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1 Executive Summary

1.1 Abstract

Total returns to USA rivers in 2020 was 1,715 salmon; this is the sum of documented returns to traps and returns estimated by redd counts. Returns to the USA ranks 11th out of the 30-year time series (1991-2020) and 22nd out of the full 54-year time series (1967-2020). Most returns (1,705; 99.4%) were to the Gulf of Maine Distinct Population Segment (GoM DPS), which includes the Penobscot River, Kennebec River, Sheepscot River and Eastern Maine coastal rivers with only 10 returns documented outside of the GoM DPS. Documented returns to traps totaled 1,618 and returns estimated by redd counts were 97 adult salmon. Overall, 13.6% of the adult returns to the USA were 1SW salmon, 84.7% were 2SW salmon and 1.7% were 3SW or repeat spawners. Most (77.2%) returns were of hatchery smolt origin and the balance (22.8%) originated from either natural reproduction, Age 0 parr, hatchery fry, or planted eggs. A total of 4,003,000 juvenile salmon (eggs, hatchery fry, Age 0 parr, and 1 smolt), and 2,270 adults were stocked into U.S. rivers. Of those fish, 70,681 carried a mark and/or tag, no naturally reared fish were marked in 2020. Eggs for USA hatchery programs were taken from a total of 1,622 females consisting of 122 sea-run females and 1,500 captive/domestic and domestic females. Total egg take (6,406,000) was lower than the previous three years' average of 7,354,000. Production of farmed salmon in Maine was not available, due to regulations concerning privacy.

1.2 Adult Returns to USA Rivers

Total returns to USA rivers was 1,715 (Table 1.2.1), which is a slight increase from 2019 (1,535, Table 1.2.2). Returns are reported for three meta-population areas (Figure 1.2.1): Long Island Sound (LIS, 0 total returns), Central New England (CNE, 10 total returns), and Gulf of Maine (GOM, 1,705 total returns). The ratio of sea ages for fish sampled at traps and weirs was used to estimate the number of 2SW spawners. Since 2015, CNE rivers' sea ages are based on the estimates from 2009-2014, as fish are no longer handled at the trap. The majority of the 1,715 adult returns to USA were 2SW (1,452 = 84.7%), with 1SW (234 = 13.6%), 3SW (22 = 1.3%) and repeat spawners (7 = 0.4%) making up the remainder of the total (Table 1.2.2). The 2020 2SW returns (84.7%) were greater than the previous 10-year average of 73.6%. Most (77.2%) returns were hatchery smolt origin, with the remainder (22.8%) natural origin. Age and origin of returns in 2020 were consistent with historical numbers with 2SW salmon making up the largest proportion for both origins (Figure 1.2.2).

In the U.S., returns are well below conservation spawner requirements. Returns of 2SW fish were only 3.2% of the USA CL, with returns to the three areas ranging from 0 to 6.5% (Table 1.2.3). Out of rivers with returning salmon, the Narraguagus River ranked the highest at 25.1% of CL followed by the Dennys (15.5%) and Penobscot Rivers (9.5%; Table 1.2.4).

United States marine survival metrics for the Penobscot River hatchery origin smolts to this point has used total smolts stocked and subsequent adult returns by sea age to generate a smolt-to-adult return rate (SAR). These revised estimates were updated using the methods of Stevens et al. (2019) to decouple losses of smolts in-river and in the estuary to provide an estimate of postsmolts entering the Gulf of Maine. 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 was then applied to subsequent adult returns to calculate a postsmolt to adult return rate (PSAR). The US Atlantic Salmon Assessment Committee (USASAC) discussed the approach and agreed it would provide a better estimate of marine survival. Data tables that report smolts stocked, postsmolts estimated and marine survival estimates from 1970 to 2020 adult returns are provided in the USASAC Annual report (USASAC 2020). The USASAC recommends adoption of the PSAR metric for use in marine survival work as this metric removes the impact of stocking location, dams and other river/estuary impacts.

Two sea-winter SAR rates for Penobscot River smolts from the 2018 cohort equaled 0.179%, with PSAR rates at 0.216%, both values were greater than the 2017 estimate (SAR = 0.130% and PSAR = 0.157%). The 2018 Penobscot River estimates were well beneath the Narraguagus (2.648%), East Machias (2.006%) and Sheepscot River (0.722%) estimates, which is consistent for much of the time series (Figure 1.2.3 and Table 1.2.5). Mean values (five/ten year estimates) follow along with historic trends, with the East Machias and Narraguagus Rivers having higher rates (Figure 1.2.3 and Table 1.2.5).

It should be reiterated that Penobscot River SAR and PSAR estimates are based on hatchery smolt stocking and adult returns. Prior to 2020 the Narraguagus, Sheepscot and East Machias Rivers were based on fry, egg planting and wild reproduction to adult returns (SAR). In 2020, and going forward, Age 0 parr will be included within the smolt estimates to adult returns (SAR) for these rivers in reporting.

1.3 Description of Fisheries and By-catch in USA Waters

Atlantic salmon (*Salmo salar*), are not subject to a plan review by the National Marine Fisheries Service because 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 USA waters of the Northeast Shelf could be from 4 primary sources: 1) Gulf of Maine Distinct Population Segment (endangered); 2) Long Island Sound or Central New England Distinct Population Segments (non-listed); 3) trans-boundary Canadian populations (many southern Canadian stocks are classified as Endangered by Canada); or 4) escaped fish from USA or Canada aquaculture facilities. Bycatch and discard of Atlantic salmon is monitored annually by the Northeast Fisheries Science Center using the Standardized Bycatch Reporting Methodology (Wigley and Tholke 2020). While bycatch is uncommon, we summarize observed events from 1989 through September 2020 using reports and data queries. Prior to 1993, observers recorded Atlantic salmon as an aggregate weight per haul. Therefore, no individual counts are available for these years, however 8 observed interactions occurred. After 1993, observers recorded Atlantic salmon encounters on an individual basis. Between 1993 and 2020, 7 observed interactions have occurred, with a total count of 7 individuals. In total, Atlantic salmon bycatch has been observed across 7 statistical areas in the Gulf of Maine region, primarily in benthic fisheries. Four interactions were observed in bottom otter trawl gear and 11 interactions were observed in sink gillnet gear (Figure 1.3.1). Bycatch of Atlantic salmon is a rare event as interactions have been observed in only 7 years of a 30-year time series and no Atlantic salmon have been observed since August 2013.

1.4 Stock Enhancement Programs

During 2020, approximately 4,003,000, juvenile salmon were released into USA rivers (Table 1.4.1). Of these, 1,454,000 were hatchery fry; 1,6333,000 were planted eyed eggs; 155,000 were parr; and 737,000 were smolts. Most of these restoration stockings were within the GoM, with the Connecticut (LIS) and Saco (CNE) rivers receiving limited allocations (Table 1.4.1). Besides juveniles, 2,270 adult salmon were released into USA rivers, of which, 2,221 were stocked into the GoM (Table 1.4.2).

1.5 Tagging and Marking Programs

Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 70,681 salmon released into USA waters were marked or tagged. Tags and marks for parr, smolts, and adults included: PIT, radio, clips and punches. All tagging and marking occurred within the GoM (Table 1.5.1). The number of marked fish was down significantly from 2019 (367,088), due to COVID impacts preventing smolt trapping (marking in the field) and reductions in marking (for management and studies) of hatchery reared fish prior to stocking.

1.6 Farm Production

Reporting an annual estimate of production of farmed Atlantic salmon has been discontinued because of confidentiality statutes in Maine Department of Marine Resources (MDMR) regulations since 2010 (Table 1.6.1).

In 2020, no aquaculture origin fish were reported captured in Maine rivers. MDMR maintains a protocol; "Maine Department of Marine Resources Suspected Aquaculture Origin Atlantic Salmon Identification and Notification Protocol" (MDMR, 2016) that guides procedures and reporting for disposition of captured aquaculture Atlantic salmon. There were no reportable escape events from the commercial salmon farming industry in Maine.

Atlantic salmon farming operations in the northeastern U.S. have typically been concentrated in marine net pens among the many islands in large bays characteristic of the Maine coast. There is recent interest in initiating land-based Atlantic salmon aquaculture in Maine. Two proposals are moving forward for building land based Recirculating Aquaculture Systems (RAS) within the boundaries of GoM distinct population segment; one at the former site of the Verso Paper Mill along the shores of the Penobscot

River, and the other facility proposed for the Belfast area; to be built at the former Belfast Water Works along the shores of the Little River. Both proposals to date are to build a RAS facility to produce Atlantic salmon for commercial sale. The facilities are planning to use Atlantic salmon that do not originate from North America for production. A potential source of Atlantic salmon eggs for importation annually would be Stofnfiskur; a company based in Iceland and is a well-known for exporting clean disease-free ova supporting salmon aquaculture throughout the world. A thorough review of the information provided along with discussions concerning designs of the facility for wastewater discharge permits are ongoing with the applicants. A quarantine facility will also be required for receiving imported eyed eggs from out of the State of Maine. The facility owned by Whole Oceans in Brewer, Maine was issued a discharge permit by the State of Maine Department Environmental Protection with further federal review of a facility Containment plan prior to building the facility and starting production.

1.7 Smolt Emigration

NOAA's National Marine Fisheries Service (NOAA) and the MDMR have conducted seasonal field activities assessing Atlantic salmon smolt populations using Rotary Screw Traps (RSTs) in selected Maine rivers since 1996. Monitoring has focused on estimating abundance of migrating populations (Figure 1.7.1, Table 1.7.1), as well as using the RST platform for enumerating individuals, tagging and sample collection. Prior to 2020, naturally reared smolt data presented only included egg planted, fry stocked and fish which were the product of wild spawning, going forward these data will include Age 0 parr.

No evaluation of smolt emigration took place in 2020 due to COVID-19. Expectations are that trapping activities will resume in 2021, with projects within the GoM assessments shifting in geography. The Sheepscot River trapping activities will discontinue ending the 18-year time series, with RSTs being reallocated to the Sandy River which is a tributary of the Kennebec River. The feasibility of trapping in the East Branch of the Penobscot River will be investigated, which will be part of a marine grow out/adult stocking project proposed by the MDMR beginning in 2022. The East Machias (seven-year time series) and Narraguagus (24-year time series) River evaluations will continue in 2021.

1.8 COVID-19 Impacts to Maine Salmon Program

The COVID-19 pandemic had the potential to significantly impact Atlantic salmon recovery activities in 2020 given social distancing guidance and mandates at federal and state levels. The USASAC discussed this issue and provided an assessment of the impact that the restrictions associated with the pandemic had on the ongoing recovery efforts. The discussion focused on impacts within the GoM area within four primary activities: juvenile assessments (electrofishing and smolts), adult monitoring, hatchery operations and outreach efforts. A summary of the discussions follows.

Juvenile assessments (electrofishing)

Juvenile young of the year and parr assessments via electrofishing typically occur in Maine rivers from July to September. Electrofishing surveys are conducted for three primary reasons: assessment of juvenile populations, collection of parr broodstock, and assessment of restoration efforts.

Due to the timing of these efforts and the pandemic, juvenile assessments via electrofishing were conducted as planned in 2020. Last minute decisions allowed the activities to occur. It was noted that broodstock collection efforts within the GoM area were given priority over juvenile population assessments. Close collaboration between the Maine Department of Marine Resources (MDMR) and U.S. Fish and Wildlife Service (USFWS) staff at Craig Brook National Fish Hatchery (CBNFH) allowed the work to be completed efficiently and in a compressed timeframe compared with previous years. The success of the 2020 broodstock collections, attributed to the concentrated early efforts of MDMR and CBNFH, will likely result in the adoption of a similar procedure in 2021.

Juvenile assessments (smolts)

Juvenile smolt assessments via smolt trapping typically occurs in select Maine rivers from late April through early June. Smolt assessments are conducted to estimate the out-migrating smolt abundance on monitored rivers. These data are used to assess the efficacy of specific restoration activities or to assess marine productivity when combined with estimates of adult returns.

The impacts are:

- No smolt evaluation to monitor the emigration of naturally reared smolts on the Narraguagus River.
- No smolt evaluation to monitor the emigration of hatchery reared Age 0 parr stoked at high densities on the East Machias River.
- No smolt evaluation to monitor the emigration of Dennys and Penobsoct origin smolts stocked (planted) as eggs into the Sandy River, a tributary of the Kennebec River.
- No smolt evaluation data is available to compare and contrast smolt productivity between coastal rivers under different stock enhancement strategies.
- No ability to estimate marine survival for the 2020 smolt cohort for any smolt monitored rivers

Adult monitoring

Adult monitoring efforts occur from April through November each year. Monitoring is primarily conducted via two means: enumerating and sampling adults collected at traps during the adult spawning run and redd surveys conducted in the fall. These efforts contribute to the annual estimate of adult returns and spawners, support the estimation of marine survival rates and offer the opportunity to collect sea-run broodstock for some rivers.

There were moderate impacts to the adult monitoring efforts in 2020. Most activities occurred, but protocols were modified to accommodate social distancing practices. The modifications enacted had varying impact on the efforts where some presented increased challenges and other provided benefits and increased efficacy. Some procedural changes are being considered for 2021 based on these efficiencies.

Penobscot River

- The sea-run broodstock target was reduced to 400 (200 2SW females, 170 2SW males and 30 grilse), with a maximum of 30 per day, but only 221 broodstock were collected.
- Operations at the Milford Trap were impacted very little, although broodstock collection was delayed to June 15th, which resulted in temperature challenges given the warmer river temperatures.
- Overall, a greater proportion of the fish swam volitionally into the river this year than years past.
- Fish were collected from the Milford trap by MDMR staff and deposited directly into USFWS trucks which were staged at the facility. The fish were transported directly to CBNFH where hatchery staff collected biological data and processed the broodfish before transferring them to the isolation tanks. This minimized the handling and allowed for easier temperature mitigation

as the truck tanks were iced down as needed prior to collection and transport. No mortalities were noted during transport.

- Considering that MDMR staff were not processing the fish at the trap as usual, there may be some inconsistencies with the injury assessment provided by CBNFH staff on captured salmon, especially compared to previous years.
- The new processing and data collection procedures did cause some difficulties in database development and auditing. Better coordination based on this year's experiences will help in the future.

Saco River

- No changes were made to the adult trap operations besides updated safety protocols.

Kennebec River

MDMR staff were not allowed access to the Lockwood dam trap facility and therefore they were unable to process any fish at that facility. As an alternative, the fish were cooled in insulated truck tanks after captured and transported directly to the Sandy River for processing and release. This caused some difficulties for staff and schedules, but anecdotally it appeared a better process for the fish as there was less handling.

