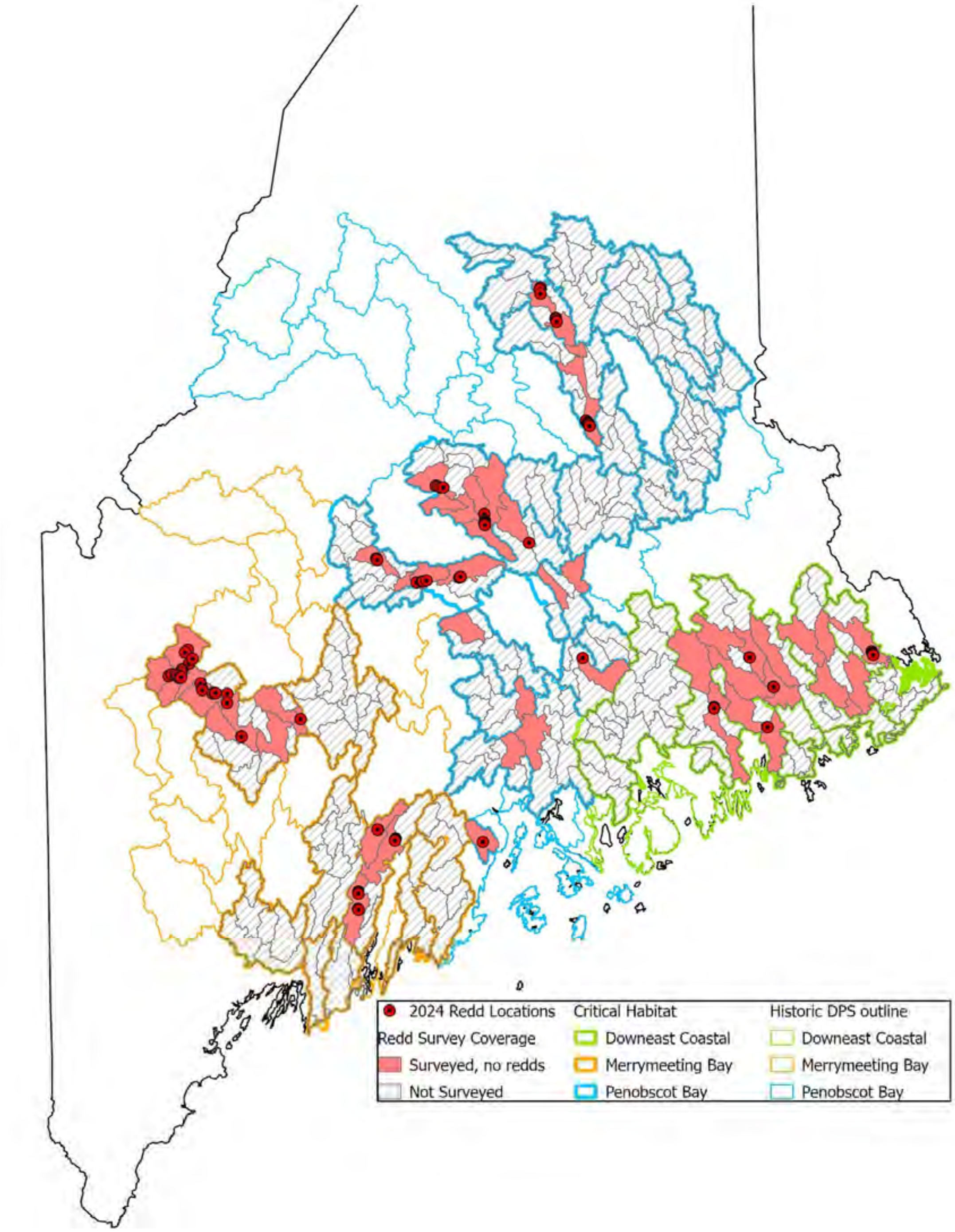


Figure 2.5.3.1. Documented spawning activity in 2024 at a HUC-12 watershed summary level that visualizes HUC-12 units where redd surveys were conducted (pink shaded) and red dots denote location of documented redds. These redds contribute to the 2025 cohort.

2.6 Genetic Diversity

Maintenance of genetic diversity is a critical component of the Atlantic salmon recovery program. USFWS monitors genetic diversity for the program through assessment of broodstock collected from rivers as parr or returning adults, which represent both individuals from natural reproduction and stocked individuals from the hatchery. Identification of origin (hatchery or wild) is determined through genetic parentage analysis. Therefore, estimates of these two groups combined represent the total genetic diversity present in the various populations monitored.

Effective population size (Ne) is defined as the size of an ideal population (N) that will result in the same amount of genetic drift as the actual population being considered. Many factors can influence Ne, such as sex ratios, generation time (Ryman et al. 1981), overlapping generations (Waples 2002), reproductive variance (Ryman and Laikre 1991), and gene flow (Wainwright and Waples 1998). Applied to conservation planning, the concept of Ne has been used to identify minimal targets necessary to maintain adequate genetic variance for adaptive evolution in quantitative traits (Franklin and Frankham 1980), or as the lower limit for a wildlife population to be genetically viable (Soulé 1987). Estimation of Ne in Atlantic salmon is complicated by a complex life history that includes overlapping generations, precocious male parr, and repeat spawning (Palstra et al. 2009). Effective population size is measured on a per generation basis, so counting the number of adults spawning annually is only a portion of the total Ne for a population. In Atlantic salmon, Palstra et al. (2009) identified a range of Ne to N ratios from 0.03 to 0.71, depending on life history and demographic characteristics of populations. Assuming a Ne to N ratio of 0.2 for recovery planning, the Ne for a GOM DPS of Atlantic Salmon population should be approximately equal to the average annual spawner escapement, assuming a generation length of five years. Although precocious male parr can reproduce and be included in estimates of the number of adult spawners, Palstra et al. (2009) determined that reproduction by male Atlantic salmon parr makes a limited contribution to the overall Ne for the population.

The GOM DPS diversity goals are: 1) monitor genetic diversity of each of broodstock; 2) screen for non-DPS origin fish in the broodstock (including commercial aquaculture escapees); and 3) evaluate diversity to help inform hatchery practices, stocking activities and other recovery activities. Of eight extant stocks, seven are in the conservation hatchery program. The Penobscot River is supported by the capture at Milford Dam of returning sea-run adult broodstock (1 – 2 years at sea), which are transported to U.S. Fish and Wildlife Craig Brook National Fish Hatchery (CBNFH) for spawning. Domestic broodstock maintained at U.S. Fish and Wildlife Green Lake National Fish Hatchery also supports enhancement efforts in the Penobscot and Kennebec rivers. This product is created annually by offspring from the spawned sea-run adults from CBNFH. Six other populations also have river-specific broodstocks but these collected as parr after 18+ months of river exposure. These parr resulted from limited natural reproduction or stocked fry/eggs. Most fish are released in the river of broodstock collection but the Penobscot broodstock typically serves as a sole donor stock for the Sandy/Kennebec River.

2.6.1 Allelic Diversity

Allelic diversity of a population is obtained by computing the mean number of unique alleles per locus. Eighteen variable microsatellite loci are monitored to characterize genetic diversity for all individuals considered for use in broodstocks (Figure 2.6.1.1). Loci analyzed were *Ssa197*, *Ssa171*, *Ssa202*, *Ssa85* (O'Reilly et al. 1996), *Ssa14*, *Ssa289* (McConnell et al. 1995), *SSOSL25, SSOSL85*, *SSOSL311*, *SSOSL438* (Slettan et al. 1995, 1996), and *SSLEEN82* (GenBank accession number U86706), *SsaA86*, *SsaD157*, *SsaD237*, *SsaD486*, (King et al 2005), *Sp2201*, *Sp2216*, and *SsspG7* (Paterson et al. 2004). Individuals characterized represent either parr collected for broodstock purposes (Dennys, East Machias, Machias, Narraguagus, Pleasant, and Sheepscot rivers) or adults returning to the Penobscot River and collected for broodstock at CBNFH. Annual characterization allows for comparison of allelic diversity among broodstocks and years. This year's characterization added in parr broodstock collected in 2022 and sea-run broodstock collected in 2024. Based on 18 loci, the average number of alleles per locus ranged from 10.69 alleles per locus for the Pleasant River to 13.33 alleles per locus for the Penobscot River (Figure 2.6.1.1). This characterization also enables screening for individuals that originated from the aquaculture industry or landlocked salmon populations and avoid their use as broodstock.

2.6.2 Observed and Expected Heterozygosity

Observed heterozygosity is "the number of heterozygotes as a proportion of the total individuals typed", whereas expected heterozygosity is "the proportion of heterozygotes expected from the allele frequencies under random mating, based on Hardy-Weinberg equilibrium" (Frankham et al. 2017). Both metrics are estimated for each broodstock from the 2022 collection year parr, the 2024 collection year Penobscot adult returns and the 2021 Penobscot domestic broodstock. Average estimates of expected heterozygosity based on 18 microsatellite loci (starting in 2008) ranged from 0.671 in the East Machias to 0.687 for the Penobscot adult return broodstock and the Penobscot domestic broodstock. Observed heterozygosity estimates of broodstocks based on 18 loci ranged from 0.695 in the Dennys to 0.714 in the Penobscot domestic broodstock.

2.6.3 Effective Population Size

Estimates of Ne size, based on 18 loci, vary both within broodstocks over time, and between broodstocks. Estimates are obtained using the linkage disequilibrium method that incorporates bias correction found in Ne Estimator (V2.01, Do et al. 2013). Estimates are based on the minimum allele frequency of 0.010, and confidence intervals are generated by the jackknife option. Parr-based broodstocks typically incorporate a single year class, thereby not violating assumptions for effective population size estimates of overlapping generations. Within the parr-based broodstocks, the lowest Ne from the 2022 collection year was estimated for the Dennys broodstock (N_e =97.6, 100.7-157.0 95% CI), and the highest was observed in the Narraguagus broodstock (N_e = 134.9 (107.1-174.8 95% CI). Ne estimates fluctuate annually (Figure 2.6.3.1). The average Ne from 2008 to the 2022 collection year across the parr-based broodstocks ranges from N_e=70.8 in the Dennys to Ne =134.3 in the Narraguagus. Within the Penobscot River, adult broodstocks typically include three to four year classes (including grilse). Ne estimates for the Penobscot since 2008 have ranged from maximum Ne =546.5 (465.8-650.7 95% CI) in 2017 to the low Ne =178.1 in 2024 (154.8-205.7 95% CI), with an average Ne =389.2. The Ne estimate for the 2021 Penobscot domestic year class (collected from juveniles from a single year class) is

Ne =81.6 in (74.7-89.1 95% CI). This large reduction in 2022 sea-run Penobscot can be due to decreased broodstock number over time.

2.6.4 Inbreeding Coefficient

The inbreeding coefficient (F) is used to measure the degree of inbreeding and represents the probability that two alleles at a given locus within an individual come from a common ancestor. Inbreeding coefficients are an estimate of the fixation index. An individual that is not inbred will have F = 0, and an inbred individual will have F = 1 (Kalinowski et al. 2012; Frankham et al. 2017). Estimates in the 2022 parr collection year ranged from -0.025 in the Dennys River to -0.043 in the Narraguagus and Sheepscot River. The 2024 collection year for the Penobscot had an estimated inbreeding coefficient of -0.025, and the 2021 Penobscot Domestic broodstock had an estimated inbreeding coefficient of -.041.

2.6.5 Summary

Maintenance of genetic diversity within Maine Atlantic salmon populations is an important component of restoration. Past population bottlenecks, the potential for inbreeding, and low Ne sizes that have been sustained for multiple generations contribute to concerns for loss of diversity. Contemporary management of hatchery broodstocks, which consists of most of the Atlantic salmon currently maintained by the population, works to monitor estimates of diversity and implement spawning and broodstock collection practices that contributed to maintenance of diversity. Overall, genetic diversity as measured by allelic variability has been maintained since the start of consistent genetic monitoring in the mid-1990s. There are concerns that consistently low estimates of allelic diversity in the Pleasant relative to the other broodstocks reflects the initial bottleneck experienced by that broodstock after founding in the late 1990's. Implementation of pedigree lines in the past to retain representatives of all hatchery-produced families helped to limit loss of diversity resulting from a genetic bottleneck in the Pleasant River, along with active management to limit loss of diversity through stocking and broodstock collection practices. However, low, sustained estimates of effective population size in the six parr-based broodstocks and decreased estimate of effective population size in the Penobscot River should continue to be monitored, as they indicate that populations are at a risk for loss of genetic diversity.

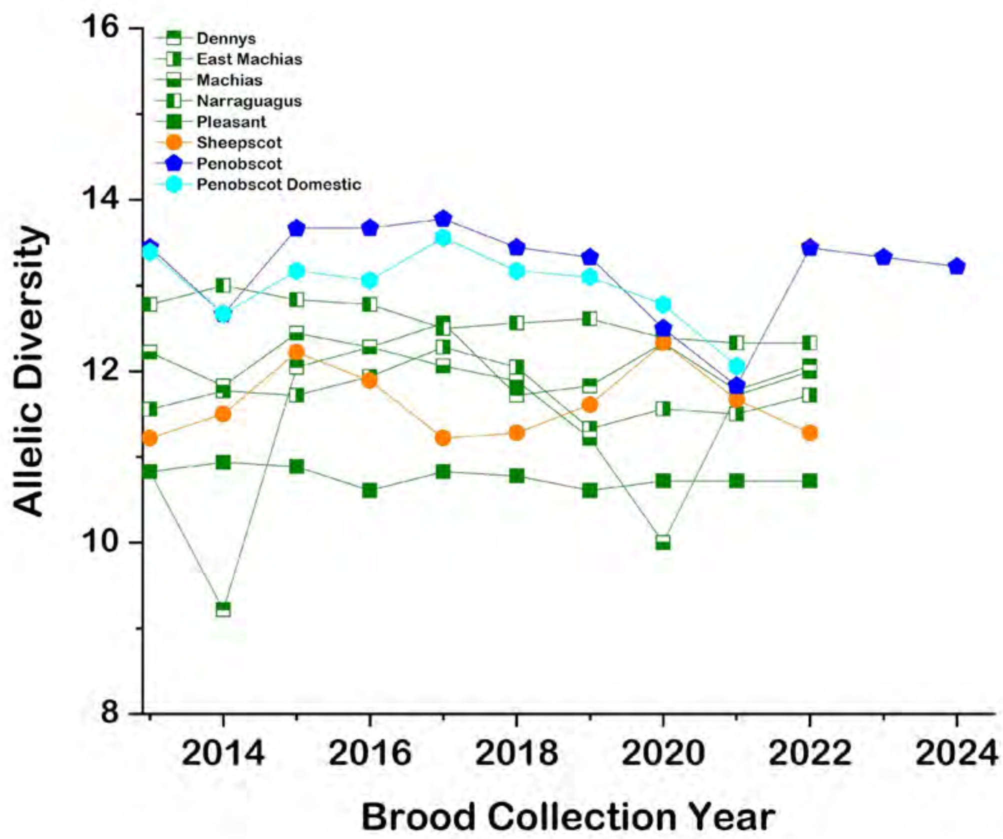


Figure 2.6.1.1. Allelic diversity time series for GOM DPS salmon populations, measured from 18 microsatellite loci for Dennys, East Machias, Machias, Narraguagus, Pleasant, Sheepscot, Penobscot, and Penobscot Domestic populations.

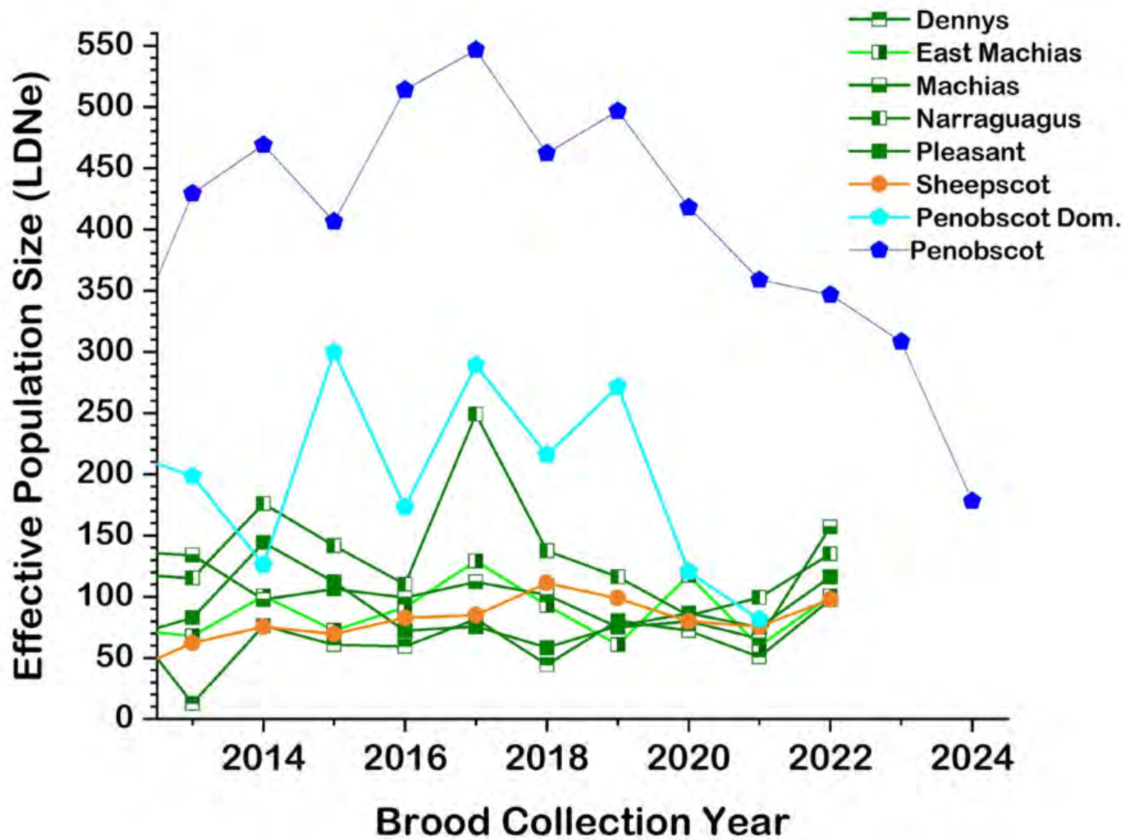


Figure 2.6.3.1 Time series of effective population size for seven GOM DPS distinct individual populations. Estimates for the parr-based broodstock populations (Dennys, East Machias, Machias, Narraguagus, Pleasant, and Sheepscot) approximate the number of breeders. Analysts calculated estimates primarily of a single cohort sampled as juveniles (parr) from each river. Analysts estimate effective population size of Penobscot sea-run broodstock from returning adults in the return year and for the Penobscot Domestic (Penobscot Dom) in spawning year.

2.7 Literature Cited

Beall, E., Dumas, J., Claireaux, D., Barriere, L. and Marty, C., 1994. Dispersal patterns and survival of Atlantic salmon (Salmo salar L.) juveniles in a nursery stream. ICES Journal of marine science, 51(1), pp.1-9.

Dennis B, Munholland PL, Scott JM. 1991. Estimation of growth and extinction parameters for endangered species. Ecology 61:115-143.

Do, C., R.S. Waples, D. Peel, G.M, Macbeth, B.J. Tillet, and J.R. Ovenden. 2013. NeEstimator V2: re-implementation of software for the estimation of contemporary effective population size (N_e) from genetic data. Molecular Ecology Resources 14(1): 209-214.

Fay, C.A., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan, et al. 2006. Status Review for Anadromous Atlantic Salmon (Salmo salar) in the United States. National Marine Fisheries Service/ U.S. Fish and Wildlife Service Joint Publication. Gloucester, MA. 294 pp. http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/atlanticsalmon.pdf

Eisenhauer, Z.J., Christman, P.M., Matte, J.M., Ardren, W.R., Fraser, D.J. and Grant, J.W., 2021. Revisiting the restricted movement paradigm: the dispersal of Atlantic salmon fry from artificial redds. *Canadian Journal of Fisheries and Aquatic Sciences*, *78*(4), pp.493-503.

Frankham, R., Bradshaw, C.J. and Brook, B.W., 2014. Genetics in conservation management: revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. Biological Conservation, 170, pp.56-63.

Frankham, R., Ballou, J.D., Ralls, K., Eldridge, M., Dudash, M.R., Fenster, C.B., Lacy, R.C. and Sunnucks, P., 2017. Genetic management of fragmented animal and plant populations. Oxford University Press.

Franklin, I.R. and Frankham, R., 1998. How large must populations be to retain evolutionary potential? Animal Conservation, 1(1), pp.69-70.

Holmes EE. 2001. Estimating risks in declining populations with poor data. Proceedings of the National Academy of Sciences 98:5072-5077. www.pnas.org/cgi/doi/10.1073/panas.081055898

Holmes, E.E. and W.F. Fagan. 2002. Validating population viability analyses for corrupted data sets. Ecology 83:2379-2386.

Hornby, D. D. 2020. RivEx (Version 10.35) [Software].

Kalinowski, ST, Taper, ML & Marshall, TC 2006. Revising how the computer program CERVUS accommodates genotyping error increases success in paternity assignment. Molecular Ecology 16 (5): 1099-1106.

Kalinowski, S.T., Van Doornik, D.M., Kozfkay, C.C. and Waples, R.S., 2012. Genetic diversity in the Snake River sockeye salmon captive broodstock program as estimated from broodstock records. Conservation Genetics, 13, pp.1183-1193.

King, T.L., M.S. Eackles, B.H. Letcher. 2005. Microsatellite DNA markers for the study of Atlantic salmon (Salmo salar) kinship, population structure, and mixed-fishery analyses. Molecular Ecology Notes 5:130-132.

Legault, C.M., 2005. Population viability analysis of Atlantic salmon in Maine, USA. Transactions of the American Fisheries Society, 134(3), pp.549-562.

McClure M.M., E.E. Holmes, B.L. Sanderson, C.E. Jordan. 2003. A large-scale, multispecies status assessment: Anadromous salmonids in the Columbia River basin. Ecological Applications 13:964-989.

McConnell, S.K., P.T. O'Reilly, L. Hamilton, J.M. Wright, and P. Bentzen. 1995. Polymorphic microsatellite loci from Atlantic salmon (Salmo salar): genetic differentiation of North American and European populations. Canadian Journal of Fisheries and Aquatic Sciences 52: 1863-1872.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42,156 p.

National Marine Fisheries Service 2009. Endangered and Threatened Species; Designation of Critical Habitat for Atlantic Salmon (Salmo salar) Gulf of Maine Distinct Population Segment. Federal Register Notice 74 FR 29299

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 2018. Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (Salmo salar). 74 pp.

O'Reilly, P.T., L. C. Hamilton, S.K. McConnell, and J.M. Wright. 1996. Rapid detection of genetic variation in Atlantic salmon (Salmo salar) by PCR multiplexing of dinucelotide and tetranucleotide microsatellites. Canadian Journal of Fisheries and Aquatic Sciences 53: 2292-2298.

Palstra, F.P., O'Connell, M.F. and Ruzzante, D.E., 2009. Age structure, changing demography and effective population size in Atlantic salmon (Salmo salar). Genetics, 182(4), pp.1233-1249.

Paterson, S., S.B. Piertney, D. Knox, J. Gilbey, and E. Verspoor. 2004. Characterization and PCR multiplexing of novel highly variable tetranucleotide Atlantic salmon (Salmo salar L.) microsatellites. Molecular Ecology Notes 4:160-162.

Piry S, Alapetite A, Cornuet, J.-M., Paetkau D, Baudouin, L., Estoup, A. (2004) GeneClass2: A Software for Genetic Assignment and First-Generation Migrant Detection. Journal of Heredity 95:536-539.

Ryman, N., Baccus, R., Reuterwall, C. and Smith, M.H., 1981. Effective population size, generation interval, and potential loss of genetic variability in game species under different hunting regimes. Oikos, pp.257-266.

Ryman, N. and Laikre, L., 1991. Effects of supportive breeding on the genetically effective population size. Conservation Biology, 5(3), pp.325-329.

Slettan, A., I. Olsaker, and O. Lie. 1995. Atlantic salmon, Salmo salar, microsatellites at the loci SSOSL25, SSOSL85, SSOSL311, SSOSL417 loci. Animal Genetics 26:281-282.

Slettan, A., I. Olsaker, and O. Lie. 1996. Polymorphic Atlantic salmon, Salmo salar L., microsatellites at the SSOSL438, SSOSL429, and SSOSL444 loci. Animal Genetics 27:57-58.

Soulé, M.E. ed., 1987. Viable populations for conservation. Cambridge University Press.

Symons, P.E.K., 1979. Estimated escapement of Atlantic salmon (Salmo salar) for maximum smolt production in rivers of different productivity. Journal of the Fisheries Board of Canada, 36(2), pp.132-140.

USASAC (U.S. Atlantic Salmon Assessment Committee). 2009. Annual report of the U.S. Atlantic Salmon Assessment Committee 21: 2008 activities. Portland, Maine.

USASAC (U.S. Atlantic Salmon Assessment Committee). 2020. Annual report of the U.S. Atlantic Salmon Assessment Committee 32: 2019 activities. Virtual.

USASAC (U.S. Atlantic Salmon Assessment Committee). 2023. Annual report of the U.S. Atlantic Salmon Assessment Committee 35: 2022 activities. Portland, Maine.

USASAC (U.S. Atlantic Salmon Assessment Committee). 2024. Annual report of the U.S. Atlantic Salmon Assessment Committee 36: 2023 activities. Portland, Maine.

Waples, R.S., 2002. Effective size of fluctuating salmon populations. Genetics, 161(2), pp.783-791.

Wainwright, T.C. and Waples, R.S., 1998. Prioritizing Pacific Salmon Stocks for Conservation: Response to Allendorf et al. Conservation Biology, 12(5), pp.1144-1147.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L.G. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

3 Gulf of Maine

Summary

Documented adult Atlantic salmon returns to rivers in the geographic area of the Gulf of Maine (GOM) Distinct Population Segment (DPS; collectively known as the GOM DPS; 73 FR 51415-51436) (NMFS and USFWS 2009) in 2024 was 1,517 salmon (Table 3.0.1). Returns are the sum of counts at fishways and weirs (1,449) and estimates from redd surveys (68). No fish returned "to the rod" because angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Penobscot, Kennebec, and Union rivers.

Total escapement to these same rivers in 2024 was 1,391 salmon (Table 3.0.2). Escapement to the GOM DPS equals releases at traps and free-swimming individuals (estimated from redd counts) plus released pre-spawn captive broodstock (adults used as hatchery broodstock and released as kelts are not included), stocked pre-spawn adults, and recaptured salmon previously released downstream for telemetry studies.

Naturally reared population growth rates to the DPS have varied since 1990, although the rate has been somewhat consistent since 1997 with a mean growth rate of 0.96, (Figure 3.0.1). Most returns were two Sea-Winter (2SW – two years at sea) salmon that emigrated as 2-year-old smolts, thus, cohort replacement rates are calculated assuming a five-year lifespan. To show sustained improvement, population growth must be observed for at least two generations (10 years). The 10-year geometric mean naturally reared growth rate for the period 2014 to 2024 is 1.14 (95% CI: 0.66 – 1.94) for the DPS. Of the three Salmon Habitat Recovery Units (SHRU) comprising the DPS, Merrymeeting Bay SHRU experienced the greatest growth rate of 1.46 (95% CI: 0.81 – 2.64); growth rate for the Penobscot Bay SHRU was 1.22 (95% CI: 0.63 – 2.38) and Downeast Coastal SHRU was 0.91 (95% CI: 0.55 – 1.51). These estimates indicate that the geometric mean growth rate for the DPS has been slightly above replacement. It is likely that consistent annual stocking rates have helped maintain the replacement rate and variations are due to marine survival. Naturally reared returns are still well below 500 (Figure 3.0.2). For more detail on population growth rates, see Section 2.3 above.

Table 3.0.1. Returns to the Gulf of Maine in 2024 for the monitored rivers within each Salmon Habitat Recovery Unit (SHRU). Counts are from fishway traps at dams or redd-based estimates from spawner surveys. Age and origins are prorated based on observed catches at traps, cohort specific catches at smolt traps, or historical age ratios. Abbreviations: SHRUs - Downeast Coastal (DEC); Penobscot Bay (PNB) and Merrymeeting Bay (MMB); Sea-Winter Abbreviations (number of winters spent at sea: 1SW = One Sea-Winter, or Grilse, 2SW = two Sea-Winter, 3SW = Three Sea-Winter).

SHRU	Drainage	Method	1SW - Hatchery	2SW - Hatchery	3SW - Hatchery	Repeat Spawner - Hatchery	1SW - Naturally Reared	2SW - Naturally Reared	3SW - Naturally Reared	Repeat Spawner - Naturally Reared	Total Hatchery	Total Naturally Reared	Grand Total
DEC	Dennys	Redd Est	0	0	0	0	3	12	0	0	0	15	15
DEC	East Machias	Redd Est	0	0	0	0	0	0	0	0	0	0	0
DEC	Machias	Redd Est	0	0	0	0	3	11	0	0	0	14	14
DEC	Narraguagus	Redd Est	2	0	0	0	1	9	0	0	2	10	12
DEC	Pleasant	Redd Est	0	0	0	0	1	4	0	0	0	5	5
DEC	Union	Trap	0	1	0	0	0	0	0	0	1	0	1
MMB	Androscoggin	Trap	11	3	1	0	1	1	0	0	15	2	17
MMB	Kennebec	Trap	15	22	2	0	1	10	3	0	39	14	53
MMB	Sheepscot	Redd Est	2	6	0	0	1	7	0	0	8	8	16
PNB	Cove Brook	Redd Est	0	0	0	0	0	0	0	0	0	0	0
PNB	Ducktrap	Redd Est	0	0	0	0	1	2	0	0	0	3	3
PNB	Great Works Stream	Redd Est	1	0	0	0	0	2	0	0	1	2	3
PNB	Kenduskeag Stream	Redd Est	0	0	0	0	0	0	0	0	0	0	0
PNB	Penobscot	Trap	316	978	19	5	18	40	2	0	1,318	60	1,378
PNB	Souadabscook Stream	Redd Est	0	0	0	0	0	0	0	0	0	0	0
		Totals	347	1,010	22	5	30	98	5	0	1,384	133	1,517

Table 3.0.2. Sea-run returns and total escapement in 2024 for the monitored rivers within each Salmon Habitat Recovery Units (SHRUs) and rivers. Salmon are counted either at trapping facilities or using a redd-based estimate. Escapement is the total returns and pre-spawn adults into a drainage, minus broodstock and dead-on-arrival (DOA) salmon. SHRU abbreviations: DEC = Downeast Coastal; PNB = Penobscot Bay and MMB = Merrymeeting Bay.

Method	SHRU	Drainage	Returns	Brood Stock	DOA	Escapement	Captive Pre-Spawn	Sea-Run Pre-Spawn	Total Escapement
Estimate	DEC	Dennys	15	0	0	15	0	0	15
Estimate	DEC	East Machias	0	0	0	0	0	0	0
Estimate	DEC	Machias	14	0	0	14	0	0	14
Estimate	DEC	Narraguagus	12	0	0	12	0	0	12
Estimate	DEC	Pleasant	5	0	0	5	0	0	5
Trap	DEC	Union	1	0	0	1	0	0	1
Trap	MMB	Androscoggin	17	0	1	16	0	0	16
Trap	MMB	Kennebec	53	0	1	52	196	0	248
Estimate	MMB	Sheepscot	16	0	0	16	0	0	16
Estimate	PNB	Cove Brook	0	0	0	0	0	0	0
Estimate	PNB	Ducktrap River	3	0	0	3	0	0	3
Estimate	PNB	Great Works	3	0	0	3	0	0	3
Estimate	PNB	Kenduskeag	0	0	0	0	0	0	0
Trap	PNB	Penobscot	1,378	606	2	770	286	2	1,058
Estimate	PNB	Souadabscook	0	0	0	0	0	0	0
			1,517	606	4	907	482	2	1,391

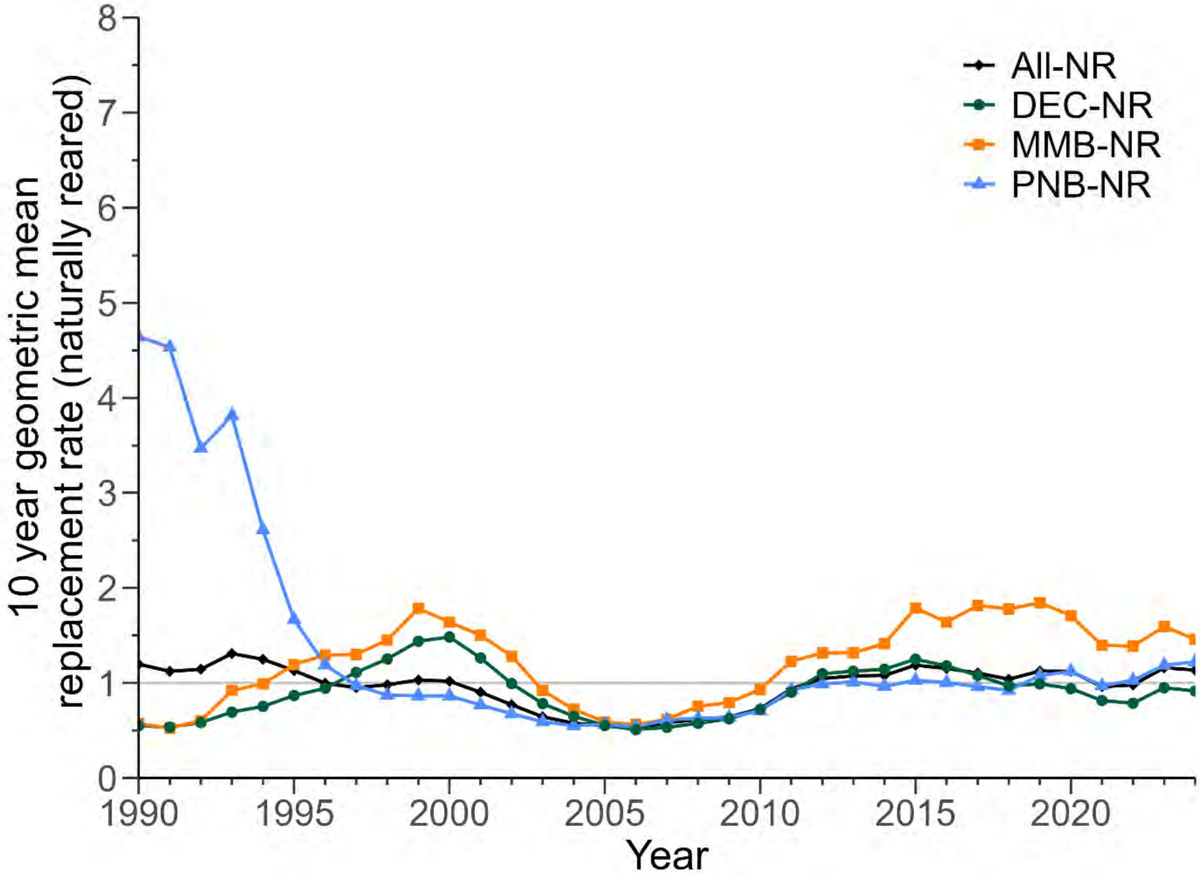


Figure 3.0.1. Ten-year geometric mean replacement rate for returning naturally reared (NR) Atlantic salmon in the Gulf of Maine Distinct Population Segment and the three Salmon Habitat Recovery Unit (SHRU) 1990 to 2024. SHRU abbreviations: PNB = Penobscot Bay, MMB = Merrymeeting Bay and DEC = Downeast Coastal.