The Hydro Kennebec adult trap facility, which is the second dam on the river, was not run. In past years a small number of fish have been able to bypass Lockwood and have been captured at Hydro Kennebec. It is not known if any fish were able to bypass Lockwood given that the Hydro Kennebec trap was not operated.

Narraguagus River

- There were no impacts to the adult trap operations.

<u>Hatchery operations</u>

There are two USFWS fish hatcheries involved in the recovery of Atlantic salmon in Maine: CBNFH and Green Lake National Fish Hatchery (GLNFH). Hatchery operations occur year round and are focused on receiving, maintaining and spawning the broodstock and the subsequent maintenance and stocking of the various hatchery products.

There were moderate impacts to hatchery operations in 2020. Most activities occurred, but protocols were modified to accommodate social distancing practices. The modifications enacted had varying impact on the efforts where some presented increased challenges and other provided benefits and increased efficacy.

- Modification were made to most operations to account for social distancing protocols, increased equipment and vehicle disinfection, minimizing staff exchange across tasks, and excluding volunteers from the University, NGOs and the public.
- Change to sea-run bloodstock collection protocols on the Penobscot River were noted above.
- Smolt stocking occurred earlier (March 23rd – April 14th), which resulted in earlier release dates with a two-week overlap compared to previous years.
- Biological sampling (e.g. length and weight) of stocked smolts did not occur.

- Planned marking activities for some stocking efforts (e.g. 68K smolts stocked in the Piscataquis) did not occur.
- Smolts that were destined for the Sandy River were stocked below Lockwood on the Kennebec River.
- Fall stocking activities were unaffected.

Outreach

The salmon restoration community engages in a wide variety of outreach activities throughout the year. Numerous outreach activities were not conducted in 2020 due to social distancing guidelines associated with the pandemic. One activity that was impacted in 2020 was the Fish Friends Program (aka Salmon in Schools). The Fish Friends Program is a collaborative program involving the USFWS, MDMR, public volunteers and numerous school districts throughout the State of Maine. The program involves the transfer of Atlantic salmon eggs to classrooms, the rearing of these eggs to the fry stage by the children of the classroom, the teaching of specific curriculum by the teachers of the participating classrooms and the eventual release of fry into streams in the spring. This program contributes in a small way to the restoration activities of the species, but to a much larger degree to increasing the awareness and youth of the State of Maine to the plight of Atlantic salmon, the restoration program that is underway within their state and the importance of the state's freshwater resources to the restoration of the species. Unfortunately, participation in the Salmon in School program was greatly reduced in 2020.

- Most participating schools went to remote learning in March 2020 and therefore the teachers who had received eggs earlier in 2020 had to stock the resulting fry out alone as the students were not able to participate. A total of 102 Fish Friends tanks were active in 2020.
- Participation in the program was severely limited in 2021 and with an approximate 50% reduction in participation. This was partially due to restrictions associated with social distancing guideline but also due to the prioritization of hatchery products to the primary restoration activities.
- During 2021 consideration is being given to pivoting the Fish Friends Program to be responsive to the restrictions associated with the pandemic. Items being considered are implementing additional measures to support their safety of Fish Friend mentors during egg delivery or to developing a virtual Fish Friends Program where subsequent activities would be focused on a single tank that is available for viewing via video stream.

References

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

Wigley SE, Tholke C. 2020. 2020 discard estimation, precision, and sample size analyses for 14 federally managed species groups in the waters off the Northeastern United States. NOAA Technical Memorandum NMFS-NE-261; 175 p.

Table 1.2.1 Estimated Atlantic salmon returns to USA by geographic area, 2020. "Natural" includes fish originating from natural spawning, Age 0 parr, hatchery fry or planted eggs. Some numbers are based on redds. Ages and origins are prorated where fish are not available for handling.

Area	1SW		2SW		3SW		Repeat Spawners		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	
LIS	0	0	0	0	0	0	0	0	0
CNE	1	2	1	6	0	0	0	0	
GOM	194	37	1,103	342	19	3	6	1	
Total	195	39	1,104	348	19	3	6	1	

Table 1.2.2 Estimated Atlantic salmon returns to the USA, 1967-2020. "Natural" includes fish originating from natural spawning, Age 0parr, hatchery fry, or planted eggs. Starting in 2003 estimated returns based on redds are included.

Year	Sea age				Total	Origin	
	1 SW	2SW	3SW	Repeat		Hatchery	Natural
1967	75	574	39	93	781	114	667
1968	18	498	12	56	584	314	270
1969	32	430	16	34	512	108	404
1970	9	539	15	17	580	162	418
1971	31	407	11	5	454	177	277
1972	24	946	38	17	1,025	495	530
1973	18	623	8	13	662	422	240
1974	52	791	35	25	903	639	264
1975	77	1,250	14	30	1,371	1,126	245
1976	172	836	6	16	1,030	933	97
1977	63	1,027	7	33	1,130	921	209
1978	145	2,269	17	33	2,464	2,082	382
1979	225	972	6	21	1,224	1,039	185
1980	707	3,437	11	57	4,212	3,870	342
1981	789	3,738	43	84	4,654	4,428	226
1982	294	4,388	19	42	4,743	4,489	254
1983	239	1,255	18	14	1,526	1,270	256
1984	387	1,969	21	52	2,429	1,988	441
1985	302	3,913	13	21	4,249	3,594	655
1986	582	4,688	28	13	5,311	4,597	714
1987	807	2,191	96	132	3,226	2,896	330
1988	755	2,386	10	67	3,218	3,015	203
1989	992	2,461	11	43	3,507	3,157	350
1990	575	3,744	18	38	4,375	3,785	590
1991	255	2,289	5	62	2,611	1,602	1,009
1992	1,056	2,255	6	20	3,337	2,678	659
1993	405	1,953	11	37	2,406	1,971	435
1994	342	1,266	2	25	1,635	1,228	407
1995	168	1,582	7	23	1,780	1,484	296
1996	574	2,168	13	43	2,798	2,092	706
1997	278	1,492	8	36	1,814	1,296	518
1998	340	1,477	3	42	1,862	1,146	716
1999	402	1,136	3	26	1,567	959	608
2000	292	535	0	20	847	562	285
2001	269	804	7	4	1,084	833	251
2002	437	505	2	23	967	832	135
2003	233	1,185	3	6	1,427	1,238	189
2004	319	1,266	21	24	1,630	1,395	235
2005	317	945	0	10	1,272	1,019	253
2006	442	1,007	2	5	1,456	1,167	289
2007	299	958	3	1	1,261	940	321
2008	812	1,758	12	23	2,605	2,191	414
2009	243	2,065	16	16	2,340	2,017	323
2010	552	1,081	2	16	1,651	1,468	183
2011	1,084	3,053	26	15	4,178	3,560	618
2012	26	879	31	5	941	731	210
2013	78	525	3	5	611	413	198
2014	110	334	3	3	450	304	146
2015	150	761	9	1	921	739	182
2016	232	389	2	3	626	448	178
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

Table 1.2.3 Two sea winter (2SW) returns for 2020 in relation to spawner requirements (i.e. 2SW Conservation Limits) for USA rivers.

Area	DPS	Spawner Requirement	2SW returns	Percentage of Requirement
Long Island Sound	LIS	17,785	0	0.0%
Central New England	CNE	5,516	7	0.1%
Gulf of Maine	GOM	22,134	1,445	6.5%
Total		45,435	1,452	3.2%

Table 1.2.4. 2020 2SW returns against 2SW Conservation Limits for select USA rivers.

Region	Name	CL	Returns	% of CL Met
LIS	Connecticut	17,427	0	0.00%
CNE	Merrimack	2,599	3	0.12%
CNE	Pawcatuck	358	0	0.00%
CNE	Saco	1,672	4	0.24%
GOM	Androscoggin	847	5	0.59%
GOM	Dennys	109	17	15.53%
GOM	Ducktrap	50	0	0.00%
GOM	East Machias	337	20	5.93%
GOM	Kennebec	4,628	49	1.06%
GOM	Machias	792	23	2.90%
GOM	Narraguagus	363	91	25.10%
GOM	Penobscot	12,899	1219	9.45%
GOM	Pleasant	131	7	5.36%
GOM	Sheepscot River	342	11	3.21%
GOM	Union	715	3	0.42%

Table 1.2.5. Available time series of 1SW and 2SW smolt to adult return rates (SAR) for monitored USA rivers. SAR (and PSAR for Penobscot) for monitored rivers are identified as being derived from hatchery origin (Hat.) or naturally reared origin (NR)salmon. No smolt estimates were available for smolt years 2016 and 2017 for the Narraguagus River so no corresponding SAR estimates are available. Within the five and ten year mean calculations the current year is included. The 2019 1SW PN PSAR estimate is not available but will be available in 2022.

River	Penobscot		Penobscot		Narraguagus		Sheepscot		East Machias	
Origin	Hat. SAR		Hat. PSAR		NR		NR		NR	
Smolt Year	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW
1969	0.074%	0.947%								
1970	0.074%	1.091%	0.105%	1.558%						
1971	0.021%	0.551%	0.031%	0.819%						
1972	0.014%	0.699%	0.024%	1.228%						
1973	0.029%	0.848%	0.054%	1.584%						
1974	0.045%	0.562%	0.058%	0.722%						
1975	0.068%	0.525%	0.108%	0.836%						
1976	0.019%	0.668%	0.036%	1.295%						
1977	0.038%	0.197%	0.077%	0.393%						
1978	0.103%	1.265%	0.190%	2.342%						
1979	0.232%	0.857%	0.576%	2.131%						
1980	0.128%	0.665%	0.294%	1.523%						
1981	0.101%	0.361%	0.167%	0.599%						
1982	0.058%	0.406%	0.159%	1.107%						
1983	0.057%	0.617%	0.117%	1.263%						
1984	0.041%	0.567%	0.097%	1.344%						
1985	0.090%	0.238%	0.229%	0.609%						
1986	0.124%	0.337%	0.323%	0.879%						
1987	0.131%	0.373%	0.300%	0.851%						
1988	0.127%	0.374%	0.387%	1.141%						
1989	0.102%	0.251%	0.209%	0.516%						
1990	0.040%	0.274%	0.102%	0.692%						
1991	0.140%	0.190%	0.408%	0.554%						
1992	0.042%	0.076%	0.158%	0.288%						
1993	0.047%	0.186%	0.177%	0.703%						
1994	0.028%	0.215%	0.098%	0.754%						
1995	0.084%	0.163%	0.113%	0.218%						
1996	0.043%	0.141%	0.100%	0.326%						
1997	0.041%	0.098%	0.103%	0.245%	0.113%	0.942%				
1998	0.039%	0.046%	0.122%	0.145%	0.249%	0.284%				

River	Penobscot		Penobscot		Narraguagus		Sheepscot		East Machias	
Origin	Hat. SAR		Hat. PSAR		NR		NR		NR	
Smolt Year	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW
1999	0.040%	0.233%	0.103%	0.597%	0.086%	0.778%				
2000	0.127%	0.301%	0.299%	0.706%	0.345%	1.722%				
2001	0.033%	0.148%	0.082%	0.361%	0.435%	0.653%				
2002	0.073%	0.386%	0.170%	0.903%	0.257%	1.800%	0.279%	0.836%		
2003	0.123%	0.094%	0.299%	0.228%	0.946%	0.615%	0.103%	0.334%		
2004	0.001%	0.050%	0.003%	0.117%	0.000%	0.724%	0.098%	0.261%		
2012	0.010%	0.031%	0.032%	0.103%	0.000%	0.680%	0.083%	0.826%		
2013	0.015%	0.100%	0.031%	0.204%	0.000%	2.348%	0.166%	0.332%	0.752%	2.068%
2014	0.020%	0.039%	0.024%	0.048%	0.000%	0.570%	0.125%	0.438%	0.315%	1.366%
2015	0.055%	0.120%	0.067%	0.146%	0.000%	0.621%	0.131%	0.984%	1.212%	2.828%
2016	0.053%	0.076%	0.064%	0.092%	na	na	0.138%	0.138%	0.183%	1.100%
2017	0.048%	0.130%	0.059%	0.157%	na	na	0.079%	0.830%	0.139%	2.231%
2018	0.052%	0.179%	0.062%	0.216%	1.589%	2.648%	0.328%	0.722%	0.803%	2.006%
2019	0.032%				0.263%		0.214%		0.327%	
5-Year Mean	0.048%	0.109%	0.055%	0.132%	0.617%	1.280%	0.178%	0.622%	0.533%	1.906%
10-Year Mean	0.041%	0.120%	0.071%	0.221%	0.350%	1.251%	0.147%	0.570%		

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.

Year	Month	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
		Totals	15	32.7

Table 1.4.1. Number of juvenile Atlantic salmon by lifestage stocked in USA, 2020 by area and drainage. Central New England (CNE); Gulf of Maine (GoM; Long Island Sound (LIS).

Area	Drainage	Year	0 Parr	1 Parr	1 Smolt	2 Smolt	Eyed Egg	Fry	Total
LIS	Connecticut	2020		1,000				222,000	223,000
LIS	Pawcatuck	2020						0	0
CNE	Saco	2020					24,000	0	24,000
GOM	Androscoggin	2020						2,000	2,000
GOM	Dennys	2020					40,000	149,000	189,000
GOM	East Machias	2020	68,000					0	68,000
GOM	Kennebec	2020			89,000		679,000	3,000	771,000
GOM	Machias	2020	16,000				102,000	181,000	299,000
GOM	Narraguagus	2020					66,000	164,000	230,000
GOM	Penobscot	2020	70,000		648,000		498,000	614,000	1,830,000
GOM	Pleasant	2020					85,000	89,000	174,000
GOM	Sheepscot	2020					163,000	28,000	191,000
GOM	Union	2020						2,000	2,000
		Total	154,000	1,000	737,000	0	1,633,000	1,454,000	4,003,000

Table 1.4.2 Stocking summary for sea-run, captive reared domestic adult Atlantic salmon for the USA in 2020 by purpose and geographic area.

Area		Purpose	Captive Reared Domestic		Sea Run		Total
			Pre-spawn	Post-spawn	Pre-spawn	Post-spawn	
Central New England	CNE	Restoration	0	49	0	0	49
Gulf of Maine	GOM	Restoration	0	2,016	2	203	2,221
Total for USA			0	2,065	2	203	2,270

Table 1.5.1 Summary of tagged and marked Atlantic salmon released in USA, 2020. Includes hatchery and wild origin fish.

Mark Code	Life Stage	CNE	GOM	LIS	Total
Adipose clip	0 Parr		68,030		68,030
Adipose punch	Adult		170		170
Adipose clip	Adult				
Floy tag	Adult				
Passive Integrated Transponder (PIT)	Adult		2,303		2,303
Radio tag	Adult				
Upper caudal punch	Adult		88		88
Acoustic Tag	Smolt				
Adipose clip	Smolt				
Passive Integrated Transponder (PIT)	Smolt				
Radio tag	Smolt		90		90
		0	70,681	0	70,681

Table 1.6.1. State of Maine - USA commercial Atlantic salmon aquaculture production and suspected aquaculture captures to Maine rivers 2000 to 2019. Due to confidentiality statutes in MDMR regulations related to single producer, adult production rates are not available 2011 to 2020.

Year	Total Salmon Stocked (smolt + Age 0 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

Table 1.7.1 Naturally reared smolt population estimate (± Std. Error) from maximum likelihood estimates for the Narraguagus, Sheepscot and East Machias Rivers, Maine USA.

	Narraguagus River			Sheepscot River			East Machias River		
Smolt Year	Low SE	Pop Est	Up SE	Low SEL	Pop Est.	Up SE	Low SE	Pop Est.	Up SE
1997	2,429	2,869	3,309	N/A	N/A	N/A	N/A	N/A	N/A
1998	2,594	2,845	3,096	N/A	N/A	N/A	N/A	N/A	N/A
1999	3,711	4,247	4,783	N/A	N/A	N/A	N/A	N/A	N/A
2000	1,601	1,843	2,085	N/A	N/A	N/A	N/A	N/A	N/A
2001	2,191	2,562	2,933	N/A	N/A	N/A	N/A	N/A	N/A
2002	1,536	1,774	2,012	N/A	N/A	N/A	N/A	N/A	N/A
2003	1,096	1,201	1,306	N/A	N/A	N/A	N/A	N/A	N/A
2004	1,069	1,284	1,499	N/A	N/A	N/A	N/A	N/A	N/A
2005	1,062	1,287	1,512	N/A	N/A	N/A	N/A	N/A	N/A
2006	2,137	2,339	2,541	N/A	N/A	N/A	N/A	N/A	N/A
2007	1,063	1,177	1,291	N/A	N/A	N/A	N/A	N/A	N/A
2008	796	962	1,128	N/A	N/A	N/A	N/A	N/A	N/A
2009	1,086	1,176	1,266	1,661	1,813	1,965	N/A	N/A	N/A
2010	1,922	2,149	2,376	3,572	3,944	4,316	N/A	N/A	N/A
2011	1,023	1,404	1,785	2,706	3,176	3,646	N/A	N/A	N/A
2012	725	969	1,213	2,132	2,507	2,882	N/A	N/A	N/A
2013	974	1,237	1,500	2,799	3,036	3,273	463	556	649
2014	1,417	1,615	1,813	1,416	1,650	1,884	814	1,019	1,224
2015	960	1,201	1,442	1,372	1,558	1,744	212	263	314
2016	NA	NA	NA	2,662	2,924	3,186	926	1,223	1,520
2017	NA	NA	NA	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	NA	NA	NA	NA	NA	NA	NA	NA	NA

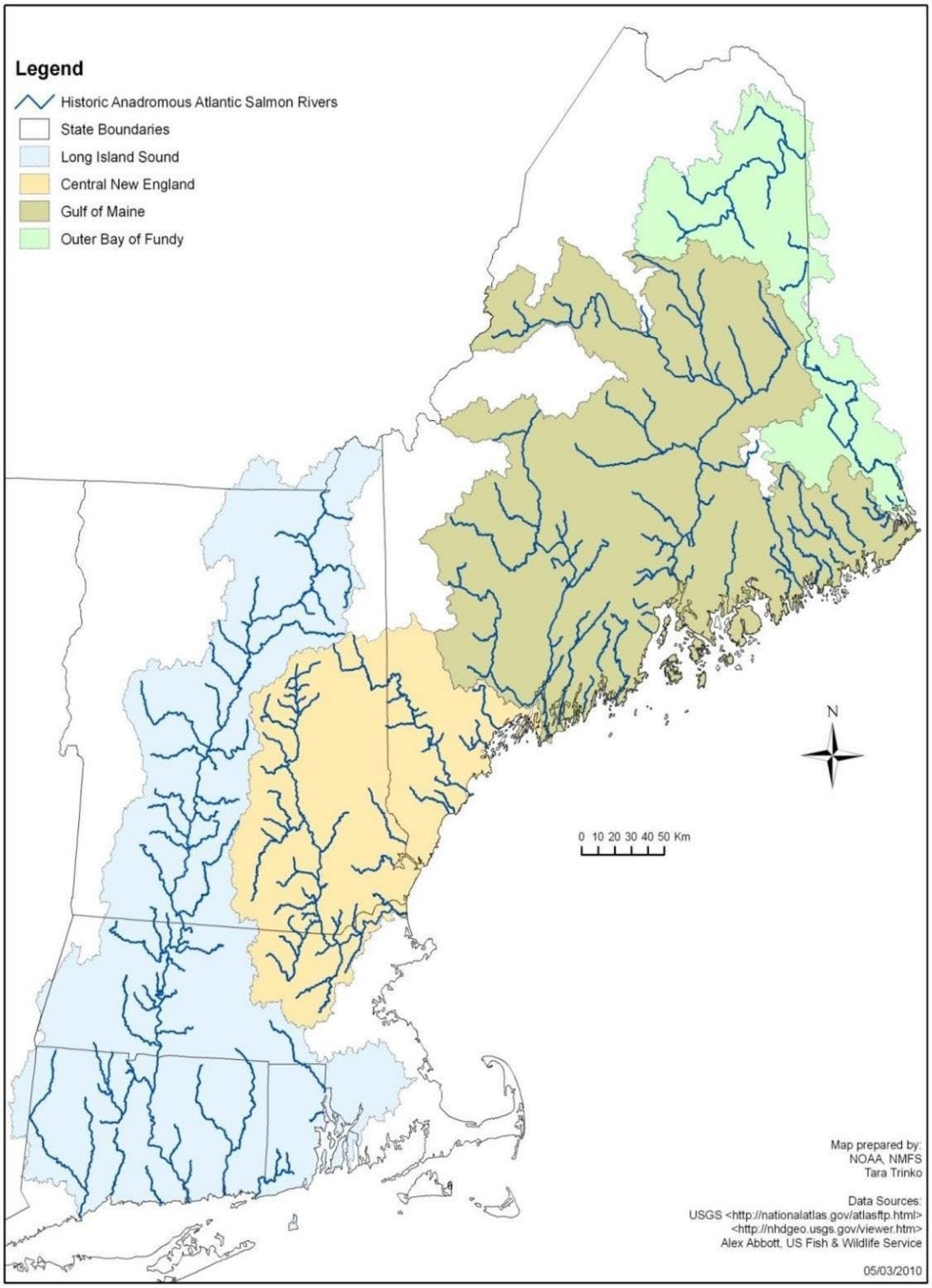

Figure 1.2.1 Map of geographic areas used in summaries of USA data for returns, stocking, and marking in 2020.

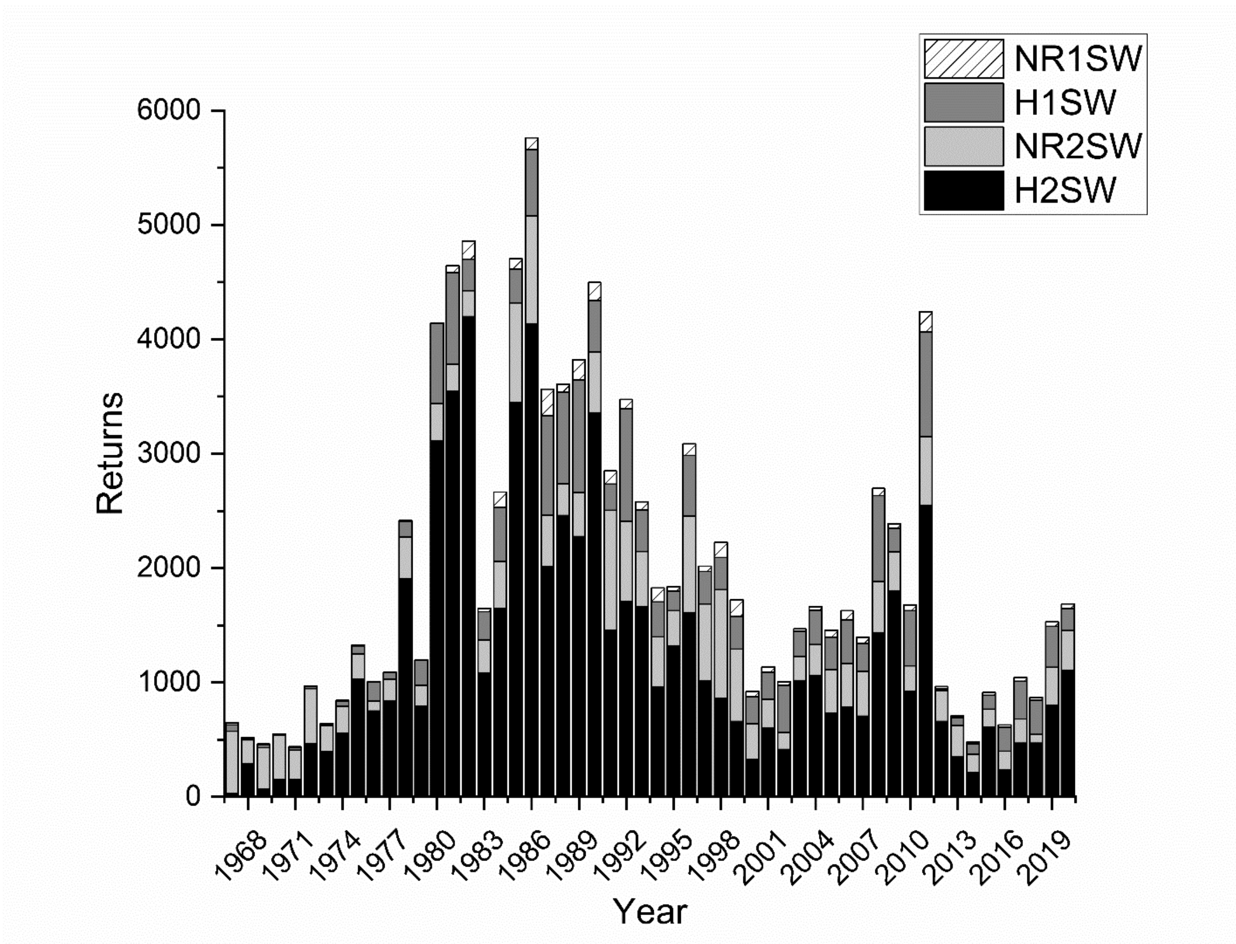

Figure 1.2.2 Origin and sea age of Atlantic salmon returning to USA rivers, 1967 to 2020, 1SW and 2SW only. NR = Naturally Reared; H = Hatchery Reared; SW = Sea Winter.

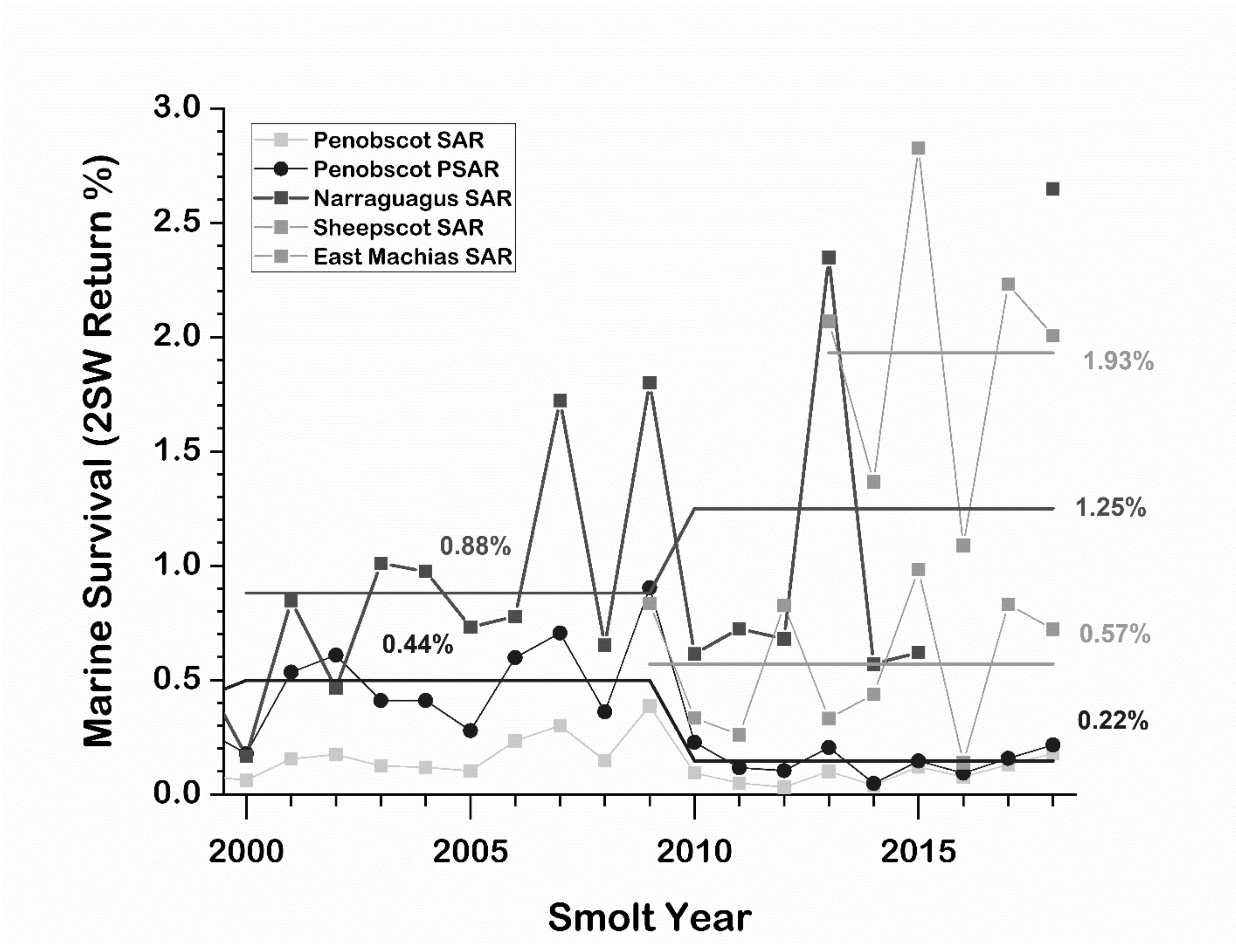

Figure 1.2.3 Two-Sea-Winter adult return rates calculated according to the number of smolts stocked or smolt population estimates (SAR) for 4 Maine Rivers: Penobscot (Slate), Narraguagus (Olive), Sheepscot (Orange), and East Machias (Green) and the PSAR (blue circles) from 2000 to 2018 Atlantic salmon smolt cohorts. Time series of decade (or time series) averages expressed as line labeled with percent returns.