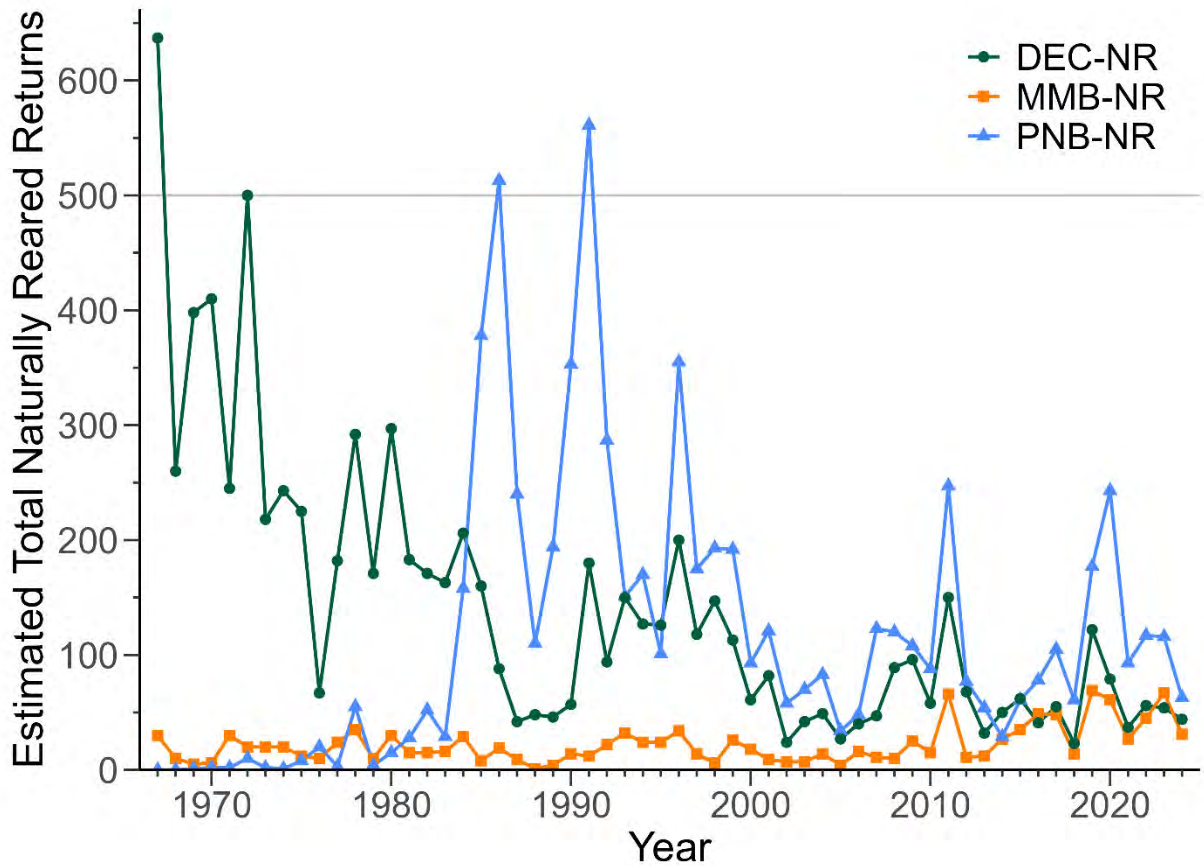


Figure 3.0.2. Estimated Naturally Reared (NR) Returns to the Gulf of Maine 1965 to 2024. NR refers to the egg and fry lifestages. Salmon Habitat Recovery Unit abbreviations: PNB = Penobscot Bay, MMB = Merrymeeting Bay and DEC = Downeast Coastal. The horizontal gray line indicates the criteria for down listing under the 2019 Recovery Plan for the Gulf of Maine Distinct Population Segment (USFWS and NMFS 2018).

3.1 Adult returns and escapement

The Maine Department of Marine Resources, Bureau of Sea-Run Fisheries and Habitat (MDMR) and its authorized representatives operate counting facilities on several rivers in Maine to capture and count sea-run adult Atlantic salmon (*Salmo salar*) returning to the GOM DPS. This is done to determine annual returns and estimate escapement, collect biological data, procure sea-run broodstock, and exclude suspected aquaculture Atlantic salmon and invasive species for each river in which salmon are trapped (Table 3.0.1 and 3.0.2). To standardize operations among trapping facilities, MDMR staff developed protocols and methods for tending that consider safe handling and transport of salmon as needed. These protocols, which are updated annually, provide site-specific guidance on data collection and marking as needed.

Proration of data for returning adult Atlantic salmon.

Data collected from captured adult salmon include fork length to the nearest cm, degree of fin erosion (i.e., fin scores, any noticeable marks, and scale samples. These data are used to make an initial determination of age and origin followed by confirmation via scale analysis. These data are also used to prorate adults into appropriate categories when data collection is impacted during periods when handling is limited or is not occurring (generally due to high temperatures or staffing) or when all scales in sample are considered regenerated (which prevents accurate age/origin determination). The most common proration actions include assignments to the following variables: “Sex”, “Origin”, “Freshwater Age”, “Sea Age”, and “in-season recaptures”.

Sex proration

Proration of “Sex” occurs at the end of the season by computing the sex ratio of salmon handled at trapping facilities upon initial capture, along with sex data obtained at the hatchery during spawning. This computed sex ratio is used to assign a prorated sex to the proportion of unknown/unhandled fish during the season. Observed sex ratios from spawned broodstock are not exclusively used to generate the ratio because there are many reasons why a fish may be sent to the hatchery beyond broodstock sex ratio targets, thus sex ratios of broodstock are not wholly representative of the returning salmon population.

Origin proration

Proration of origin occurs at the end of the season by analyzing scale samples, incorporating observed marks and/or tags, and fin condition data from handled fish. The observed ratio of hatchery (H) to wild individuals is then applied to the fish of unknown origin (i.e., those that passed a counting facility during non-handling periods or fish that were handled but had regenerated scales)

Freshwater Age proration

Salmon assigned the origin of W are assigned a freshwater age. Proration of freshwater age occurs at the end of the season by analyzing the scale data on fish handled and applying the resulting freshwater age ratio to unknown fish. The freshwater age structure of all observed W fish is applied to the prorated W individuals’ proportions according to the observed ratios.

Sea Age proration

Salmon assigned a prorated sea age are individuals that are observed via video or other means without handling the fish. Proration of sea age for returning adult Atlantic salmon is generally assigned using observed fork length; i.e., salmon < 63 cm FL are assigned as 1SW, and salmon > 63 cm FL are assigned as 2SW or greater. Sea age for multi sea winter fish is based on scale pattern analysis for handled fish. The scales collected from handled fish are read to determine sea age ratios, which are then applied to individuals of unknown sea age. Fish that are noted as potential three sea-winter (3SW) fish based on size are assigned first, and the remaining multi sea-winter (MSW) subset is prorated as described.

Redd-based proration

Starting with 2019 returns, we documented proration methods fully in a working paper (available upon request, USASAC 2020). Briefly, for populations where natural production (wild spawning, egg planting, or fry stocking) is the exclusive source of adult spawners, the proration method is the two-step 80:20 proration. In step 1, the Redds Based Estimate (RBE) is multiplied by 0.8 and rounded to the nearest whole fish to determine the number of large salmon (2SW, MSW, or repeats). In step 2, numbers of 1SW salmon were calculated by subtracting large salmon from the RBE total.

For 2019 to 2024 returns to the East Machias, Sheepscot, and Narraguagus rivers, a modified proration method was used to enable evaluation of the efficacy of ambient fall parr stocking. In these drainages, ambient parr originating from U.S. Fish and Wildlife Service's Craig Brook National Fish Hatchery (CBNFH; Sheepscot River) and Peter Gray Hatchery (PGH; East Machias and Narraguagus rivers) were stocked in the fall. In both these systems, smolt trapping was used to generate a population estimate of emigrant smolts and calculate the proportion of ambient parr relative to the proportion of naturally reared smolts (i.e., wild-spawned, egg-planted, or fry-stocked). The resulting ratio of ambient parr to natural origin smolts was used to prorate the origin of returning adults. During this period, adult return origin was pro-rated by 0.46 fall parr origin for Sheepscot returns, 0.98 for the East Machias, and 0.80 for the Narraguagus.

This pro-ration method assumes equal marine survival between smolts of natural origin (wild, egg-planted, or fry stocked) and fall parr origins. It would be useful to test this assumption in a watershed where returning adults were handled. This is a research need for ambient fall parr evaluations. With the onset of ambient parr stocking in the Narraguagus River some direct evaluation of adult returns by origin is expected from catches in the Cherryfield Dam adult trap, which could potentially be used to meet this research need.

The following are drainage summaries of adult returns to the GOM in 2024.

3.1.1. Merrymeeting Bay

Androscoggin River

The Brunswick fishway trap was operated from 1 May to 15 November 2024. Seventeen adult Atlantic salmon were passed at the Brunswick fishway trap. These consisted of 11 (64.7%) hatchery reared 1SW, three (17.6%) hatchery reared 2SW adults, one hatchery reared 3SW (5.9%), one naturally reared 1SW (5.9%) and one naturally reared 2SW adult (5.9%) (Table 3.0.1). Due to the proximity of the Androscoggin River to several other trapped rivers, adults that are handled at this facility are marked differently from other rivers, with an upper caudal punch to identify strays from recaptured salmon. Biological data were collected from 14 trap-captured returning Atlantic salmon in accordance with the 2024 MDMR Adult Trap protocols, and the presence of marks and tags were recorded.

No redd counts were conducted in the Androscoggin drainage in 2024. The Little River, which is normally minimally surveyed, was deemed likely inaccessible to migrating adult salmon in 2024 due to drought-induced low water conditions over a set of steep ledges near the confluence.

Kennebec River

The majority of the Atlantic salmon returns to the Kennebec River drainage occurred at the Lockwood Dam (fish lift operated by Brookfield Renewable Power (BRP) staff from 1 May to 31 October 2024). Of the 53 total returns, 51 were captured at Lockwood (Table 3.0.2.). Two Atlantic salmon were observed in the fishway window at the Benton Falls fish lift facility (operated by Essex Hydro Associates staff from 01 May to 31 October 2024) located on the Sebasticook River (tributary of the Kennebec). These two adult salmon were assigned as hatchery reared based on the lack of a stocking program and few adults returning over the last few years. The Benton Falls fish lift had major operational issues and was unable to operate from the last week of June until the end of the season. Percentages of captured and observed salmon of the Kennebec returns after proration were as follows: 3SW salmon 9.4%, 2SW 60.4% and 1SW 30.2%. Origins for 3SW returns were: three naturally reared and two hatchery. Origins for 2SW returns were: 10 naturally reared and 22 hatchery. For 1SW returns, one was naturally reared and 15 were hatchery reared origin. Hatchery origin salmon made up 73.6% of returns to the Kennebec drainage with naturally reared salmon making up the remaining 26.4%. One salmon was recaptured. The hatchery reared origin returns were likely from stocked smolts raised at the U.S. Fish and Wildlife Service (USFWS) Nashua National Fish Hatchery (NNFH) in New Hampshire. The dorsal fins of adults returning from smolt stocking in the Kennebec River (hatchery origin adults) tended to be eroded compared to their naturally reared counterparts. Therefore, a dorsal fin erosion score was used to prorate the origin of adults. Out of the 13 salmon that were prorated in 2024, all due to scale regeneration, one was determined 3SW, 9 were 2SW and 3 were 1SW. The single 3SW was determined to be hatchery origin. Seven of the 2SW were prorated as hatchery and two were prorated as wild. All three 1SW were prorated as hatchery origin. The freshwater ages of the two prorated wild 2SW adults were based on the known freshwater proportions: 13% 2-year-olds, 75% 3-year-olds and 13% 4-year-olds.

One year class of naturally reared adults appeared to be severely under-represented in the returns to the Kennebec at the Lockwood lift. Of the 12 known ages for naturally reared returns, only two Atlantic salmon returned from the 2020 smolt cohort, which should have been the largest group returning in 2024 comprising individuals with a fresh water age to sea winter age of 3:1 and 2:2. The 2020 smolt cohort was assessed via rotary screw trap in 2022 and the outgoing population estimate was 9,694 (95% CI 9,080 - 10,308) and comprised 64% and 36%, respectively, for 2-year-olds and 3-year-olds. The return ratios for naturally reared adults with known ages were 13%, 75% and 13%, respectively, for 2, 3 and 4-year-olds. It appears that either survival was lower for the 2020 smolt cohort after emigrating from the Sandy River, or this cohort is staying longer in the North Atlantic Ocean.

Other noted shifts in age dynamics in 2024 include the increase in 3SW returns. There has only been one other year since Lockwood fishway has been operational that 3SW salmon were captured in the Merrymeeting Bay SHRU. That was in 2017 when two individuals were captured. Six 3SW salmon returned to the Merrymeeting Bay SHRU this year between the Androscoggin and the Kennebec rivers.

One 1SW salmon was caught by an angler in the Sandy River during the summer months. The total escapement to the Kennebec River was 52 salmon.

Redd surveys in the Kennebec drainage in 2024 were limited to the Sandy River. Seventy-eight sea-run redds and two redds originating from captive reared gravid released salmon were observed. A total of 116.4 river km was surveyed for redds, covering 34.3% of the surveyed spawning habitat in the Kennebec River drainage. (Table 3.1.1).

Sheepscot River

There were 13 redds observed in the Sheepscot River; 11 were in the mainstem and two were in the West Branch. A total of 63.1 river km was surveyed, which contained 83.0% of the spawning habitat in the drainage (Table 3.1.1.). The RBE indicated that 16 adults returned (95% CI 6 – 42) (Table 3.1.2). The breakdown of returns are as follows: two 1SW hatchery origin, one naturally reared 1SW, six hatchery 2SW and seven naturally reared 2SW salmon. Ambient parr were not stocked in 2020, corresponding to the P20 portion of the adult returns; therefore, the typical percentage used in the RBE to determine the hatchery portion of the returns was adjusted to 46% from 55% used in previous years. During spawner surveys, a spent dead 2SW female was found near a redd. Injuries were consistent with those of avian predation. Scale samples were collected and upon analysis, it was determined that the salmon likely originated from the ambient parr program.

3.1.2 Penobscot Bay

Penobscot River

The fish lift at the Milford Hydro-Project, owned by BRP, was operated daily by MDMR staff from 19 April through 15 November. Biological data including length, sex, scales, genetics, and injury assessment were collected on all fish handled and released. Fish were handled five days per week (Monday through Friday) and only on weekends when staffing was available and at river temperatures < 23°C per MDMR handling protocols for fish safety.

The fish lift was also used to collect adult sea-run Atlantic salmon broodstock for the USFWS. Biological data were collected by USFWS staff for all broodstock after fish arrived at CBNFH and provided to MDMR to prevent duplicative data collection between agencies. The protocol also allowed for broodstock collection to occur at temperatures exceeding 23°C, as fish were not processed for biological data collection until water can be tempered to safe handling temperatures, thereby reducing stress on fish. Biological data were collected from broodstock on the day of capture when possible. In cases where processing was delayed (typically 1 to 2 days), MSW vs grilse size counts were maintained in daily catch data and once collected, morphometric data were assigned based on size and numbers.

In addition to the fish lift at Milford Dam, BRP operated a fish lift daily at the Orono Hydro project. BRP staff identified MSW or grilse by size, checked for adipose clips (or punches), scanned for passive integrated transponder (PIT) tags, and identified fish as male or female when secondary sexual characteristics were obvious. Fish captured at the Orono facility were trucked to the boat launch located in the Milford head pond just upstream of the Milford dam on the western shore. The counts of salmon collected at the Orono Hydro facility are included in the Penobscot River totals.

A total of 1,378 sea-run Atlantic salmon returned to the Penobscot River (Table 3.0.1.). Scale samples were collected from 896 captured salmon and analyzed to characterize the age and origin structure of the run. Origin (natural or naturally reared), sex, and age proportions were applied to salmon that were trapped but not scale-sampled from the seasonal composition.

In addition, video monitoring was conducted at Milford Dam to aid in counts when environmental conditions warrant reduced handling, i.e., warm water temperatures. In-season recaptures were reported based on the size, presence of tags or marks observed, and dorsal fin deformity, as described previously.

Of returning salmon, 21 were 3SW (1.5%), 1,018 were age 2SW (73.9%), 334 were age 1SW (24.2%), and five were repeat spawners (0.4%). Hatchery origin returns were 95.6% (1,318) of the returning salmon and the remaining 4.4% (60) were naturally reared origin (Table 3.0.1). No aquaculture-suspect salmon were captured.

Video Recapture proration

Because a proportion of returning salmon to the Penobscot were not handled but instead were counted using video or direct observation (thus are not marked). It is possible for fish to be observed multiple times, therefore it is necessary to account for fish that were observed versus handled so as not to inflate estimates of returns. Numbers were recorded daily of: first capture fish, dead fish, fish removed for broodstock, marked fish, and known recapture fish. The proportions of marked and unmarked fish that were captured and observed (via telemetry, PIT tag antenna, external tags, or visually observed) were assumed to be the same as the proportions during times when staff are not present and/or when fish are not handled. Those proportions were used to prorate for recaptured fish. Only fish that remained in the river were used to prorate counts, i.e., known removals (mortality, broodstock, etc.) were excluded. Atlantic salmon released back into the river (due to failure to pass disease screening, etc.) were included in the proration. This proration method for in-season recaptures was applied by calculating a proration percentage based on a daily running total, using Microsoft Excel's integer function to calculate whole fish, excluding fractions of fish because sample rounding is biased low by rounding down, underestimating the total catch for the day.

There were four primary data points used in recapture calculations: (1) total capture events, (2) number of in-season recaptures, (3) known number of marked fish in the river, and (4) known number of unmarked fish in the river. Total capture events were calculated by adding all the individual events in which fish were encountered, minus any known mortalities. Recapture events were calculated by adding all the events in which it was clear that a fish had been previously handled. This includes visual observation of marks (adipose clip/punch), injuries observed, or documentation via radio or PIT tag detection, or Floy tag observation.

Unmarked in-river salmon were calculated daily by subtracting the number of fish that were marked on the day from the total number of fish observations on that day as well as subtracting any fish recaptured that day.

First capture fish were calculated daily with the ratio of known marked fish and unmarked fish informing proration of unknown individuals. The beginning of the season was heavily represented because of favorable temperatures, with regular handling of fish and marks applied. Later in the season, with higher temperatures and reduced staffing, prorated marks were included as part of the running total to inform estimated recapture events. At the end of each day, an estimated total of first capture fish versus recaptured individuals was used to calculate a running total by day to inform subsequent calculations such that the ratio of marked to unmarked fish included prorated marks because the probability of incidence of recapture increases as the number of marked individuals in the population increases. Without this adjustment, the recapture rate would have been underestimated.

Spawner Surveys

Spawner surveys were conducted in the Penobscot drainage. In the Ducktrap River, 61.6% of spawning habitat and 4.6 km of river were surveyed (Table 3.1.1.), with one redd observed resulting in an RBE of 3 (95% CI: 1 - 9). In Kenduskeag Stream, 1.4% of spawning habitat and 1.5 river km were surveyed; there were zero redds observed in Kenduskeag Stream. In Great Works Stream, 1.3 river km was surveyed, with one redd observed in Great Works Stream, resulting in an RBE of 3 (95% CI: 1 - 9). In the East Branch Penobscot River, 15.9 river km and 61.0% of the spawning habitat were surveyed, with a total of 32 redds observed. In the Piscataquis Drainage 40.7 river km and 24.2% of the spawning habitat were surveyed with 74 redds observed. (Table 3.1.1). No RBE was calculated for the East Branch and the Piscataquis because they are accounted for in the Milford trap count.

3.1.3 Downeast Coastal

Dennys River

Twelve redds were observed in the Dennys River in 2024. Surveys covered 74.5% of the habitat and 21.3 km of stream (Table 3.1.1). Surveys were not conducted in Cathance Stream due to drought conditions. Based on the RBE, the estimated escapement was 15 (95%CI: 6 - 40; Table 3.1.2.).

East Machias River

Zero redds were documented during the 2024 redd surveys covering 93.3% (15.1 km) of known spawning habitat (Table 3.1.1).

Machias River

A total of 10 redds were counted in 2024. Drought conditions limited the ability to survey using canoes and much of the 2024 survey was done on foot focusing on historically high use spawning shoals. Surveys covered 37.5% of the known-spawning habitat and 29.7 km of stream (Table 3.1.1). Based on the RBE, the estimated escapement was 14 (95%CI: 5 – 36; Table 3.1.2.).

Pleasant River

There were two redds observed in 2024, both produced by sea-run salmon and located upstream of Saco Falls. Surveys covered 79.9% of the habitat and 13.6 km of stream (Table 3.1.1). Based on the RBE, estimated escapement was five (95%CI: 2 – 14; Table 3.1.2.).

Narraguagus River

The Narraguagus Fishway Trap, located at the Cherryfield ice control dam, was operated from 26 April to 31 October 2024. There were five returns to the fishway trap in 2024 including one adipose clipped 1SW indicating it was released as a 0+ parr. A total of eight redds were counted, originating from sea-run spawners. Surveys covered 86.5% (66.1 km) of known spawning habitat (Table 3.1.1). The RBE was used to determine returns because it was greater than the trap count. The RBE of the estimated return was 12 (95%CI: 4 – 31; Table 3.1.2.). Data collected at the trap were used to prorate the breakdown of age and origins. Returns are broken down as follows: three 1SW (25.0%) and nine 2SW (75.0%) salmon returned with 16.7% of hatchery origin and 83.3% naturally reared origin (Table 3.0.1.).

Union River

The fish trap at Ellsworth Dam on the Union River is operated by the dam owners, BRP, under protocols established by the MDMR. The trap was operated from 29 April to 31 October 2024. One male 2SW salmon was captured in 2024 (Table 3.0.1.). The salmon was estimated to be ~80 cm long and had fin scores: Dorsal=1; Caudal =1. The pectoral and ventral fins were obviously deformed. There were no fin clips or tags observed. MDMR was contacted immediately per the Atlantic salmon handling protocol and provided with photographs of the fish. Based upon the fin deformities it was determined that this fish was not of naturally reared origin. Scale and tissue samples were collected from the fish and an orange Floy tag was applied to the dorsal musculature. The fish was released back to the river downstream of the Ellsworth Dam. Scale analysis showed it to be hatchery origin and initial genetic analysis from Cooke Aquaculture determined it to not be a U.S. based aquaculture salmon. Results from the USFWS lab in Lamar, PA are pending.

Table 3.1.1. Results of redd surveys by Salmon Habitat Recovery Unit (SHRU), Drainage and Stream for 2024 by redd origin. Origins are: Captive Reared Freshwater (CRF) and Sea-run Redds (Sea-run). Effort is shown by both total kilometers surveyed and the proportion of the spawning habitat surveyed by drainage and individual stream. Percent stream survey values of N/A indicate that habitat data were unavailable for this analysis. Bolded drainage totals may not equal the sum of the individual stream totals since not all streams in a drainage may be surveyed. Abbreviations for SHRUs: DEC = Downeast Coastal, MMB = Merrymeeting Bay and PNB = Penobscot Bay.

SHRU/Drainage	Stream	CRF	Sea-run	Total Redds	% Stream Spawn Habitat Surveyed	Stream Total KM surveyed
DEC/Dennys	Dennys River	0	12	12	74.5	21.3
Dennys River Drainage Total	**All Surveyed**	**0**	**12**	**12**	**74.5**	**21.3**
DEC/East Machias	Barrows Stream	0	0	0	N/A	0.5
DEC/East Machias	Beaverdam Stream	0	0	0	84.8	1.2
DEC/East Machias	Chase Mill Stream	0	0	0	100.0	2.3
DEC/East Machias	East Machias River	0	0	0	100.0	6.9
DEC/East Machias	Northern Stream	0	0	0	89.1	4.1
East Machias River Drainage Total	**All Surveyed**	**0**	**0**	**0**	**93.3**	**15.1**
DEC/Machias	Machias River	0	10	10	33.7	10.6
DEC/Machias	Mopang Stream	0	0	0	33.7	5.6
DEC/Machias	Old Stream	0	0	0	44.3	2.4
DEC/Machias	West Branch Machias River	0	0	0	93.3	11.1
Machias River Drainage Total	**All Surveyed**	**0**	**10**	**10**	**37.5**	**29.7**
DEC/Narraguagus	Bog Brook	0	0	0	N/A	0.1
DEC/Narraguagus	Narraguagus River	0	8	8	94.0	66.0
Narraguagus River Drainage Total	**All Surveyed**	**0**	**8**	**8**	**86.5**	**66.1**
DEC/Pleasant	Pleasant River	0	2	2	80.4	13.6
Pleasant River Drainage Total	**All Surveyed**	**0**	**2**	**2**	**79.9**	**13.6**
MMB/Lower Kennebec	Lemon Stream	0	0	0	N/A	1.2
MMB/Lower Kennebec	Mt Blue Stream	0	0	0	N/A	0.4
MMB/Lower Kennebec	Orbeton Stream	0	12	12	98.0	17.1
MMB/Lower Kennebec	Perham Stream	0	1	1	84.1	2.3
MMB/Lower Kennebec	Saddleback Stream	0	0	0	N/A	0.1
MMB/Lower Kennebec	Sandy River	2	61	63	96.0	89.5
MMB/Lower Kennebec	South Branch Sandy River	0	4	4	100.0	4.3
MMB/Lower Kennebec	Temple Stream	0	0	0	N/A	1.7
Lower Kennebec River Drainage Total	**All Surveyed**	**2**	**78**	**80**	**34.3**	**116.4**
MMB/Sheepscot	Sheepscot River	0	11	11	87.0	35.3
MMB/Sheepscot	West Branch Sheepscot River	0	2	2	93.9	27.8

SHRU/Drainage	Stream	CRF	Sea-run	Total Redds	% Stream Spawn Habitat Surveyed	Stream Total KM surveyed
Sheepscot River Drainage Total	**All Surveyed**	**0**	**13**	**13**	**83.0**	**63.1**
PNB/Ducktrap	Ducktrap River	0	1	1	61.6	4.6
Ducktrap River Drainage Total	**All Surveyed**	**0**	**1**	**1**	**60.4**	**4.6**
PNB/East Branch Penobscot	East Branch Penobscot River	0	32	32	61.0	15.9
East Branch Penobscot River Drainage Total	**All Surveyed**	**0**	**32**	**32**	**20.1**	**15.9**
PNB/Penobscot	Cove Brook	0	0	0	97.4	4.4
PNB/Penobscot	Great Works Stream	0	1	1	N/A	1.3
PNB/Penobscot	Hemlock Stream	0	0	0	N/A	0.4
PNB/Penobscot	Kenduskeag Stream	0	0	0	1.4	1.5
PNB/Penobscot	Marsh Stream	0	0	0	N/A	0.5
PNB/Penobscot	Pollard Brook	0	0	0	N/A	0.6
PNB/Penobscot	Souadabscook Stream	0	0	0	N/A	0.1
Penobscot River Drainage Total	**All Surveyed**	**0**	**1**	**1**	**1.1**	**8.8**
PNB/Piscataquis	Black Stream	0	0	0	N/A	0.8
PNB/Piscataquis	East Branch Pleasant River	0	17	17	84.6	3.4
PNB/Piscataquis	Houston Brook	0	0	0	N/A	2.5
PNB/Piscataquis	Middle Branch Pleasant River	0	0	0	N/A	2.0
PNB/Piscataquis	Piscataquis River	0	43	43	12.1	11.3
PNB/Piscataquis	Pleasant River	0	4	4	52.2	3.7
PNB/Piscataquis	Schoodic Stream	0	6	6	N/A	0.8
PNB/Piscataquis	West Branch Pleasant River	0	**4**	4	88.5	16.2
Piscataquis River Drainage Total	**All Surveyed**	**0**	**74**	**74**	**24.2**	**40.7**

Redd Based Returns to Small Coastal Rivers

Estimated returns to Maine are based on the total number of adult Atlantic salmon returning to traps on the Androscoggin, Kennebec, Penobscot, Union and Narraguagus rivers, as well as spawner surveys. For small coastal rivers without traps, historical capture data from the Pleasant, Narraguagus and Union River traps are used to predict returns in the Cove Brook, Dennys River, Ducktrap River, East Machias River, Kenduskeag Stream, Souadabscook Stream, Machias River, Pleasant River, and the Sheepscot River based on observed redd counts. Estimated returns based on RBE use the equation:

$$\ln Adults = 1.1986 + 0.6098(\ln Redds).$$

A total of 46 redds was surveyed in Cove Brook, Souadabscook and Kenduskeag streams, and the Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot, and Ducktrap rivers. The RBE for 2024 is 65 adults (95%CI: 24 to 171; Table 3.1.6). Total redd numbers across the GOM DPS were similar to 2023 (95%CI: 24 to

171; Figure 3.1.1.). Trends in estimated returns across surveyed drainages followed similar negative trajectories from 2022 to 2024 (Figure 3.1.2).

Table 3.1.2. Redds based estimates (RBE) and 95% confidence intervals of total Atlantic salmon escapement to the Cove Brook, Kenduskeag and Souadabscook streams, Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot, and Ducktrap rivers for 2024. Survey effort is indicated as units of spawning habitat surveyed for redds relative to the total measured spawning habitat by river, where 1 unit = $100m^2$). SHRU = Salmon Habitat Recovery Unit.

SHRU	Rivers	Total Spawn Habitat Units	Surveyed Habitat Units	Observed Redds	RBE	L95	U95
DEC	Dennys	238.5	177.6	12	15	6	40
DEC	East Machias	58.9	55.0	0	0	NA	NA
DEC	Machias	449.8	168.8	10	14	5	36
DEC	Narraguagus	265.8	229.9	8	12	4	31
DEC	Pleasant	141.4	113.0	2	5	2	14
MMB	Sheepscot	325.4	270.2	13	16	6	42
PNB	Cove Brook	7.3	7.1	0	0	NA	NA
PNB	Ducktrap	43.8	26.4	1	3	1	9
PNB	Kenduskeag Stream	66.0	1.0	0	0	NA	NA
PNB	Souadabscook Stream	51.1	15.0	0	0	NA	NA
	Grand Total	1,647.9	1,063.8	46	65	24	171

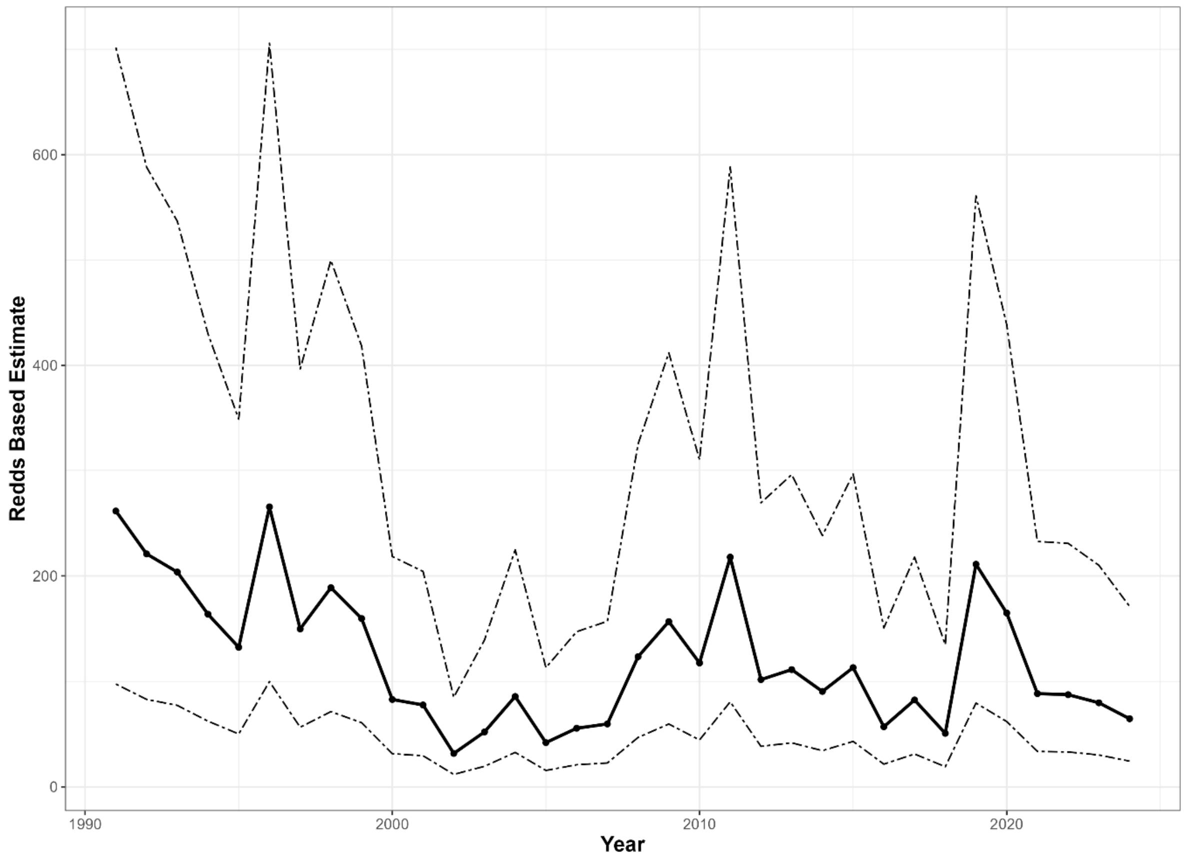


Figure 3.1.1. Annual total redds based estimate (RBE; solid line) and 95% CI (dashed lines) for Cove Brook, Kenduskeag and Souadabscook streams, Dennys, Ducktrap, East Machias, Machias, Narraguagus, Pleasant, Sheepscot and rivers, 1991 – 2024.