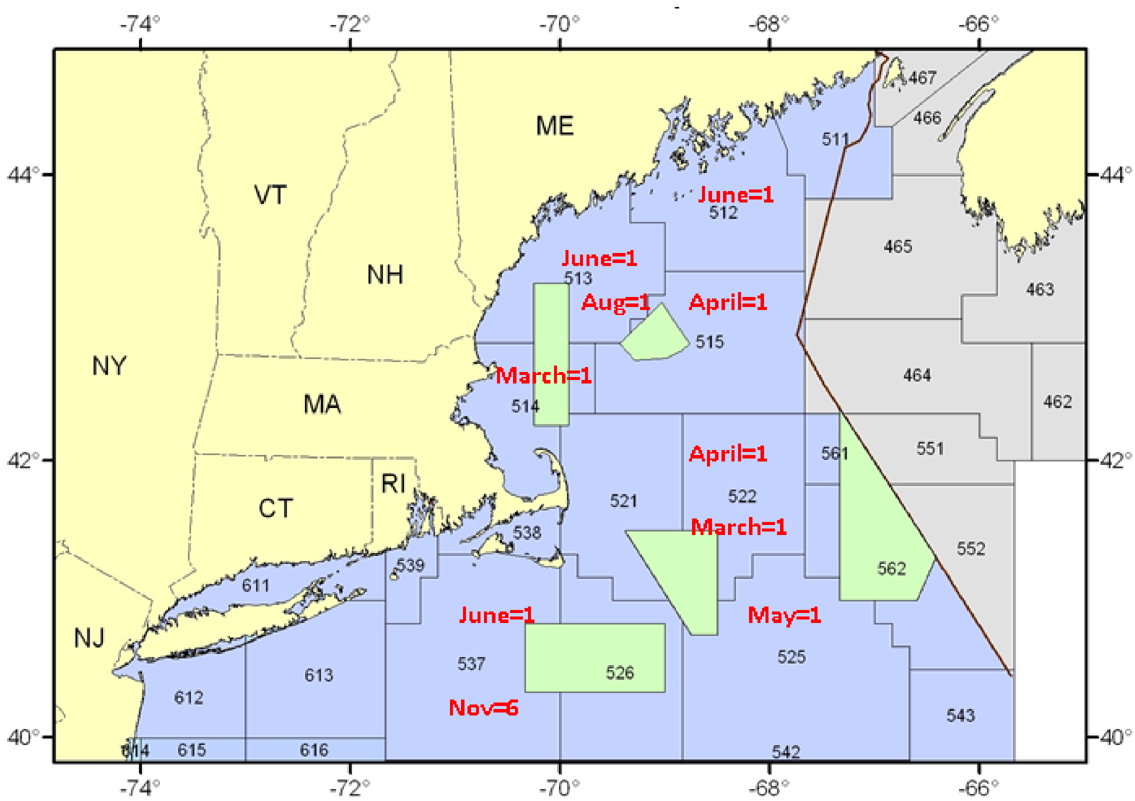

Figure 1.3.1 Map of Gulf of Maine region showing the month and number of Atlantic salmon interactions between 1993 and 2020 (e.g., June=1: 1 salmon interaction in the area in June). Location of the label within the statistical grid does not denote more specific locations. Blue polygons are USA statistical areas, grey zones are in Canada and green-shaded polygons represent regulated access areas.

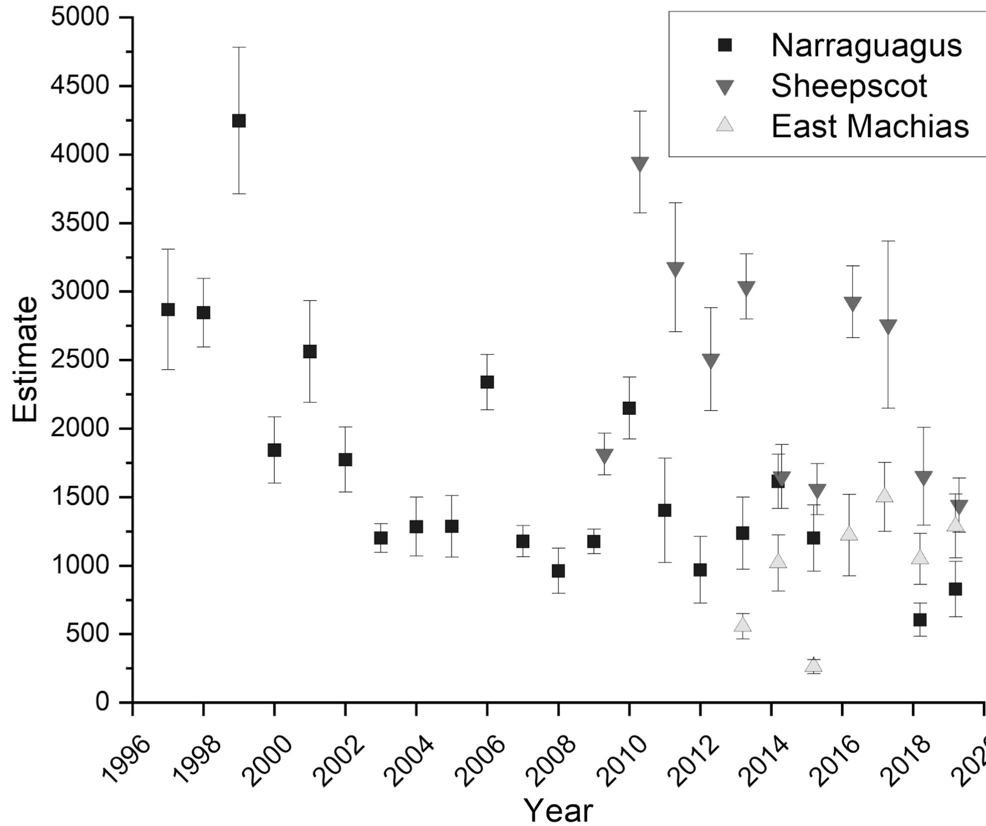

Figure 1.7.1. Population Estimates (± Std. Error) of emigrating naturally reared (natural reproduction, Age 0 parr, hatchery fry or planted eggs) smolt in the Narraguagus (no estimate in 2016 and 2017), Sheepscot, and East Machias (no estimate 2015-2017) rivers, Maine (1997-2019), using DARR 2.0.2. No sampling occurred in 2020 due to COVID-19. 2020 Change Note: Sheepscot and East Machias Rivers now include Age 0 parr origins within the summary, which was not previously reported.

2 Viability Assessment - Gulf of Maine Atlantic Salmon

2.1 Overview of DPS and Annual Viability Synthesis

2.1.1 Change in Status Assessment Approach

While this report summarizes, all U.S. populations related to metrics and general trends to national reporting needs in support of NASCO (e.g., Chapter 1), these populations are now dominated by the endangered Gulf of Maine Distinct Population Segment (GoM DPS) in Maine. Section 2 summarizes the more detailed metrics needed to monitor the health of these populations using metrics used for other endangered salmonids in the U.S. 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). Taking this approach allows US stock assessment scientists to integrate an annual GoM DPS assessment within the overall US assessment making more effective use of staff resources. Integrating this annual reporting (required under 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. This section is meant to be a brief annual summary not a benchmark 5-year viability assessment. A benchmark assessment will be produced in a future assessment cycle.

2.1.2 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). There are three Major Population Groupings (MPG) referred to as Salmon Habitat Recovery Units (SHRUs) for the GoM DPS (NMFS 2009) based on watershed similarities and remnant population structure. The three SHRUs are Downeast Coastal (DEC), Penobscot Bay (PNB), and Merrymeeting Bay (MMB). The GoM DPS critical habitat ranges from the Dennys River southward to the Androscoggin River (NMFS 2009).

At the time of listing, nine distinct individual populations (DIPs) were identified. In the DEC SHRU, there were five extant DIPs in the Dennys, East Machias, Machias, Pleasant and Narraguagus Rivers. In the PNB SHRU, there were three - Cove Brook, Ducktrap River, and mainstem Penobscot. In the MMB SHRU there was one DIP in the Sheepscot River. Of these nine populations, seven of them are supported by conservation hatchery programs. These hatchery programs propagate wild-exposed parr or returning adults to increase effective spawning populations. Cove Brook and the Ducktrap River DIPs were not supplemented.

Because conservation hatchery activities play a major role in fish distribution and recovery, a brief synopsis is included in the boundary delineation. The core conservation hatchery strategy for six of these DIPs is broodstock collected primarily from wild-exposed or truly wild parr collections. These juveniles are then raised to maturity in a freshwater hatchery. All five extant DEC DIPs (Dennys, East Machias, Machias, Pleasant, and Narraguagus) are supported using this approach as well as the Sheepscot DIP in the MMB SHRU. For the mainstem Penobscot, the primary hatchery strategy is collection of sea-run adult broodstock that are a result of smolt stocking (85% or more of adult collections) or naturally reared or wild returns. For the Ducktrap River population, no conservation hatchery activities were implemented. In general, DIPs are stocked in their natal river. However, because there are expansive areas of Critical Habitat that are both vacant and of high production quality, these seven populations (primarily the Penobscot) can serve as donor stocks for other systems, especially the Kennebec River in MMB SHRU and Cove Brook within the PNB SHRU (native population was extirpated in 2009).

2.1.3 Synthesis of 2020 Viability Assessment

Totaling 1,705 estimated adult returns to the GoM DPS, the 2020 spawning run was the 8th highest return since 1991. Of these 1,322 (78%) of returns were of hatchery-stocked smolt origin. Naturally reared returns remained low across the GoM DPS (383) but were above 200 in PNB and above 50 in DEC and MMB SHRUs. About 63% of naturally reared returns were documented in the PNB SHRU. Abundance remains critically low relative to interim recovery targets of 500 naturally reared returns per SHRU. The PNB SHRU was at 49% of this target, 4-fold higher than returns to the MMB SHRU (16%). The populations in the DEC SHRU were estimated at 79 naturally reared returns (21%). With no documented returns in 2020, the Ducktrap DIP in PNB is at an elevated extirpation risk with returns documented in only 4 of the last 11 years.

Population growth is monitored by 10-year geometric mean population growth rates of naturally reared adults as per recovery plan criteria. The GoM DPS rate for 2020 returns was 1.12 (95% CL 0.60-2.09); because error bounds around this rate overlap 1.0, this indicates relative stability. 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 natural reproduction in the wild but products of the US hatchery system (e.g., stocked fry and planted eggs). As such, the inclusion of hatchery products in the 10-year geometric mean replacement rate overestimates wild population growth rate. New methods are under development to evaluate the wild reared component (see Section 2.3.1). These newly calculated metrics of natural population growth suggest that wild population components have finite growth rates below 1 (declining population) for all 3 SHRU. This new method will be undergoing peer review in the coming year but is described in this report.

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. Spawner surveys in 2020 covered 1,220 units (11%) of 10,900 units of mapped spawning habitat representing a 2% decrease in effort over 2018. Coverage is limited in MMB and PNB habitat but does focus on priority management areas. In the DEC SHRU, redds were found in 21of 72 HUC12s (29%). In the MMB SHRU, redds were found in 15 of 75 HUC12s (20%) and in the PNB SHRU, redds were found in 23 of 148 HUC12s (16%). Overall survey coverage was limited to managed/focal areas so likely underrepresents WPA. This is especially true in PNB SHRU as total escapement was 1,212 adults but redd counts were only 165 due to survey coverage limitations and size of the watershed. Modeling of juvenile production areas from these spawner surveys suggest that of overall juvenile habitat 17% of the DEC SHRU and MMB SHRU will have wild production. This occupancy decreases to 10% in the PNB SHRU. These Wild Production Areas will be buffered from stocking in 2021 to minimize competition between wild and hatchery origin juveniles. In addition, in 2023 these areas will be targeted for broodstock electrofishing efforts in efforts to bring components of wild spawning into the captive reared brood program.

The 2020 assessment also modeled occupied freshwater production habitat in December and summarized the production area from both natural redds (WPA) and geo-referenced stocking locations. For this analysis, we assume that 3 cohorts of fish comprise the standing juvenile fish population (2018, 2019, and 2020). Using this method, we estimated December 2020 mean proportion occupancy for each of the 3 SHRUs at a HUC-12 resolution. While the 3 SHRU vary in size and number of HUC-12 units, the amount of occupied juvenile rearing area is typically between 8,800 to 13,600 units of habitat in each SHRU. Areas with greater than 0.01 occupancy are categorized as occupied. The DEC SHRU with 72 HUC-12 areas had cohort occupancy of between 9,800 and 10,300 units in 21 areas (29%). While still at only modest occupancy, the DEC SHRU has a generally broad distribution of juveniles in the Dennys, East Machias, Machias, Narraguagus, and Pleasant Rivers. The PNB SHRU with 148 HUC-12 areas had cohort occupancy of between 10,300 and 18,400 units in 22 areas (15%). Dispersal was relatively broad but mean proportion occupancy was lower. In addition, changing spatial management focus is notable with

14 HUC12 areas being occupied for all 3 cohorts and 8 being occupied in only 1 of the 3 years. Finally, the MMB SHRU with 75 HUC-12 areas had cohort occupancy of between 12,000 and 13,600 units in 16 areas (21%). The consistent focus on the Sheepscot and Sandy River has led to 12 HUC12 areas being occupied by all 3 cohorts and moderately high proportional occupancy in the core areas.

Genetic diversity of the DPS is monitored through assessment of sea-run adults for the Penobscot River and juvenile parr collections for 6 other populations. Allelic diversity has remained relatively constant since the mid-1990's. However, slight decreases have been detected in the Penobscot and Sheepscot populations. All populations are now above 10 of 18 monitored loci but stabilizing diversity is essential and genetic rescue methods could be further investigated. Estimates of effective population size have increased for the Penobscot, due to increased broodstock targets and equalized broodstock sex ratios, but for the remaining rivers effective population size estimates have either remained constant or slightly decreased. Implementation of pedigree lines have helped to retain diversity following bottleneck (Pleasant) and variable parr broodstock captures (Dennys) by retaining representatives of all hatchery families and supplementing with river-caught parr from fry stocking or natural reproduction. Populations below 100 LDNe are at elevated risk and the upward trajectory of all these populations between 2016 and 2018 should be maintained.

2.2 Population Size

Overall stock health can be measured by comparing monitored adult abundance to management targets. Because juvenile rearing habitat has been measured or estimated accurately, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed the Conservation Limit (CL). These values have been calculated for all US populations. The Conservation Limit for the GoM DPS is 29,192 adults (Atkinson 2020). In self-sustaining populations, the number of returns can frequently exceed this amount by 50–100%, allowing for sustainable harvests and buffers against losses between return and spawning. When calculating the CL for US populations in the context of international assessments by the ICES WGNAS, the metric focuses on only 2SW adult returns (hatchery and natural-reared). The 2SW CL is 22,134. These CL targets represent long-term goals for sustainable population sizes. Adult returns are partitioned into two categories. Hatchery returns are those adult salmon that are a product of an accelerated smolt program or released as fall parr or fall fingerlings. The other category, naturally reared returns are those adult salmon that are a product of natural spawning, egg planting, and fry stocking.

Given the endangered status of GoM Atlantic salmon, the first management target for downlisting from endangered to threatened is 500 naturally reared returns in each of the 3 SHRUs. For delisting, the next target is 2,000 naturally reared returns. This level of abundance is the minimum population required to have a less than 50 percent chance of falling below 500 spawners under another period of low marine survival. Estimates of both abundance and population growth rate can be corrected for the input of hatchery fish, but this requires differentiating between returns of wild origin and egg/fry-stocked salmon. That metric requires genetic determination of parentage, but the ability to adequately sample returning adults on all rivers is limited. The estimate of 2,000 spawners thus serves as a starting point for evaluating population status, but this benchmark and the methods by which it is calculated should be re-evaluated in the future as more data and better methods for partitioning returning adults become available. The threshold of 2,000 wild spawners per SHRU, totaling 6,000 wild spawners annually for the GoM DPS is the current recovery target for delisting.

Because the goal of the GoM DPS Recovery Plan is a wild, self-sustaining population, monitoring (counts and growth rates) of wild fish are desired metrics. However, with extensive and essential conservation hatchery activities (planting eggs and stocking fry and fingerlings), it is currently not feasible to enumerate only wild fish. Initially, NMFS (2009) attempted to minimize bias in estimating abundance (and mean population growth rates) by excluding the Penobscot River due to stocking of hatchery fish (smolts and marked parr). In subsequent years, managers have established an intermediate target – 500 naturally-reared adult spawners (i.e., returning adults originating from wild spawning, egg planting, fry stocking, or fall parr stocking). This is a helpful metric in the short-term to monitor recovery progress of wild fish combined with individuals that have had 20+ months of stream rearing before migrating to sea. However, full recovery will only be achieved with abundance from adult spawners of wild origin. All fish handled at traps are classified as to rearing origin by fin condition and scale analysis. For redd-based estimates, each population is pro-rated on an annual basis using naturally reared to stocked ratios at smolt emigration or other decision matrices to partition naturally reared and stocked returns (USASAC 2020).

Total adult returns to the GoM DPS in 2020 were 1,705 adults with 1,322 hatchery-origin fish returning to the Penobscot, Narraguagus, East Machias, and Sheepscot Rivers (Figure 2.2.1 and Table 2.2.1). Because of the abundance of the PNB SHRU smolt-stocked component, returns to that SHRU dominated (84%) total abundance with 1,439 returns. The additional 126 hatchery returns were documented in the DEC SHRU (115) and Merrymeeting Bay SHRU (11).

Naturally reared returns were also highest in Penobscot Bay at 243 (Table 2.2.1 and Figure 2.2.2). However, the Ducktrap River population had 0 documented returns for the third consecutive year. The 11-year average for this system was 3 adults with 0 returns in 7 of these years. The DEC SHRU had 79 documented naturally reared returns across 6 of 6 monitored river systems while the Merrymeeting Bay SHRU had 61 natural returns to 3 of the 3 monitored systems.

Table 2.2.1. Documented returns from trap and redd-count monitoring for GoM DPS Atlantic salmon by SHRU for return year 2020 and percentage of naturally reared fish relative to the interim 500 fish target (% of 500) by SHRU.

SHRU	Hatchery	Natural	Sub Totals	% of 500
Downeast Coastal	115	79	194	15.8%
Penobscot Bay	1,196	243	1,439	48.6%
Merrymeeting Bay	11	61	72	12.2%
Gulf of Maine DPS	**1,322**	**383**	**1,705**	**-**

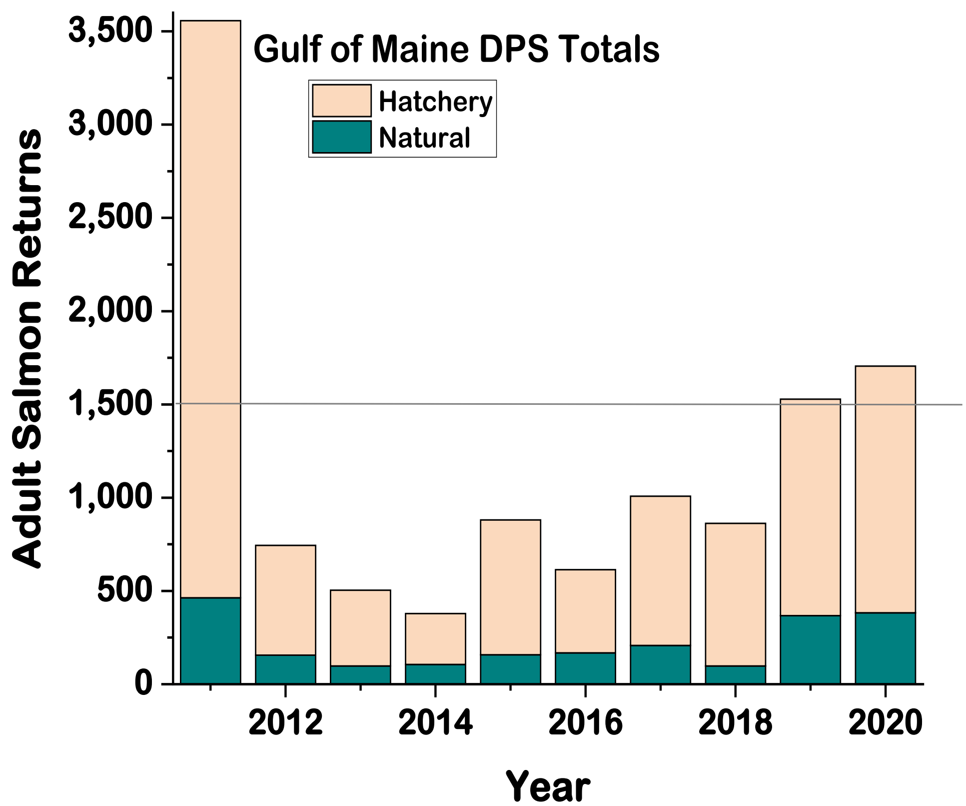

Figure 2.2.1. Time-series of total estimated returns to the GoM DPS of Atlantic salmon for the last decade illustrating the dominance of hatchery-reared origin (parr or smolt stocked; tan bars) Atlantic salmon compared to naturally reared (wild, egg stocked, fry stocked; teal bars) origin. Line at 1,500 represents downlisting level of 500 naturally reared fish per SHRU.

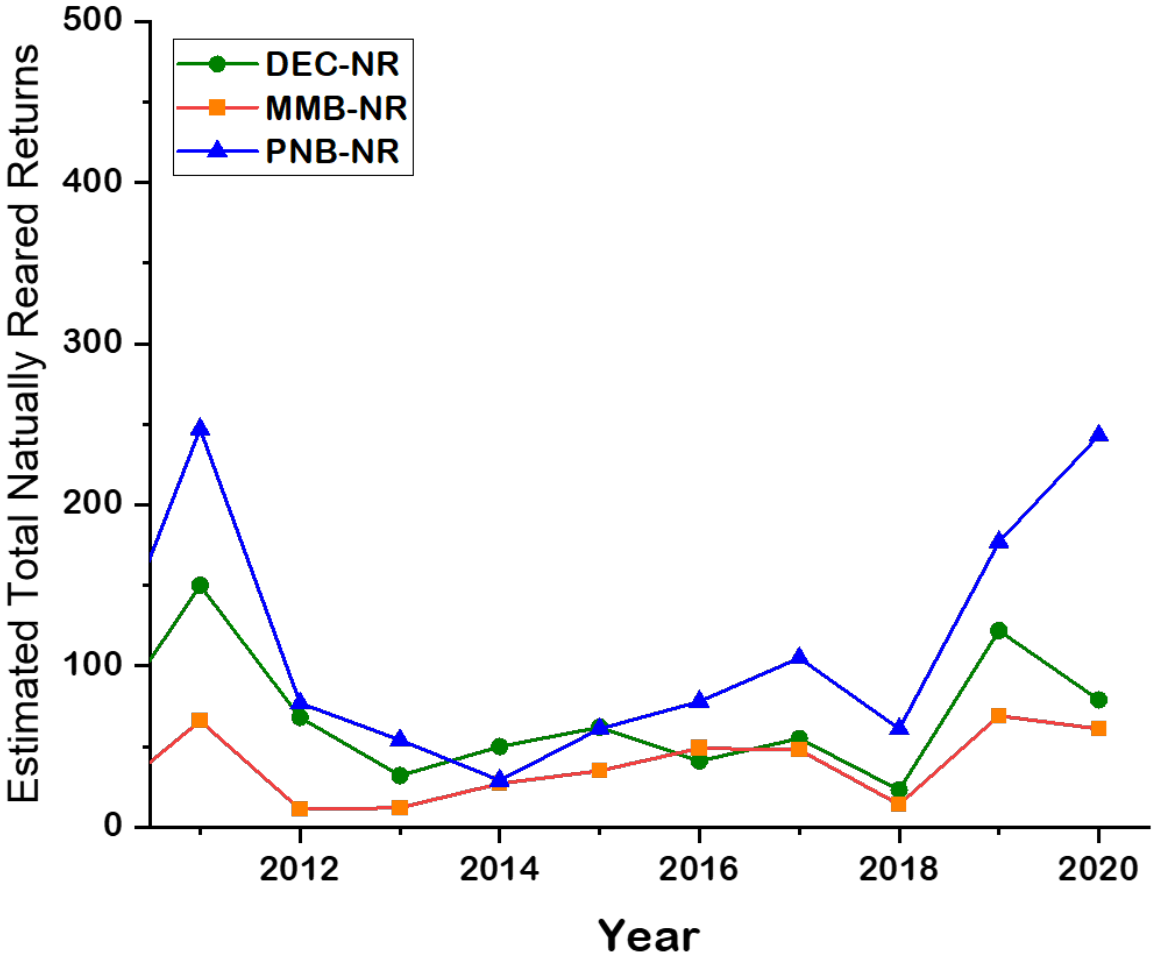

Figure 2.2.2. Time series of last decade of naturally reared adult returns to the Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) SHRUs. Note: naturally reared interim target of 500 natural spawners is maximum axis value.

2.3 Population Growth Rate

Another metric of recovery progress in each SHRU demonstrates a sustained population growth rate indicative of an increasing population. The mean life span of Atlantic salmon is 5 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 (GM_R) population growth rate is calculated as:

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

where GM_R is the geometric mean population growth rate of the most recent 10-year period and Rt is the natural log of the 5-year replacement rate in year t. The 5-year replacement rate in year t is calculated as:

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

where Nt is the number of adult spawners in year t and Nt-5 is the number of adult spawners 5 years prior. Naturally reared adult spawners are counted in the calculation of population growth rate in the current recovery phase (reclassification to threatened) objectives. In the future, only wild adult spawners 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 as a result of declining numbers of returning salmon. 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 2.3.1). In the most recent year (2020) the Merrymeeting Bay SHRU had the highest growth rate (1.71; 95% CI: 1.10 – 2.65) and the Downeast Coastal SHRU had the lowest growth rate (0.94; 95% CI: 0.52 – 1.69) (Table 2.3.1).

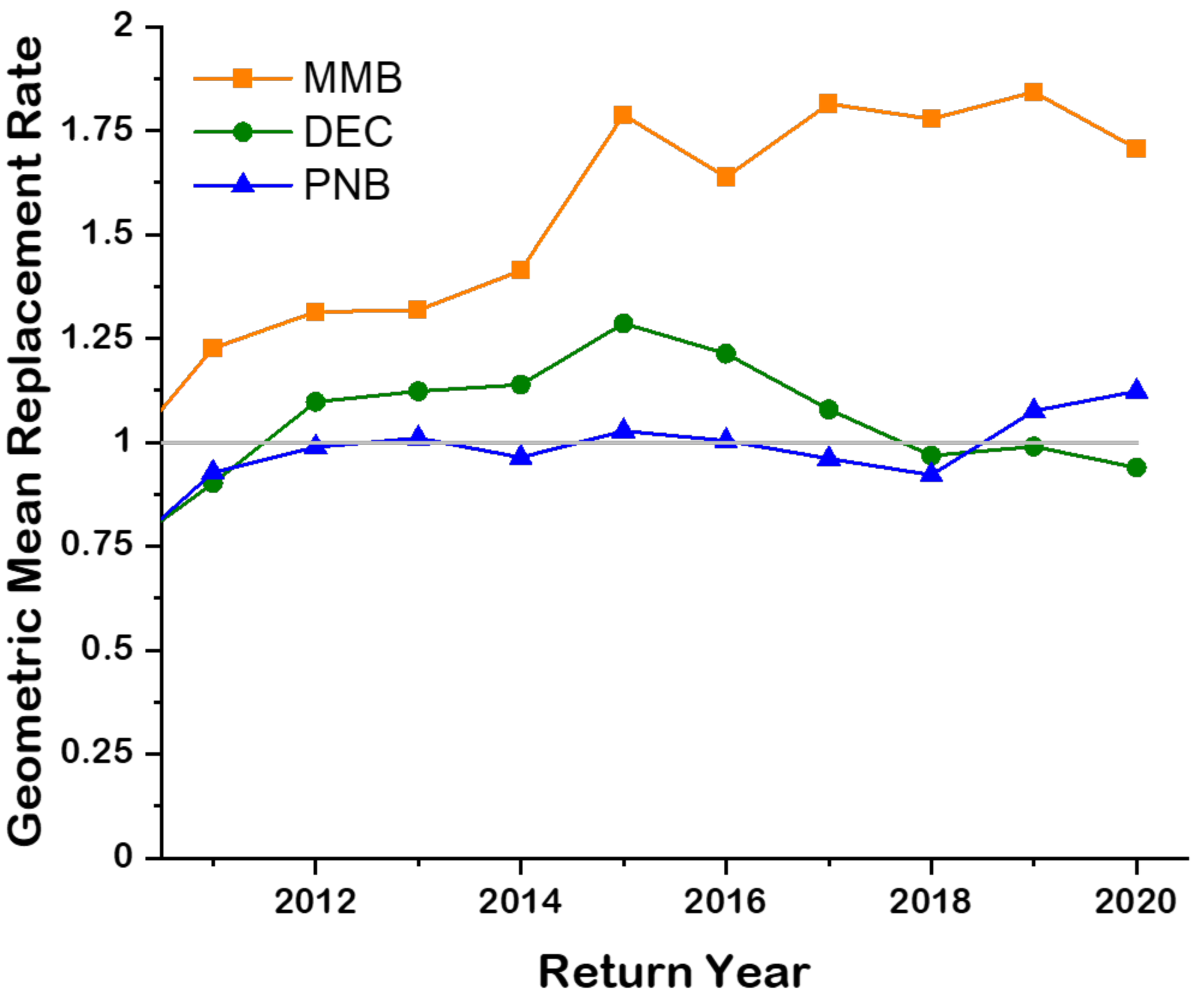

Figure 2.3.1. Annually calculated ten-year geometric mean replacement rates for the GoM DPS of Atlantic salmon for Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) for each SHRU individually for the last decade.