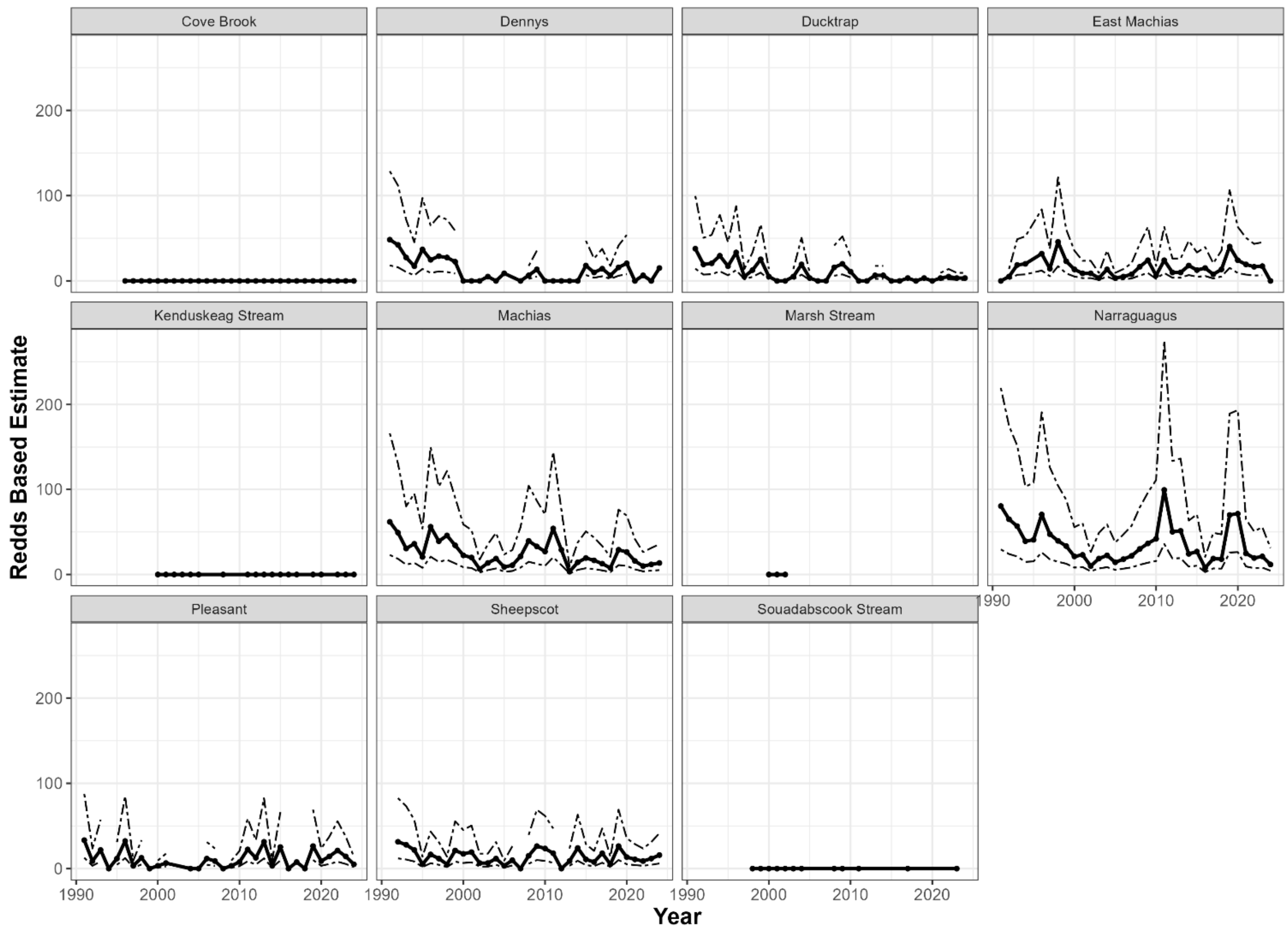


Figure 3.1.2. Individual annual redds based estimates (RBE; solid line) and 95% CI (dashed lines) of adult returns to drainages included in the Gulf of Maine Distinct Population Segment, 1991 - 2024.

3.2 Juvenile Population Status

Understanding the spatial distribution of juvenile Atlantic salmon provides information on habitat quality and productivity, which is a crucial input for developing effective recovery actions for Atlantic salmon. This was recognized in the listing of Atlantic Salmon (74 FR 29345; NMFS and USFWS 2009) and in the designation of Critical Habitat (74 FR 29300; NMFS 2009), when the number of habitat units in each SHRU was prorated, based on a habitat quality score and expressed in terms of functional units. One of the best ways to evaluate habitat quality is to measure juvenile abundance, spatial distribution, and smolt production.

Juvenile abundance estimates

Introduction

MDMR conducts single pass catch per unit of area (CPUA; 1 unit = $100m^2$) electrofishing surveys (Bateman et al. 2005; Stevens et al. 2010) at sites that are divided into four groups: Wild Production Areas (WPAs), Project sites, Index sites, and those selected using the Generalized Randomized Tessellated Stratification tool (GRTS).

WPAs are sites based on locations of redds in years that coincide with the current year's cohort for 0+ parr and are used to evaluate spawning success. Project sites are selected to answer specific questions related to stock enhancement changes, habitat alterations, or other management needs. Index sites are longer term sites that were subjectively selected. GRTS sites are sites derived using the techniques described by (Stevens and Olsen 2004). GRTS and Index sites are sampled annually. WPAs and Project sites change from year to year as defined by redd distribution or research needs. Often WPAs are co-located with GRTS and Project sites so are included in those categories.

Sampling locations are divided among the three SHRUs within the GOM. Streams that are included in the sampling design, referred to as 'management drainages', are streams that are currently managed for Atlantic salmon. This means that there is active restoration work that involves stock enhancement or monitoring (e.g., spawner surveys; Table 3.2.1). Additionally, the Narraguagus and Sandy rivers have been identified as Life Cycle Monitoring Stations (LCMS).

Table 3.2.1. Currently managed rivers. Rearing habitat from the (Wright et al. 2008) Species Distribution and Habitat Model. SHRU = Salmon Habitat Recovery Unit.

SHRU	Rivers	Drainage Area (hectares)	Rearing Habitat ($100\ m^2$)	Drainage length (km)
DEC	Dennys	33,836.2	2,098.0	121.3
DEC	East Machias	80,797.3	6,951.0	238.0
DEC	Machias	129,072.7	19,602.0	537.9
DEC	Narraguagus	63,496.3	7,180.0	203.0
DEC	Pleasant	32,845.7	2,580.0	90.9
MMB	Sandy	153,567.5	36,790.8	1,567.8
MMB	Sheepscot	64,980.9	6,751.0	163.7
PNB	Cove Brook	14,147.2	218.0	8.1
PNB	East Branch Penobscot	289,561.3	35,246.0	448.6

Results

A total of 179 sites was surveyed between June 21st and September 30th, using single pass electrofishing survey techniques across all three SHRUs. A list of survey types for each drainage is presented in Table 3.2.2. Mean parr densities (parr / 100m^2) for GRTS and Index sites surveyed in 2024 ranged from a high of 6.4 parr/100m^2 in the Piscataquis drainage to a low of 0 parr/100m^2 in the Ducktrap River (Table 3.2.3).

Table 3.2.2 Summary of electrofishing efforts within the Gulf of Maine Distinct Population Segment in 2024 by site type. Generalized Randomized Tessellated Stratification tool (GRTS) sites and index sites are both used for long term trend analysis however, GRTS sites are spatially randomly selected and Index sites may have been selected more subjectively e.g., for historical reasons or long-term evaluation of a management action. Broodstock sites are where parr broodstock were collected. Abbreviations for Salmon Habitat Recovery Units (SHRUs): DEC = Downeast Coastal, MMB = Merrymeeting Bay and PNB = Penobscot Bay.

SHRU	Drainage	GRTS	Index	Project	Broodstock	Totals
DEC	Dennys	0	0	0	1	1
DEC	East Machias	0	0	0	1	1
DEC	Machias	0	0	9	4	13
DEC	Narraguagus	12	0	6	4	22
DEC	Pleasant	0	0	1	3	4
MMB	Lower Kennebec	34	0	5	0	39
MMB	Sheepscot	0	14	0	10	24
PNB	Ducktrap	2	0	3	0	5
PNB	East Branch Penobscot	0	0	28	0	28
PNB	Penobscot	2	0	3	0	5
PNB	Piscataquis	19	0	15	3	37
	Totals	69	14	70	26	179

Life Cycle Monitoring and Juvenile Assessment

The Sandy and Narraguagus rivers have been established as Life Cycle Monitoring Stations to observe trends in each drainage and attempt to tie trends to management actions. Both systems have extensive sampling programs in place to monitor multiple life stages across the salmon life cycle, including smolt and adult traps, fall juvenile assessment using electro-fishing, and spawner survey sampling plans. Since this section is focused on juvenile assessment, the following will describe trends and observations from fall juvenile electrofishing surveys.

Table 3.2.3. Summary of large parr density (parr/100m^2) results for Index and Generalized Randomized Tessellated Stratification sites across sampled drainages for 2024. Abbreviations for Salmon Habitat Recovery Units (SHRUs): DEC = Downeast Coastal, MMB = Merrymeeting Bay and PNB = Penobscot Bay.

SHRU	Rivers	n	Mean	SD	Low 95	Up 95
DEC	Machias	8	2.0	2.3	0.3	3.6
DEC	Narraguagus	18	2.3	3.1	0.9	3.8
MMB	Middle Sandy	13	0.3	0.7	-0.1	0.7
MMB	Sheepscot	14	1.5	2.0	0.5	2.6
MMB	Upper Sandy	24	0.8	1.2	0.4	1.3
PNB	Cove Brook	1	0.0	NA	NA	NA
PNB	Ducktrap	5	0.0	0.0	0.0	0.0
PNB	East Branch Penobscot	27	0.1	0.5	0.0	0.3
PNB	Penobscot	4	1.0	1.2	0.0	2.2
PNB	Piscataquis	34	6.4	7.0	4.1	8.8

Within each drainage, sites were selected using the GRTS selection tool as described by Stevens and Olsen (2004). These sites are sampled annually with a target of 12 GRTS sites sampled in the Narraguagus and 30 sampled in the Sandy River (Table 3.2.2). The Sandy River is divided into two management reaches: the Upper Sandy River (20 sites) and the Middle Sandy River (10 sites) due to differences in management actions and geomorphic characteristics. These sites are stratified by stream width classes as follows; A = 0 to 6 meters, B = 6 to 12 m, C = 12 to 18 m and D = > 18 m. This stratification allows for better comparison of habitat types based on the assumption that cumulative drainage areas, thermal conditions, etc. would be similar within width classes. Challenges posed by stream flow, fishing conditions, or weather have prevented full sampling of GRTS sites in a given year, however, over the ten-year period (2015 to 2024), an average of 39 sites, 11 in the Narraguagus and 28 in the Sandy, were surveyed (Table 3.2.4).

Within the LCMS GRTS selected sites in the Sandy and Narraguagus drainages, parr-per-unit (100m^2) of large parr over the period 2015 to 2024 ranged from 0.23 ± 0.27 to 7.45 ± 4.57 parr/unit (Table 3.2.4). Trends in densities over the period of 2015 to 2024 decline over time but there is substantial variation within drainages (Figure 3.2.2). Densities over the ten-year period were similar between the Narraguagus and both Sandy River reaches but differed between the Upper and Middle Sandy River reaches with the Upper Sandy River having higher densities (ANOVA, $F_{(3,103)} = 5.2$, $p < 0.05$). Densities also differed among width classes with A class sites having higher abundances than all other width classes. All other width classes (B, C, and D) had similar densities (ANOVA, $F_{(3,278)} = 9.2$, $p < 0.05$; Figure 3.2.3).

During fall juvenile electrofishing surveys, captured parr are measured for fork length to the nearest millimeter and weighed to nearest 0.1 gram. A total of 1,362 parr was measured across the 388 sites surveyed between 2015 and 2024 (Table 3.2.7). Comparisons of fish condition (weight at a given length) across sites and width classes were performed using the methods outlined in Cone (1989), where the slope of the relationship between log length and log weight are compared to other sites. Across the ten-year period of 2015 to 2024, parr captured in sites within the B (6–12-meter) width class had a higher body condition than the other width classes ($p = 0.01$). Figure 3.2.5 illustrates the relative body condition between width classes.

As reported in the 2024 USASAC report on 2023 activities (add citation), higher densities were observed in the A class (0-to-6-meter) sites but the parr had better condition in the C class (12-to-18-meter) sites. Use of the

GRTS methods in combination with the establishment of Life Cycle Monitoring Stations has helped to identify some of these relationships and is leading managers to explore processes influencing growth and abundance. Ongoing habitat rehabilitation projects as described below help with increasing complexity and access to thermal refuges. Tying these findings related to juvenile abundance surveys to habitat data to develop tools to identify optimal scenarios for stocking or habitat protections continues to be a priority.

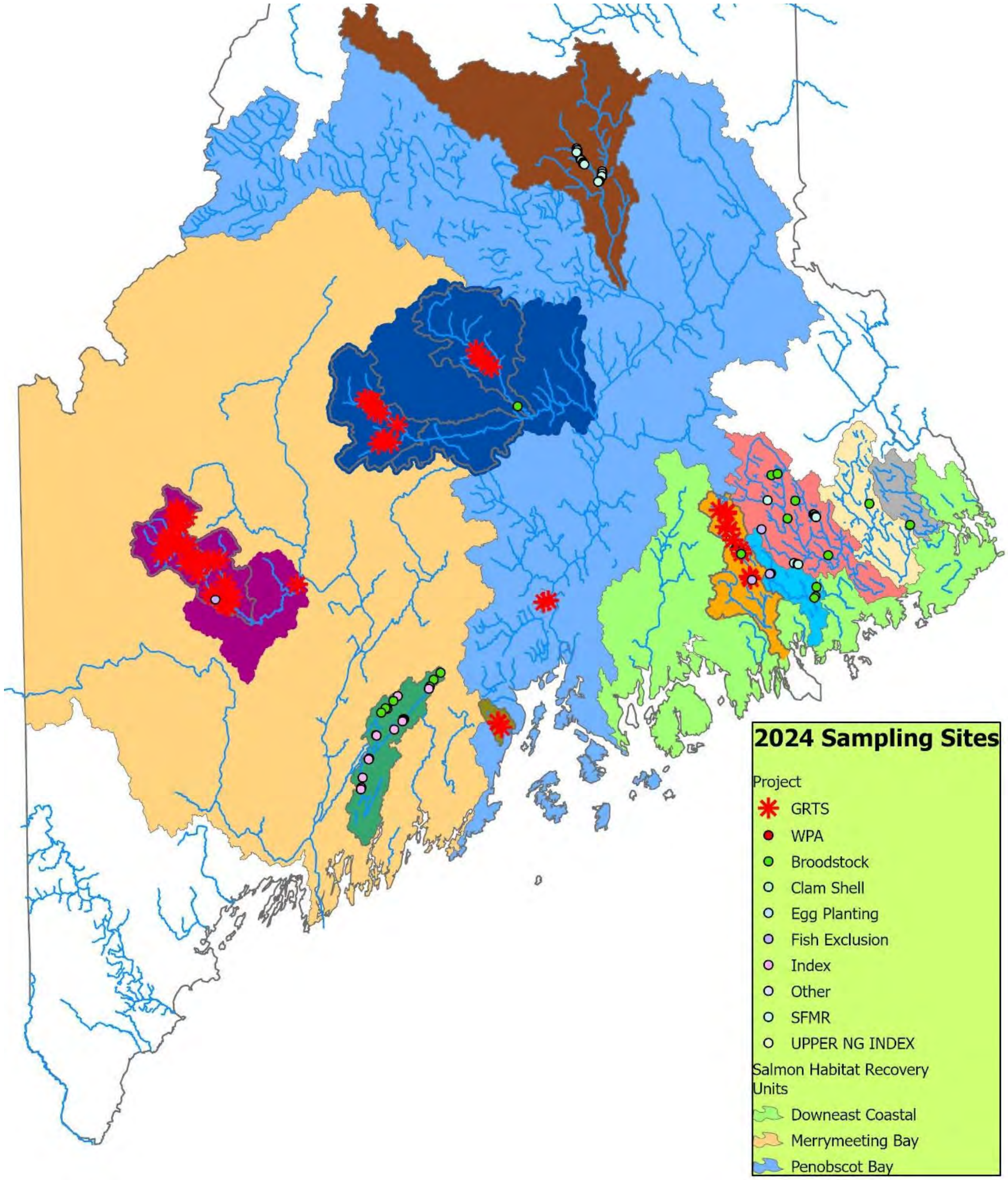


Figure 3.2.1. Location of juvenile assessment sites (179) surveyed in 2024 for juvenile abundance and distribution estimates within the Gulf of Maine Distinct Population Segment of Atlantic salmon.

Table 3.2.4. Annual mean catch-per-unit ($100m^2$) ± 95% CI of large parr for all Life Cycle Monitoring Stations (LCMS), 2015 to 2024.

LCMS	Year	n	Mean Parr/$100m^2$ ± 95CI
Narraguagus	2015	10	2.5 ± 1.7
Narraguagus	2016	12	2.1 ± 2.2
Narraguagus	2017	8	7.5 ± 4.6
Narraguagus	2018	12	3.6 ± 2.4
Narraguagus	2019	11	2.5 ± 1.5
Narraguagus	2020	7	3.0 ± 1.6
Narraguagus	2021	12	1.5 ± 0.9
Narraguagus	2022	12	3.5 ± 2.6
Narraguagus	2023	10	2.5 ± 2.5
Narraguagus	2024	13	2.4 ± 2.0
Middle Sandy River	2015	11	3.7 ± 3.9
Middle Sandy River	2016	6	1.5 ± 0.9
Middle Sandy River	2017	13	1.8 ± 1.3
Middle Sandy River	2018	14	0.9 ± 0.7
Middle Sandy River	2019	10	0.6 ± 0.7
Middle Sandy River	2020	10	2.8 ± 2.4
Middle Sandy River	2021	10	1.7 ± 1.2
Middle Sandy River	2022	11	1.3 ± 1.2
Middle Sandy River	2023	9	0.2 ± 0.3
Middle Sandy River	2024	13	0.3 ± 0.4
Upper Sandy River	2015	20	2.7 ± 1.4
Upper Sandy River	2016	7	3.3 ± 2.7
Upper Sandy River	2017	17	3.5 ± 1.6
Upper Sandy River	2018	20	1.8 ± 0.8
Upper Sandy River	2019	21	3.6 ± 1.4
Upper Sandy River	2020	18	4.6 ± 1.9
Upper Sandy River	2021	20	3.4 ± 1.2
Upper Sandy River	2022	18	3.2 ± 1.6
Upper Sandy River	2023	12	2.0 ± 1.2
Upper Sandy River	2024	21	0.8 ± 0.5

Table 3.2.5 Mean catch-per-unit (100m^2) ± 95% CI of large parr across width classes and management reaches 2015 to 2024 for Life Cycle Monitoring Stations in the Narraguagus and Sandy rivers. Width classes include: A = 1 to 6 meters, B = 6 to 12 meters, C = 12 to 18 meters, C = greater than 18-meter stream width. SHRU = Salmon Habitat Recovery Unit.

SHRU	Reach	Width Class	n	Mean Parr/100m^2 ± 95CI
DEC	Narraguagus	A	44	5.1 ± 1.4
DEC	Narraguagus	B	39	2.1 ± 0.8
DEC	Narraguagus	C	13	0.5 ± 0.5
DEC	Narraguagus	D	11	0.5 ± 0.5
MMB	Middle Sandy	A	10	2.5 ± 1.1
MMB	Middle Sandy	B	43	1.7 ± 1.2
MMB	Middle Sandy	C	15	1.8 ± 1.3
MMB	Middle Sandy	D	39	0.9 ± 0.4
MMB	Upper Sandy	A	21	2.9 ± 1.4
MMB	Upper Sandy	B	86	2.8 ± 0.7
MMB	Upper Sandy	C	28	3.4 ± 1.2
MMB	Upper Sandy	D	39	2.7 ± 0.8

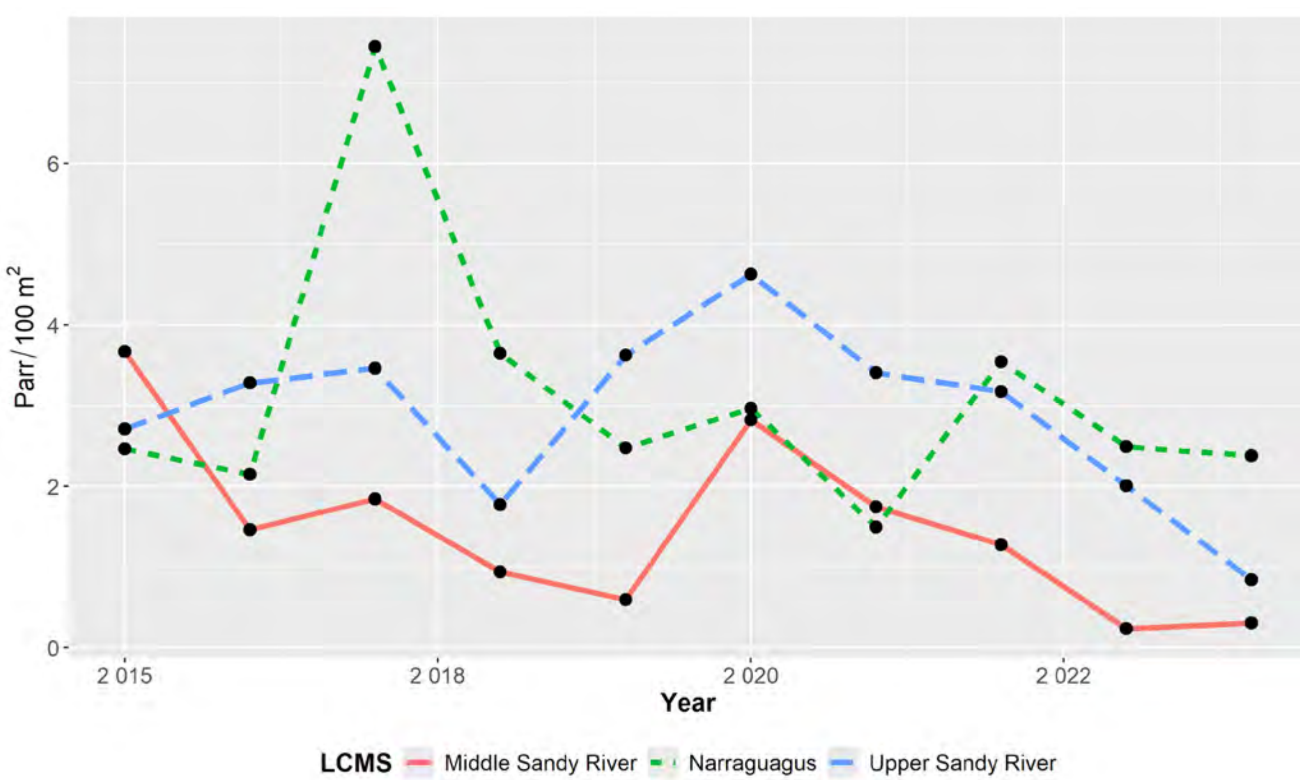


Figure 3.2.2. Trends of mean catch per unit (100m^2) by drainage 2015 to 2024 for Life Cycle Monitoring Station (LCMS) in the Sandy and Narraguagus rivers.

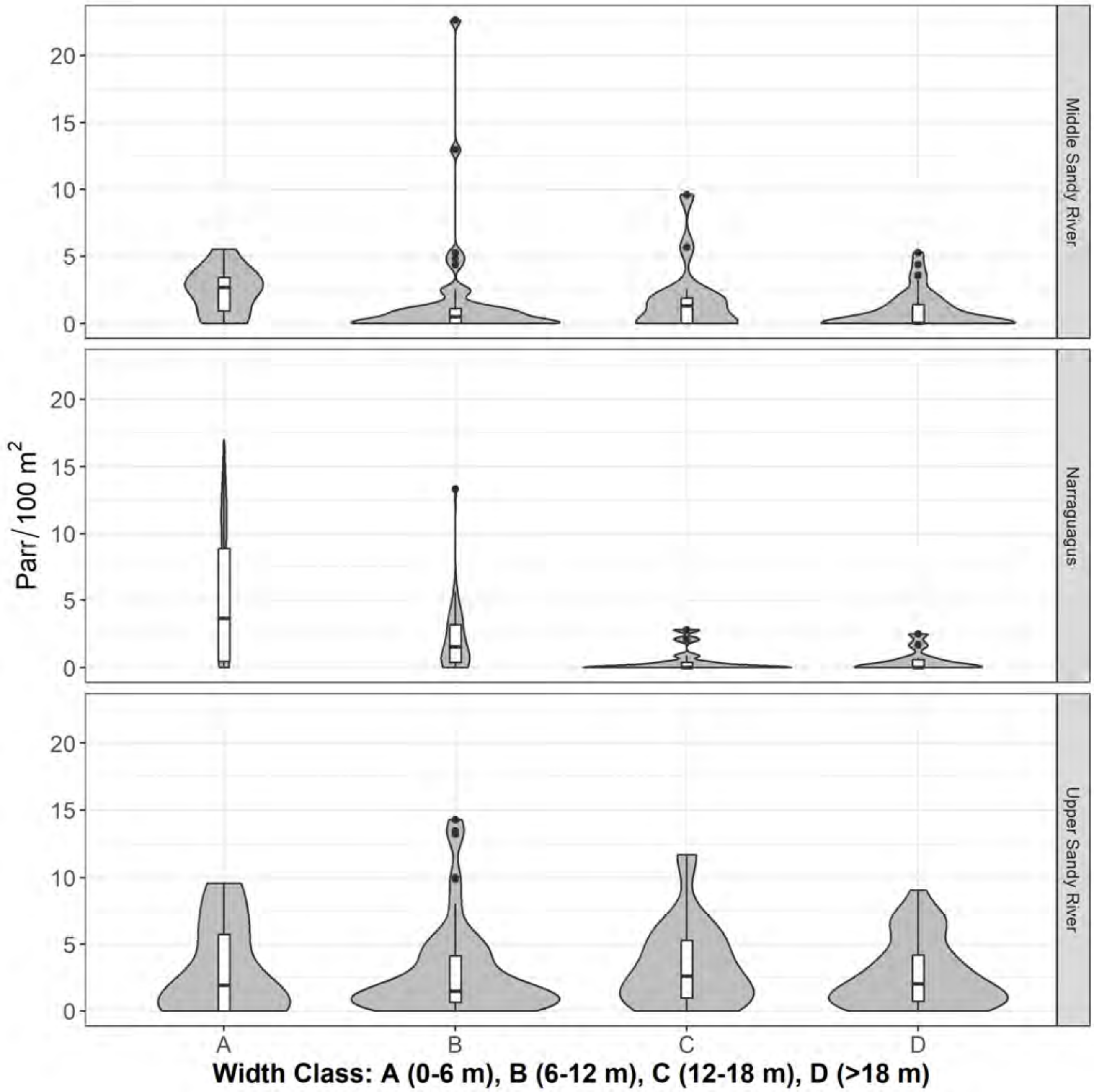


Figure 3.2.3. Violin plots showing abundance as catch per unit ($100m^2$) for large parr (2015 to 2024) across four width classes for Life Cycle Monitoring Stations in the Sandy and Narraguagus rivers. Width classes are as follows: A = 1 – 6 meters, B = 6 -12 meters, C = 12 – 18 meters and D = > 18 meters.

Table 3.2.7. Mean large parr fork length (mm) ± 95% CI and mean weight (g) ± 95%CI across width classes for sites sampled from 2017 to 2023 in the Narraguagus and Sandy rivers. Width classes are as follows: A = 1 – 6 meters, B = 6 -12 meters, C = 12 – 18 meters and D ≥18 meters.

Width Category	n	Mean FL (mm) ± 95%CI	Mean Weight (g) ± 95%CI
A	462	109.3 ± 1.9	107.5 ± 16.5
B	584	111.8 ± 1.8	110.0 ± 17.7
C	126	110.0 ± 3.0	107.0 ± 16.7
D	190	111.7 ± 2.7	109.0 ± 17.3

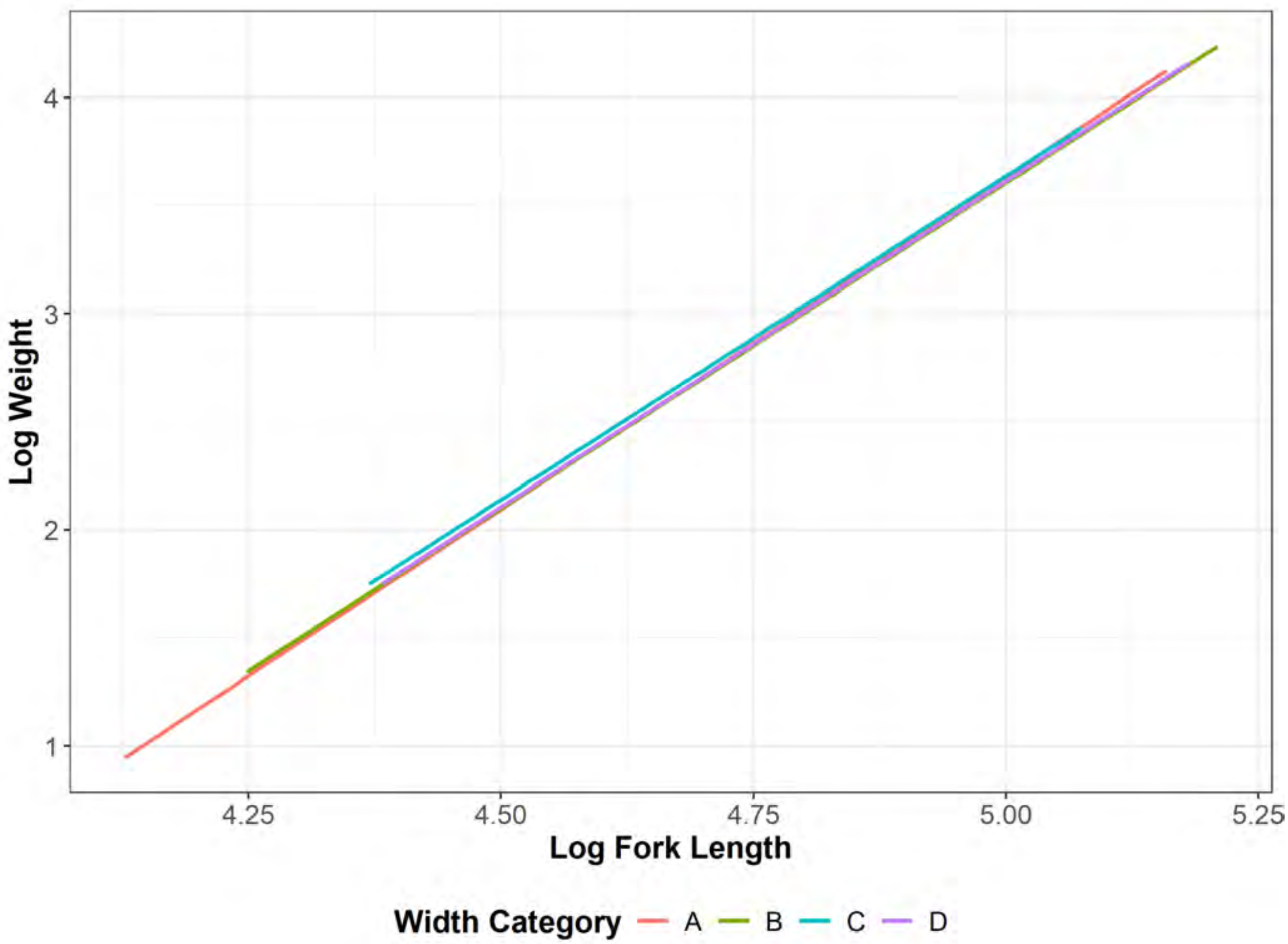


Figure 3.2.5. Plot of large parr condition across width classes determined by the relationship of log fork length and log weight of parr sampled from 2015 to 2024 based on methods outlined by (Cone 1989). Width classes are as follows: A = 1 – 6 meters, B = 6 -12 meters, C = 12 – 18 meters and D ≥18 meters.

Smolt Abundance

The following is a summary of smolt trapping activities that occurred in the spring of 2024. The main goal of trapping out-migrating salmon smolts is to estimate the number of emigrants, determine age and origin, and use this information in determining smolt-to-adult (SAR) marine survival rates for cohort-specific adult returns. A more detailed report on smolt population dynamics is available in the annual working paper, which is available upon request.

MDMR estimated smolt abundance using rotary screw traps at two sites in the Narraguagus River (in partnership with Project SHARE). Unique captures totaled 880 smolts (both sites combined) between 14 April and 23 May 2024 (Table 3.2.6).

MDMR scientists calculated population estimates using Darroch Analysis with Rank Reduction (DARR) 2.0.2 for program R (Bjorkstedt 2005; R Core Team 2024) for each site (Figure 3.2.6 and Table 3.2.7).

Population estimates (± SE) for each river/site were based on a one-site mark-recapture design. Long-term monitoring continued at the lower river site at Little Falls (river km 11.16). The total population estimate for all smolts exiting the Narraguagus River (hatchery 0+ parr origin and naturally reared origin) was 1,550 ± 116. The naturally reared smolt population estimate was 541 ±79. The hatchery population estimate was 1,015 ± 89. At the Route 9 site (river km 47.69), the total population estimate for all smolts emigrating from the upper sub-watershed was estimated at 914 ± 62. The naturally reared smolt population estimate was 352 ± 48. The hatchery population estimate was 574 ± 52.

Table 3.2.6. 2024 Atlantic salmon smolt trap deployments, total captures, and capture timing by origin in the Narraguagus River.

Site	Dates Deployed		Origin	Total Capture	First Capture	Median Capture Date	Last Capture
Little Falls	18-Apr	23-May	H	325	20-Apr	4-May	21-May
			W	153	23-Apr	4-May	22-May
Route 9	14-Apr	19-May	H	251	19-Apr	4-May	15-May
			W	151	16-Apr	2-May	16-May
			Total	880			

Table 3.2.7. Maximum likelihood mark-recapture population estimates ± Standard Error for naturally reared and hatchery origin Atlantic salmon smolts emigrating from the Narraguagus River in 2024, using DARR 2.0.2.