Table 2.3.1. Ten-year geometric mean replacement rates (GM_R) for GoM DPS Atlantic salmon as calculated for 2020 return year with 95% confidence limits (CL).			
SHRU	**GM_R**	**Lower 95% CL**	**Upper 95% CL**
Downeast Coastal	0.94	0.52	1.69
Penobscot	1.12	0.49	2.56
Merrymeeting Bay	1.71	1.10	2.65
Gulf of Maine DPS	**1.12**	**0.60**	**2.09**

The geometric mean population growth rate based on the 5-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 our 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.

2.3.1 Genetic Parentage Analysis

In order to remove this bias and gain an estimate of the true wild population growth rate, we need to be able to discern returns resulting from hatchery inputs from those resulting from natural reproduction in the wild. We can determine if a returning adult salmon was stocked as a parr or smolt through the presence of marks or scale analysis but determining if a returning adult was a result of natural reproduction or stocking at the fry or egg stage is problematic because these life stages are not marked by the time of stocking.

A solution to this problem is to use genetic parentage analysis. All hatchery broodstock are genotyped and matings between individuals in the hatchery are known. By genotyping salmon collected in the wild at later life stages, we can determine if they were the product of a known hatchery mating. If the individual cannot be matched to a known set of parents in the hatchery, it can be assumed that individual is the product of natural spawning. Since we genotype returning adult salmon that are captured in trapping facilities and parr that are collected for future broodstock, we can use parentage analysis of the individuals deemed to be naturally reared to determine the proportion of these individuals that are produced from natural reproduction (truly wild) and the proportion that are the product of fry stocking and/or egg planting. We can then partition the total number of returning adult salmon into true wild versus hatchery components of the population and use analytical methods to gain better estimates of the true wild population growth rates.

Model description

This new method for estimating the wild population growth rate is described by Sweka and Bartron (*manuscript in preparation*) and uses methods described by Holmes (2001) and McClure et al. (2003). Underlying this approach was an exponential decline model (Dennis et al 1991):

$$N_{t+1} = N_t e^{(\mu+\varepsilon)} \qquad [1]$$

where N_{t+1} is the number of salmon at time *t*+1, N_t is the number of salmon at time *t*, μ is the instantaneous population growth rate, and ε is normally distributed error with a mean of 0 and variance of σ^2. Total estimated adult returns were used as input data and were the combination of salmon observed in trapping facilities and salmon estimated from redd surveys. The use of raw return data presents problems when estimating μ because spawners only represent a single life stage and the delay between birth and reproduction can lead to large fluctuations in annual spawner numbers (McClure et al. 2003). Therefore, we used a running sum (R_t) of five consecutive years of spawning counts (S_{t+j-1}) as input data to estimate μ as recommended by Holmes (2001) and Holmes and Fagan (2002).

$$R_t = \sum_{j=1}^{5} \quad S_{t+j-1} \qquad [2]$$

Five consecutive counts were summed together because the majority of Atlantic Salmon in the GoM DPS will return to spawn five calendar years after their parents spawned. The population growth rate ($\hat{\mu}$) was estimated as:

$$\hat{\mu} = mean\left[ln\left(\frac{R_{t+1}}{R_t}\right)\right] \qquad [3]$$

We used a slope method (Holmes 2001; Holmes and Fagan 2002) to gain an estimate of the variance on the population growth rate ($\hat{\sigma}^2$)

$$\hat{\sigma}^2 = slope\ of\ variance\ of\ \left[ln\left(\frac{R_{t+\tau}}{R_t}\right)\right] vs.\tau \qquad [4]$$

for τ = 1,2,3,4, and 5 corresponding to time lags in the life history of Atlantic Salmon from spawning until offspring return to spawn.

The input of hatchery origin fish confounds estimates of the population growth rate (μ). If these hatchery origin fish successfully reproduce and contribute to the next cohort, which is the goal of stocking these hatchery fish, then estimates of μ based on total spawners is overestimated and subsequent extinction risks are underestimated. We estimated μ in two ways: (1) using running sums of total spawners as described in equation [3] (hereafter referred to as $\hat{\mu}_{Total}$) and (2) adjusting for the proportion of hatchery origin fish in the running sums of spawners (McClure et al. 2003; hereafter referred to as $\hat{\mu}_{Wild}$) as

$$\hat{\mu}_{Wild} = mean\left[\frac{1}{T} ln(\widehat{w}_t) + ln\left(\frac{R_{t+1}}{R_t}\right)\right] \qquad [5]$$

where T = an approximate 5 year generation time for Atlantic Salmon and $\widehat{w}_t$= the proportion of the running sum of adult returns that were born in the wild. The value of $\hat{\mu}_{Wild}$ assumes that hatchery fish that survive to spawn, reproduce at the same rate as wild fish and that wild spawners in the time series could have come from either hatchery or wild parents. We can view the value of $\hat{\mu}_{Total}$ as the population growth rate under stocking levels that produced the observed time series of total spawners and the value of $\hat{\mu}_{Wild}$ as the population growth rate of wild fish only, in the absence of stocking.

Input Data

Time series of adult return data were obtained from the U.S. Atlantic Salmon Assessment Committee database. Although the available data extended back to 1967, we restricted the data used in this analysis to 2010 - 2020 which represents the last 10 years of the running sum of adult returns.

Genetic parentage analysis of broodstock taken to the hatchery was used to differentiate wild and hatchery fish within the naturally reared component of returning salmon. Penobscot River broodstock were obtained by trapping adults and transporting them to Craig Brook National Fish Hatchery. Other rivers used a captive broodstock program whereby fish were captured as age 1+ parr in the rivers and transported to Craig Brook National Fish Hatchery for culture until they matured and could be spawned in the hatchery. We make the assumption that the broodstock collected and subsequently analyzed for parentage are representative of all salmon in the natural environment.

Growth rates were estimated for each SHRU and for the GoM DPS as a whole. Therefore, adult returns and the proportion of naturally reared returns that were wild origin were combined among rivers within a SHRU and among all rivers for the entire GoM DPS. Information from parentage analysis to determine the proportion of naturally reared returns that were wild origin was available for spawning runs from 2003 – 2018. In the Penobscot SHRU, the year of broodstock collection and parentage analysis corresponded to the year the adults returned. However, in other SHRUs the year of broodstock collection and parentage analysis did not correspond to the year these fish would have returned as adults because they were collected as parr (mostly age 1). Therefore, we made the assumption that the proportion of naturally reared fish that were wild origin found in the parr collected for broodstock would be the same for fish from these cohorts that remained in the river and would return as sea run adults three years later. [The majority of naturally reared returns in the GoM DPS become smolts at age 2 and return after two winters at sea.] Within this assumption, we assumed that any differential survival between hatchery and wild origin fish took place over the first year of life when the fish were at the fry and age 0 parr stages.

Within a year, the proportion of returns that were wild $(\widehat{w}'_t)$ was estimated as

$$\widehat{w}'_t = \frac{\rho_t S_{NR,t}}{S_{T,t}} \qquad [8]$$

where ρ_t = the proportion of naturally reared returns that were of wild origin as estimated through parentage analysis at time t, $S_{NR,t}$ = the number of naturally reared spawners, and $S_{T,t}$ = the total number of spawners. The number of wild origin returns in year t $\left(S_{W,t}\right)$ was then

$$S_{W,t} = \widehat{w}'_t S_{T,t} \qquad [9]$$

and the number of hatchery origin spawners in year t $(S_{H,t})$ was

$$S_{H,t} = S_{T,t} - S_{W,t} \qquad [10]$$

Results

Instantaneous population growth rates were near 0 and 95% confidence limits overlapped 0 for all SHRUs and the Gulf of Maine as a whole when we include all returning Atlantic salmon regardless of origin. These results indicate neither increasing nor decreasing populations. However, when we account for the proportion of adult returns that were of hatchery origin, all SHRUs had wild population growth rates that were less than 0 with the Penobscot SHRU being the most negative. The reason why the Penobscot SHRU has the lowest population growth rate is because the vast majority of adult returns to this SHRU are of hatchery origin. The negative growth rates for the wild component of these populations indicates that if stocking hatchery origin fish were to cease, these populations would show abrupt declines.

Table 2.3.1. Population growth rates of Atlantic Salmon in the GoM DPS estimated by the running sum method for both the total population and the wild component. Growth rates are presented as both instantaneous (μ) and finite (λ) rates. Numbers in parentheses represent 95% confidence limits.

SHRU	**μ_{total}**	**μ_{wild}**	**λ_{total}**	**λ_{wild}**
Downeast Coastal	0.0350 (-0.0320, 0.1021)	-0.2455 (-0.3125, -0.1784)	1.0356 (0.9685, 1.1075)	0.7823 (0.7316, 0.8366)
Penobscot	-0.0396 (-0.1798, 0.1005)	-0.6244 (-0.7645, -0.4842)	0.9611 (0.8354, 1.1058)	0.5356 (0.4655, 0.6162)
Merrymeeting Bay	0.0161 (-0.0310, 0.0631)	-0.2849 (-0.3320, -0.2378)	1.0162 (0.9695, 1.0652)	0.7506 (0.7175, 0.7883)
Gulf of Maine	**-0.0315** **(-0.1594, 0.0964)**	**-0.5546** **(-0.6824, -0.5054)**	**0.9690** **(0.8527, 1.1011)**	**0.5743** **(0.5054, 0.6527)**

2.4 Spatial Structure of DPS

For the GoM DPS, a sustained census population of 500 naturally reared adult spawners (assuming a 1:1 sex ratio) in each SHRU was chosen to represent the effective population size for down listing to threatened. In 2020, none of the three SHRUs approached this level of spawning in the wild. Trap counts provide some insights into the spatial structure of spawners at a watershed level, but the details provided by redd counts during spawner surveys enhance our understanding of escapement and wild production at a finer geographic scale. Spawning was documented in all three SHRUs and monitoring of both spawning activity and conservation hatchery supplementation programs allow an informative evaluation of habitat occupancy and juvenile production potential.

We evaluated the spatial structure of juvenile production by modeling occupancy at a sub drainage level - USGS Hydrologic Unit Codes (HUC)-12 level - to describe recruitment at a spatial scale proposed to better manage critical habitat. This evaluation informs managers relative to the most likely habitats where wild spawning or juvenile stocking has produced freshwater production cohorts. These summaries provide visual products to better evaluate production habitat use at a SHRU level while also providing quantitative estimates of occupancy in Critical Habitat management areas. These evaluations can assist in evaluation of the spatial structure of production and set expectation for natural-reared production based on modelled habitat use.

Our spatial assessment objectives this year were to 1) calculate first-year salmon distribution for wild production of spawners in 2020 and 2) visualize and quantify distribution of the likely juvenile distributions of 3 freshwater production cohorts across watersheds. These evaluations provide metrics to measure the relative impact of wild spawning and supplementation in each of the three SHRUs. This is the first year this method has been applied to multiple cohorts and should be considered provisional. This approach is evolving to provide a tool to allow a better understanding of spatial drivers and relative contributions of wild and stocked production on pre-smolt populations. Our goal was to further develop and vet these summary metrics as tools to both investigate both gaps in assessment data and inform hatchery stocking practices to reduce interactions between wild-spawned and hatchery fish. Overall, improved spatial data should help managers understand production shortfalls (wild and hatchery supplementation) to better optimize natural smolt production across critical habitat at a watershed level.

2.4.1 Wild Production Areas – Redd Distributions and the 2020 Cohort

Spawner surveys in 2020 covered 1,220 units (11%) of 10,900 units of surveyed spawning habitat (see Section 5). This coverage is similar to previous years since surveys are limited to managed drainages. Given the low spawner escapement relative to available habitat, monitoring is limited in MMB and PNB habitat but focused on priority management areas. In the DEC SHRU where redd surveys consistently exceed 80% coverage, estimates of wild production areas more accurately represent overall production. In MMB, redd counts generally capture expected redds related to documented escapement and likely closely represent overall wild production. In PNB, escapement and redd surveys are more variable and spawning areas are expansive and not well described nor well surveyed. As such, while provided for context, the PNB occupancy maps underrepresent wild production.

The geolocation of redds in 2020 were used to document Wild Production Areas (WPA) of the 2021-yearclass in these river systems. The spatial extent of WPA assumes an upstream distribution of juveniles of 0.5 km upstream and 1 km downstream (including tributary streams). In the DEC SHRU, redds were found in 21 of 72 HUC12s (29%). Within these 21 areas over, 38% of total rearing habitat (9,753 units) was documented as WPA. Within a HUC-12 the proportion occupancy ranged from 0 to 0.67 (Figure 2.4.1.1; Table 2.4.1.1) In the MMB SHRU, redds were found in 15 of 75 HUC12s (20%) and within these areas proportion occupancy ranged from 0 to 0.73. Although overall survey coverage was incomplete, coverage of actively managed areas was high. Within these 15 areas over, 38% of total rearing habitat (13,458 units) was documented as WPA. In the PNB SHRU, redds were found in 23 of 148 HUC12s (16%) and overall survey coverage was limited and likely underrepresents WPA.

These WPA will be buffered from stocking in 2021 to minimize competition between wild and hatchery origin juveniles. In addition, in 2023 these areas will be targeted for broodstock collection during electrofishing efforts to bring components of wild spawning into the captive reared brood program.

Table. 2.4.1. Estimates of total juvenile nursery habitat units (100 m2) occupied by wild Atlantic salmon in the 2021 cohort determined from 2020 spawning surveys.

SHRU	Total Habitat Units (# HUC12s)	Total Habitat in WPA with redds (#HUC12s)	WPA 2021 Cohort	% Occupied WPA in HUC12 with Redds	% Occupied WPA all HUC12
Downeast Coastal	57,634 (72)	25,769 (21)	9,753	38%	17%
Merrymeeting Bay	138,710 (75)	28,167 (15)	13,458	38%	17%
Penobscot Bay	238,008 (148)	52,273 (23)	15,072	48%	10%
Totals	434,353 (295)	106,209 (59)	38,283	36%	9%

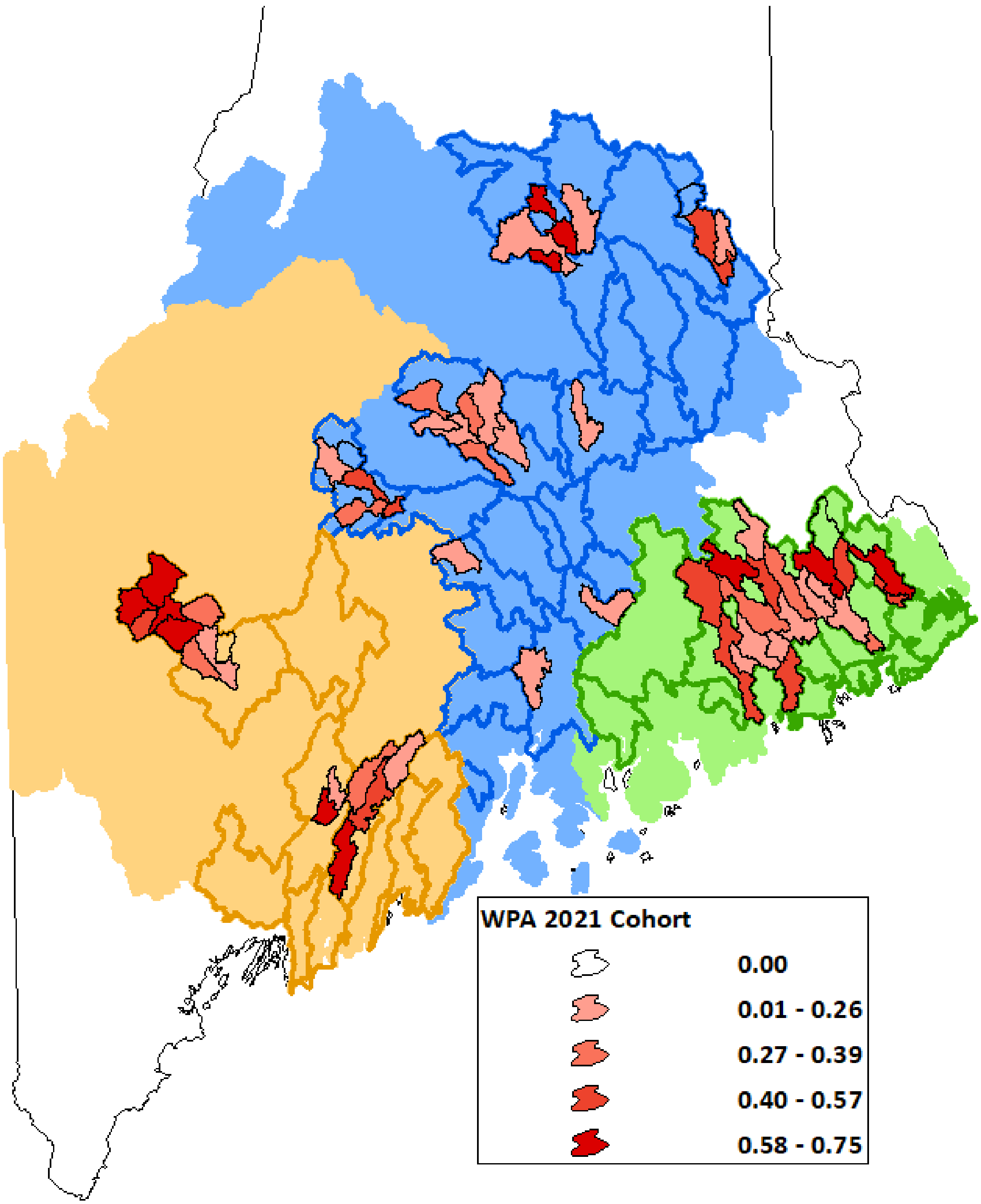

Figure 2.4.1.1 Map highlighting wild production for the 2021 cohort in individual HUC 12 areas where redds were documented and redd dispersion was modeled to indicate occupancy (fish present or absent). For example, for 100 units of habitat, if the distribution model predicted fish in 15 units – proportion occupancy would be 0.15.

2.4.2 Freshwater Cohorts and Hatchery Production Units

An important element of GoM DPS Atlantic salmon populations is their dependence on conservation hatcheries (Legault 2005). Since most US salmon are products of stocking, it is important to understand the magnitude, types, and spatial distribution of these inputs to understand juvenile spatial structure throughout Critical Habitat. Atlantic salmon hatcheries are operated by the FWS and the Downeast Salmon Federation (DSF). All egg takes occur at FWS facilities operating as conservation hatcheries that collect fish from remnant local stocks within the GoM DPS and produce products 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 production. For example, the Sandy River in the MMB SHRU has received donor stocking from the Penobscot and Dennys Rivers populations. From a management perspective, rebuilding Atlantic salmon populations will require increasing natural production of smolts in all available Critical Habitat (Recovery Plan). This management is focused on best use of hatchery production to optimally maintain population diversity, habitat occupancy, and effective population sizes. Examining the spatial contributions of multiple cohorts provides insights into likely gaps in freshwater production and where they occur on the landscape. This will provide an information base to further examine fish dispersal, optimal production areas, and site-specific stocking targets. Ultimately, these data should inform targeted management at a more refined spatial scale than an entire watershed and facilitate sub-drainage (HUC12) management.

The goal of this spatial analysis is to visualize and assess freshwater production at a HUC-12 level. This composite of freshwater production comes from a GIS Analysis of wild production from redds combined with naturally reared production resulting from spatially explicit stocking data for egg-planted, fry stocked, or parr stocked juveniles. This freshwater production yields both wild and naturally reared smolts that are an important conservation tool because these supplementation methods are designed to minimize selection for hatchery traits at the juvenile stage. Analyses show that these wild and naturally reared smolts typically have a higher (4-7 times) marine survival rate than hatchery reared smolts. The numbers of hatchery fish released, and eggs planted in the GoM DPS are presented in Section 5. The focus here is on the distribution of these fish throughout critical habitat and providing insights on densities relative to optimizing habitat use.

For the 2020 assessment, we modeled the occupied freshwater production habitat in December. This summary was based on production from both natural redds (WPA) and geo-referenced stocking locations. For this analysis, we assume that 3 cohorts of fish comprise the overall freshwater population. Numerically most juveniles would be age-0 (2020 cohort). By biomass, age-1 (2019 cohort) fish would dominate as they comprise most of the pre-smolt population and would be the second most abundant age class. Finally, a smaller number of age-2 (2018 cohort) fish would make up the balance of the river population. Occupancy was estimated by geospatial documentation of both WPA and egg planting and juvenile stocking for each cohort through November 2020. All input data were georeferenced and the Atkinson-Kocik occupancy model was used to document dispersal rates (Working Paper in Progress). We are continuing to develop these methods and metrics. As noted above, the spatial extent of WPA assumed an upstream distribution of juveniles of 0.5 km upstream and 1 km downstream (including tributary streams). Similar dispersions were calculated for all hatchery products as well. These hatchery production areas are Egg Planted Production Areas (EPA) that are based on point positions of artificial redds and similar diffusion models as WPA. For Fry or Parr stocked production areas (FPA or PPA), these areas are based on linear distances stocked and a similar diffusion model from both the upstream stocking point and downstream end of the reach. By combining all these production areas, we can estimate both occupancy and the amount of vacant CH (vacant CH = total CH – WPA – EPA- FPA-PPA). These values should be considered minimal occupancy areas because: not all redds are counted, assumptions on dispersion while well supported in literature and local data, need additional study, and weighting of redd survey areas needs further refinement.

Using this method, we estimated December 2020 mean proportion occupancy for each of the 3 SHRUs at a HUC-12 resolution (Figure 2.4.2.1). While the 3 SHRU vary in size and number of HUC-12 units, the amount of occupied juvenile rearing area is typically between 8,800 to 13,600 units of habitat in each SHRU. The DEC SHRU with 72 HUC-12 areas had cohort occupancy of between 9,800 and 10,300 units in 21 areas (29%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1). While still at only modest occupancy, the DEC SHRU has a generally broad distribution of juveniles in the Dennys, East Machias, Machias, Narraguagus, and Pleasant Rivers. The PNB SHRU with 148 HUC-12 areas had cohort occupancy of between 10,300 and 18,400 units for the 3 cohorts in 22 areas (15%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1.). Dispersal was relatively broad but mean proportion occupancy was lower (Figure 2.4.2.1). In addition, changing management focus is notable with 14 HUC12 areas being occupied for all 3 cohorts and 8 being occupied in only 1 of the 3 years. Finally, the MMB SHRU with 75 HUC-12 areas had cohort occupancy of between 12,000 and 13,600 units in 16 areas (21%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1). The consistent focus on the Sheepscot and Sandy River has led to 12 HUC12 areas being occupied by all 3 cohorts and moderately high proportional occupancy in the core areas.

By organizing these data spatially, the Stock Assessment Team is providing a resource to further refine occupancy by targeting areas to conduct juvenile assessments and to further refine density and dispersion measures. Until there is significantly more wild production and/or greatly increased hatchery that would allow complete use of all HUC12 units in critical habitat, it is important to look at juvenile production spatially to examine effort and approaches to supplementation to maximize smolt production. This can be accomplished by considering production density at a HUC12 level and projecting climate impacts on habitats and distinct individual populations. The next steps of spatial stock assessment will work towards integrating density based on historic electrofishing and other sources. Independent efforts to look at climate resilience could then be merged with this spatial assessment to better manage Atlantic salmon habitat, hatchery supplementation, and passage priorities to support salmon conservation now and in the future.

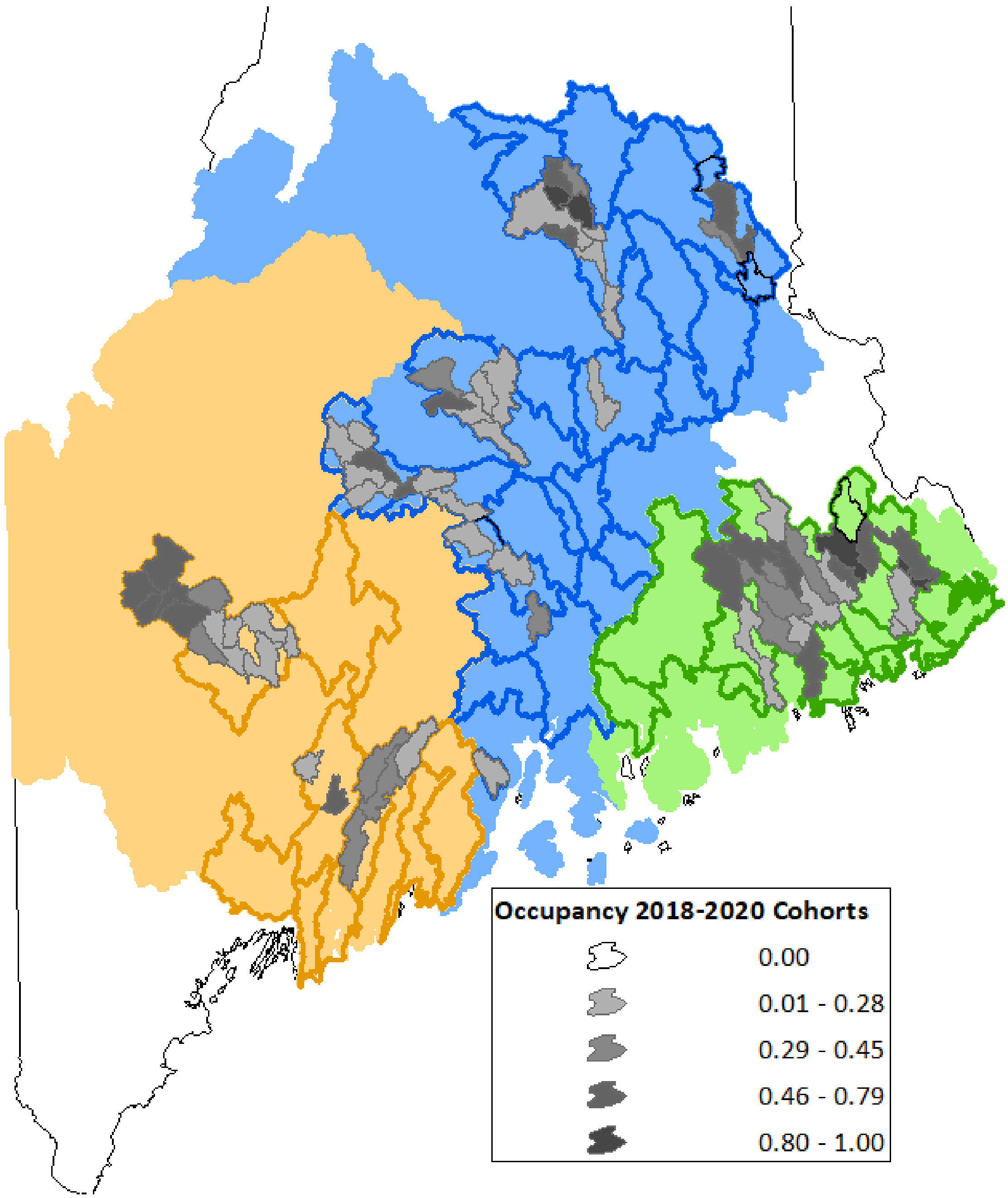

Figure 2.4.2.1 Map highlighting the relative proportion of river habitat occupied (see figure legend) by the 2018, 2019 and 2020 cohorts at a HUC-12 watershed summary level. Production is a synthesis of modeled distributions from spawning surveys of Atlantic salmon in the autumn proceeding the cohort year, cohort year egg planting, and fry and parr stocking.

2.5 Genetic Diversity

As part of the Atlantic salmon recovery program, maintenance of genetic diversity is a critical component of the process. Genetic diversity for the Atlantic salmon program is monitored through assessment of collected broodstock from the wild, 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 (N_e) 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 N_e, 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 N_e 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 N_e for a population. In Atlantic salmon, Palstra et al. (2009) identified a range of N_e to N ratios from 0.03 to 0.71, depending on life history and demographic characteristics of populations. Assuming a N_e to N ratio of 0.2 for recovery planning, the N_e for a GoM DPS of Atlantic salmon population should be approximately equal to the average annual spawner escapement, assuming a generation length of 5 years. Although precocious male parr can reproduce and therefore 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.

For the GoM DPS our diversity goals are to 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 8 extant stocks, 7 are in the conservation hatchery program. The Penobscot River is supported by capture of returning sea-run adult broodstock at Milford Dam, which are transported to Craig Brook National Fish Hatchery for spawning. A domestic broodstock, maintained at Green Lake National Fish Hatchery, also supports production in the Penobscot River, and is created annually by offspring from the spawned sea-run adults at Craig Brook National Fish Hatchery. Six other populations have river-specific broodstocks, maintained by parr-based broodstocks, comprising offspring resulting from natural reproduction which may occur, or primarily recapture of stocked fry.