Site	Origin	Estimate ± Standard Error
Little Falls	Hatchery	1,015 ± 89
	Naturally reared	541 ± 79
	Hatchery and Naturally Reared	1,550 ± 116
Route 9	Hatchery	574 ± 52
	Naturally reared	352 ± 48
	Hatchery and Naturally Reared	914 ± 62

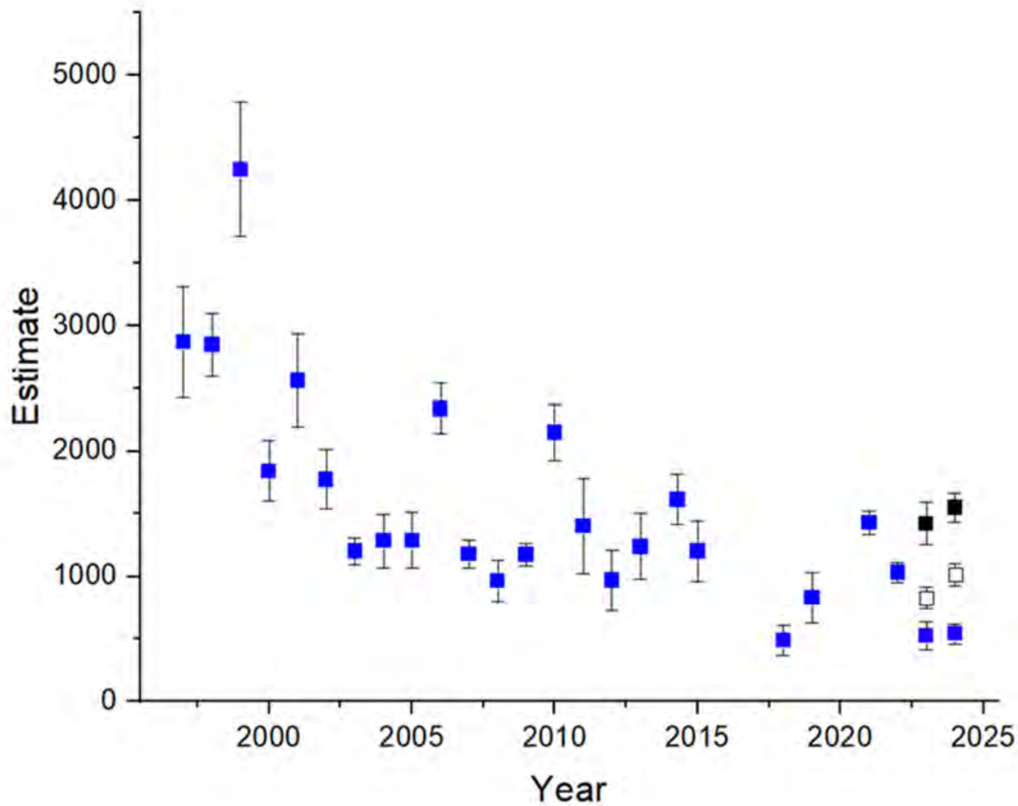


Figure 3.2.6. Population Estimates (± Std. Error) of emigrating smolts on the Narraguagus River (Little Falls Trapping Site; river km 11.16), using DARR 2.0.2. Blue boxes = naturally reared; Open boxes = hatchery reared fall parr; and Black boxes = combined estimate.

3.3 Fish Passage and Migratory Fish Habitat Enhancement and Conservation

Habitat Assessment

MDMR staff conducted habitat surveys in three streams within the Merrymeeting Bay SHRU in 2024 using the standard MDMR Big River habitat survey methodology. Surveys were completed in three different streams in 2024. The surveys quantified physical habitat features including spawning and rearing habitat abundance and location in the newly restored section of Temple Stream (tributary of the Sandy River, Kennebec Drainage) following the removal of Walton's Mill Dam. Surveys were conducted in two days and spanned 1.93 km of Temple Stream. The data has been entered into the DMR Habitat database, audited, and is currently being geo-processed. The new dataset will be appended to the current habitat database and will be included in the ASHAB (Atlantic Salmon Habitat) dataset which is scheduled to be issued in March 2024. A preliminary analysis of the data suggests 141 units of rearing habitat and 22 units of spawning habitat were documented in this reach. This reach was surveyed prior to the dam removal, indicating that, an estimate of 130 units of rearing and 18 units of spawning habitat has been gained since the removal. The site is predicted to continue to stabilize in coming years and therefore, more habitat is expected to emerge as fine sediment moves downstream.

MDMR assisted Merrymeeting Bay Trout Unlimited (MMB TU) with a habitat survey upon request for the Little River, a tributary to the Androscoggin River. MDMR trained the MMB TU volunteers, then provided staff to accompany volunteers on the survey. The objective of this survey was to locate and quantify spawning habitat. The Little River provides some of the only accessible suitable rearing habitat in the lower Androscoggin River. Surveys were conducted during three days (including the training day) and spanned 3.98 km of the Little River. The data has been entered into the DMR Habitat database, audited, and is currently being geo-processed. The new dataset will be appended to the current habitat database and will be included in the ASHAB (Atlantic Salmon Habitat) dataset which is scheduled to be issued in March 2024. A preliminary analysis of the data suggests 53.31 units of rearing habitat and 0 units of spawning habitat are present in this reach.

MDMR surveyed a section of the South Branch Sandy River impacted by emergency stream excavation work performed by the town of Phillips following a major destructive flood in 2023 with the objective of inventorying the heavily modified stream conditions for Atlantic salmon spawning and rearing habitat. The surveys quantified physical habitat features including spawning and rearing habitat abundance and location in the newly modified section of the South Branch Sandy River. Approximately 2.70 km of the South Branch Sandy River were surveyed in three days. The data has been entered into the DMR Habitat database, audited, and is currently being geo-processed. These data will not be appended to the ASHAB (Atlantic Salmon Habitat layer in GIS) but used as a reference for post-restoration assessments. A preliminary analysis of the data suggests 241.18 units of rearing habitat and 31.3 units of spawning habitat are present in this reach. In 2006, this section of habitat was surveyed, documenting 275 units of rearing habitat and 8 units of spawning habitat. While rearing habitat appears to be similar and spawning habitat appears to be higher, other important habitat elements have changed, including the complexity of habitat types, large wood presence, and access to side channels, which is where most of the feeding and spawning occurs.

Rapid Stream Assessment - USFWS, DMR, and Midcoast Conservancy have continued to work on a Rapid Stream Assessment of the Sheepscot River. The project objective is to understand the on-the-ground habitat conditions and factors impacting the watershed's processes to develop a strategic approach that restores the Sheepscot Watershed in a holistic manner. Initial assessments were done in 2022 focusing on the West Branch Sheepscot and one region on the mainstem. Activities in 2024 included updating the field methodology to incorporate lessons learned from the field pilot launched in 2022 and providing training to restoration practitioners on how to execute the assessment. Project partners continue to work on the development of written summaries of the assessed reaches that will be incorporated into a larger watershed action plan.

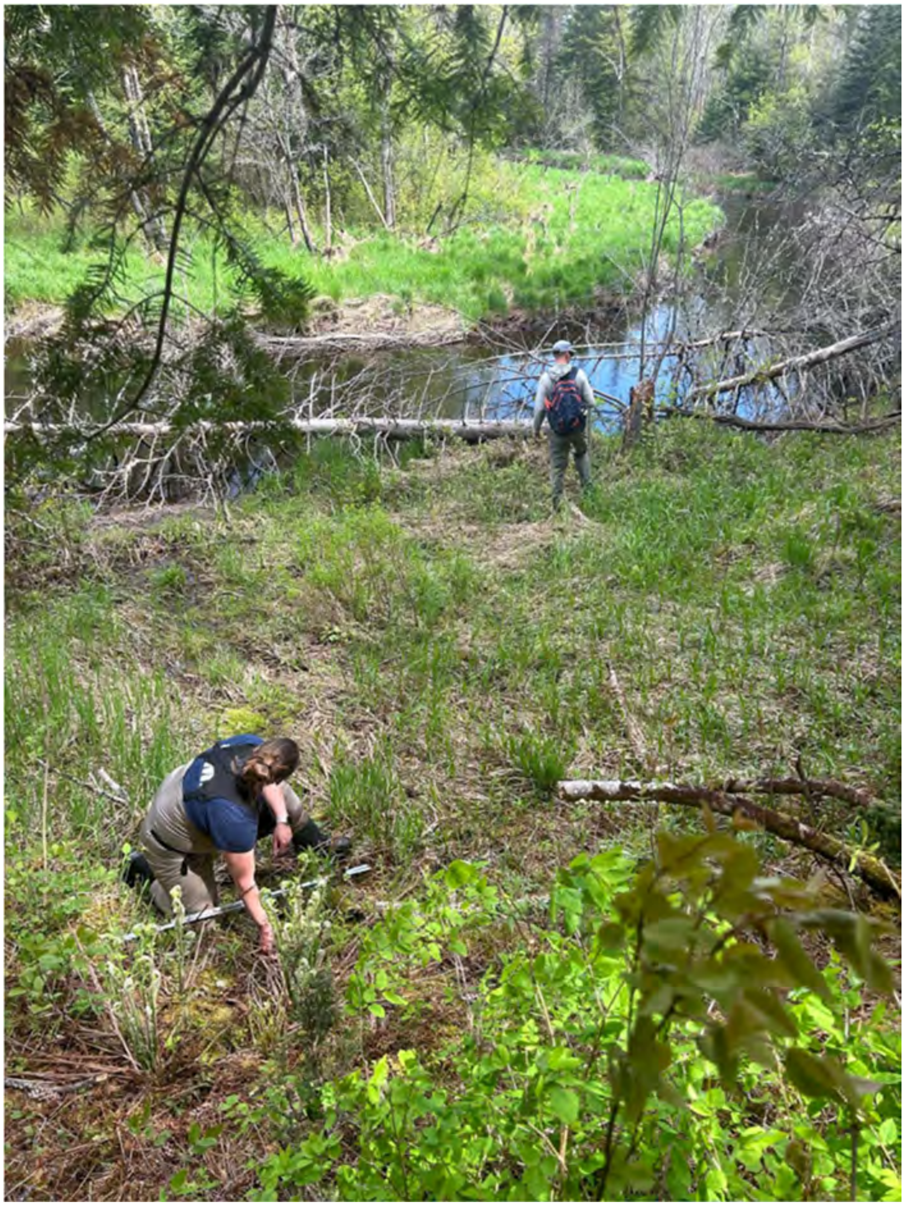


Figure 3.3.1. Jen Noll (Maine Department of Marine Resources) takes a water temperature reading of a spring during a rapid stream assessment on the West Branch of the Sheepscot River.

Habitat Connectivity

Numerous studies have identified how stream barriers can disrupt ecological processes, including hydrology, passage distribution of large woody debris, and movement of organisms. Thousands of barriers that block the movement of diadromous fish, other aquatic and terrestrial species, sediment, nutrients, and coarse wood exist in Maine streams. These barriers include dams and road-stream crossings. All barriers 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, costlier economically and more environmentally damaging than replacements installed before disaster. Table 3.3.1. provides a partial list of projects accomplished in 2024.

Table 3.3.1. Aquatic Organism Passage projects completed in 2024 restoring stream connectivity in Gulf of Maine Distinct Population Segment Atlantic Salmon watersheds, stream name, and distance (stream miles and kilometers) of stream above the barrier that was restored. Lead partners are Maine Department of Transportation (MDOT), Natural Resource Conservation Service (NRCS), Project SHARE, and The Nature Conservancy (TNC).

Lead Partner	Watershed	Stream	Stream Miles	Stream Kilometers
MDOT	Mattawamkeag	Macwahoc Stream	25.0	40.2
MDOT	Mattawamkeag	Thomas Brook	2.5	4.0
MDOT	Mattawamkeag	Unnamed Trib to Spaulding Lake	0.4	0.6
MDOT	Narraguagus	Unnamed Trib to Narraguagus River	0.4	0.6
MDOT	Oyster River	Unnamed Trib to Bisbee Brook	1.1	1.8
MDOT	Penobscot Bay	Spring Brook	4.1	6.6
MDOT	Lower Kennebec	Rusty Brook	1.2	2.0
NRCS	Piscataquis	Carlton Stream	0.3	0.5
NRCS	Piscataquis	Meadow Brook	0.3	0.4
NRCS	Upper Kennebec	Gulf Stream	1.2	1.9
NRCS/TNC	Lower Kennebec	Gilman Stream	1.6	2.6
NRCS/TNC	Lower Kennebec	Middle Sandy River	0.6	1.0
NRCS/TNC	Lower Kennebec	Middle Sandy River	0.4	0.6
NRCS/TNC	Lower Kennebec	Middle Sandy River	0.2	0.4
NRCS/TNC	Lower Kennebec	Middle Sandy River	0.1	0.2
NRCS/TNC	Lower Penobscot	Bear Brook – Little Pushaw Pond	0.8	1.2
NRCS/TNC/ Project SHARE	Machias	Mopang Stream	14.5	23.2
NRCS/TNC	Piscataquis	East Branch Seboeis Stream	2.6	4.2
NRCS/TNC	Piscataquis	Middle West Branch Pleasant River	0.5	0.8
NRCS/TNC	Piscataquis	Middle Branch Pleasant River	1.9	3.0
NRCS/TNC	Piscataquis	Middle Branch Pleasant River	0.6	1.0
NRCS/TNC	Piscataquis	Middle Branch Pleasant River	0.6	1.0
NRCS/TNC	Piscataquis	Sebec River	0.3	0.5
NRCS/TNC	Piscataquis	Sebec River	0.1	0.2
NRCS/TNC/ Project SHARE	Pleasant	Colonel Brook	2.5	4.0
NRCS/TNC	Sheepscot	Clary Lake – Sheepscot River	0.3	0.4
NRCS/TNC	West Branch Penobscot	Gulliver Brook	9.0	14.4

Lead Partner	Watershed	Stream	Stream Miles	Stream Kilometers
NRCS/TNC	West Branch Penobscot	Unnamed Trib to Nollesemic Lake	1.5	2.4
NRCS/TNC	West Branch Penobscot	Unnamed Trib to Nollesemic Lake	0.6	1.0
Project SHARE	Narraguagus	Crotchcamp Brook	6.2	10.0
Project SHARE	Narraguagus	McCoy Brook	2.1	3.3
		Total	83.5	134.0

Figure 3.3.2. Mopang Stream aquatic organism passage project, prior to construction (left) and post construction (right), Machias River Drainage, Maine, 2024. *Photo credit: Project SHARE.*

Habitat Complexity and Suitability

Large Wood Additions – Project SHARE continued wood addition projects throughout the Narraguagus River and three tributaries in 2024. These actions were undertaken to restore natural processes to stream reaches that were likely changed by historic log drives that made the river over widened, shallow, simplified, and unable to reconnect with its floodplain. Wood additions are implemented to create a diversity of complex habitats for Atlantic salmon, brook trout, other native sea-run fish, as well as terrestrial species living within the riparian corridor.

A total of 745 pieces of large wood was added to reaches of the Narraguagus River mainstem and three of its tributaries (Table 3.3.2). The SHARE crew used a variety of wood addition methods to complete these projects including the use of Maine Army National Guard (MEANG) helicopters to transport self-placing wood or wood that is allowed to be transported by river processes. The 2024 effort was kept small with easy road access so that the logistics of implementation could be worked out. An after-action meeting was held to discuss changes that could be made going forward. The MEANG and SHARE staff are excited to continue the partnership moving forward. This newly established partnership provides valuable training for the MEANG pilots and crews while allowing SHARE to add large wood into remote areas that may be lacking a riparian source of trees.

Table 3.3.2. Wood additions completed by Project SHARE in Downeast Coastal rivers in 2024. Strategic refers to wood placed in specific locations often secured in place mechanically. Helicopter transported, self-placing wood additions are allowed to disperse under normal stream processes.

Watershed	**Stream**	**Method**	**Wood Pieces**	**Habitat Units ($100m^2$)**
Narraguagus	Baker Brook	Strategic	211	84
Narraguagus	Little Narraguagus River	Strategic	17	4
Narraguagus	Mainstem	Strategic	198	143
Narraguagus	Mainstem	Helicopter/Self-placing	37	4
Narraguagus	Mainstem/Side Channel	Strategic	88	22
Narraguagus	Rocky Brook	Strategic	194	18
		Total	**745**	**275**

Figure 3.3.3. Maine Army National Guard UH-60 helicopter preparing to drop a load of logs into the Narraguagus River, 2024. Photo Credit: Project SHARE.

Figure 3.3.4. Releasing a load of large wood at the drop site as seen from the UH-60 helicopter crew chief's perspective, Narraguagus River, 2024. Photo credit: SFC Joseph Leclair.

3.4 Hatchery Operations

Hatchery operations described below are arranged seasonally, progressing from transfers of 2023 cohort eggs through 2024 juvenile and adult stocking, 2024 adult broodstock collection, 2024 disease sampling, 2024 juvenile broodstock collection and 2024 spawning.

Egg Transfers

CBNFH and U.S. Fish and Wildlife Service's Green Lake National Fish Hatchery (GLNFH) transferred 2,214,700 eyed eggs in 2024 to MDMR, Downeast Salmon Federation (DSF), and Fish Friends (FF) educational program (Table 3.4.1.). Eyed eggs from each population were allocated for egg planting, fry production, 0+ parr production and smolt production. Aliquots from each family (one female/one male) of eyed eggs, when practical, were included in each transfer to ensure equal genetic representation in all life stages.

Table 3.4.1. Eyed egg transfers from Craig Brook National Fish Hatchery (CBNFH) and Green Lake National Fish Hatchery (GLNFH) in 2024. Receiving entities include Maine Department of Marine Resources (MDMR), Downeast Salmon Federation (DSF), and Fish Friends (FF) educational program. Eggs transferred to MDMR are immediately planted in the stream and are not accounted for in the juvenile table that follows. Note: Egg numbers rounded to the nearest 100.

Originating Entity	Strain	Rearing History	Receiving Entity	Purpose	Number
CBNFH	East Machias	Captive/domestic	DSF	0+ parr production	100,000
CBNFH	Narraguagus	Captive/domestic	DSF	0+ parr production	100,000
CBNFH	Penobscot	Sea-run	GLNFH	Smolt production	972,900
CBNFH	Pleasant	Captive/domestic	DSF	Fry production	112,000
CBNFH	Pleasant	Captive/domestic	MDMR	Natal river egg planting	100,000
CBNFH	Sheepscot	Captive/domestic	MDMR	Natal river egg planting	110,000
CBNFH	Sheepscot	Captive/domestic	GLNFH	0+ parr production	18,000
CBNFH	Sheepscot	Captive/domestic	FF	Education	1,000
CBNFH	Penobscot	Sea-run	FF	Education	4,000
CBNFH	Dennys	Captive/domestic	FF	Education	200
GLNFH	Penobscot	Captive/domestic	MDMR	Natal river egg planting	197,100
GLNFH	Penobscot	Captive/domestic	MDMR	Non-natal river egg planting	486,100
GLNFH	Penobscot	Captive/domestic	FF	Education	13,400

Juvenile Stocking and Transfers

CBNFH, GLNFH, NNFH, DSF's Pleasant River Hatchery and the Fish Friends program released 2,680,500 juveniles (fry, parr, and smolts) throughout the GOM DPS (Table 3.4.2). Please refer to the previous table for egg planting numbers, categorized as egg transfers to MDMR. Stocking operations are a collaborative effort between MDMR and hatchery management.

Efforts are made to ensure equal distribution of genetic material from all juvenile life stages released in the GOM DPS. Particular attention is paid to releasing groups of juvenile Atlantic salmon comprising as many families as feasible into high quality habitat. In turn, those areas will be targeted for future captive parr broodstock collections the following year [two years post egg-planting, one year post fry release]. These actions ensure the broad distribution of genetic material throughout varying habitat conditions.

In 2024, GLNFH released 185,600 0+ parr into the Penobscot River drainage. This action was taken due to staffing shortages at GLNFH and resulted in an increase of about 100,000 parr stocked in 2024 over recent years and will reduce the 2025 Penobscot River hatchery smolt cohort from 630,000 to 530,000. A transfer of 104,300 age 0+ parr was made from GLNFH to NNFH for the 2025 smolt cohort for the Kennebec River.

Table 3.4.2. Juvenile stocking and transfers of Gulf of Maine Distinct Population Segment populations in 2024. Abbreviations found within the table: CBNFH = Craig Brook National Fish Hatchery, GLNFH = Green Lake National Fish Hatchery, NNFH = Nashua National Fish Hatchery, DSF = Downeast Salmon Federation, UMO = University of Maine, FF = Fish Friends, BWWTP = Bangor Wastewater Treatment Plant, HYDRO = Hydroelectric project smolt passage study. Note: Juvenile numbers rounded to the nearest 100.

Originating Entity	Receiving Drainage or Entity	Strain	Action	Parr	Smolt	Fry
FF [Fry] HYDRO [Smolt]	Androscoggin River	Penobscot	Release	0	220	7,000
GLNFH	BWWTP	Penobscot	Transfer	8	0	0
CBNFH / FF	Dennys River	Dennys	Release	0	0	228,400
CBNFH / FF	East Machias River	East Machias	Release	0	0	269,100
NNFH [Parr] FF [Fry]	Kennebec River	Penobscot	Release	0	86,700	2,600
CBNFH	Machias River	Machias	Release	0	0	264,400

Originating Entity	Receiving Drainage or Entity	Strain	Action	Parr	Smolt	Fry
CBNFH	Narraguagus River	Narraguagus	Release	0	0	306,200
GLNFH	NNFH	Penobscot	Transfer	103,700	0	0
GLNFH [Parr and Smolt] CBNFH / FF [Fry] HYDRO [Smolt]	Penobscot River	Penobscot	Release	185,600	631,200	370,200
CBNFH	Pleasant River	Pleasant	Release	0	0	207,600
GLNFH [Parr] CBNFH / FF [Fry]	Sheepscot River	Sheepscot	Release	15,800	0	104,300
FF	Union River	Penobscot	Release	0	0	1,200

Broodstock

Penobscot Domestic Broodstock [GLNFH]

Four cohorts of domestic broodstock are maintained at GLNFH: juvenile (age-one), sub-adult (age-two) and adult (ages -three and -four). The combined total of domestic broodstock reared at any given time is approximately 3,000 individuals. GLNFH annually receives Penobscot sea-run eyed eggs, which represent each family created during spawning at CBNFH, for smolt production. To create a new domestic broodstock cohort, 960 age-0+ parr are randomly selected from one outside rearing pool. Each pool of parr represents a mix of each family of eggs created during the previous spawn year. Sixty fish are lethally sampled for fish health monitoring.

Future broodstock are PIT tagged in December of their second year and a fin clip is collected for genetic analysis. Following tagging, future broodstock are transferred from the broodstock holding area to the brood pit and classified as broodstock.

In the event of a shortfall of Penobscot sea-run eyed eggs for smolt production, either from a lack of broodstock or low fecundity, eyed eggs from age-four domestic females are allocated to smolt production in a manner that captures the genetic variability of that cohort to produce a full complement of Penobscot River smolts. Eyed eggs from age-three females are reserved for egg planting by MDMR in the Sandy River drainage, a tributary to the upper Kennebec River.

Penobscot Sea-run Broodstock [CBNFH]

Penobscot sea-run broodstock represent multiple life stages (grilse, multi-sea winter, repeat spawners) of both hatchery- and natural-origin adults returning annually to the Penobscot River. CBNFH has shifted from a 'target' number of broodstock to maintaining a minimum effective population size (N_e) of 500 for the Penobscot River population. The goal is to produce a minimum of 250 individual family groups that will support full smolt production at GLNFH and produce approximately 0.5M fry at CBNFH for release to the Penobscot River and its tributaries. In the event of a strong run of adults, more may be collected and released pre-spawn into quality spawning habitat. The minimum number of adults for a pre-spawn release would be 100 (50 females and 50 males), requiring a total adult collection of 600.

A total of 605 (out of 607 collected) Penobscot sea-run adults was incorporated into the 2024 broodstock population. Adults were captured at the Milford Dam between late May and early July. The broodstock consisted of 51 1SW adults, 535 2SW adults, 18 3SW adults, and three repeat spawners. Two of the 607 died before they could be included in the broodstock population. The remaining adults were PIT tagged, tissue sampled for genetics, blood sampled for Infectious Salmonid Anemia virus detection, and scale sampled for aging, weighed, measured, and photographed at CBNFH. MDMR and CBNFH biologists shared resources such as tags, tagging needles and other materials and collaborated on data collection methods that met the needs of both agencies.

Captive Parr Broodstock

In 2018, CBNFH equalized the number of age 1+ parr collected for the six captive broodstock populations (Dennys, East Machias, Machias, Narraguagus, Pleasant, and Sheepscot). Parr collection targets for all populations were set at 200 individuals with up to 15 extra parr to mitigate against potential losses (up to 1,290 total) (Table 3.4.3.). This cohort size was derived by using average broodstock maturation estimates, broodstock needed to maintain 1:1 spawning protocol, rearing space at the facility and biomass considerations.

In 2023, parr collection targets were increased to 250 for each population (up to 1,500 cohort total). This action was undertaken to attempt to offset the reduction of biomass from older year classes of adult brood which became a strategy to reduce total phosphorus discharge. See Phosphorus Reduction at CBNFH section for additional details.

Parr collection targets in 2024 remained at 250 per population. See spawning section for additional details.

Table 3.4.3. Captive broodstock parr collection targets by population and year. Note: + was allowed variance around collections between 2018 and 2022.

Population	<2006	2008-2017	2018-2022	2023-2024
Dennys	150	200	200 + 15	250
East Machias	150	200	200 + 15	250
Machias	250	300	200 + 15	250
Narraguagus	250	300	200 + 15	250
Pleasant	100	200	200 + 15	250
Sheepscot	150	200	200 + 15	250

Table 3.4.4. Average number of captive broodstock, per age class, at Craig Brook National Fish Hatchery.

Year	Age-1+ Parr	Pre-broodstock Age-2	Broodstock Age-3	Broodstock Age-4	Broodstock Age-5
2023	1,500	1,275	1,250	940	480
2024	1,500	1425	1390	685	370

The annual average size of each of the six captive broodstock populations in 2024 remained approximately 650 individuals, representing five-year classes (Table 3.4.4.). Historically, as fish matured and were spawned, spent age 4 broodstock and the entire age 5 cohort would be released to their natal river. In addition, approximately 20 spent age 3 females, and an equal number of age 3 males, would be retained to repeat spawn in future years. This was done to provide insurance against low maturation or to boost egg production as needed.

Due to effluent phosphorus limitations, beginning in 2023 all spent age three broodstock plus the entire age 4 and age 5 cohorts were released. See Phosphorus Reduction at CBNFH for additional details. In 2024, it was decided to retain immature age 4 broodstock in the event they may spawn in 2025, thus ensuring as much genetic contribution from as many broodstock as feasible without dramatically impacting the amount of phosphorus discharged. This action resulted in approximately 45 age 4 broodstock being held over to 2025.

Age-2 future broodstock, collected the prior year as age 1+ parr, are tagged with PIT tags and sampled for genetic characterization annually in June or July. A total of 1,435 age 2 future broodstock, (captured as age 1+ parr collected in 2023) was tagged and will be genotyped prior to their first spawn in 2025.

In 2024, parr collections totaled 1,511 from the six populations. Collection targets were met in five of the six populations (East Machias collected only 235).

Disease Prevention and Monitoring

Hatcheries employ facility-specific biosecurity plans and water treatments to prevent the introduction of disease to reared fish populations. Surface water sources for CBNFH and GLNFH are continuously filtered and irradiated before use. New infrastructure installed in 2024 at DSF's PGH also provided some filtration and irradiation of surface water. Biosecurity measures include annual fish health sampling, disinfection of eggs from other facilities, disinfection of equipment, the use of footbaths, and keeping populations segregated.

Disease prevention is further achieved through prophylactic formalin treatments on eggs, newly captured age-1+ parr and sea-run adults, and any fish that display clinical signs of illness or external parasites.

Disease monitoring at CBNFH, GLNFH and facilities operated by DSF adhere to protocols established in the USFWS Handbook of Aquatic Animal Health Procedures and Protocols, with some modification to accommodate the endangered status of Atlantic salmon. Service hatcheries collaborate with USFWS Lamar Fish Health Center (LFHC) and Kennebec River Biosciences for veterinarian services in the event of atypical or unusual disease events requiring either prescriptions or medicated feed. DSF facilities collaborate with the Maine State Fish Health Laboratory as well as Kennebec River Biosciences.

In accordance with State of Maine aquatic health regulations and as a condition of each facility's National Discharge Elimination System Permit, any incidence of disease, and the recommended course of treatment is reported to the Maine Department of Environmental Protection as well as other partners within 24 hours of detection.

For USFWS hatcheries LFHC analyzes samples collected from necropsied mortalities, ovarian fluid, and lethal whole-body samples collected from each juvenile lot (60 each) prior to stocking.

Atlantic salmon mortalities, from USFWS facilities, are screened for a suite of salmonid viruses and bacteria including but not limited to: Furunculosis (*Aeromonas salmonicida)*, Enteric Redmouth [ERM] (*Yersinia ruckeri*)*,* Bacterial Kidney Disease [BKD] (*Renibacterium salmoninarum),* Infectious Hematopoietic Necrosis virus [IHN], Infectious Pancreatic Necrosis virus [IPN], Viral Hemorrhagic Septicemia virus [VHS], and Infectious Salmonid Anemia virus [ISA].

No positive findings were made in 2024 except for two ISA diagnoses discussed below.

Infectious Salmonid Anemia Monitoring

ISA is an extremely infectious orthomyxovirus first reported among Norwegian salmon farms in the mid-1980s and first reported in the U.S. in 2000 (Bouchard et al. 2001). Due to the proximity of aquaculture installations to Maine rivers, sea-run adults from the Penobscot River are monitored for the disease prior to being accepted as broodstock.

Sea-run adults are isolated in a screening facility at CBNFH to undergo ISA screening. Blood samples are analyzed using Polymerase Chain Reaction (PCR) testing at the LFHC. Adults negative for ISA are accepted into the broodstock program and transferred to the holding area for spawning.

In the event of a positive or suspect ISA result, additional tests are conducted on the affected fish. If diagnosed with the non-pathogenic strain of ISA (HPRO), the affected individual is released to the Penobscot River at a location above the Milford dam. The risk of releasing HPRO positive fish back to the river is negligible as the virus is extant in the population (John Coll, USFWS, LFHC, personal communication). The aim of releasing the affected individual is to avoid breeding it in a hatchery setting. Any adults initially isolated in the same room with the HPRO individual, are moved into the general hatchery population.

In 2024, two individuals were diagnosed, via PCR, for HPRO and were released to the Penobscot River.

In the event a positive diagnosis for a pathogenic strain of ISA the affected individual is euthanized. Samples of blood and tissue are collected for analysis at the LFHC and the U.S. Department of Agriculture's Animal and Plant Health Inspection Service. Any adults held in the same isolation room as the affected fish are isolated for an additional 28 days and then resampled.

No individuals were identified with pathogenic strains in 2024.

Infectious Pancreatic Necrosis Virus at the Peter Gray Hatchery

IPN was detected for the second year in a row during a routine health screening of Atlantic salmon 0+ parr held at the PGH, operated by the DSF in East Machias despite the installation of water filtration and ultraviolet treatment systems in early 2024. In August 2024, a 60-fish sample from each strain (East Machias and Narraguagus) was sent to the Maine State Fish Health Laboratory in Augusta. IPN was detected and samples were shared with Kennebec River Biosciences for confirmation and strain identification. The virus was likely introduced to the hatchery through the influent, which draws raw water directly from the East Machias River.

Once again, the decision to depopulate the hatchery was made following deliberation by federal and state agencies. The remaining cohorts of the Narraguagus [43,496] and East Machias [44,556] strain 0+ parr, were euthanized using a 15-minute MS-222 bath. The parr were then frozen and buried in a gravel pit off site on private property, away from any waterways, deep enough to discourage scavengers but shallow enough to allow for quick decomposition.

Once the hatchery was depopulated the facility, including influent and effluent areas underwent a deep cleaning process using a bleach solution. The hatchery will be fallow through 2025 and additional upgrades to the facility's water treatment infrastructure are expected.

Spawning Activities and Egg Production

Spawning Activities

Totals of 298 Penobscot sea-run origin females, 487 captive females, and 308 Penobscot-origin domestic females were spawned at CBNFH and GLNFH during November and December 2024, and atypically late, January 2025. Eggs produced at these facilities provide eggs for planting, fry production, parr and smolt production, domestic broodstock and educational programs.

CBNFH and GLNFH experienced a delay, similar to that experienced in 2022, in the onset of spawning [see Photoperiod Manipulation] that was not related to changes in photoperiod treatments. Captive broodstock at CBNFH did not begin spawning until the third week of November, nearly two weeks later than the typical start of the season. Spawning of Penobscot Atlantic salmon sea-run broodstock deviated drastically in 2024, . One group of sea-runs spawned as expected during the second and third weeks of November. A small second group of sea-runs spawned in mid-December. A third group did not spawn until the first and second weeks of January 2025. This occurrence is unprecedented at CBNFH, and the mechanism of delay is currently unknown but thought to be a combination of environmental factors.

Both CBNFH and GLNFH continue to use the Mate Matcher software, detailed in previous reports, to guide paired matings.

Photoperiod Manipulation

Photoperiod manipulation has been used at CBNFH since 2010 to mitigate against the effects of warm water temperatures (>10°C), typically experienced in late October, on early egg and fry survival. Photoperiod manipulation entails providing 16 hours of artificial light, in addition to ambient light, beginning on June 20th for one month. On or about July 20th the amount of artificial light is gradually reduced until the amount of ambient and artificial light is equalized in early November. Not only does the practice delay spawning towards more favorable water temperature conditions, but it can provide greater flexibility during the spring release season when river conditions and road accessibility can affect fry stocking activities.

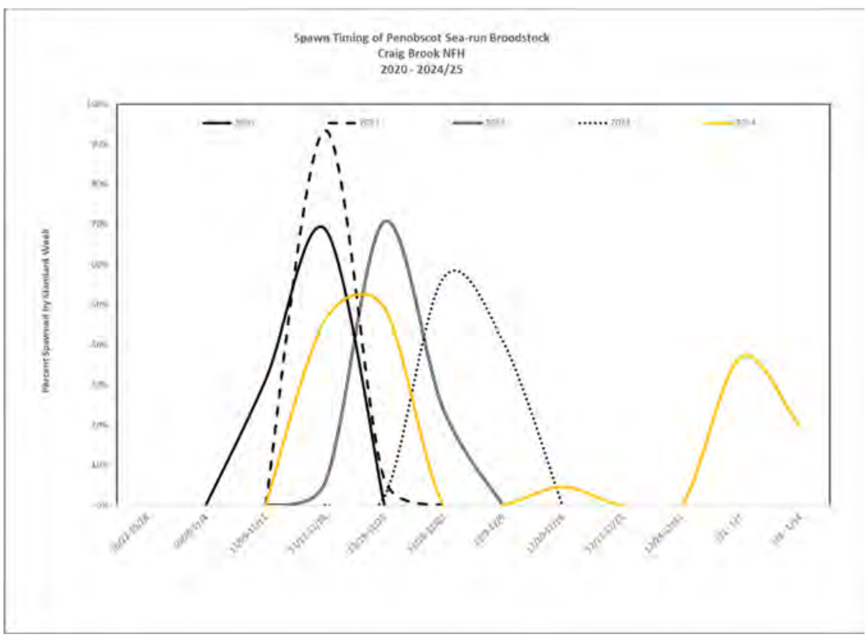


Figure 3.4.1. Spawn timing of Penobscot sea-run broodstock cohorts (2006 – 2024). The 2024 cohort is highlighted in yellow.

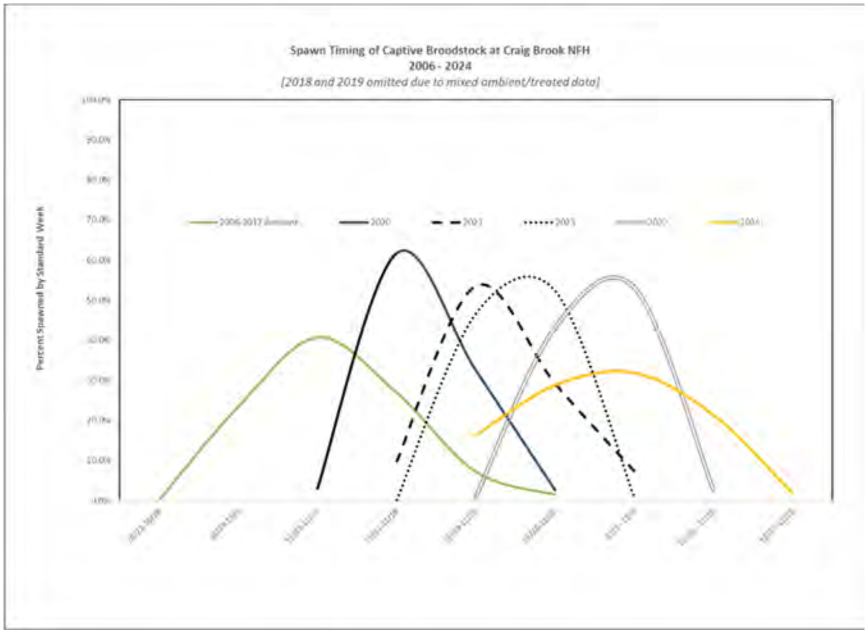


Figure 3.4.2. Spawn timing of captive brood cohorts at Craig Brook National Fish Hatchery, 2006 – 2024.

CBNFH will be considering the continued use of photoperiod manipulation during 2025 given the trend of delayed spawning experienced since 2022. In addition, CBNFH may participate in an Investigation New Animal Drug project for the use of hormones to induce spawning in the event of significant delays.

Cryopreservation Activities

Cryopreservation is a process in which a living cell can be frozen, stored, thawed, and remain viable for future growth. The cryopreservation lab at the USFWS's Warm Springs Fish Technology Center (WSFTC) focuses on developing and implementing cryopreservation techniques to secure the remaining genetic diversity of endangered species, reduce issues caused by non-coincident mating, improve control in artificial spawning programs, and transfer wild genetics into hatchery stocks. Cryopreserved sperm can also assist reproductive efforts by allowing spawning to take place whenever females are ready. For vulnerable species with limited populations, this reduces the need to hold males for long periods of time and can increase the flexibility and genetic diversity in future generations (https://www.fws.gov/project/cryopreservation-lab).

CBNFH continued investigations into the applicability of cryopreservation to assist in lowering total phosphorus discharge into Alamoosook Lake [see Phosphorus Reduction at CBNFH]. Using cryopreservation of milt may lower the amount of biomass [broodstock inventory] needed to successfully spawn each year. Lower biomass would result in less food being fed, further lowering the amount of total phosphorus. In addition, cryopreservation may allow CBNFH to create more diverse families in the future by having milt from different generations readily available. Building on work conducted in 2023, additional investigations were conducted in 2024. Representatives from the WSFTC conducted a site visit in November to initiate fertilization trials using cryopreserved milt. Batches of eggs were fertilized with cryopreserved milt that were frozen in different ways, to determine the best methods. Studies included examining differences among cryoprotectant chemical solutions, dilution ratios, and freezing rates.

Eggs from two Narraguagus captive females were divided into several equal aliquots. Each aliquot was fertilized with either cryopreserved milt or fresh milt from Narraguagus captive males, as a control. As of this writing, the eggs have not yet reached the eyed-egg stage and therefore have not been examined to determine eye-up survival.

Figure 3.4.3. Aliquots of Narraguagus captive broodstock eggs, fertilized with different cryopreservation study milt samples, are incubated in individual sample cups placed in a Heath tray at Craig Brook National Fish Hatchery.

Egg Production

Sea-run, captive and domestic broodstock spawned in 2024 at CBNFH and GLNFH produced 4,235,142 green eggs for the Maine program: 2,212,105 eggs from Penobscot sea-run broodstock; 493,569 eggs from domestic broodstock; 1,529,468 eggs from captive broodstock populations (Table 3.4.5).

Egg production from CBNFH and GLNFH contribute towards river-of-origin and out-of-basin egg planting, fry production, educational programs, private rearing (fry and parr production), parr and smolt production.

Table 3.4.5. Atlantic salmon egg production in 2024 for the Maine program by drainage, parent origin, the number of females used and fecundity. Parent origin include captive reared parr, sea-run adults, or domestic brood.

Drainage	Parent Origin	Females	Green Eggs	Fecundity
Dennys	Captive	86	280,233	3,259
East Machias	Captive	79	248,585	3,147
Machias	Captive	70	222,259	3,175
Narraguagus	Captive	93	322,758	3,471
Penobscot	Sea Run	298	2,212,105	7,423
Penobscot	Domestic	308	493,569	1,602
Pleasant	Captive	85	265,913	3,128
Sheepscot	Captive	74	189,720	2,564
		1,093	**4,235,142**	

Adult Stocking

A total of 3,241 adults was stocked into GOM DPS drainages (Table 3.4.6). CBNFH pre-spawn releases included two adults that tested positive to non-pathogenic ISA (see Infectious Salmonid Anemia Monitoring*)* as well as a number of captive broodstock that were held over the winter due to poor release conditions in December 2023. Those releases are included in the post-spawn releases in the table below. A total of 583

Penobscot sea-run adults was released post-spawn in January 2025 due to the unprecedented delay in spawning. GLNFH released spent age-three broodstock following spawning. Due to unexpected staff shortages at GLNFH in 2024, 286 age-four gravid broodstock were released prior to spawning to relieve workloads.

All released broodstock were PIT tagged and had either a double upper caudal fin punch or a double adipose punch. Releases of spent broodstock are coordinated with MDMR biologists, as well as state and federal game wardens.

Table 3.4.6. Adult broodstock released pre- and post-spawn from Craig Brook National Fish Hatchery (CBNFH) and Green Lake National Fish Hatchery (GLNFH) in 2024. Notes: * indicates some broodstock were released in March 2024 due to either high water or ice conditions post-spawning 2023; ** indicates the two HPRO positive Penobscot sea-run adults released to the river; ^ indicates the 2024 cohort of Penobscot sea-run broodstock were actually released in January 2025.

Originating Entity	Receiving Drainage	Strain	Pre/Post Spawn	Lot	Number Stocked
CBNFH	Dennys	Dennys	Pre-Spawn	Captive/Domestic	0
CBNFH	Dennys	Dennys	Post-Spawn*	Captive/Domestic	486
CBNFH	East Machias	East Machias	Pre-Spawn	Captive/Domestic	0
CBNFH	East Machias	East Machias	Post-Spawn	Captive/Domestic	138
CBNFH	Machias	Machias	Pre-Spawn	Captive/Domestic	0
CBNFH	Machias	Machias	Post-Spawn*	Captive/Domestic	430
CBNFH	Narraguagus	Narraguagus	Pre-Spawn	Captive/Domestic	0
CBNFH	Narraguagus	Narraguagus	Post-Spawn	Captive/Domestic	160
CBNFH	Penobscot	Penobscot	Pre-Spawn**	Sea-run	2
CBNFH	Penobscot	Penobscot	Post-Spawn^	Sea-run	583

Originating Entity	Receiving Drainage	Strain	Pre/Post Spawn	Lot	Number Stocked
CBNFH	Pleasant	Pleasant	Pre-Spawn	Captive/Domestic	0
CBNFH	Pleasant	Pleasant	Post-Spawn*	Captive/Domestic	425
CBNFH	Sheepscot	Sheepscot	Pre-Spawn	Captive/Domestic	0
CBNFH	Sheepscot	Sheepscot	Post-Spawn	Captive/Domestic	144
GLNFH	Penobscot	Penobscot	Pre-Spawn	Captive/Domestic	286
GLNFH	Penobscot	Penobscot	Post-Spawn	Captive/Domestic	391
GLNFH	Kennebec	Penobscot	Pre-Spawn	Captive/Domestic	196

Phosphorus Reduction at CBNFH

In 2023, the USFWS entered into a Federal Facility Compliance Agreement (FFCA) with the U.S. Environmental Protection Agency (EPA) to address ongoing violations of CBNFH's National Pollution Discharge Elimination System (NPDES) permit and Section 301(a) of the Clean Water Act (CWA), 33 U.S.C. § 1331 (a). Under the current NPDES permit, issued in 2010, CBNFH is permitted to discharge 112 pounds of total phosphorus (TP) annually. There is an additional limit of 28 pounds of TP per quarter. These limits were established in 2007 following the renewal of the permit in 2005.

Prior to 2007, CBNFH had a TP limit of 730 pounds per year. However, CBNFH transitioned from a smolt production facility to a multi-strain broodstock facility prior to 2000, which significantly reduced discharge to an annual average of 150 pounds of TP [Figure 3.4.3]. Since 2007 CBNFH has constructed a three-million-dollar wastewater treatment facility, undergone numerous engineering reviews and in-house structural redesigns in an effort to improve TP removal. Unfortunately, due to the extreme nature of the TP limit and lack of additional technological or chemical advancements to address the issue, CBNFH has been in violation of the 112-pound annual limit since its inception as well as violating the quarterly limits on a regular basis.

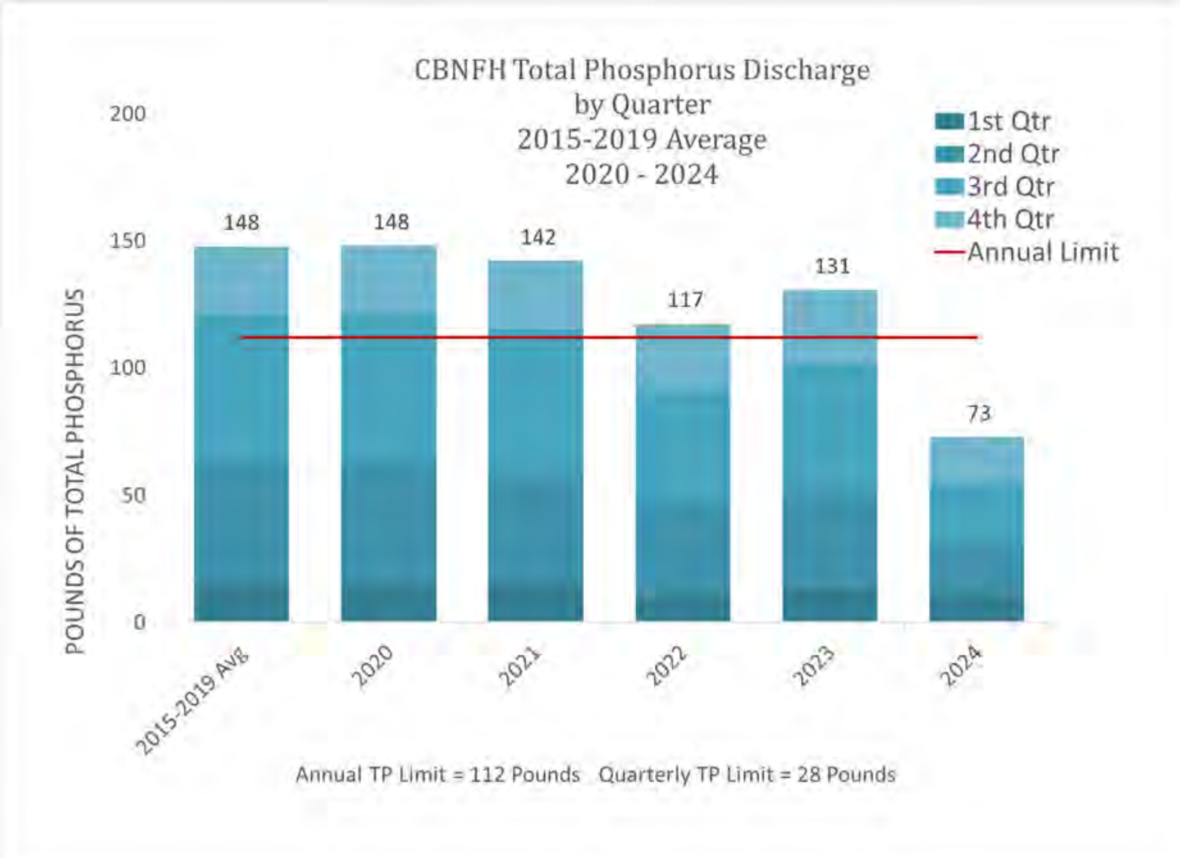


Figure 3.4.3. Annual discharge of total phosphorus (TP), by quarter, at Craig Brook National Fish Hatchery (CBNFH) between 2015 and 2024.

Following the signing of the FFCA by representatives of the USFWS and EPA, CBNFH began moving broodstock off station. In the spring of 2023, previously spawned age five and four broodstock from all six captive populations were released. As previously reported, the number of parr broodstock collected in 2023 was increased to 250 per population to mitigate against the loss of older year classes. Following spawning in 2023 all age five broodstock, all age four broodstock and spent age three broodstock were released. These reductions represented a loss of one-third of the broodstock inventory and one-half of the biomass.

In 2024, CBNFH changed from feeding industry standard brood diets to age three and age four broodstock to using feed design for recirculating aquaculture systems (RAS). The RAS diet is formulated with food-grade binders to thicken fish waste and uneaten feed before it enters the wastewater treatment facility, hopefully facilitating greater solids removal. In addition, the RAS diet is slightly lower in phosphorus than traditional broodstock diets. Age two and early age three broodstock are still fed the traditional broodstock diet to promote gamete growth prior to their first spawn.

Additional infrastructure changes were made to the wastewater treatment plant to streamline waste removal, effluent trenches in the receiving building were skim-coated with concrete and painted with epoxy paint to facilitate effluent water flow, and feed rates were adjusted to the minimal level required to ensure proper growth and gamete development. To further control feeding rates, water temperatures at the hatchery were kept at or below 13° C whenever feasible, slowing the metabolic requirements of the broodstock.

Due to these efforts, CBNFH was able to achieve a TP discharge of 73 pounds in 2024, well under the 112 pound limit. Additional evaluation of the genetic implications of reducing broodstock populations will be required moving forward and will guide decisions on whether any population will be able to return to pre-FFCA levels.

3.5 General Program Information

Gulf of Maine Distinct Population Segment Recovery Plan

The Recovery Plan for the GOM DPS of Atlantic Salmon was completed in 2018. Work plans designed to support the recovery plan were developed by the Collaborative Management Strategy SHRU coordinating committees and approved in 2023. These plans reference key actions for each SHRU that will help increase connectivity, habitat function, and stock enhancement.

3.6 References

Bateman, D. S., R. E. Gresswell, and C. E. Torgersen. 2005. Evaluating Single-Pass Catch as a Tool for Identifying Spatial Pattern in Fish Distribution. Journal of Freshwater Ecology 20(2):335-345.

Bjorkstedt, E. P. 2005. DARR 2.0 updated software for estimating abundance from stratified mark-recapture data.

Bouchard, D., B. K.A, C. Giray, W. Keleher, and P. L. Merrill. 2001. First report of Infectious Salmon Anemia (ISA) in the United States. Bulletin of the European Association of Fish Pathologists 21:86-88.

NMFS. 2009. Endangered and Threatened Species; Designation of Critical Habitat for Atlantic Salmon (Salmo salar) Gulf of Maine Distinct Population Segment; Final Rule. Federal Register 74(117):29343 - 29387.

NMFS, and USFWS. 2009. Endangered and Threatened Species; Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic Salmon. Federal Register 74(117).

R Core Team. 2024. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Stevens, D. L., and A. R. Olsen. 2004. Spatially Balanced Sampling of Natural Resources. Journal of the American Statistical Association 99(465):262-278.

Stevens, J. R., M. Simpson, and J. Trial. 2010. Standard Operating Procedure for Juvenile Atlantic Sampling by Electrofishing in Wadeable Streams. Maine Department of Marine Resources.

Wright, J., J. Sweka, A. Abbot, 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).

4 Non-Gulf of Maine Distinct Population Segments

Long Island Sound DPS

This DPS has been designated as extinct and includes the Connecticut and the Pawcatuck rivers.

4.1 Connecticut River

The Connecticut River Atlantic Salmon Restoration Program ended in 2013 and in 2014 the new Atlantic Salmon Legacy Program was initiated by the Connecticut Department of Energy and Environmental Protection (CTDEEP) for activities solely within the state of Connecticut. The following is a summary of work on Atlantic salmon.

4.1.1 Adult Returns

No sea-run Atlantic salmon adults were observed returning to the Connecticut River watershed. However, the Rainbow Dam Fishway on the Farmington River was not operated in 2024 due to its poor physical condition. As such, if salmon returned to the river, there was no way to observe and document them. The Leesville Dam Fishway on the Salmon River was operated but with no trap or video system, the only way to observe returning salmon is by snorkeling below the dam or receiving angler reports. No snorkeling observations were made and no angler reports were received in 2024. This does not mean that no salmon returned to the watershed, but that none were documented.

4.1.2 Hatchery Operations

A total of 624,601 green eggs was produced (2023 = 742,451). Only the Kensington State Fish Hatchery (KSFH) in CT maintained domestic broodstock. Contributing broodstock included 127 females and 119 males. Both males and females were a mix of 3+ and 4+ year old fish. All fish were spawned twice. During the first spawn each female was crossed with four separate males, followed several days later with a single second spawn cross (1 female x 1 male). Those eggs will be used for fry stocking for the Connecticut Legacy Program including the Salmon-in-Schools program.

4.1.3 Stocking

4.1.3.1 Juvenile Atlantic Salmon Releases

A total of 391,100 juvenile Atlantic salmon was stocked into the Connecticut River watershed, all in Connecticut (2023 = 334,738). Selected stream reaches in the Farmington River were stocked with fed fry (N = 222,084) and unfed fry (N = 58,823). Selected reaches in the Salmon River were also stocked with both fed (N = 62,322) and unfed (N = 47,805) fry. All fed fry were produced at the KSFH and all of the unfed fry were produced at the Tripp Streamside Incubation Facility (TSIF). The TSIF received eyed eggs from the KSFH. In addition, unfed 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. An estimated 16,367 fry were released by the school program. An additional 100 smolts were stocked into the Salmon River, not as a part of a deliberate smolt stocking program but as a means to reduce fish density at the KSFH.

4.1.3.2 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.

4.1.4 Juvenile Population Status

4.1.4.1 Smolt Monitoring

No videography monitoring of the smolt migration at the viewing window at the Rainbow Dam Fishway (Farmington River) occurred in 2024 due to staff shortages. A new hydro project was developed at the upstream Upper Collinsville Dam and the FERC license required construction and operation of upstream and downstream passage, documented by videography. Such monitoring documented the downstream passage of 45 smolts in the Denil fishway (2023= 43). The unmonitored downstream fish passage facility covered 98% of the river flow compared to the 2% passed by the Denil. There was a lot of spill at the dam during the smolt migration season so this fish count cannot be considered a census.

4.1.4.2 Index Station Electrofishing Surveys

No electrofishing surveys of juvenile salmon populations were conducted in 2024.

4.1.5 Fish Passage

4.1.5.1 Hydropower Relicensing

Similar to the past several years, State and federal resource agencies continued to spend considerable time on FERC-related processes for the relicensing of four mainstem dams and one pumped storage facility. Some agreements relevant to relicensing have been made while others remain under discussion. Since no salmon are stocked upstream of the Holyoke Dam, such agreements have little relevance to Atlantic salmon.

4.1.5.2 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, Upper Collinsville 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. Many diadromous fish species were observed and counted using this technology, but no adult salmon were observed. Smolts were observed passing the Upper Collinsville Dam (see 3.1.4.1).

4.1.5.3 New Fishways

None to report.

4.1.5.4 Dam Removals

None to report.

4.1.5.4 Culvert Fish Passage Projects

None to report.

4.1.6 Genetics

The genetics program previously developed for the Connecticut River program has been terminated. Best accepted broodstock management practices are attempted at the KSFH.

4.1.7 General Program Information

The Connecticut River Salmon Association (CRASC), in cooperation with CTDEEP, maintained its Salmon-in-Schools program, providing 17,400 eggs for 58 tanks in 47 schools in Connecticut. An estimated 4,324 students participated in learning about the history of Atlantic salmon.

As reported last year, the CRASC, which had been managing migratory fish restoration on the Connecticut River since 1983, went out of existence toward the end of 2023. The State and federal partners created a new organization called the Connecticut River Migratory Fish Cooperative (CRMFC), which had its first full meeting in 2024. The partners, organizational structure, and activities will remain similar to those of CRASC but without any salmon-related activities. The Legacy Program which stocks salmon fry in a few areas in Connecticut is strictly a State of Connecticut program and not under the CRMFC.

4.1.8 Migratory Fish Habitat Enhancement and Conservation

There were several stream restoration projects throughout the basin but since most of them no longer impact Atlantic salmon habitat, they will not be listed here.

4.2 Central New England DPS

This DPS has been designated as extinct and includes the Merrimack and the Saco rivers.

4.2.1 Merrimack River

The salmon restoration program for this watershed ended in 2013.

4.2.1.1 Adult Returns

Two Atlantic salmon adults were observed returning to the Merrimack River and were lifted at the Essex Dam fish lift. The fish were not handled by biologists but lifted by power company staff. Only available data was fish counts. No stocking occurred in the Merrimack River since 2017 and documented returns since then averaged only 3.5 adults per year. Additionally, a review of prior return data suggests that these individuals were likely hatchery origin strays. USASAC decided to assign these fish hatchery 2SW origin.

Table 4.2.1.1. Estimates of age and origin breakdown of returning Adult Atlantic salmon to the Merrimack River at the Essex Dam fish lift.

Hatchery	Hatchery	Hatchery	Hatchery	Naturally Reared
1SW	**2SW**	**3SW**	**Repeat**	**2SW**
	2			

4.2.1.2 Hatchery Operations

There were no hatchery activities supporting salmon management in the Merrimack River watershed.

4.2.1.3 Juvenile Atlantic salmon releases

No salmon of any life stage were released into the Merrimack River.

4.2.1.4 Juvenile Population Monitoring

None was conducted.

4.2.1.5 Fish Passage developments relevant to Atlantic salmon

There are no such developments to report.

4.2.1.6 Educational activities

None reported.

4.2 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, was shut down for repairs the entire 2024 season. The Cataract Denil fishway located on the West Channel in Saco and Biddeford operated from 1 May to 31 October 2024 and the Skelton fish lift operated from 1 May to 31 October 2024. One Atlantic salmon was documented in the Saco River in 2024. However, the count should be considered a minimum because of the possibility of adults ascending Cataract without passing through one of the counting facilities. A review of prior return data and stocking data suggests that this individual was likely a natural reared 2SW origin fish.

Table 4.2.1.1. Ratios used to determine the origin of each age class of Sea-Winter (SW) returns of Atlantic salmon of unknown origin/ freshwater age on the mainstem Saco River at the Skelton Fishlift.

Sea age	Count	Hatchery %	Wild %
1SW - Known %	0	0	0
1SW - Pro-rated proportion	**0**	**0**	**0**
MSW – Known %	1	0	100
MSW - Pro-rated proportion	**0**	**0**	**0**

4.2.2 Hatchery Operations

Egg Collection

The Saco Salmon Restoration Alliance & Hatchery (SSRA) has ceased receiving eggs or broodstock from Nashua National Fish Hatchery. The broodstock program will now rely on annual naturally reared parr collections from the drainage. In the winter (January - February) of 2024, the University of New England (UNE) staff spawned 121 adults that produced 20,000 eggs. Due to unknown issues none of the eggs developed.

Broodstock Collections

In 2024, no parr were collected from the Saco River due to poor egg production and lack of stocking.

4.2.3 Stocking

Juvenile Salmon Releases

In 2024, no juveniles were released in the Saco River drainage.

Adult Salmon Releases

In 2024, 71 post-spawn adult Atlantic salmon were stocked into the Saco River drainage.

4.2.4 Juvenile Population Status

In 2024, MDMR did not conduct any electrofishing surveys in the Saco River.

Smolt Monitoring

In 2024, there was no smolt monitoring.

Tagging

No salmon released into the Saco River drainage were tagged or marked in 2024.

4.2.5 Fish Passage

In 2024, the fishlift on the East Channel Cataract remained shut down for the entire salmon migration season.

4.2.6 Genetics

All adult returns captured at Skelton Dam are tissue sampled. Samples are preserved and kept at MDMR in Augusta. Currently no plans have been made to characterize them genetically.

4.2.7 General Program Information

In 2019, the Saco Salmon Restoration Alliance & Hatchery (SSRA) began a partnership with UNE. The partnership relies on the UNE to rear broodstock and assist the SSRA with spawning. In 2024, UNE was unable to hold broodstock due to program changes and facility maintenance. This is currently under review and may resume in 2025.

In addition, to maintain a source of broodstock the SSRA collects parr. The parr are taken annually from the Saco River drainage, reared at the SSRA hatchery and then transferred to the UNE for spawning in the fall.

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 2024.

4.3 Outer Bay of Fundy

Several tributaries of the St John River (Aroostook River, Prestile Stream, and the Meduxnekeag River), as well as the St Croix River, which are partially located within the U.S., historically contributed to the Outer Bay of Fundy stock of Atlantic salmon. Abundance and distribution of this stock is substantially reduced compared to historic levels. In November of 2010, the Committee on the Status of Endangered Wildlife in Canada assessed the status of the Outer Bay of Fundy stock as ‘endangered’. For a species assessed as ‘endangered’, the Department of Fisheries and Oceans (DFO) must decide whether to list the species under the Species at Risk Act. To inform this decision a recovery potential assessment was completed in 2016 (Gibson et al. 2016).

4.3.1 St. Croix River

This river is the boundary between the U.S. and Canada. There have been no U.S. activities regarding Atlantic salmon in this watershed for many years. The activities described below reflect only U.S. activities. No activities by the DFO are included.

4.3.1.1 Adult Returns

In 2024, no Atlantic salmon adults were observed returning to the St. Croix River.

4.3.1.2 Hatchery Operations

In 2024, no hatchery activities supporting sea-run salmon management occurred.

4.3.1.3 Juvenile Atlantic Salmon Releases

In 2024, no salmon of any life stage were released into the St. Croix River.

4.3.1.4 Juvenile Population Monitoring

In 2024, no juvenile population monitoring occurred.

4.3.1.5 Fish Passage Developments Relevant to Atlantic Salmon

The Milltown Dam (first barrier, at tidewater) removal, started in 2023 was completed in 2024. Funding provided by the National Fish and Wildlife Foundation and NOAA are jumpstarting efforts to improve fish passage at the next two upstream dams, Woodland Dam and Grand Falls Dam. Feasibility analysis, engineering, and fundraising for improvements at these facilities are now underway.

4.3.1.6 Educational Activities

In 2024, no activities were reported.

4.3.2 Meduxnekeag River

This river flows mostly in Maine but enters New Brunswick shortly before flowing into the St. John River. U.S. salmon management activities in this watershed have been sporadic and relatively minor in past years. All activities reported herein are U.S. activities without any reference to activities undertaken by DFO.

4.3.2.1 Adult Returns

In 2024, no Atlantic salmon adults were observed returning to the Meduxnekeag River.

4.3.2.2 Hatchery Operations

In 2024, there were no hatchery activities that supported Atlantic salmon management in this watershed.

4.3.2.3 Juvenile Atlantic Salmon Releases

In 2024, no salmon of any life stage were released into the Meduxnekeag River.

4.3.2.4 Juvenile Population Monitoring

In 2024, no activities were reported.

4.3.2.5 Fish Passage Developments Relevant to Atlantic Salmon

In 2024, no passage developments were reported.

4.3.2.6 Educational Activities

In 2024, no activities were reported.

4.3.3 Prestile Stream

This river flows mostly in Maine but enters New Brunswick shortly before flowing into the St. John River. U.S. salmon management activities in this watershed have been sporadic and relatively minor in past years. All activities reported herein are U.S. activities without any reference to activities undertaken by DFO.

4.3.3.1 Adult Returns

In 2024, no Atlantic salmon adults were observed returning to Prestile Stream.

4.3.3.2 Hatchery Operations

In 2024, there were no hatchery activities that supported Atlantic salmon management in this watershed.

4.3.3.3 Juvenile Atlantic Salmon Releases

In 2024, no salmon of any life stage were released into Prestile Stream.

4.3.3.4 Juvenile Population Monitoring

In 2024, no juvenile population monitoring was conducted.

4.3.3.5 Fish Passage Developments Relevant to Atlantic Salmon

In 2024, there were no passage developments reported.

4.3.3.6 Educational Activities

In 2024, no activities were reported.

4.3.4 Aroostook River

This river flows mostly in Maine but enters New Brunswick shortly before flowing into the St. John River. The Tinker Dam is located a short distance downstream of the international boundary. Any adult fish that ascends the Aroostook River from the St. John must use the fishway at the Tinker Dam. U.S. salmon management activities in this watershed have been sporadic and relatively minor in past years.

4.3.4.1 Adult Returns

One MSW hatchery origin female salmon returned to Tinker dam in 2024. DFO (Sherisse McWilliam personal communication) indicated that this fish was likely a captive reared adult released into the mainstem St. John River from the Mactaquac Biodiversity Facility (MBF). These were collected as parr/smolt/pre-smolt from the Tobique River and raised at MBF until mature adults and then released back to spawn in the river.

4.3.4.2 Hatchery Operations

Atlantic Salmon for Northern Maine, Inc. is raising salmon at the Dug Brook Hatchery (David Putnam, personal communication). The Mactaquac Biodiversity Facility provided 37,000 eyed eggs again in January 2025.

There are currently 250 adult fish that will be divided into two groups in the Fall: 100 will be stripped for eggs and milt and released, and 150 will be stocked to spawn naturally in the river. The 2026 spawning cohort has 204 fish currently. Atlantic Salmon for Northern Maine, Inc. is currently attempting to expand capacity at Dug Brook to raise 500 adults per year but are limited by wastewater outflow/treatment regulations. Plans include setting up several large tanks on the Caribou property, where wastewater can be put into the city sewer system.

Atlantic Salmon for Northern Maine, Inc. will apply for a stocking permit from ME DMR for adult fish for October 2025. As there are no current regulations pertaining to sea-run salmon in the Aroostook River, those fish may be available to anglers as kelts in the spring.

4.3.4.3 Juvenile Atlantic Salmon Releases

In 2024, approximately 28,000 fed fry were stocked during the spring and fall. Also, broodstock numbers exceeded tank capacity at Dug Brook, so several hundred parr and smolts were released in the Fall from Dug Brook.

4.3.4.4 Juvenile Population Monitoring

In 2024, none was reported.

4.3.4.5 Fish Passage Developments Relevant to Atlantic Salmon

In 2024, no passage developments were reported.

4.3.4.6 Educational Activities

In 2024, no activities were reported.

5 Emerging Issues in U.S. Salmon and Proposed Terms of Reference

Summary

This section provides an overview of information presented, identified and/or developed at the meeting related to emerging issues or new science or management activities important to Atlantic salmon in New England. 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 the scope of standard stock routine updates that are typically included in other sections. This section reviews select working papers, ensuing discussions, and ad-hoc topics to provide information on discussions and decisions made by the USASAC.

5.1 Reporting on 2024 USASAC Terms of Reference

In support of ICES/NASCO, we provided reporting on the following TORs in last years' meeting (2024) for Atlantic salmon in the United States.

Term of Reference	Section within the report
Describe the key events of the annual fisheries bycatch (targeted fisheries are closed) and aquaculture production	1
Update age-specific stock conservation limits based on new information as available including updating the time-series of the number of river as available including updating the time-series of the number of river stocks with established CL's by jurisdiction.	1 and 5
Describe the status of the stocks including updating the time-series of trends in the number of river stocks meeting CL's by jurisdiction.	1
Identification of significant new or emerging threats to, or opportunities for, salmon conservation and management;	1, 3 and 5
Compilation of Tag releases	1

In support of Collaborative Management Strategy (CMS), we provided reporting on the following TORs identified in 2024 for Atlantic salmon in the United States to report on this year.

Term of Reference	Section within the report
Status of U.S. Populations for the Gulf of Maine DPS at SHRU level	1, 3 and 4
Adult Returns Estimate (Hatchery and Naturally Reared)	1, 3 and 4
Freshwater Production Summaries – Smolts and pre-smolt production CPUE	1 and 3
Marine Survival – hatchery index Penobscot and naturally-reared Narraguagus	1 and 2
Diversity Metric	2
Hatchery production	1, 3 and 4
Connectivity	3 and 5
Distribution - occupancy maps and data	3

Beyond those provided by ICES/NASCO and the CMS, the USASAC develops their own TORs and emerging issues. These are variable scope and include topics identified prior to, or during each of the annual meetings. We report on TORs identified in 2024, or before, with summaries provided below.

Scale Archiving and Inventory Update

The USASAC previously noted that the lack of dedicated resources and capacity has delayed an effort to better archive and inventory historic scale samples throughout New England. In 2017, a general inventory was conducted by New England fishery agencies participating in USASAC. We found that much information is currently contained in databases such as the Maine program's Adult Trap and Bioscale database. However, storage details and the condition of samples has not been adequately summarized. The USASAC supported continued efforts of an ad-hoc committee to work towards identifying funding sources and drafting a proposal to add capacity to inventory and archive historic scale samples throughout New England. NOAA supported travel time and supplies to advance this effort led by Steve Gephard (Ct. DEEEP – Retired) and Ruth Haas-Castro (NOAA).

Steve Gephard presented on the successful conclusion of documenting location of scales collected and inventoried. These scales are stored in archival materials and organized by numbered bins with up to six boxes in each bin. Additionally, a master database in Excel documents this information and summaries through 2020 collections from the State of Maine. Maine collections are currently stored at MDMR offices in Jonesboro (Downeast Collections) and Augusta (Merrymeeting Bay and Penobscot Bay) archives. The group concurred that the ideal situation would be to have all archived samples in one location. As such the committee suggests to continue to work with MDMR leadership to move archive scales into that secure and safe location. Additionally, the Excel datasheet will be distributed to members of the USASAC [Danielle Frechette (MDMR), Timothy Sheehan (NOAA) and Jim Hawkes (NOAA)] to ensure that this work is archived.

The ad hoc group has concluded major activities for this project, general check-ins will occur as needed.

Need for Accurate and Consistent Reporting on Habitat Connectivity Gains

In 2021, the USASAC discussed the increasing need for accurate reporting of habitat accessibility data at both the international and domestic level. At the international level, the U.S. identifies habitat accessibility goals as part of their NASCO Implementation Plan. Progress towards attaining these goals need to be reported to NASCO annually as part of the U.S.'s Annual progress Report. At the domestic level, the Recovery Plan for Atlantic salmon states that a minimum of 90,000 units of accessible and suitable habitat must be obtained before delisting is considered. The determination of suitable habitats are left to the discretion of scientists and managers. The Critical Habitat Rule (74 FR 29300, 2019) identified watersheds that were known to contain the most abundant, suitable habitats for Atlantic salmon, although the scale at which these habitats were identified are too coarse for reporting requirements noted above. To accurately report on progress towards these habitat criteria, a standardized definition of what constitutes suitable habitat is required. Once defined, an inventory should be created that identifies where suitable habitats are located in the DPS, the relative productivity of these suitable habitats and a method to calculate how much suitable habitat meets the criteria as accessible each year. Ultimately, a database, which tracks all of these metrics, is needed and this database needs to be consistently maintained.

Emily O'Regan (NOAA NEFSC affiliate) provided an update on the refinement of US Atlantic Salmon Habitat Model including the development of a high spatial resolution stream network (100m). The initial results of the physical habitat model were presented and plans for the future including developing suitability metrics. Future efforts will focus on refining habitat estimates in the DPS SHRUs and provide guidance for management activities (e.g. stocking). There was limited discussion with some questions regarding the construction of the model and methods to reduce error in the 100m sections.

An update will be provided to the USASAC in 2026.

5.2 Emerging Issues

Cryopreservation Activities of Broodstock Milt

Cryopreservation is a process in which a living cell can be frozen, stored, thawed while remaining viable. The Cryopreservation Lab at the U.S. Fish and Wildlife Service's Warm Springs Fish Technology Center in Georgia focuses on developing and implementing cryopreservation techniques to secure genetic diversity of endangered species, reduce issues caused by non-coincident mating, improve control in artificial spawning programs, and transfer wild genetics into hatchery stocks. Cryopreserved sperm can also assist with hatchery spawning efforts by allowing fertilization to take place whenever females are ready. For vulnerable species with limited populations, this reduces the need to hold males for long periods of time and can increase the flexibility and genetic diversity in future generations. Craig Brook National Fish Hatchery is exploring the option of cryopreservation as a means to lower the amount of total phosphorus discharged into Alamoosook Lake by reducing the requirement of maintaining male broodstock within the hatchery. Using cryopreservation may lower the amount of biomass needed to successfully spawn in any given year resulting in less food being fed and lowering the amount of total phosphorus. In addition, it may allow Craig Brook National Fish Hatchery to create more diverse families by having milt from different generations readily available. This process has the possibility of improving eye up by ensuring sterile milt is not being used. Cryopreservation techniques are widely used in the aquaculture industry (Yang et al. 2018). Further details on this effort were presented in Section 3.

Oliver Cox (USFWS) provided an update on Cryopreservation within the USFWS hatcheries maintaining Atlantic salmon broodstock in Maine. He informed the group that fertilization trials are underway and results will be forthcoming. There are plans to continue to expand studies next year, although budget and priorities uncertainties remain. Ultimately, if the work continues and is successful, the USFWS would look to implement this approach into the salmon recovery program.

Updates or progress related to this will be presented at the USASAC meeting in 2026.

Inclusion of parr in “naturally reared” USASAC reporting

Starting in 2020, the USASAC discussed the option of including fall parr within the naturally reared reporting for adults and other components to address recovery plan requirements. Through subsequent follow-up discussions, the USASAC decided to not include fall parr stocked salmon within the grouping of naturally reared fish, but to continue to include them within the hatchery classification. The communication of that decision is provided below:

Follow-up on parr discussion from mid-year meeting in October

James Hawkes - NOAA Federal **<james.hawkes@noaa.gov>**

to Catherine, David, Tim, Ernie, Peter, Rory, Steve, Meredith, John, Emily, John, Denise, Mitch, Dan, Jennifer, Oliver, Marija, Paul, Danielle, Jason, Matt, Colby, Justin, Ruth, Dan, Sean, Dan

Hello all.

As promised, I looked further into categorizing fall parr origin adult returns as naturally reared within the USASAC report.

Here is the challenge:

Within the Penobscot Basin there is a low proportion (sometimes zero) of marked fall parr and smolts (in most years), which means that origin assignments would predominantly be scale-based. Given the sampling strategy for adult returns, determining origin from scale-based assignments would require a significant amount of proration, plus according to Jason Valliere (MDMR), parr stocked (p8s) and smolt (age 1) scales are generally indistinguishable from one another. Further, we do not have solid information to estimate the proportion or number of parr that make it to the ocean, therefore including stocked fall parr within our hatchery return rate calculations would compromise our estimate.

Within the Narraguagus and other small coastal salmon rivers there is some marking of parr, but only on the Narraguagus (for now) are fish handled/scale sampled to assist with origin determinations.

From an international perspective, we report total adult returns by age: we do not report adult returns by origin. Given this, reporting fall parr as hatchery origin versus natural reared would have no impact on our international reporting/activities. From a domestic perspective, reporting fall parr as hatchery origin is considered a non-issue.

Conclusion: Given all this, I propose that we continue to report fall parr as hatchery origin as we have done in the past. I can write a small summary explanation for inclusion in the USASAC report to introduce the topic and to explain the rationale for not changing our reporting procedures and instead to keep reporting fall parr as hatchery origin. If anyone has any questions or concerns about this, please do let me know and I would be very happy to discuss this one on one. From my perspective, to consider reporting fall parr as naturally reared will require a comprehensive marking and monitoring program to obtain accurate and representative estimates of the contribution of fall parr to our adult returns. Possibly that is something that can be considered in the future.

Thank you.

James Hawkes

Research Fishery Biologist

Atlantic Salmon Ecosystems Branch (AtSEB)
NOAA Fisheries | U.S. Department of Commerce

Evaluation of life stage specific contributions to restoration stocking efforts

The primary goal of the recovery program is recovering stocks. This is thought to be initially accomplished through the supplementation of perennially low sea-run escapement with hatchery origin juveniles. Historically, age-1 smolts raised at Green Lake National Fish Hatchery have been used to maximize the number of smolts entering the ocean and the number of sea-run returns. These hatchery-origin, sea-run returns have been the staple of the Penobscot River broodstock for decades. In contrast to smolt stocking, where fish have limited exposure to the river system, alternative life stages are used to increase riverine experience. Other hatchery products (egg, fry, parr) and direct stocking of pre-spawned adults, accomplish this, but naturally-reared origin returns remain low and well below conservation objectives. However, the number of stocked individuals remains well below stocking requirements to fill unoccupied habitat. The challenge to the stocking program is to identify what stock life stages result in the greatest increase in smolt production per capita and ultimately the highest marine return rate.

Justin Stevens (MDMR) presented a summary of two different stocking strategies (fry and adult stocking) within the Piscataquis River in the 2000s and 2010s. This effort looked at the productivity of each with the fry stocking effort exhibiting greater abundances in the YOY (median Fry = 8.9/100m^2; Adult stock = 1.9/100m^2), Parr (median Fry = 5.4/100m^2; Adult stock = 0.9/100m^2) and smolt estimates (Fry = 7,600; Adult stock = 3,500). These results demonstrate that not all stocking products are equal. The discussion that followed by USASAC members emphasized the need to fully seed these habitats and encouraged future hatchery product evaluation efforts.

There are no plans for presenting a follow up in the 2026 meeting at this time.

NASCO Stocking Guideline Recommendations

A NASCO working group (WG) was formed in 2023 to develop Atlantic salmon stocking best practices. The WG, made up of members from several nations, was charged with considering the biological and ecological benefits of stocking, evaluating new approaches of stocking, and drafting guidelines for recommendation. Steve Gephard (Chair of the WG), presented the adopted guidelines to the USASAC. His presentation included a review of the WG's investigations and consultations, its conclusions (risk and benefits), and the guidelines, which covered six different types of stocking. The presentation only covered the category for recovery programs (relevant to Maine) as well as guidelines that pertained to all six types of stocking. These guidelines emphasized broodstock selection, mating, culture of the progeny as well as the stocking of the fish. Gephard suggested that the GOM Recovery Program complies with most of the guidelines that pertain to its category, with two notable exceptions 1) dependence on hatcheries and 2) utilization of the smolt life-stage.

After reviewing the guidelines, Gephard raised an idea of an expanded fry stocking project in a targeted sub-drainage to prompt discussion within the USASAC. As part of this presentation, Gephard acknowledged that without hatchery smolts the viability of the GOM DPS would be severely compromised as shown prior population viability assessments. However, the successes of smolt stocking is sometimes questioned, it needs to be emphasized that such stocking generates adult returns. Ensuing discussion emphasized that the GOM DPS contains good Atlantic salmon habitat and the recovery program needs to prioritize getting salmon into it. It was suggested that a logical approach would be to stock earlier lifestages (eggs and fry) within the headwaters, with parr and smolts lower in the basin. This has mostly been followed, but the egg and fry stocking has been limited due to constraints with egg numbers and staff. Ensuing discussions acknowledged present (and future) staffing challenges as a significant hurdle to implementing a large scale resource intensive basin wide stocking program and consideration could be given to recruiting (and relying on) volunteers. Including the public could not only help stock fish but help develop greater public support for the Program. There was some discussion pertaining to which is more important to the public: having big fish (adults) or little fish (juveniles) in the river. The consensus seemed to be that either is good, it is just important to develop messaging and continue to educate folks on the importance of all life stages. The Program must continue to stock smolts, but it should be open to trying different approaches, especially if they might lead to increased natural spawning and subsequent increases in wild-origin adult returns.

There are no plans for follow up reporting in 2026.

5.3 Data Deficiency and Data Needs

Directionality using pit tags

During 2024, PIT monitoring was in place at Mattaceunk (Weldon) dam on the Penobscot River, which was used to track passage of various species of PIT tagged sea-run fish. The PIT tag antenna in the Mattaceunk fish ladder is the only PIT monitoring station on the Penobscot River, and it consists of a single antenna, which removes the ability to determine directionality of fish movement. More than 100 PIT-tagged adult Atlantic salmon were in the river in 2024 as a part of the Salmon for Maine's River (SFMR) project and although many of these fish were acoustically tagged, the single antenna prevented the ability to detect directionality of fish at Weldon Dam. It was suggested that this array be expanded and additional arrays to be installed at other dams to justify continued tagging of animals at Milford, to evaluate passage efficiency at monitored dams, and to support the SFMR project.

Citations:

NASCO. 2003. Resolution by the Parties to the Convention for the Conservation of Salmon in the North Atlantic Ocean, The Williamsburg Resolution. Adopted at the Twentieth Annual Meeting of North Atlantic Salmon Conservation Organization in June 2003, as amended.

U.S. Fish and Wildlife Service and NMFS. 2018. Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). 74 pp.

Yang, H., E. Hu, J. T. Buchanan, and T. R. Tiersch. 2018. A Strategy for Sperm Cryopreservation of Atlantic Salmon, Salmo salar, for Remote Commercial-scale High-throughput Processing. J World Aquac Soc 49(1):96-112.

5.4 Draft Terms of Reference for 2026 Meeting

The purpose of this section is to outline terms of reference identified at the 2025 USASAC annual meeting. These draft TORs will be integrated with requests that emerge from the Maine Collaborative Management Strategy Annual Report (April 2025) and the NASCO Annual Meeting (June 2025) to develop Final 2025 TOR and an agenda for the 2026 USASAC Meeting. The final Terms of Reference will be reviewed during our summer 2025 teleconference to organize intersessional work as appropriate.

In **support of NASCO**, we anticipate reporting on the following with respect to Atlantic salmon in the United States

Describe the key events of the annual fisheries bycatch (targeted fisheries are closed) and aquaculture production

Update age-specific stock conservation limits based on new information as available including updating the time-series of the number of river stocks with established CL's by jurisdiction.

Describe the status of the stocks including updating the time-series of trends in the number of river stocks meeting CL's by jurisdiction.

Identification of significant new or emerging threats to, or opportunities for, salmon conservation and management;

Compilation of Tag releases

In **support of the Maine Cooperative Management Strategy Implementation Team**, we anticipate reporting on the following with respect to Atlantic salmon in the Gulf of Maine DPS.

Status of U.S. Populations for the Gulf of Maine DPS at SHRU level including:

- *Adult Returns Estimate (Hatchery and Naturally Reared)*
- *Freshwater Production Summaries – Smolts and pre-smolt production CPUE*
- *Marine Survival – hatchery index Penobscot and naturally-reared Narraguagus*
- *Diversity Metric*
- *Hatchery production*
- *Connectivity*
- *Distribution - occupancy maps and data*

In **support of the USASAC**, we propose the following Terms of Reference:

Need for Accurate and Consistent Reporting on Habitat Connectivity Gains - Update

Cryopreservation Activities of Broodstock Milt – Update

6 List of Attendees, Working Papers, and Glossaries

6.1 List of Attendees

Participants for the 2025 USASAC meeting. Virtual (V) and Not Attending (-)

Last Name	First Name	Email	Agency	Location	3/4	3/5	3/6
Hawkes	Jim	James.Hawkes@noaa.gov	NOAA	Orono, ME	V	V	V
Kocik	John	John.Kocik@noaa.gov	NOAA	Orono, ME	V	V	V
Atkinson	Ernie	Ernie.Atkinson@maine.gov	ME DMR	Jonesboro, ME	V	V	V
Gephard	Steve	sgephard@gmail.com	CTDEEP-retired	Deep River, CT	V	V	V
Sweka	John	John_Sweka@fws.gov	USFWS	Lamar, PA	V	V	V
Sheehan	Tim	Tim.Sheehan@noaa.gov	NOAA	Woods Hole, MA	V	V	V
Haas-Castro	Ruth	Ruth.Haas-Castro@noaa.gov	NOAA	Woods Hole, MA	V	V	V
Kircheis	Dan	Dan.Kircheis@noaa.gov	NOAA	Orono, ME	V	V	V
Valliere	Jason	jason.valliere@maine.gov	ME DMR	Bangor, ME	V	V	V
Noll	Jennifer	Jennifer.B.Noll@maine.gov	ME DMR	Augusta, ME	V	V	V
Bean	David	David.Bean@noaa.gov	NOAA	Orono, ME	V	-	-
Christman	Paul	Paul.Christman@maine.gov	ME DMR	Augusta, ME	V	V	V
Cox	Oliver	Oliver_Cox@fws.gov	USFWS	Ellsworth, ME	V	V	-
Danielle	Frechette	Danielle.Frechette@maine.gov	ME DMR	Augusta, ME	V	V	V
Graham	Goulette	Graham.Goulette@noaa.gov	NOAA	Orono, ME	V	V	V
Stevens	Justin	Justin.Stevens@maine.gov	ME DMR	Augusta, ME	V	V	V
Tierney	Dan	dan.tierney@noaa.gov	NOAA	Orono, ME	V	V	V
O'Regan	Emily	emily.oregan@noaa.gov	NOAA	Orono, ME	V	V	V
Ouellet	Val	vouellet@asf.ca	ASF	Hampden, ME	V	V	-
Saunders	Rory	rory.saunders@noaa.gov	NOAA	Orono, ME	V	V	V
Bruchs	Colby	colby.w.b.bruchs@maine.gov	ME DMR	Jonesboro, ME	V	V	V
Buckley	Denise	denise_buckley@fws.gov	USFWS / CBNFH	East Orland, ME	V	V	-
Nemeth	Maranda	maranda.nemeth@noaa.gov	NOAA	Portland, ME	V	-	-

6.2 List of Program Summaries and Technical Working Papers (doc) and PowerPoint Presentation Reports (ppt)

Number	Author(s)	Title
WP25-01	Atkinson	GOM DPS Summary (ppt)
WP25-02	Gephard	Non-GOM DPS Summary (ppt)
WP25-03	Atkinson	Central New England: Merrimack River and Saco River Outer Bay of Fundy (ppt)
WP25-04	Sheehan	2025 WGNAS ToRs overview for USASAC (ppt)
WP25-05	Sheehan	Summary of U.S. data to WGNAS (ppt)
WP25-06	Tholke et al.	ATS bycatch annual update (ppt & doc)
WP25-07	Bean	Aquaculture activities 2024 (doc)
WP25-08	Haas-Castro et al.	Image analysis update 2024 (ppt & doc)
WP25-09	Bruchs et al.	Update on Maine River Atlantic Salmon Smolt Studies: 2024 (ppt & doc)
WP25-10	Frechette	Salmon for Maine’s Rivers/ Mattaceunk PIT Tag Summaries and Discussion (ppt)
WP25-11	Frechette and Kocik	Gentics Tech Memo - Project Summary (ppt)
WP25-12	Stevens	Evaluation of lifestage specific contributions to restoration stocking efforts (ppt)
WP25-13	Gephard	NASCO stocking guidelines (ppt)
WP25-14	Gephard and Haas-Castro	Scale Archiving Update (ppt & doc)
WP25-15	Atkinson	Occupancy estimate process (ppt)
WP25-16	O'Regan	Atlantic salmon Habitat Model Update (ppt)
WP25-17	St.Croix International Waterway Comm	2024 Anadromous Fish Counts at Woodland Dam

6.3 Past Meeting locations, dates, and USASAC Chair

Location	Meeting Date	Committee Chair	Affiliation
Woods Hole, MA	December 12-16, 1988	Larry Stolte	USFWS
Woods Hole, MA	January 29-February 2, 1990	Jerry Marancik	USFWS
Turners Falls, MA	January 28-February 1, 1991	Jerry Marancik	USFWS
Turners Falls, MA	January 27-31, 1992	Larry Stolte	USFWS
Turners Falls, MA	January 25-29, 1993	Larry Stolte	USFWS
Turners Falls, MA	January 24-28, 1994	Larry Stolte	USFWS
Turners Falls, MA	February 6-9, 1995	Larry Stolte	USFWS
Nashua, NH	March 19, 1996	Larry Stolte	USFWS
Hadley, MA	March 3-5, 1997	Larry Stolte	USFWS
Hadley, MA	March 2-4, 1998	Larry Stolte	USFWS
Gloucester, MA	March 1-4, 1999	Larry Stolte	USFWS
Gloucester, MA	March 6-9, 2000	Jan Rowan	USFWS
Nashua, NH	March 26, 2001	Joseph McKeon	USFWS
Concord, NH	March 5-9, 2002	Joseph McKeon	USFWS
East Orland, ME	February 25-27, 2003	Joseph McKeon	USFWS
Woods Hole, MA	February 23-26, 2004	Joseph McKeon	USFWS
Woods Hole, MA	February 28-March 3, 2005	Joan Trial	MDMR
Gloucester, MA	February 27 - March 2, 2006	Joan Trial	MDMR
Gloucester, MA	March 5-8, 2007	Joan Trial	MDMR
Portland, ME	March 11-13, 2008	John Kocik	NOAA
Portland, ME	March 2-5, 2009	John Kocik	NOAA
Portland, ME	March 1-4, 2010	John Kocik	NOAA
Portland, ME	March 8-10, 2011	John Kocik	NOAA
Turners Falls, MA	March 5-8, 2012	John Kocik	NOAA
Old Lyme, CT	February 25-28, 2013	John Kocik	NOAA
Old Lyme, CT	February 24-27, 2014	Mike Bailey	USFWS
Kittery, ME	February 9-12, 2015	Mike Bailey	USFWS

Location	Meeting Date	Committee Chair	Affiliation
Yarmouth, ME	February 29-March 3, 2016	Mike Bailey	USFWS
Portland, ME	February 13-16, 2017	Ernie Atkinson	MDMR
Portland, ME	February 26-March 2, 2018	Ernie Atkinson	MDMR
Portland, ME	March 4-8, 2019	Ernie Atkinson	MDMR
Portland, ME	March 2-6, 2020	Ernie Atkinson	MDMR
Virtual	March 1-4, 2021	Jim Hawkes	NOAA
Virtual	February 28 - March 2, 2022	Jim Hawkes	NOAA
Portland, ME	February 28 - March 2, 2023	Jim Hawkes	NOAA
Portland, ME	March 5-7, 2024	Jim Hawkes	NOAA
Virtual	March 4-6, 2025	Jim Hawkes	NOAA

6.4 Glossary of Abbreviations

AASF - Adopt-A-Salmon Family
ARH - Arcadia Research Hatchery
BRP - Brookfield Renewable Partners
CNEFRO - Central New England Fisheries Resource Office
CRASA - Connecticut River Atlantic Salmon Association
CTDEP - Connecticut Department of Environmental Protection
CTDEEP - Connecticut Department of Energy and Environmental Protection
CRASC - Connecticut River Atlantic Salmon Commission
CBNFH - Craig Brook National Fish Hatchery
DSI - Decorative Specialties International
DI - Developmental Index
DDENFH - Dwight D. Eisenhower National Fish Hatchery
DPS - Distinct Population Segment
DSRFH - Division of Sea Run Fisheries and Habitat
DSF - Downeast Salmon Federation
DSFWSRC - Downeast Salmon Federation Wild Salmon Resource Center
FERC - Federal Energy Regulatory Commission
GIS - Geographic Information System
GCC - Greenfield Community College
GLNFH - Green Lake National Fish Hatchery
GOM - Gulf of Maine
ICES - International Council for the Exploration of the Sea
ISAV - Infectious Salmon Anemia Virus
KSSH - Kensington State Salmon Hatchery
MAA - Maine Aquaculture Association
MASC - Maine Atlantic Salmon Commission
MDMR - Maine Department of Marine Resources
MDOT - Maine Department of Transportation
MEANG – Maine Air National Guard
MIFW - Maine Inland Fish and Wildlife
MAFW - Massachusetts Division of Fisheries and Wildlife
MAMF - Massachusetts Division of Marine Fisheries
NNFH - Nashua National Fish Hatchery
NAS - National Academy of Sciences
NHD - National Hydrologic Dataset
NOAA - National Oceanic and Atmospheric Administration
NMFS - National Marine Fisheries Service
NEASC - New England Atlantic Salmon Committee
NHFG - New Hampshire Fish and Game Department
NHRRTF - New Hampshire River Restoration Task Force
NASCO - North Atlantic Salmon Conservation Organization
NANFH - North Attleboro National Fish Hatchery
NEFSC - Northeast Fisheries Science Center
NUSCO - Northeast Utilities Service Company
P8 - Parr 8
P20 - Parr 20

P32 - Parr 32
PIT - Passive Integrated Transponder
PGE - PG&E National Energy Group
PGH - Peter Gray Hatchery
PNFH - Pittsford National Fish Hatchery
PPT - Power Point, Microsoft
PSNH - Public Service of New Hampshire
RIFW - Rhode Island Division of Fish and Wildlife
RCNSS - Richard Cronin National Salmon Station
RRSFH - Roger Reed State Fish Hatchery
RFCS - Roxbury Fish Culture Station
2SW - Two sea winter adult salmon
3SW - Three sea winter adult salmon
4SW - Four sea winter adult salmon
SCIWC - St. Croix International Waterway Commission
SHRU – Salmon Habitat Recovery Unit
SSSV - Salmon Swimbladder Sarcoma Virus
SOCNFW - Silvio O. Conte National Fish and Wildlife Refuge
SNHHDC - Southern New Hampshire Hydroelectric Development Corp
SOFA - Sunderland Office of Fishery Assistance
TNC - The Nature Conservancy
UMASS - University of Massachusetts / Amherst
USACOE - U.S. Army Corps of Engineers
USASAC - U.S. Atlantic Salmon Assessment Committee
USGen - U.S. Generating Company
USGS - U.S. Geological Survey
USFWS - U.S. Fish and Wildlife Service
USFS - U.S. Forest Service
VTFW - Vermont Fish and Wildlife
WSFH - Warren State Fishery Hatchery
WRNFH - White River National Fish Hatchery
WSS - Whittemore Salmon Station

6.5 Glossary of Definitions

Term	Definition
Conservation Limit	Management target defined as the number of spawners to achieve long-term average maximum sustainable yield
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.
Escapement (Natural)	Natural escapement is calculated using the equation = Returns - broodstock take - known mortalities.
Escapement (Total)	Total Escapement is calculated using the equation = Natural escapement + pre-spawn Stocking
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.

Term	Definition
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.
Pre-spawn Stocking	Domestic fish released prior to spawning season AND Sea Run fish that were taken to the hatchery, not used as broodstock, and released prior to spawning season.
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.
Salmon Habitat Recovery Units	The critical habitat rule divided the DPS range into three recovery units, termed Salmon Habitat Recovery Units, or SHRUs: (1) The Merrymeeting Bay SHRU, which covers the Androscoggin and Kennebec basins, and extends east to include the Sheepscot, Pemaquid, Medomak, and St. George watersheds; (2) the Penobscot Bay SHRU, which covers the entire Penobscot basin and extends west to and includes the Ducktrap watershed; and (3) the Downeast SHRU, including all coastal watersheds from the Union River east to the Dennys River. Federal Register, 117, 29300–29341. Retrieved from https://federalregister.gov/a/E9-14268
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.
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.

Term	Definition
Fed Fry	Fry that have been 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 with the appearance of “parr marks” on each side of the juvenile Atlantic salmon, until the commencement of migration to the sea as smolts.
Age 0 Parr	Life stage occurring during the period from when “parr marks” appear, often referring to fish that are stocked from a hatchery during this time. The two most common parr hatchery products are (1) accelerated parr and (2) ambient parr (see definitions below).
Accelerated Parr	Parr reared as part of a 1-year smolt program that incubates eggs and fry utilizing heated water.
Ambient Parr	Parr reared under ambient hatchery water conditions that does not involve utilizing heated water to advance egg and fry development.
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	(P8) A parr stocked at age 0 that migrates as 1 Smolt (8 months spent in freshwater).
Parr 20	(P20) A parr stocked at age 0 that migrates as 2 Smolt (20 months spent in freshwater).
Parr 32	(P32) A parr stocked at age 0 that migrates at 3 Smolt (32 months spent in freshwater).
Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
Wild Smolt	A wild smolt is an Atlantic salmon which is the product of natural spawning, emerged from a redd and was reared in the river prior to emigrating to the ocean.
Hatchery Smolt	A hatchery smolt is a product of hatchery spawning which has spent nine months (or more) of its life within a hatchery prior to stocking. These

Term	Definition
	include fall parr origin (i.e. fingerlings, parr 8, parr 20, or parr 32), Age 1 and Age 2 smolts. This definition was modified by the 2019 Status Review. See Naturally Reared Smolt below.***
Naturally Reared Smolt	A naturally reared smolt is the product of wild spawning, Age 0 parr stocking, egg planting, or fry stocking. Currently (March 2020), it is not reasonable to differentiate between wild smolt and a smolt the product of egg planting or fry stocking. Databases prior to 2021 will not include parr stocked fish as naturally-reared.***
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	Hatchery fish released in the period from two years after hatch. Prior to 2000, this stage was a common hatchery product of between 15 and 25 cm and intended to be a functional migratory smolt. Starting in 2009, this age category represents a larger life stage (30 - 50 cm) released for hatchery operational purposes, not as a targeted tool to create sea-run returns.
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	(2SW) A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	(3SW) A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	(4SW) A salmon that survives past December 31 four 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.

Term	Definition
Repeat Spawner	A salmon that returns numerous times to the river for the purpose of reproducing. Previous spawner.

Appendix 1. Juvenile Atlantic salmon stocking summary for New England in 2024.

United States

Number of fish stocked by lifestage

River	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	0	391,000	0	0	0	100	0	391,100
Total for Connecticut Program								**391,100**
Androscoggin	0	7,000	0	0	0	200	0	7,200
Dennys	0	228,000	0	0	0	0	0	228,000
East Machias	0	269,000	0	0	0	0	0	269,000
Kennebec	486,000	3,000	0	0	0	86,700	0	575,700
Machias	0	264,000	0	0	0	0	0	264,000
Narraguagus	0	306,000	0	0	0	0	0	306,000
Penobscot	197,000	370,000	185,600	0	0	631,200	0	1,383,800
Pleasant	100,000	208,000	0	0	0	0	0	308,000
Sheepscot	110,000	104,000	15,800	0	0	0	0	229,800
Union	0	1,000	0	0	0	0	0	1,000
Total for Maine Program								**3,572,500**
Total for United States								**3,963,600**
Grand Total								**3,963,600**

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

*2 Smolt: Hatchery fish released in the period from two years after hatch. Prior to 2000, this stage was a common hatchery product of between 15 and 25 cm and intended to be a functional migratory smolt. Starting in 2009, this age category represents a larger life stage (30 - 50 cm) released for hatchery operational purposes, not as a targeted tool to create searun returns.

Appendix 2. Number of adult Atlantic salmon stocked in New England rivers in 2024.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	486	0	0	486
East Machias	Restoration	0	138	0	0	138
Kennebec	Restoration	196	0	0	0	196
Machias	Restoration	0	430	0	0	430
Narraguagus	Restoration	0	160	0	0	160
Penobscot	Restoration	286	391	2	583	1,262
Pleasant	Restoration	0	425	0	0	425
Saco	Restoration	0	71	0	0	71
Sheepscot	Restoration	0	144	0	0	144
Total		482	2,245	2	583	3,312

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 3.1. Atlantic salmon marking database for New England; marked fish released in 2024 .

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
Gomez & Sulliv	1	1_Smolt	H	Androscoggin	RAD	201		May	Androscoggin
Normandeau	1	1_Smolt	H	Penobscot	RAD	25		Apr	Penobscot
Normandeau	1	1_Smolt	H	Penobscot	RAD	153		May	Penobscot
USFWS	1	1_Smolt	H	Penobscot	AD	111,832		Apr	Penobscot
MEDMR		Adult	W	Androscoggin	UCP	15		Jun	Androscoggin
USFWS	3	Adult	H	Dennys	PIT	72	DUCP	Dec	Dennys
USFWS	4	Adult	H	Dennys	PIT	72	DUCP	Dec	Dennys
USFWS	3	Adult	H	East Machias	PIT	91	DUCP	Dec	East Machias
USFWS	4	Adult	H	East Machias	PIT	69	DUCP	Dec	East Machias
MEDMR		Adult	W	Kennebec	AP	50		Jun	Kennebec
MEDMR		Adult	W	Kennebec	AP	1	UCP	Jun	Kennebec
USFWS	4	Adult	H	Kennebec	PIT	196	DAP	Nov	Kennebec
USFWS	4	Adult	H	Machias	PIT	81	DUCP	Dec	Machias
USFWS	3	Adult	H	Machias	PIT	85	DUCP	Dec	Machias
MEDMR		Adult	W	Narraguagus	AP	4		Jun	Narraguagus
MEDMR		Adult	W	Narraguagus	AD	1	UCP	Jun	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	63	DUCP	Dec	Narraguagus
USFWS	3	Adult	H	Narraguagus	PIT	75	DUCP	Dec	Narraguagus
MEDMR		Adult	W	Penobscot	RAD	29	PING, PI	Jun	Penobscot
MEDMR		Adult	W	Penobscot	PIT	184	AP	Jun	Penobscot
MEDMR		Adult	W	Penobscot	RAD	4	PING, PI	Jun	Penobscot
MEDMR		Adult	W	Penobscot	PIT	55	AD, UCP	Jun	Penobscot
USFWS	3	Adult	H	Penobscot	PIT	260	DAP	Dec	Penobscot
USFWS		Adult	W	Penobscot	FLOY	2	AP, PIT	Jul	Penobscot
USFWS	6	Adult	H	Penobscot	PIT	20	DAP	Dec	Penobscot

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	4	Adult	H	Penobscot	PIT	111	DAP	Dec	Penobscot
USFWS	4	Adult	H	Penobscot	PIT	286	DAP	Nov	Penobscot
USFWS	3	Adult	H	Pleasant	PIT	68	DUCP	Dec	Pleasant
USFWS	4	Adult	H	Pleasant	PIT	68	DUCP	Dec	Pleasant
MEDMR		Adult	W	Saco	AP	1		Jun	Saco
USFWS	3	Adult	H	Sheepscot	PIT	83	DUCP	Dec	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	63	DUCP	Dec	Sheepscot
MEDMR		Adult	W	Union	FLOY	1	AP	Jun	Union

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; DAP = Double adipose punch; PUNCH = Double adipose or upper caudal punch

Appendix 3.2. Grand Summary of Atlantic Salmon marking data for New England; marked fish released in 2024.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	1,763	0	1,763
Hatchery Juvenile	111,832	111,832	112,211
Wild Adult	259	1	347
Total			**114,321**

Appendix 4. Estimates of Atlantic salmon returns to New England in 2024 from trap counts and redd surveys. (N.R. represents naturally reared origin.)

	Assessment Method	1SW Hatchery	1SW N.R.	2SW Hatchery	2SW N.R.	3SW Hatchery	3SW N.R.	Repeat Hatchery	Repeat N.R.	Total	2020-2024 Average
Androscoggin	Trap	11	1	3	1	1	0	0	0	**17**	10
Connecticut	Trap	0	0	0	0	0	0	0	0	**0**	2
Cove Brook	Redd Est	0	0	0	0	0	0	0	0	**0**	0
Dennys	Redd Est	0	3	0	12	0	0	0	0	**15**	8
Ducktrap	Redd Est	0	1	0	2	0	0	0	0	**3**	3
East Machias	Redd Est	0	0	0	0	0	0	0	0	**0**	15
Great Works Stream	Redd Est	1	0	0	2	0	0	0	0	**3**	2
Kenduskeag Stream	Redd Est	0	0	0	0	0	0	0	0	**0**	5
Kennebec	Trap	15	1	22	10	2	3	0	0	**53**	76
Machias	Redd Est	0	3	0	11	0	0	0	0	**14**	16
Merrimack	Trap	0	0	2	0	0	0	0	0	**2**	4
Narraguagus	Redd Est	2	1	0	9	0	0	0	0	**12**	37
Penobscot	Trap	316	18	978	40	19	2	5	0	**1,378**	1,254
Pleasant	Redd Est	0	1	0	4	0	0	0	0	**5**	13
Saco	Trap	0	0	0	1	0	0	0	0	**1**	3
Sheepscot	Redd Est	2	1	6	7	0	0	0	0	**16**	12
Souadabscook Stream	Redd Est	0	0	0	0	0	0	0	0	**0**	0
Union	Trap	0	0	1	0	0	0	0	0	**1**	1
Total		**347**	**30**	**1,012**	**99**	**22**	**5**	**5**	**0**	**1,520**	**1,461**

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

Appendix 5. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2024.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	127	625,000
Penobscot	Domestic	308	494,000
Dennys	Captive	86	280,000
East Machias	Captive	79	249,000
Machias	Captive	70	222,000
Narraguagus	Captive	93	323,000
Pleasant	Captive	85	266,000
Sheepscot	Captive	74	190,000
Total	**Captive/Domestic**	**922**	**2,649,000**
Penobscot	Sea Run	298	2,212,000
Total	**Sea Run**	**298**	**2,212,000**
Grand Total for Year	**2024**	**1,220**	**4,861,000**

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

Appendix 6. 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															
1993-2014	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															
1977-2014	2,071	21,264,000	7,600	33,662	208,351,000	6,000	0	0		2,395	28,935,000	9,900	38,128	258,550,000	6,400
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
2017	0	0		96	590,000	6,100	0	0		0	0		96	590,000	6,100
2018	0	0		128	738,000	5,800	0	0		0	0		128	738,000	5,800
2019	0	0		128	719,000	5,600	0	0		0	0		128	719,000	5,600
2020	0	0		116	630,000	5,400	0	0		0	0		116	630,000	5,400
2021	0	0		123	651,000	5,300	0	0		0	0		123	651,000	5,300
2022	0	0		118	656,000	5,600	0	0		0	0		118	656,000	5,600
2023	0	0		126	742,000	5,900	0	0		0	0		126	742,000	5,900
2024	0	0		127	625,000	4,900	0	0		0	0		127	625,000	4,900
Total Connecticut	2,071	21,264,000	7,600	34,754	214,771,000	6,100	0	0		2,395	28,935,000	9,900	39,220	264,970,000	6,100
Dennys															
1939-2014	26	214,000	7,600	125	687,000	4,600	1,410	5,937,000	4,200	40	330,000	7,700	1,601	7,168,000	4,800
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
2017	0	0		87	392,000	4,500	95	328,000	3,500	0	0		182	721,000	4,000
2018	0	0		0	0		95	285,000	3,000	0	0		95	285,000	3,000

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
2019	0	0		0	0		109	353,000	3,200	0	0		109	353,000	3,200
2020	0	0		0	0		100	429,000	4,300	0	0		100	429,000	4,300
2021	0	0		0	0		90	380,000	4,200	0	0		90	380,000	4,200
2022	0	0		0	0		85	277,000	3,300	0	0		85	277,000	3,300
2023	0	0		0	0		69	283,000	4,100	0	0		69	283,000	4,100
2024	0	0		0	0		86	280,000	3,300	0	0		86	280,000	3,300
Total Dennys	26	214,000	7,600	212	1,079,000	4,600	2,244	9,154,000	4,045	40	330,000	7,700	2,522	10,778,000	4,100
East Machias															
1995-2014	0	0		0	0		1,565	6,413,000	4,100	0	0		1,565	6,413,000	4,100
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
2017	0	0		0	0		92	383,000	4,200	0	0		92	383,000	4,200
2018	0	0		0	0		132	421,000	3,200	0	0		132	421,000	3,200
2019	0	0		0	0		108	344,000	3,200	0	0		108	344,000	3,200
2020	0	0		0	0		137	653,000	4,800	0	0		137	653,000	4,800
2021	0	0		0	0		119	500,000	4,200	0	0		119	500,000	4,200
2022	0	0		0	0		79	318,000	4,000	0	0		79	318,000	4,000
2023	0	0		0	0		119	454,000	3,800	0	0		119	454,000	3,800
2024	0	0		0	0		79	249,000	3,100	0	0		79	249,000	3,100
Total East Machias	0	0		0	0	0	2,653	10,676,000	3,918	0	0		2,653	10,676,000	3,900
Kennebec															
1979-2014	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Total Kennebec	5	50,000	10,000	0	0	0	0	0		0	0		5	50,000	10,000
Lamprey															

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
1992-2014	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															
1941-2014	456	3,263,000	7,300	0	0		2,764	11,319,000	4,100	8	52,000	6,400	3,228	14,634,000	5,600
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
2017	0	0		0	0		122	525,000	4,300	0	0		122	525,000	4,300
2018	0	0		0	0		92	394,000	4,300	0	0		92	394,000	4,300
2019	0	0		0	0		127	405,000	3,200	0	0		127	405,000	3,200
2020	0	0		0	0		106	439,000	4,100	0	0		106	439,000	4,100
2021	0	0		0	0		91	371,000	4,100	0	0		91	371,000	4,100
2022	0	0		0	0		87	321,000	3,700	0	0		87	321,000	3,700
2023	0	0		0	0		81	335,000	4,100	0	0		81	335,000	4,100
2024	0	0		0	0		70	222,000	3,200	0	0		70	222,000	3,200
Total Machias	456	3,263,000	7,300	0	0	0	3,762	14,850,000	3,618	8	52,000	6,400	4,226	18,165,000	3,800
Merrimack															
1983-2014	1,582	12,306,000	7,900	11,980	59,105,000	4,500	0	0		540	5,709,000	10,800	14,102	77,121,000	5,800
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
2017	0	0		307	946,000	3,100	0	0		0	0		307	946,000	3,100
2018	0	0		264	1,023,000	3,900	0	0		0	0		264	1,023,000	3,900
2019	0	0		21	56,000	2,600	0	0		0	0		21	56,000	2,600
Total Merrimack	1,582	12,306,000	7,900	13,169	62,837,000	3,300	0	0		540	5,709,000	10,800	15,291	80,853,000	3,600
Narraguagus															

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
1962-2014	0	1,303,000		0	0		2,851	11,215,000	3,900	0	0		2,851	12,518,000	3,900
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
2017	0	0		0	0		134	501,000	3,700	0	0		134	501,000	3,700
2018	0	0		0	0		102	401,000	3,900	0	0		102	401,000	3,900
2019	0	0		0	0		81	314,000	3,900	0	0		81	314,000	3,900
2020	0	0		0	0		140	591,000	4,200	0	0		140	591,000	4,200
2021	0	0		0	0		89	366,000	4,100	0	0		89	366,000	4,100
2022	0	0		0	0		63	206,000	3,300	0	0		63	206,000	3,300
2023	0	0		0	0		113	539,000	4,800	0	0		113	539,000	4,800
2024	0	0		0	0		93	323,000	3,500	0	0		93	323,000	3,500
Total Narraguagus	0	1,303,000		0	0	0	3,902	15,296,000	3,855	0	0		3,902	16,599,000	3,900
Orland															
1967-2014	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															
1992-2014	20	157,000	7,700	556	8,000	700	0	0		13	76,000	5,400	589	241,000	6,000
2022	0	0		1	7,000	6,600	0	0		0	0		1	7,000	6,600
Total Pawcatuck	20	157,000	7,700	557	15,000	3,600	0	0		13	76,000	5,400	590	248,000	6,300
Penobscot															
1871-2014	20,935	178,707,000	7,900	9,741	28,290,000	3,000	329	1,400,000	4,300	0	0		31,005	208,398,000	7,200
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
2017	310	2,289,000	7,400	581	1,760,000	3,000	0	0		0	0		891	4,048,000	4,500

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
2018	249	1,882,000	7,600	762	2,129,000	2,800	0	0		0	0		1,011	4,011,000	4,000
2019	280	1,572,000	5,600	647	1,726,000	2,700	0	0		0	0		927	3,298,000	3,600
2020	122	927,000	7,600	704	1,898,000	2,700	0	0		0	0		826	2,825,000	3,400
2021	77	489,000	6,300	622	1,657,000	2,700	0	0		0	0		699	2,146,000	3,100
2022	320	2,072,000	6,500	597	1,026,000	1,700	0	0		0	0		917	3,098,000	3,400
2023	252	1,503,000	6,000	482	1,261,000	2,600	0	0		0	0		734	2,764,000	3,800
2024	298	2,212,000	7,400	308	494,000	1,600	0	0		0	0		606	2,706,000	4,500
Total Penobscot	23,325	195,178,000	7,000	15,460	42,551,000	2,500	329	1,400,000	4,300	0	0		39,114	239,129,000	4,100
Pleasant															
2001-2014	0	0		123	468,000	5,900	642	2,420,000	4,300	0	0		765	2,889,000	4,500
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
2017	0	0		0	0		83	346,000	4,200	0	0		83	346,000	4,200
2018	0	0		0	0		91	277,000	3,000	0	0		91	277,000	3,000
2019	0	0		0	0		87	288,000	3,300	0	0		87	288,000	3,300
2020	0	0		0	0		91	422,000	4,600	0	0		91	422,000	4,600
2021	0	0		0	0		96	388,000	4,000	0	0		96	388,000	4,000
2022	0	0		0	0		77	238,000	3,100	0	0		77	238,000	3,100
2023	0	0		0	0		93	405,000	4,400	0	0		93	405,000	4,400
2024	0	0		0	0		85	266,000	3,100	0	0		85	266,000	3,100
Total Pleasant	0	0		123	468,000	5,900	1,461	5,499,000	3,800	0	0		1,584	5,968,000	3,800
Sheepscot															
1995-2014	18	125,000	6,900	0	0		1,427	5,409,000	3,700	45	438,000	9,900	1,490	5,973,000	4,000
2015	0	0		0	0		85	317,000	3,700	0	0		85	317,000	3,700

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
2016	0	0		0	0		133	109,000	800	0	0		133	109,000	800
2017	0	0		0	0		81	334,000	4,100	0	0		81	334,000	4,100
2018	0	0		0	0		84	271,000	3,200	0	0		84	271,000	3,200
2019	0	0		0	0		80	278,000	3,500	0	0		80	278,000	3,500
2020	0	0		0	0		106	417,000	3,900	0	0		106	417,000	3,900
2021	0	0		0	0		104	464,000	4,500	0	0		104	464,000	4,500
2022	0	0		0	0		64	219,000	3,400	0	0		64	219,000	3,400
2023	0	0		0	0		88	289,000	3,300	0	0		88	289,000	3,300
2024	0	0		0	0		74	190,000	2,600	0	0		74	190,000	2,600
Total Sheepscot	18	125,000	6,900	0	0	0	2,326	8,297,000	3,336	45	438,000	9,900	2,389	8,861,000	3,400
St Croix															
1993-2014	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															
1974-2014	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
Total Union	600	4,611,000	7,900	0	0	0	0	0		0	0		600	4,611,000	7,900

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

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

Note: Connecticut data are preliminary prior to 1990.

Appendix 7. 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	7,600	34,754	214,771,000	6,100	0	0		2,395	28,935,000	9,900	39,220	264,970,000	6,100
Dennys	26	214,000	7,600	212	1,080,000	4,600	2,244	9,154,000	4,000	40	330,000	7,700	2,522	10,778,000	4,100
East Machias	0	0		0	0		2,653	10,676,000	3,900	0	0		2,653	10,676,000	3,900
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		3,762	14,850,000	3,600	8	52,000	6,400	4,226	18,165,000	3,800
Merrimack	1,582	12,306,000	7,900	13,169	62,837,000	3,300	0	0		540	5,709,000	10,800	15,291	80,852,000	3,600
Narraguagus	0	1,303,000		0	0		3,902	15,295,000	3,900	0	0		3,902	16,598,000	3,900
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	20	157,000	7,700	557	15,000	3,700	0	0		13	76,000	5,400	590	248,000	6,300
Penobscot	23,325	195,178,000	7,000	15,460	42,549,000	2,500	329	1,400,000	4,300	0	0		39,114	239,127,000	4,100
Pleasant	0	0		123	468,000	5,900	1,461	5,499,000	3,800	0	0		1,584	5,967,000	3,800
Sheepscot	18	125,000	6,900	0	0		2,326	8,296,000	3,300	45	438,000	9,900	2,389	8,860,000	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	**28,190**	**239,085,000**	**8,500**	**64,275**	**321,720,000**	**5,000**	**16,677**	**65,170,000**	**3,900**	**3,041**	**35,540,000**	**11,700**	**112,183**	**661,516,000**	**5,900**

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 8. 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								
2001-2014	0	16,000	0	0	0	500	0	16,500
2015	0	2,000	0	0	0	0	0	2,000
2016	0	2,000	0	0	0	0	0	2,000
2020	0	2,000	0	0	0	0	0	2,000
2021	0	1,000	0	0	0	0	0	1,000
2022	0	4,000	0	0	0	0	0	4,000
2023	0	6,000	0	0	0	0	0	6,000
2024	0	7,000	0	0	0	200	0	7,200
Totals:Androscoggin	**0**	**40,000**	**0**	**0**	**0**	**700**	**0**	**40,700**
Aroostook								
1978-2014	0	6,900,000	317,400	38,600	0	32,600	29,800	7,318,400
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								
1988-2014	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								
1967-2014	0	148,725,000	2,849,700	1,836,700	64,700	3,771,900	1,828,100	159,076,100
2015	0	391,000	0	0	0	0	0	391,000
2016	0	64,000	0	0	0	0	0	64,000
2017	0	194,000	0	0	0	0	0	194,000
2018	0	197,000	8,500	0	0	0	0	205,500
2019	0	336,000	0	0	0	0	0	336,000
2020	0	222,000	0	1,000	0	0	0	223,000
2021	0	34,000	0	0	0	0	0	34,000
2022	0	304,000	0	0	0	0	0	304,000
2023	0	335,000	0	0	0	300	0	335,300
2024	0	391,000	0	0	0	100	0	391,100
Totals:Connecticut	**0**	**151,193,000**	**2,858,200**	**1,837,700**	**64,700**	**3,772,300**	**1,828,100**	**161,554,000**
Dennys								
1975-2014	0	4,048,000	225,400	7,300	0	532,700	30,000	4,843,400
2015	0	110,000	0	0	0	0	0	110,000
2016	0	343,000	0	0	0	0	0	343,000
2017	0	126,000	0	0	0	0	0	126,000
2018	0	234,000	0	300	0	0	400	234,700
2019	0	175,000	10,000	0	0	0	0	185,000
2020	40000	149,000	0	0	0	0	0	189,000
2021	43000	313,000	0	0	0	0	0	356,000
2022	0	262,000	0	0	0	0	0	262,000
2023	0	204,000	0	0	0	0	0	204,000

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2024	0	228,000	0	0	0	0	0	228,000
Totals:Dennys	**83,000**	**6,192,000**	**235,400**	**7,600**	**0**	**532,700**	**30,400**	**7,081,100**
Ducktrap								
1986-2014	0	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**0**	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias								
1973-2014	0	3,753,000	288,100	42,600	0	108,400	30,400	4,222,500
2015	0	11,000	192,000	0	0	0	0	203,000
2016	0	12,000	199,700	0	0	0	0	211,700
2017	0	10,000	211,600	0	0	0	0	221,600
2018	0	10,000	119,500	0	0	0	0	129,500
2019	0	0	226,000	0	0	0	0	226,000
2020	0	0	68,000	0	0	0	0	68,000
2021	0	19,000	171,600	0	0	0	0	190,600
2022	0	19,000	164,700	0	0	0	0	183,700
2023	0	18,000	0	0	0	0	0	18,000
2024	0	269,000	0	0	0	0	0	269,000
Totals:East Machias	**0**	**4,121,000**	**1,641,200**	**42,600**	**0**	**108,400**	**30,400**	**5,943,600**
Kennebec								
2001-2014	4615000	326,000	0	0	0	800	0	4,941,665
2015	275000	2,000	0	0	0	0	0	276,587
2016	619000	3,000	0	0	0	0	0	622,364
2017	447000	0	0	0	0	0	0	447,106
2018	1228000	0	0	0	0	0	0	1,227,673
2019	918000	0	0	0	0	0	0	917,614
2020	679000	3,000	0	0	0	88,800	0	770,400
2021	759000	2,000	0	0	0	100,100	0	861,390
2022	438000	3,000	0	0	0	97,500	0	538,593
2023	654000	3,000	0	0	0	98,800	0	755,476
2024	486000	3,000	0	0	0	86,700	0	575,785
Totals:Kennebec	**11,118,000**	**345,000**	**0**	**0**	**0**	**472,700**	**0**	**11,934,653**
Lamprey								
1978-2014	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**
Machias								
1970-2014	27000	6,780,000	100,500	125,700	0	250,400	44,100	7,327,687
2015	49000	503,000	500	0	0	0	0	552,732
2016	40000	186,000	0	0	0	0	0	226,348
2017	61000	187,000	0	0	0	0	0	247,800
2018	84000	145,000	0	0	0	0	0	229,500
2019	91000	183,000	0	0	0	0	100	274,100
2020	102000	181,000	16,000	0	0	0	0	299,000
2021	40000	290,000	17,200	0	0	0	0	347,200

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
	Number of fish stocked by life stage							
2022	0	221,000	15,600	0	0	900	0	237,500
2023	0	212,000	0	0	0	0	0	212,000
2024	0	264,000	0	0	0	0	0	264,000
Totals:Machias	**494,000**	**9,152,000**	**149,800**	**125,700**	**0**	**251,300**	**44,200**	**10,217,867**
Merrimack								
1975-2014	0	41,787,000	431,800	658,200	0	1,981,500	638,100	45,496,600
2015	0	4,000	0	0	0	0	0	4,000
2016	0	4,000	0	0	0	0	100	4,100
2017	0	2,000	0	0	0	0	0	2,000
Totals:Merrimack	**0**	**41,797,000**	**431,800**	**658,200**	**0**	**1,981,500**	**638,200**	**45,506,700**
Narraguagus								
1970-2014	79000	7,183,000	117,100	14,600	0	400,200	84,000	7,878,045
2015	0	165,000	0	0	0	0	0	165,000
2016	0	219,000	0	0	0	97,100	0	316,100
2017	0	170,000	31,100	0	0	99,000	0	300,100
2018	0	100,000	21,700	400	0	99,900	600	222,600
2019	66000	179,000	0	0	0	95,500	100	340,600
2020	66000	164,000	0	0	0	0	0	230,000
2021	283000	280,000	112,800	0	0	0	0	675,672
2022	0	72,000	89,700	0	0	0	0	161,700
2023	0	16,000	0	0	0	0	0	16,000
2024	0	306,000	0	0	0	0	0	306,000
Totals:Narraguagus	**494,000**	**8,854,000**	**372,400**	**15,000**	**0**	**791,700**	**84,700**	**10,611,817**
Pawcatuck								
1979-2014	0	6,301,000	1,209,200	268,100	0	127,500	500	7,906,300
2015	0	7,000	0	0	0	0	0	7,000
2016	0	7,000	0	0	0	1,200	0	8,200
2017	0	4,000	0	0	0	0	0	4,000
2019	0	16,000	0	0	0	0	0	16,000
2021	0	3,000	0	0	0	0	0	3,000
2022	0	5,000	0	0	0	0	0	5,000
2023	0	7,000	0	0	0	0	0	7,000
Totals:Pawcatuck	**0**	**6,350,000**	**1,209,200**	**268,100**	**0**	**128,700**	**500**	**7,956,500**
Penobscot								
1970-2014	675000	27,593,000	6,684,800	1,394,400	0	18,283,500	2,508,200	57,138,532
2015	89000	518,000	257,800	0	0	375,600	0	1,240,580
2016	473000	1,025,000	263,200	0	0	569,300	0	2,330,673
2017	575000	409,000	253,300	0	0	569,700	0	1,806,821
2018	397000	1,143,000	219,900	0	0	559,100	0	2,319,033
2019	491000	631,000	92,900	0	0	554,700	0	1,769,263
2020	498000	614,000	70,000	0	0	648,000	0	1,830,000
2021	306000	242,000	112,200	0	0	620,400	0	1,280,847
2022	438000	213,000	11,400	0	0	648,300	1,000	1,311,793
2023	360000	754,000	40,100	0	0	642,800	0	1,797,341

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2024	197000	370,000	185,600	0	0	631,200	0	1,383,829
Totals:Penobscot	**4,499,000**	**33,512,000**	**8,191,200**	**1,394,400**	**0**	**24,102,600**	**2,509,200**	**74,208,712**

Pleasant

1975-2014	46000	1,692,000	16,000	1,800	0	246,900	42,400	2,044,600
2015	0	183,000	0	0	0	0	0	183,000
2016	63000	53,000	0	0	0	0	0	115,700
2017	80000	55,000	0	0	0	0	0	135,010
2018	106000	84,000	0	0	0	0	0	189,503
2019	88000	132,000	0	0	0	0	0	220,000
2020	85000	89,000	0	0	0	0	0	174,000
2021	178000	165,000	0	0	0	0	0	343,248
2022	0	326,000	0	0	0	0	0	326,000
2023	0	109,000	0	0	0	0	0	109,000
2024	100000	208,000	0	0	0	0	0	308,000
Totals:Pleasant	**746,000**	**3,096,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**4,148,061**

Saco

1975-2014	0	7,812,000	489,900	232,000	0	420,400	9,500	8,963,800
2015	0	702,000	25,000	0	0	11,700	0	738,700
2016	35000	371,000	4,000	0	0	12,000	0	421,818
2017	53000	119,000	0	0	0	0	0	172,000
2018	70000	356,000	0	0	0	0	0	426,300
2019	84000	164,000	0	0	0	0	0	248,192
2020	24000	0	0	0	0	0	0	24,000
2021	9000	0	0	0	0	0	0	8,600
2022	2000	2,000	0	0	0	0	0	4,000
2023	2000	0	0	0	0	0	0	2,100
Totals:Saco	**279,000**	**9,526,000**	**518,900**	**232,000**	**0**	**444,100**	**9,500**	**11,009,510**

Sheepscot

1971-2014	337000	3,345,000	238,000	20,600	0	92,200	7,100	4,040,213
2015	118000	19,000	14,200	0	0	0	0	150,868
2016	209000	20,000	15,400	0	0	0	0	244,170
2017	371000	18,000	15,400	0	0	0	0	404,829
2018	131000	23,000	13,100	0	0	0	0	167,130
2019	215000	9,000	17,000	0	0	0	0	241,000
2020	163000	28,000	0	0	0	0	0	191,000
2021	264000	28,000	19,300	0	0	0	0	311,300
2022	265000	19,000	13,600	0	0	0	0	297,564
2023	79000	67,000	15,500	0	0	0	0	161,748
2024	110000	104,000	15,800	0	0	0	0	229,800
Totals:Sheepscot	**2,262,000**	**3,680,000**	**377,300**	**20,600**	**0**	**92,200**	**7,100**	**6,439,622**

St Croix

1981-2014	0	1,268,000	498,000	158,300	0	808,000	20,100	2,752,400
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**

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Union								
1971-2014	0	578,000	371,400	0	0	379,700	251,000	1,580,100
2015	0	25,000	0	0	0	0	0	25,000
2016	0	26,000	0	0	0	0	0	26,000
2017	0	25,000	0	0	0	200	0	25,200
2019	0	2,000	0	0	0	0	0	2,000
2020	0	2,000	0	0	0	0	0	2,000
2021	0	1,000	0	0	0	0	0	1,000
2022	0	1,000	0	0	0	0	0	1,000
2023	0	1,000	0	0	0	0	0	1,000
2024	0	1,000	0	0	0	0	0	1,000
Totals:Union	**0**	**662,000**	**371,400**	**0**	**0**	**379,900**	**251,000**	**1,664,300**
Upper StJohn								
1979-2014	0	2,165,000	1,456,700	14,700	0	5,100	27,700	3,669,200
Totals:Upper StJohn	**0**	**2,165,000**	**1,456,700**	**14,700**	**0**	**5,100**	**27,700**	**3,669,200**

Appendix 9. 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	38,000	0	0	0	700	0	**39,000**
Aroostook	0	6,901,000	317,400	38,600	0	32,600	29,800	**7,319,700**
Cocheco	0	1,958,000	50,000	10,500	0	5,300	0	**2,024,200**
Connecticut	0	151,192,000	2,858,200	1,837,700	64,800	3,772,300	1,828,200	**161,488,100**
Dennys	83,000	6,193,000	235,400	7,600	0	532,800	30,400	**7,082,500**
Ducktrap	0	68,000	0	0	0	0	0	**68,000**
East Machias	0	4,120,000	1,641,200	42,600	0	108,400	30,400	**5,942,400**
Kennebec	11,117,000	345,000	0	0	0	472,600	0	**11,934,400**
Lamprey	0	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	495,000	9,153,000	149,700	125,600	0	251,400	44,200	**10,218,400**
Merrimack	0	41,797,000	431,700	658,100	0	1,981,400	638,300	**45,506,500**
Narraguagus	494,000	8,855,000	372,400	15,000	0	791,900	84,700	**10,613,000**
Pawcatuck	0	6,349,000	1,209,200	268,100	0	128,700	500	**7,955,700**
Penobscot	4,499,000	33,510,000	8,191,300	1,394,400	0	24,102,700	2,509,200	**74,207,300**
Pleasant	745,000	3,096,000	16,000	1,800	0	247,000	42,400	**4,148,600**
Saco	279,000	9,526,000	518,800	232,000	0	444,000	9,500	**11,009,100**
Sheepscot	2,262,000	3,681,000	377,300	20,600	0	92,200	7,100	**6,440,400**
St Croix	0	1,270,000	498,000	158,300	0	808,000	20,100	**2,754,200**
Union	0	662,000	371,400	0	0	379,900	251,000	**1,663,800**
Upper StJohn	0	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**19,975,000**	**292,472,000**	**19,122,400**	**4,884,400**	**64,800**	**34,358,400**	**5,586,200**	**376,398,300**

Summaries for each river vary by length of time series.

Appendix 10. Estimatated Atlantic salmon returns to New England rivers.

Estimated returns include rod and trap caught fish as well as returns estimated from redd counts. 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 naturally reared origin include adults produced from natural reproduction, egg planting, and fry releases.

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin									
1983-2014	57	602	6	2	10	108	0	1	**786**
2015	0	0	0	0	0	1	0	0	**1**
2016	0	0	0	0	0	6	0	0	**6**
2017	0	0	0	0	0	0	0	0	**0**
2018	0	0	0	0	0	1	0	0	**1**
2019	0	1	0	0	0	0	0	0	**1**
2020	0	3	0	0	0	2	0	0	**5**
2021	4	0	0	0	0	1	0	0	**5**
2022	8	9	0	0	0	0	0	0	**17**
2023	5	2	0	0	0	1	0	0	**8**
2024	11	3	1	0	1	1	0	0	**17**
Total for Androscoggin	85	620	0	2	11	121	0	0	**847**
Cocheco									
1992-2014	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	0	1	6	10	0	0	**18**
Connecticut									
1974-2014	58	3,612	28	2	136	2,348	14	3	**6,201**
2015	0	0	0	0	4	18	0	0	**22**
2016	0	0	0	0	0	5	0	0	**5**
2017	0	0	0	0	0	18	2	0	**20**
2018	0	0	0	0	0	2	0	0	**2**
2019	0	0	0	0	0	3	0	0	**3**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	4	0	0	**4**
2022	0	0	0	0	0	4	0	0	**4**
2023	0	0	0	0	0	0	0	0	**0**
2024	0	0	0	0	0	0	0	0	**0**
Total for Connecticut	58	3,612	16	2	140	2,402	16	16	**6,261**
Cove Brook									
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	0	0	0	**0**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2022	0	0	0	0	0	0	0	0	**0**
2023	0	0	0	0	0	0	0	0	**0**
2024	0	0	0	0	0	0	0	0	**0**
Total for Cove Brook	0	0	0	0	0	0	0	0	**0**
Dennys									
1967-2014	42	350	0	1	77	910	6	35	**1,421**
2015	0	0	0	0	4	15	0	0	**19**
2016	0	0	0	0	2	9	0	0	**11**
2017	0	0	0	0	3	12	0	0	**15**
2018	0	0	0	0	1	6	0	0	**7**
2019	0	0	0	0	3	13	0	0	**16**
2020	0	0	0	0	4	17	0	0	**21**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	1	5	0	0	**6**
2023	0	0	0	0	0	0	0	0	**0**
2024	0	0	0	0	3	12	0	0	**15**
Total for Dennys	42	350	6	1	98	999	6	6	**1,531**
Ducktrap									
1985-2014	0	0	0	0	61	271	0	0	**332**
2017	0	0	0	0	1	3	0	0	**4**
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	2	0	0	**2**
2022	0	0	0	0	1	4	0	0	**5**
2023	0	0	0	0	1	2	0	0	**3**
2024	0	0	0	0	1	2	0	0	**3**
Total for Ducktrap	0	0	0	0	65	284	0	0	**349**
East Machias									
1967-2014	22	254	1	2	79	598	1	10	**967**
2015	1	3	0	0	2	8	0	0	**14**
2016	2	10	0	0	1	3	0	0	**16**
2017	2	6	0	0	0	1	0	0	**9**
2018	2	12	0	0	0	0	0	0	**14**
2019	7	29	0	0	1	3	0	0	**40**
2020	4	18	0	0	0	2	0	0	**24**
2021	3	15	0	0	0	1	0	0	**19**
2022	3	13	0	0	0	1	0	0	**17**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2023	2	8	0	0	1	6	0	0	**17**
2024	0	0	0	0	0	0	0	0	**0**
Total for East Machias	48	368	1	2	84	623	1	1	**1,137**
Great Works Stream									
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	0	0	0	0	**0**
2023	0	8	0	0	0	0	0	0	**8**
2024	1	0	0	0	0	2	0	0	**3**
Total for Great Works Stream	1	8	0	0	0	2	0	0	**11**
Kenduskeag Stream									
2017	0	0	0	0	2	7	0	0	**9**
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	1	5	0	0	**6**
2022	0	0	0	0	1	4	0	0	**5**
2023	1	10	0	0	0	0	0	0	**11**
2024	0	0	0	0	0	0	0	0	**0**
Total for Kenduskeag Stream	1	10	0	0	4	16	0	0	**31**
Kennebec									
1975-2014	24	258	6	7	12	94	0	0	**401**
2015	0	2	0	0	3	26	0	0	**31**
2016	0	0	0	0	1	38	0	0	**39**
2017	0	0	0	0	3	35	2	0	**40**
2018	0	1	0	0	3	7	0	0	**11**
2019	2	1	0	0	4	52	0	1	**60**
2020	0	0	0	0	4	49	0	0	**53**
2021	4	0	0	0	4	17	0	0	**25**
2022	34	12	0	0	2	39	0	0	**87**
2023	9	94	1	1	0	57	0	0	**162**
2024	15	22	2	0	1	10	3	0	**53**
Total for Kennebec	88	390	5	8	37	424	5	5	**962**
Lamprey									
1979-2014	10	17	1	0	13	16	0	0	**57**
Total for Lamprey	10	17	0	0	13	16	0	0	**57**
Machias									
1967-2014	40	363	9	2	158	2,097	41	131	**2,841**
2015	3	11	0	0	1	5	0	0	**20**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2016	0	0	0	0	3	14	0	0	**17**
2017	0	0	0	0	3	11	0	0	**14**
2018	0	0	0	0	2	7	0	0	**9**
2019	0	0	0	0	6	23	0	0	**29**
2020	0	0	0	0	6	23	0	0	**29**
2021	0	0	0	0	3	13	0	0	**16**
2022	0	0	0	0	2	8	0	0	**10**
2023	0	0	0	0	2	10	0	0	**12**
2024	0	0	0	0	3	11	0	0	**14**
Total for Machias	43	374	41	2	189	2,222	41	41	**3,011**
Merrimack									
1982-2014	503	1,777	52	12	153	1,214	39	0	**3,750**
2015	0	8	1	0	0	3	1	0	**13**
2016	1	1	0	0	0	3	0	0	**5**
2017	0	0	0	0	1	4	0	0	**5**
2018	0	2	0	0	0	0	0	0	**2**
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	1	3	0	0	**4**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	0	0	0	0	**0**
2023	2	7	0	0	1	4	0	0	**14**
2024	0	2	0	0	0	0	0	0	**2**
Total for Merrimack	506	1,797	40	12	156	1,231	40	40	**3,795**
Narraguagus									
1967-2014	202	853	25	58	134	2,598	72	174	**4,116**
2015	0	0	0	0	0	27	0	0	**27**
2016	0	0	0	0	0	9	0	0	**9**
2017	20	0	0	0	7	7	0	2	**36**
2018	21	16	0	0	1	3	1	0	**42**
2019	58	18	0	2	9	35	1	0	**123**
2020	11	76	3	1	2	15	0	0	**108**
2021	2	17	0	0	3	3	0	0	**25**
2022	0	1	0	0	7	11	0	0	**19**
2023	0	0	0	0	4	17	0	0	**21**
2024	2	0	0	0	1	9	0	0	**12**
Total for Narraguagus	316	981	74	61	168	2,734	74	74	**4,538**
Pawcatuck									
1982-2014	2	151	1	0	1	25	1	0	**181**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2015	0	0	0	0	0	0	0	0	**0**
2016	0	0	0	0	0	0	0	0	**0**
2017	0	0	0	0	0	0	0	0	**0**
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	0	0	0	0	**0**
2023	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	151	1	0	1	25	1	1	**181**
Penobscot									
1968-2014	13,443	51,338	304	743	838	4,384	37	102	**71,189**
2015	110	552	7	1	9	52	0	0	**731**
2016	208	218	2	1	10	68	0	0	**507**
2017	301	451	9	0	9	79	0	0	**849**
2018	276	434	0	1	15	45	0	1	**772**
2019	288	738	2	0	7	161	0	0	**1,196**
2020	177	998	16	5	18	221	3	1	**1,439**
2021	194	270	5	1	13	73	2	3	**561**
2022	308	898	6	5	0	105	2	0	**1,324**
2023	95	1,356	5	1	2	109	2	0	**1,570**
2024	316	978	19	5	18	40	2	0	**1,378**
Total for Penobscot	15,716	58,231	48	763	939	5,337	48	48	**81,516**
Pleasant									
1967-2014	16	55	0	0	52	372	3	2	**500**
2015	5	21	0	0	0	0	0	0	**26**
2017	0	0	0	0	2	7	0	0	**9**
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	5	21	0	0	**26**
2020	0	0	0	0	2	7	0	0	**9**
2021	0	0	0	0	3	11	0	0	**14**
2022	0	0	0	0	4	17	0	0	**21**
2023	0	0	0	0	3	11	0	0	**14**
2024	0	0	0	0	1	4	0	0	**5**
Total for Pleasant	21	76	3	0	72	450	3	3	**624**
Saco									
1985-2014	179	707	5	7	50	119	6	0	**1,073**
2015	1	4	0	0	0	0	0	0	**5**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	**Total**
2016	0	0	0	0	0	2	0	0	**2**
2017	3	3	0	0	1	1	0	0	**8**
2018	0	0	0	0	1	2	0	0	**3**
2019	0	2	0	0	1	1	0	0	**4**
2020	0	0	0	0	2	4	0	0	**6**
2021	0	0	0	0	0	0	0	0	**0**
2022	2	0	0	0	0	3	0	0	**5**
2023	0	0	0	0	0	4	0	0	**4**
2024	0	0	0	0	0	1	0	0	**1**
Total for Saco	185	716	6	7	55	137	6	6	**1,111**
Sheepscot									
1967-2014	26	104	0	0	74	503	13	0	**720**
2015	1	6	0	0	1	4	0	0	**12**
2016	1	4	0	0	1	3	0	0	**9**
2017	2	9	0	0	2	6	0	0	**19**
2018	1	2	0	0	1	2	0	0	**6**
2019	3	11	0	0	2	10	0	0	**26**
2020	2	6	0	0	1	5	0	0	**14**
2021	1	5	0	0	1	4	0	0	**11**
2022	1	4	0	0	1	3	0	0	**9**
2023	1	0	0	0	1	8	0	0	**10**
2024	2	6	0	0	1	7	0	0	**16**
Total for Sheepscot	41	157	13	0	86	555	13	13	**852**
Souadabscook Stream									
2017	0	0	0	0	1	3	0	0	**4**
2019	0	0	0	0	1	2	0	0	**3**
2020	0	0	0	0	0	0	0	0	**0**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	0	0	0	0	**0**
2023	0	0	0	0	0	0	0	0	**0**
2024	0	0	0	0	0	0	0	0	**0**
Total for Souadabscook Stream	0	0	0	0	2	5	0	0	**7**
St Croix									
1981-2014	720	1,124	39	12	880	1,340	78	34	**4,227**
Total for St Croix	720	1,124	78	12	880	1,340	78	78	**4,227**
Union									
1973-2014	274	1,842	9	28	1	18	0	0	**2,172**
2017	0	0	0	0	0	0	0	0	**0**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	**2SW**	**3SW**	**Repeat**	**1SW**	**2SW**	**3SW**	**Repeat**	**Total**
2018	0	0	0	0	0	0	0	0	**0**
2019	0	0	0	0	0	2	0	0	**2**
2020	0	2	0	0	0	1	0	0	**3**
2021	0	0	0	0	0	0	0	0	**0**
2022	0	0	0	0	0	0	0	0	**0**
2023	0	0	0	0	0	0	0	0	**0**
2024	0	1	0	0	0	0	0	0	**1**
Total for Union	274	1,845	0	28	1	21	0	0	**2,178**

Appendix 11. 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				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin	85	620	7	2	11	121	0	1	**847**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,612	28	2	140	2,402	16	3	**6,261**
Cove Brook	0	0	0	0	0	0	0	0	**0**
Dennys	42	350	0	1	98	999	6	35	**1,531**
Ducktrap	0	0	0	0	65	284	0	0	**349**
East Machias	48	368	1	2	84	623	1	10	**1,137**
Great Works Stream	1	8	0	0	0	2	0	0	**11**
Kenduskeag Stream	1	10	0	0	4	16	0	0	**31**
Kennebec	88	390	9	8	37	424	5	1	**962**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	43	374	9	2	189	2,222	41	131	**3,011**
Merrimack	506	1,797	53	12	156	1,231	40	0	**3,795**
Narraguagus	316	981	28	61	168	2,734	74	176	**4,538**
Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot	15,716	58,231	375	763	939	5,337	48	107	**81,516**
Pleasant	21	76	0	0	72	450	3	2	**624**
Saco	185	716	5	7	55	137	6	0	**1,111**
Sheepscot	41	157	0	0	86	555	13	0	**852**
Souadabscook Stream	0	0	0	0	2	5	0	0	**7**
St Croix	720	1,124	39	12	880	1,340	78	34	**4,227**
Union	274	1,845	9	28	1	21	0	0	**2,178**

Appendix 12.1: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1974	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1979	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	9	18	2.022	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1981	15	19	1.261	0	0	0	11	89	0	0	0	0	0	0	11	89	0	0
1982	13	31	2.429	0	0	0	0	90	10	0	0	0	0	0	0	90	10	0
1983	7	1	0.143	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	46	1	0.022	0	0	0	0	0	100	0	0	0	0	0	0	0	100	0
1985	29	35	1.224	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	10	27	2.791	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	98	44	0.449	0	16	0	0	68	2	0	14	0	0	0	16	68	16	0
1988	93	92	0.992	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	75	47	0.629	0	6	0	6	85	0	0	2	0	0	0	12	85	2	0
1990	76	53	0.693	0	13	0	0	87	0	0	0	0	0	0	13	87	0	0
1991	98	25	0.255	0	20	0	0	64	0	0	16	0	0	0	20	64	16	0
1992	93	84	0.904	0	1	0	0	85	1	0	13	0	0	0	1	85	14	0
1993	261	94	0.361	0	0	0	2	87	0	0	11	0	0	0	2	87	11	0
1994	393	197	0.502	0	0	0	1	93	0	0	6	0	0	0	1	93	6	0

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.1: 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	0	0	100	0	0	0
2012	85	3	0.035	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2013	62	11	0.176	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
Total	**10,161**	**1,704**																
Mean			**0.452**	**0**	**8**	**0**	**3**	**70**	**3**	**0**	**3**	**0**	**0**	**0**	**11**	**70**	**6**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1974	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	3	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	5	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	5	7	1.400	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1979	5	3	0.561	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	29	18	0.630	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1981	17	19	1.129	0	0	0	11	89	0	0	0	0	0	0	11	89	0	0
1982	29	46	1.565	0	0	0	0	89	11	0	0	0	0	0	0	89	11	0
1983	19	2	0.108	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	58	3	0.051	0	0	0	0	33	33	0	33	0	0	0	0	33	66	0
1985	42	47	1.113	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	18	28	1.592	0	0	0	4	96	0	0	0	0	0	0	4	96	0	0
1987	117	51	0.436	0	18	0	0	67	2	0	14	0	0	0	18	67	16	0
1988	131	108	0.825	0	0	0	0	97	1	0	2	0	0	0	0	97	3	0
1989	124	67	0.539	0	22	0	7	69	0	0	1	0	0	0	29	69	1	0
1990	135	68	0.505	0	19	0	0	79	0	0	1	0	0	0	19	79	1	0
1991	221	35	0.159	0	17	0	0	63	0	0	20	0	0	0	17	63	20	0
1992	201	118	0.587	0	5	0	0	82	1	0	12	0	0	0	5	82	13	0
1993	415	185	0.446	0	4	0	3	87	0	0	6	0	0	0	7	87	6	0
1994	598	294	0.492	0	5	0	2	88	0	0	5	0	0	0	7	88	5	0

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.2: 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	0	0	3	41	55	0	0
2012	173	12	0.069	0	17	0	25	42	17	0	0	0	0	0	42	42	17	0
2013	186	19	0.102	5	0	0	0	95	0	0	0	0	0	5	0	95	0	0
2014	20	2	0.101	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2015	39	3	0.077	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2016	6	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	19	4	0.207	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2018	20	4	0.203	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2019	34	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

2020	22	0	0.000	0	0	0	0	0		0				0	0	0		
2021	3	0	0.000	0	0		0							0	0			
2022	30	0	0.000	0										0				
Total	**15,033**	**2,558**																
Mean			**0.330**	**0**	**11**	**0**	**4**	**69**	**2**	**0**	**3**	**0**	**0**	**0**	**14**	**69**	**5**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1979	3	3	1.034	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1980	20	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	17	15	0.902	0	0	0	0	87	13	0	0	0	0	0	0	87	13	0
1983	16	1	0.064	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0
1984	13	2	0.156	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0
1985	14	12	0.881	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1986	8	1	0.126	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1987	7	5	0.740	0	0	0	0	80	0	0	20	0	0	0	0	80	20	0
1988	33	13	0.391	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1989	28	19	0.680	0	63	0	11	26	0	0	0	0	0	0	74	26	0	0
1990	27	11	0.407	0	45	0	0	45	0	0	9	0	0	0	45	45	9	0
1991	37	2	0.054	0	50	0	0	0	0	0	50	0	0	0	50	0	50	0
1992	55	15	0.271	0	20	0	0	67	0	0	13	0	0	0	20	67	13	0
1993	77	52	0.673	0	13	0	6	77	0	0	4	0	0	0	19	77	4	0
1994	110	49	0.447	0	31	0	4	63	0	0	2	0	0	0	35	63	2	0
1995	115	42	0.367	2	38	0	5	52	0	0	2	0	0	2	43	52	2	0
1996	91	19	0.208	0	58	0	11	26	0	0	5	0	0	0	69	26	5	0
1997	148	4	0.027	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1998	119	2	0.017	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1999	99	2	0.020	0	0	0	0	50	0	0	50	0	0	0	0	50	50	0

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.3: 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	0	0	0
2012	35	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	56	3	0.054	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2014	12	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	27	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	4	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	11	3	0.282	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2018	11	3	0.272	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2019	21	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2020	15	0	0.000	0	0	0	0	0		0				0	0	0		
2021	3	0	0.000	0	0		0							0	0			
2022	23	0	0.000	0										0				
Total	**2,488**	**382**																
Mean			**0.226**	**0**	**19**	**0**	**3**	**54**	**0**	**0**	**5**	**0**	**0**	**0**	**22**	**55**	**6**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.4: 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 2019 and earlier).

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

Appendix 12.4: 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	0	0	50	50	0	0
2012	102	3	0.030	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2013	11	4	0.360	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2014	1	1	0.800	0	0	0	100	0	0	0	0	0	0	0	100	0	0	0
2015	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	3	7.528	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2017	0	1	5.405	0	0	0	100	0	0	0	0	0	0	0	100	0	0	0
Total	**4,183**	**1,422**																
Mean			**2.082**	**0**	**2**	**0**	**13**	**62**	**3**	**2**	**7**	**0**	**0**	**0**	**15**	**64**	**11**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.5: Return rates for Atlantic salmon that were stocked as fry in the Pawcatuck River .

Year	Total Fry (10,000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1982	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	15	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	38	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	56	2	0.036	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1995	37	5	0.136	0	0	0	20	80	0	0	0	0	0	0	20	80	0	0
1996	29	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	10	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	91	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	59	5	0.085	0	0	20	0	80	0	0	0	0	0	0	0	100	0	0
2000	33	2	0.061	0	50	0	0	50	0	0	0	0	0	0	50	50	0	0
2001	42	2	0.047	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2002	40	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	31	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	56	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	1	1	1.923	0	0	0	0	0	0	0	100	0	0	0	0	0	100	0
2006	8	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	12	2	0.173	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2008	31	3	0.096	0	33	0	0	67	0	0	0	0	0	0	33	67	0	0
2009	9	2	0.234	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.5: 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	0	0	0
2012	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	1	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	2	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2021	0	0	0.000	0	0		0							0	0			
2022	0	0	0.000	0										0				
Total	**635**	**27**																
Mean			**0.099**	**0**	**3**	**1**	**1**	**27**	**0**	**0**	**3**	**0**	**0**	**0**	**4**	**27**	**3**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.6: 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 2019 and earlier).

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

Appendix 12.6: 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	0	0	0
2012	15	1	0.069	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2013	21	1	0.048	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2014	8	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	12	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	2	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	7	1	0.140	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2018	9	1	0.115	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
2019	13	0	0.000	0	0	0	0	0	0	0	0			0	0	0	0	
2020	7	0	0.000	0	0	0	0	0		0				0	0	0		
2022	8	0	0.000	0										0				
Total	**609**	**124**																
Mean			**0.194**	**0**	**14**	**0**	**4**	**57**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**57**	**0**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.7: Return rates for Atlantic salmon that were stocked as fry in the Westfield River .

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

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.7: 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	0	0	100	0	0	0	0
2012	39	3	0.078	0	0	0	0	33	67	0	0	0	0	0	0	33	67	0
2013	47	3	0.064	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
Total	**1,717**	**320**																
Mean			**0.174**	**4**	**4**	**0**	**8**	**72**	**3**	**0**	**6**	**0**	**0**	**4**	**12**	**72**	**9**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 12.8: 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 2019 and earlier).

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

Appendix 12.8: 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	56	0.588	0	0	0	0	88	0	4	9	0	0	0	0	92	9	0
2012	107	92	0.858	0	0	0	8	67	0	2	23	0	0	0	8	69	23	0
2013	72	70	0.969	0	0	0	11	83	0	0	6	0	0	0	11	83	6	0
2014	82	61	0.748	0	0	0	15	66	0	8	11	0	0	0	15	74	11	0
2015	52	196	3.786	0	1	0	5	79	2	2	12	0	0	0	6	81	14	0
2016	102	209	2.040	0	0	0	1	94	1	0	3	0	0	0	1	94	4	0
2017	41	102	2.493	0	0	0	18	65	2	1	15	0	0	0	18	66	17	0
2018	114	118	1.033	0	0	0	9	76	2	0	12	1	0	0	9	76	14	1
2019	63	108	1.712	1	0	0	0	88	1	0	10			1	0	88	11	
2020	61	33	0.537	0	0	0	6	88		6				0	6	94		
2021	24	16	0.661	0	0		100							0	100			
2022	21	0	0.000	0										0				
Total	**3,225**	**5,847**																
Mean			**4.238**	**0**	**0**	**0**	**15**	**73**	**1**	**2**	**8**	**0**	**0**	**0**	**15**	**76**	**9**	**0**

Means includes year classes with complete return data (year classes of 2019 and earlier).

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

Appendix 13. Summary return rates in southern New England for Atlantic salmon that were stocked as fry.

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	PW	CT	CTAH	SAL	FAR	WE	PN
1974			0.000	0.000				
1975	0.000		0.000	0.000				
1976	0.000		0.000	0.000				
1977	0.000		0.000	0.000				
1978	1.698		1.400	1.400				
1979	5.584		0.561	0.000		1.034		8.000
1980	3.333		0.630	2.022		0.000		
1981	13.684		1.129	1.261		0.000		20.297
1982	9.600	0.000	1.565	2.429		0.902		19.274
1983	27.479		0.108	0.143		0.064		
1984	0.894		0.051	0.022		0.156		12.875
1985	3.986	0.000	1.113	1.224		0.881		8.680
1986	2.114		1.592	2.791		0.126		14.690
1987	2.449	0.000	0.436	0.449	0.165	0.740		18.108
1988	0.541	0.000	0.825	0.992	0.693	0.391	0.000	5.081
1989	0.435		0.539	0.629	0.000	0.680	0.095	14.545
1990	0.215		0.505	0.693	0.000	0.407	0.146	3.722
1991	0.117		0.159	0.255	0.000	0.054	0.099	3.166
1992	0.134		0.587	0.904	0.322	0.271	0.373	3.405
1993	0.095	0.078	0.446	0.361	0.190	0.673	0.559	1.197
1994	0.188	0.036	0.492	0.502	0.166	0.447	0.652	1.612
1995	0.308	0.136	0.210	0.184	0.041	0.367	0.192	2.629
1996	0.150	0.000	0.151	0.115	0.607	0.208	0.170	0.942
1997	0.020	0.000	0.043	0.041	0.134	0.027	0.066	0.781
1998	0.031	0.000	0.048	0.050	0.039	0.017	0.078	0.527
1999	0.046	0.085	0.070	0.072	0.454	0.020	0.056	0.527
2000	0.054	0.061	0.071	0.062	0.108	0.072	0.131	1.228
2001	0.029	0.047	0.157	0.165	0.160	0.096	0.188	0.659
2002	0.057	0.000	0.227	0.179	0.799	0.185	0.381	0.536
2003	0.150	0.000	0.209	0.211	0.526	0.071	0.284	1.430
2004	0.225	0.000	0.157	0.141	0.000	0.093	0.389	0.646
2005	0.343	1.923	0.081	0.089	0.076	0.097	0.012	0.479
2006	0.158	0.000	0.085	0.093	0.119	0.058	0.069	0.517
2007	0.877	0.173	0.098	0.095	0.178	0.099	0.088	1.370
2008	0.181	0.096	0.137	0.104	0.821	0.091	0.143	0.834

Year Stocked	Number of adult returns per 10,000 fry stocked							
	MK	PW	CT	CTAH	SAL	FAR	WE	PN
2009	0.124	0.234	0.122	0.129	0.085	0.049	0.170	0.489
2010	0.054	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	0.588
2012	0.030	0.000	0.069	0.035	0.069	0.000	0.078	0.858
2013	0.360	0.000	0.102	0.176	0.048	0.054	0.064	0.969
2014	0.800	0.000	0.101		0.000	0.000		0.748
2015	0.000	0.000	0.077		0.000	0.000		3.786
2016	7.528	0.000	0.000		0.000	0.000		2.040
2017	5.405	0.000	0.207		0.140	0.282		2.493
2018			0.203		0.115	0.272		1.033
2019		0.000	0.000		0.000	0.000		1.712
2020			0.000		0.000	0.000		0.537
2021		0.000	0.000			0.000		0.661
2022		0.000	0.000		0.000	0.000		0.000
Mean	**2.082**	**0.099**	**0.333**	**0.452**	**0.196**	**0.225**	**0.174**	**4.324**
StDev	**4.901**	**0.356**	**0.428**	**0.684**	**0.246**	**0.288**	**0.168**	**5.920**

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 (2012 and earlier).

Appendix 14. 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	80	3	0	4	0	0	0	13	80	7	0
Connecticut (basin)	0	12	0	4	78	2	0	4	0	0	0	16	78	6	0
Farmington	0	22	0	4	66	0	0	7	0	0	0	27	66	7	0
Merrimack	0	3	0	14	69	4	2	8	0	0	0	17	71	12	1
Pawcatuck	0	8	2	2	78	0	0	10	0	0	0	10	80	10	0
Penobscot	0	0	0	17	74	1	3	8	0	0	0	17	77	9	0
Salmon	0	19	0	5	75	0	0	0	0	0	0	24	75	0	0
Westfield	4	4	0	9	74	3	0	6	0	0	4	12	74	9	0
Overall Mean:	**1**	**10**	**0**	**7**	**74**	**2**	**1**	**6**	**0**	**0**	**1**	**17**	**75**	**7**	**0**

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

Appendix 15: Estimates of Atlantic salmon escapement to Maine rivers in 2024.

Natural escapement represents the salmon left to freely swim in a river and is equal to the estimated returns, minus those taken for hatchery broodstock, minus observed in-river mortalities. Total escapement equals the natural escapement plus adult salmon that are stocked prior to spawning. Natural and total escapement estimates do not incorporate any information on age distribution or sex ratios and should be used with caution in any other analyses.

					Pre-Spawn Stocking		
Drainage	**Estimated Returns**	**Broodstock Take**	**Observed Mortalities**	**Natural Escapement**	**Captive/ Domestics**	**Sea Run**	**Total Escapement**
Androscoggin	17	0	1	16	0	0	16
Cove Brook	0	0	0	0	0	0	0
Dennys	15	0	0	15	0	0	15
Ducktrap	3	0	0	3	0	0	3
East Machias	0	0	0	0	0	0	0
Great Works Stream	3	0	0	3	0	0	3
Kenduskeag Stream	0	0	0	0	0	0	0
Kennebec	53	0	1	52	196	0	248
Machias	14	0	0	14	0	0	14
Narraguagus	12	0	0	12	0	0	12
Penobscot	1,378	606	2	770	286	2	1,058
Pleasant	5	0	0	5	0	0	5
Saco	1	0	0	1	0	0	1
Sheepscot	16	0	0	16	0	0	16
Souadabscook Stream	0	0	0	0	0	0	0
Union	1	0	0	1	0	0	1
Totals	**1,518**	**606**	**4**	**908**	**482**	**2**	**1,392**

Appendix 16: Estimates of Atlantic salmon escapment to Maine rivers.

Natural escapement represents the salmon left to freely swim in a river and is equal to the estimated returns, minus those taken for hatcery broodstock, minus observed in-river mortalities. Total escapement equals the natural escapement plus adult salmon that are stocked prior to spawning. Natural and total escapement estimates do not incorporate any information on age distribution or sex ratios and should be used with caution in any other analyses.

						Pre-Spawn Stocking		
Drainage	**Year**	**Estimated Returns**	**Broodstock Take**	**Observed Mortalities**	**Natural Escapement**	**Captive/ Domestic**	**Sea Run**	**Total Escapement**
Androscoggin	**1983 - 2014**	**786**	**0**	**0**	**786**	**0**	**0**	**786**
	2015	**1**	**0**	**0**	**1**	**0**	**0**	**1**
	2016	**6**	**0**	**0**	**6**	**0**	**0**	**6**
	2017	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2018	**1**	**0**	**0**	**1**	**0**	**0**	**1**
	2019	**1**	**0**	**0**	**1**	**0**	**0**	**1**
	2020	**5**	**0**	**0**	**5**	**0**	**0**	**5**
	2021	**5**	**0**	**0**	**5**	**0**	**0**	**5**
	2022	**17**	**0**	**0**	**17**	**0**	**0**	**17**
	2023	**8**	**0**	**0**	**8**	**0**	**0**	**8**
	2024	**17**	**0**	**1**	**16**	**0**	**0**	**16**
Cove Brook	**2018**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2019	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2020	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2021	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2022	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2023	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2024	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Dennys	**1967 - 2014**	**1,421**	**0**	**5**	**1,416**	**299**	**0**	**1,715**
	2015	**19**	**0**	**0**	**19**	**0**	**0**	**19**
	2016	**11**	**0**	**0**	**11**	**0**	**0**	**11**
	2017	**15**	**0**	**0**	**15**	**297**	**0**	**312**
	2018	**7**	**0**	**0**	**7**	**39**	**0**	**46**
	2019	**16**	**0**	**0**	**16**	**0**	**0**	**16**
	2020	**21**	**0**	**0**	**21**	**0**	**0**	**21**
	2021	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	2022	**6**	**0**	**0**	**6**	**0**	**0**	**6**
	2023	**0**	**0**	**0**	**0**	**17**	**0**	**17**

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Dennys	2024	15	0	0	15	0	0	15
Ducktrap	1985 - 2014	332	0	0	332	0	0	332
	2017	4	0	0	4	0	0	4
	2018	0	0	0	0	0	0	0
	2019	0	0	0	0	0	0	0
	2020	0	0	0	0	0	0	0
	2021	2	0	0	2	0	0	2
	2022	5	0	0	5	0	0	5
	2023	3	0	0	3	0	0	3
	2024	3	0	0	3	0	0	3
East Machias	1967 - 2014	967	0	0	967	374	0	1,341
	2015	14	0	0	14	0	0	14
	2016	16	0	0	16	0	0	16
	2017	9	0	0	9	0	0	9
	2018	14	0	0	14	64	0	78
	2019	40	0	0	40	0	0	40
	2020	24	0	0	24	0	0	24
	2021	19	0	0	19	0	0	19
	2022	17	0	0	17	0	0	17
	2023	17	0	0	17	23	0	40
	2024	0	0	0	0	0	0	0
Great Works Stream	2019	0	0	0	0	0	0	0
	2020	0	0	0	0	0	0	0
	2021	0	0	0	0	0	0	0
	2022	0	0	0	0	0	0	0
	2023	8	0	0	8	0	0	8
	2024	3	0	0	3	0	0	3
Kenduskeag Stream	2017	9	0	0	9	0	0	9
	2018	0	0	0	0	0	0	0
	2019	6	0	0	6	0	0	6
	2022	5	0	0	5	0	0	5
	2023	11	0	0	11	0	0	11
	2024	0	0	0	0	0	0	0
Kennebec	1975 - 2014	401	0	7	394	196	0	590

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Kennebec	2015	31	0	0	31	0	0	31
	2016	39	0	0	39	0	0	39
	2017	40	0	0	40	0	0	40
	2018	11	0	0	11	0	0	11
	2019	60	0	0	60	0	0	60
	2020	53	0	0	53	0	0	53
	2021	25	0	0	25	0	0	25
	2022	87	0	0	87	0	0	87
	2023	162	0	1	161	0	0	161
	2024	53	0	1	52	196	0	248
Machias	1967 - 2014	2,841	0	0	2,841	451	0	3,292
	2015	20	0	0	20	0	0	20
	2016	17	0	0	17	0	0	17
	2017	14	0	0	14	0	0	14
	2018	9	0	0	9	136	0	145
	2019	29	0	0	29	0	0	29
	2020	29	0	0	29	0	0	29
	2021	16	0	0	16	0	0	16
	2022	10	0	0	10	40	0	50
	2023	12	0	0	12	322	0	334
	2024	14	0	0	14	0	0	14
Narraguagus	1967 - 2014	4,116	0	1	4,115	0	0	4,115
	2015	27	0	0	27	0	0	27
	2016	9	0	0	9	0	0	9
	2017	36	0	0	36	466	0	502
	2018	42	0	0	42	40	0	82
	2019	123	0	3	120	0	0	120
	2020	108	0	0	108	0	0	108
	2021	25	0	0	25	0	0	25
	2022	19	0	0	19	0	0	19
	2023	21	0	0	21	0	0	21
	2024	12	0	0	12	0	0	12
Penobscot	1968 - 2014	71,189	18,809	219	52,161	0	417	52,578
	2015	731	660	5	66	741	7	814

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Penobscot	2016	507	293	4	210	489	0	699
	2017	849	532	3	314	0	12	326
	2018	772	457	2	313	0	2	315
	2019	1,196	599	1	596	0	97	693
	2020	1,439	221	8	1,210	0	2	1,212
	2021	561	147	1	413	0	1	414
	2022	1,324	557	3	764	305	8	1,077
	2023	1,570	752	3	815	1,275	243	2,333
	2024	1,378	606	2	770	286	2	1,058
Pleasant	1967 - 2014	500	0	0	500	56	0	556
	2015	26	0	0	26	0	0	26
	2017	9	0	0	9	0	0	9
	2018	0	0	0	0	0	0	0
	2019	26	0	0	26	0	0	26
	2020	9	0	0	9	0	0	9
	2021	14	0	0	14	0	0	14
	2022	21	0	0	21	0	0	21
	2023	14	0	0	14	41	0	55
	2024	5	0	0	5	0	0	5
Saco	1985 - 2014	1073	0	5	1068	0	0	1068
	2015	5	0	0	5	0	0	5
	2016	2	0	0	2	0	0	2
	2017	8	0	0	8	0	0	8
	2018	3	0	0	3	0	0	3
	2019	4	0	0	4	0	0	4
	2020	6	0	0	6	0	0	6
	2021	0	0	0	0	0	0	0
	2022	5	0	0	5	0	0	5
	2023	4	0	0	4	0	0	4
	2024	1	0	0	1	0	0	1
Sheepscot	1967 - 2014	720	0	0	720	337	0	1,057
	2015	12	0	0	12	0	0	12
	2016	9	0	0	9	0	0	9
	2017	19	0	0	19	0	0	19

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Sheepscot	2018	6	0	0	6	63	0	69
	2019	26	0	0	26	0	0	26
	2020	14	0	0	14	0	0	14
	2021	11	0	0	11	0	0	11
	2022	9	0	0	9	0	0	9
	2023	10	0	0	10	24	0	34
	2024	16	0	0	16	0	0	16
Souadabscook Stream	2017	4	0	0	4	0	0	4
	2019	3	0	0	3	0	0	3
	2020	0	0	0	0	0	0	0
	2021	0	0	0	0	0	0	0
	2022	0	0	0	0	0	0	0
	2023	0	0	0	0	0	0	0
	2024	0	0	0	0	0	0	0
St Croix	1981 - 2014	4,227	0	0	4,227	0	0	4,227
Union	1973 - 2014	2,172	0	32	2,140	0	0	2,140
	2017	0	0	0	0	0	0	0
	2018	0	0	0	0	0	0	0
	2019	2	0	0	2	0	0	2
	2020	3	0	0	3	0	0	3
	2021	0	0	0	0	0	0	0
	2022	0	0	0	0	0	0	0
	2023	0	0	0	0	0	0	0
	2024	1	0	0	1	0	0	1

Appendix17: Metrics of marine survival.

The metrics of marine survival are based on return rates of Atlantic salmon smolts to Maine rivers by sea age class (1SW or 2SW) and origin (Hat = hatchery; NR = naturally-reared). Rivers are: Penobscot (PN), Narraguagus (NG), Sheepscot (SHP), East Machias (EM), Sandy (SND), Kennebec (KE), and the Kennebec/Androscoggin combined (KE-AN). Two types of return rates are calculated with PSAR referring to post-smolt to adult return rate which incorporates survival through mainstem dams as smolts outmigrate, and SAR referring to smolt to adult return rate based on either the number of smolts stocked or the population estimate of outmigrating smolts.

Smolt Year	PN (Hat/PSAR) 1SW	PN (Hat/PSAR) 2SW	NG (NR/SAR) 1SW	NG (NR/SAR) 2SW	SHP (NR/SAR) 1SW	SHP (NR/SAR) 2SW	EM (NR/SAR) 1SW	EM (NR/SAR) 2SW	SND (NR/SAR) 1SW	SND (NR/SAR) 2SW	KE (Hat/SAR) 1SW	KE (Hat/SAR) 2SW	KE-AN (Hat/SAR) 1SW	KE-AN (Hat/SAR) 2SW
1970	0.11%	1.56%												
1971	0.03%	0.82%												
1972	0.02%	1.23%												
1973	0.05%	1.58%												
1974	0.06%	0.72%												
1975	0.11%	0.84%												
1976	0.04%	1.30%												
1977	0.08%	0.39%												
1978	0.19%	2.34%												
1979	0.58%	2.13%												
1980	0.29%	1.52%												
1981	0.17%	0.60%												
1982	0.16%	1.11%												
1983	0.12%	1.26%												
1984	0.10%	1.34%												
1985	0.23%	0.61%												
1986	0.32%	0.88%												
1987	0.30%	0.85%												
1988	0.39%	1.14%												

Smolt Year	PN (Hat/PSAR) 1SW	PN (Hat/PSAR) 2SW	NG (NR/SAR) 1SW	NG (NR/SAR) 2SW	SHP (NR/SAR) 1SW	SHP (NR/SAR) 2SW	EM (NR/SAR) 1SW	EM (NR/SAR) 2SW	SND (NR/SAR) 1SW	SND (NR/SAR) 2SW	KE (Hat/SAR) 1SW	KE (Hat/SAR) 2SW	KE-AN (Hat/SAR) 1SW	KE-AN (Hat/SAR) 2SW
1989	0.21%	0.52%												
1990	0.10%	0.69%												
1991	0.41%	0.55%												
1992	0.16%	0.29%												
1993	0.18%	0.70%												
1994	0.10%	0.75%												
1995	0.11%	0.22%												
1996	0.10%	0.33%												
1997	0.10%	0.25%	0.11%	0.90%										
1998	0.12%	0.15%	0.25%	0.28%										
1999	0.10%	0.29%	0.31%	0.53%										
2000	0.10%	0.18%	0.28%	0.17%										
2001	0.23%	0.53%	0.16%	0.85%										
2002	0.13%	0.61%	0.00%	0.46%										
2003	0.17%	0.41%	0.08%	1.01%										
2004	0.17%	0.41%	0.08%	0.98%										
2005	0.17%	0.28%	0.24%	0.73%										
2006	0.10%	0.60%	0.09%	0.78%										
2007	0.30%	0.71%	0.34%	1.72%										
2008	0.08%	0.36%	0.44%	0.65%										
2009	0.17%	0.90%	0.26%	1.80%	0.28%	0.84%								
2010	0.30%	0.23%	0.95%	0.61%	0.10%	0.33%								
2011	0.00%	0.12%	0.00%	0.72%	0.10%	0.26%								

Smolt Year	PN (Hat/PSAR) 1SW	PN (Hat/PSAR) 2SW	NG (NR/SAR) 1SW	NG (NR/SAR) 2SW	SHP (NR/SAR) 1SW	SHP (NR/SAR) 2SW	EM (NR/SAR) 1SW	EM (NR/SAR) 2SW	SND (NR/SAR) 1SW	SND (NR/SAR) 2SW	KE (Hat/SAR) 1SW	KE (Hat/SAR) 2SW	KE-AN (Hat/SAR) 1SW	KE-AN (Hat/SAR) 2SW
2012	0.03%	0.10%	0.00%	0.68%	0.08%	0.83%								
2013	0.03%	0.20%	0.00%	2.35%	0.17%	0.33%	0.75%	2.07%						
2014	0.02%	0.05%	0.00%	0.57%	0.13%	0.44%	0.32%	1.37%						
2015	0.07%	0.15%	0.00%	0.62%	0.13%	0.98%	1.21%	2.83%						
2016	0.06%	0.09%			0.14%	0.14%	0.18%	1.10%						
2017	0.06%	0.16%			0.08%	0.83%	0.14%	2.23%						
2018	0.06%	0.22%	1.99%	3.31%	0.33%	0.72%	0.80%	2.01%						
2019	0.04%	0.06%	0.27%	0.40%	0.21%	0.64%	0.33%	1.31%						
2020	0.04%	0.17%									0.00%	0.01%	0.01%	0.02%
2021	0.06%	0.26%	0.49%	1.20%			0.36%	1.69%	0.05%	0.44%	0.03%	0.09%	0.04%	0.10%
2022	0.02%	0.20%	0.39%	0.88%					0.01%	0.10%	0.01%	0.02%	0.01%	0.03%
2023	0.07%		0.07%								0.02%		0.03%	

Summary

Average	0.14%	0.64%	0.28%	0.97%	0.16%	0.58%	0.51%	1.82%	0.03%	0.27%	0.02%	0.04%	0.02%	0.05%
Minimum	0.00%	0.05%	0.00%	0.17%	0.08%	0.14%	0.14%	1.10%	0.01%	0.10%	0.00%	0.01%	0.01%	0.02%
Maximum	0.58%	2.34%	1.99%	3.31%	0.33%	0.98%	1.21%	2.83%	0.05%	0.44%	0.03%	0.09%	0.04%	0.10%
Avg 1970-1990	0.17%	1.12%												
Avg Since 1991	0.12%	0.33%	0.28%	0.97%	0.16%	0.58%	0.51%	1.82%	0.03%	0.27%	0.02%	0.04%	0.02%	0.05%
Last05	0.04%	0.18%	0.31%	1.45%	0.21%	0.68%	0.34%	1.67%	0.03%	0.27%	0.02%	0.04%	0.02%	0.05%
Last10	0.05%	0.16%	0.46%	1.33%	0.17%	0.58%	0.48%	1.82%	0.03%	0.27%	0.02%	0.04%	0.02%	0.05%
Last15	0.07%	0.22%	0.37%	1.15%	0.16%	0.58%	0.51%	1.82%	0.03%	0.27%	0.02%	0.04%	0.02%	0.05%

Historic Altantic Salmon Rivers of New England

See reverse for Index of River Names listed by Drainage and Index Number

The rivers shown on this map either drain directly to coastal waters, or represent significant tributaries classified as third or fourth order streams. In general, streams shorter than five kilometers and second order streams were not included to simplify mapping at this scale (1:2,100,000).

Sources

Abbott, A. March 24, 2005. *Historic Salmon Rivers of New England* Map.

Atlantic Salmon Restoration Program - Connecticut River Watershed Map. June 6,1995. U.S. Fish and Wildlife Service.Connecticut River Coordinator's Office.

Atkins, C.G. 1874. *On the salmon of Eastern North America and its artificial culture.* Report of the Commissioner for 1872 and 1873, part II. United States Commission of Fish and Fisheries, Washington D.C. p. 226-337.

Gephard, S. 2006. Connecticut Department of Environmental Protection, Inland Fisheries Division. Personal Communication during U.S. Salmon Assessment Committee meeting.

McKeon, J. 2006. U.S. Fish and Wildlife Service Central New England Fisheries Office. Personal Communication during U.S. Salmon Assessment Committee meeting.

McMenamy, J. 2006. Vermont Department of Fish and Wildlife. Personal Communication during U.S. Salmon Assessment Committee meeting.

Rowan, J. 2006. Gephard, S. 2006. U.S. Fish and Wildlife Service Connecticult River Coordinator. Personal Communication during U.S. Salmon Assessment Committee meeting.

Trial, J. 2006. Maine Atlantic Salmon Commission. Personal Communication during U.S. Salmon Assessment Committee meeting.

Historic Atlantic Salmon Rivers of New England – Index