2.5.1 Allelic Diversity

A total of 18 variables, microsatellite loci are used to characterize genetic diversity for all individuals considered for use in broodstocks (Figure 2.5.1.1). 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 Craig Brook NFH. Individuals represent those to be used for broodstock purposes following screening of any individuals to be removed based on screening to remove potential aquaculture origin individuals, or landlocked Atlantic salmon. Annual characterization allows for comparison of allelic diversity between broodstocks, and over time. A longer time series allows for comparison of allelic diversity from the mid 1990's, but with a subset of 11 of the 18 loci. For this report, evaluating allelic diversity based on 18 loci, between 2008 and 2018 collection years (or from 2008 to 2020 in the case of the Penobscot broodstock), the average number of alleles per locus ranged from 10.69 alleles per locus for the Pleasant River to 13.44 alleles per locus for the Penobscot River.

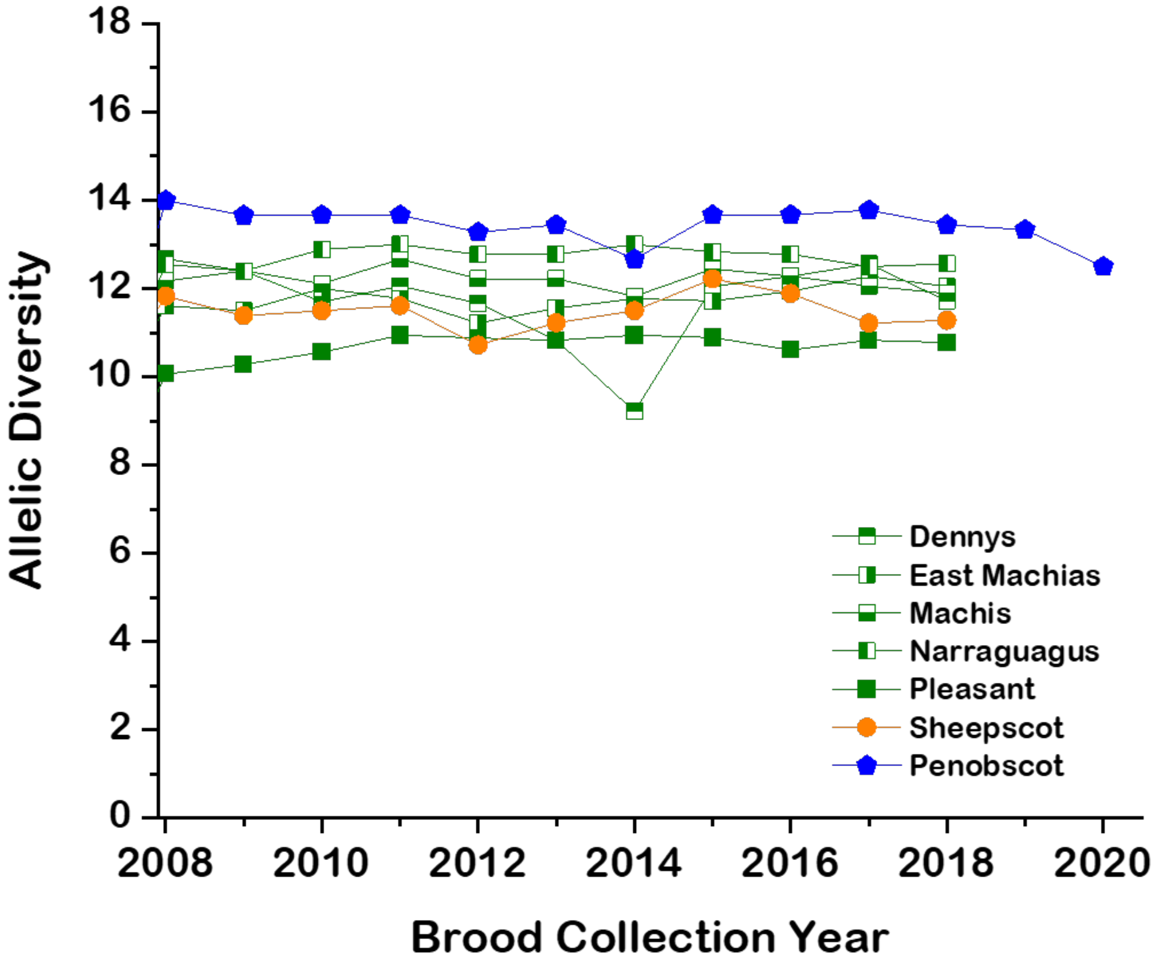

Figure 2.5.1.1. Allelic diversity time series for GoM DPS salmon populations, measured from 18 microsatellite loci. purposes (DE- Dennys, EM-East Machias, MA- Machias, NA-Narraguagus, PN-Penobscot, PL-Pleasant, SH-Sheepscot populations).

2.5.2 Observed and Expected Heterozygosity

Observed and expected heterozygosity is estimated for each broodstock. For the 2018 collection year parr broodstock and 2020 collection year Penobscot adult returns, average estimates starting in 2008 of expected heterozygosity based on 18 microsatellite loci ranged from 0.67 in the East Machias to 0.688 for the Penobscot broodstock. Observed heterozygosity estimates based on 18 loci ranged from 0.676 in the Machias to 0.707 in the Penobscot broodstock.

2.5.3 Effective Population Size

Estimates of effective population size, based on 18 loci, varies both within broodstocks over time, and between broodstocks (Figure 2.5.3.1). Estimates are obtained using the linkage disequilibrium method which 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 N_e from the 2018 collection year was estimated for the Dennys broodstock (N_e =44.6, 36.6-54.5 95% CI), and the highest was observed in the Narraguagus broodstock (N_e =137.6 (110.4-176.0 95% CI). N_e estimates fluctuate annually, so beginning with 2008, average N_e across the parr-based broodstocks ranges from N_e=69.1 in the Dennys to N_e =143.6 in the Narraguagus. Within the Penobscot River, adult broodstocks typically include three to four year classes (including grilse). N_e estimates for the Penobscot since 2008 have ranged from maximum N_e =546.5 (465.8-650.7 95% CI) in 2017 to the low N_e =287.6 in 2009 (265.7-312.0 95% CI), with an average N_e =417.3. The N_e estimate for the 2020 return the broodstock N_e = 417.9 (302.3-644.2 95% CI).

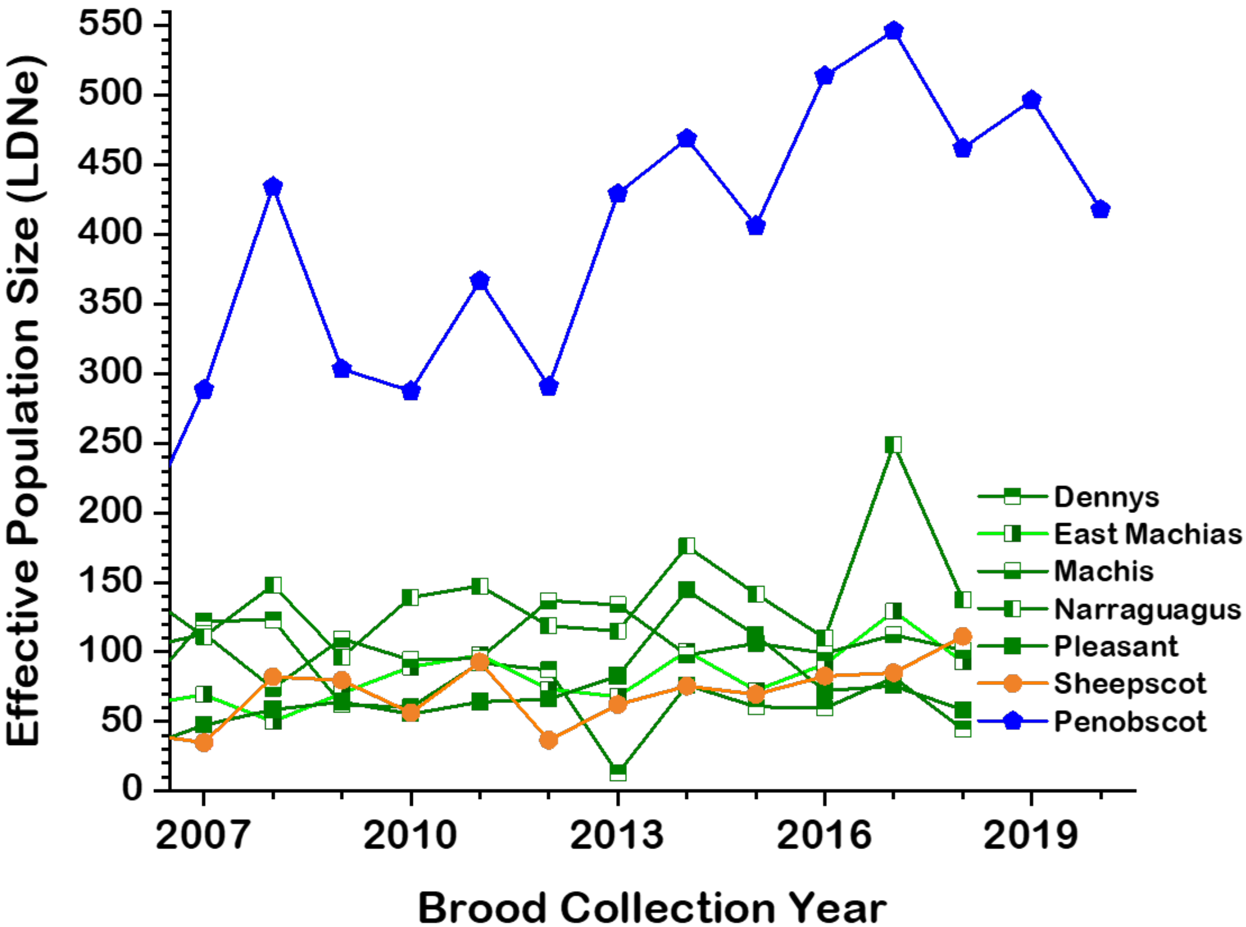

Figure 2.5.3.1. Time series of effective population size for 7 GoM DPS distinct individual populations. Estimates for the parr-based broodstock populations approximate the number of breeders, since estimates are obtained from primarily a single cohort, and are sampled as juveniles (parr), from each river. Estimates of effective population size for the Penobscot broodstock are obtained from returning

adults in a given year to the Penobscot River, and represent multiple cohorts (DE- Dennys, EM-East Machias, MA- Machias, NA-Narraguagus, PN-Penobscot, PL-Pleasant, SH-Sheepscot populations).

2.6 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 effective population 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 1990's, although there are concerns about slightly lower estimates of allelic diversity in the Sheepscot and Pleasant relative to the other broodstocks. 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 should continue to be monitored, as it indicates that populations are at a risk for loss of genetic diversity.

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3 Viability Assessment - Gulf of Maine Atlantic Salmon

3.1 Overview of DPS and Annual Viability Synthesis

3.1.1 Change in Status Assessment Approach

While this report summarizes, all U.S. populations related to metrics and general trends to national reporting needs in support of NASCO (e.g., Chapter 1), these populations are now dominated by the endangered Gulf of Maine Distinct Population Segment (GoM DPS) in Maine. Section 2 summarizes the more detailed metrics needed to monitor the health of these populations using metrics used for other endangered salmonids in the U.S. 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). Taking this approach allows US stock assessment scientists to integrate an annual GoM DPS assessment within the overall US assessment making more effective use of staff resources. Integrating this annual reporting (required under 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. This section is meant to be a brief annual summary not a benchmark 5-year viability assessment. A benchmark assessment will be produced in a future assessment cycle.

3.1.2 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). There are three Major Population Groupings (MPG) referred to as Salmon Habitat Recovery Units (SHRUs) for the GoM DPS (NMFS 2009) based on watershed similarities and remnant population structure. The three SHRUs are Downeast Coastal (DEC), Penobscot Bay (PNB), and Merrymeeting Bay (MMB). The GoM DPS critical habitat ranges from the Dennys River southward to the Androscoggin River (NMFS 2009).

At the time of listing, nine distinct individual populations (DIPs) were identified. In the DEC SHRU, there were five extant DIPs in the Dennys, East Machias, Machias, Pleasant and Narraguagus Rivers. In the PNB SHRU, there were three - Cove Brook, Ducktrap River, and mainstem Penobscot. In the MMB SHRU there was one DIP in the Sheepscot River. Of these nine populations, seven of them are supported by conservation hatchery programs. These hatchery programs propagate wild-exposed parr or returning adults to increase effective spawning populations. Cove Brook and the Ducktrap River DIPs were not supplemented.

Because conservation hatchery activities play a major role in fish distribution and recovery, a brief synopsis is included in the boundary delineation. The core conservation hatchery strategy for six of these DIPs is broodstock collected primarily from wild-exposed or truly wild parr collections. These juveniles are then raised to maturity in a freshwater hatchery. All five extant DEC DIPs (Dennys, East Machias, Machias, Pleasant, and Narraguagus) are supported using this approach as well as the Sheepscot DIP in the MMB SHRU. For the mainstem Penobscot, the primary hatchery strategy is collection of sea-run adult broodstock that are a result of smolt stocking (85% or more of adult collections) or naturally reared or wild returns. For the Ducktrap River population, no conservation hatchery activities were implemented. In general, DIPs are stocked in their natal river. However, because there are expansive areas of Critical Habitat that are both vacant and of high production quality, these seven populations (primarily the Penobscot) can serve as donor stocks for other systems, especially the Kennebec River in MMB SHRU and Cove Brook within the PNB SHRU (native population was extirpated in 2009).

3.1.3 Synthesis of 2020 Viability Assessment

Totaling 1,705 estimated adult returns to the GoM DPS, the 2020 spawning run was the 8^{th} highest return since 1991. Of these 1,322 (78%) of returns were of hatchery-stocked smolt origin. Naturally reared returns remained low across the GoM DPS (383) but were above 200 in PNB and above 50 in DEC and MMB SHRUs. About 63% of naturally reared returns were documented in the PNB SHRU. Abundance remains critically low relative to interim recovery targets of 500 naturally reared returns per SHRU. The PNB SHRU was at 49% of this target, 4-fold higher than returns to the MMB SHRU (16%). The populations in the DEC SHRU were estimated at 79 naturally reared returns (21%). With no documented returns in 2020, the Ducktrap DIP in PNB is at an elevated extirpation risk with returns documented in only 4 of the last 11 years.

Population growth is monitored by 10-year geometric mean population growth rates of naturally reared adults as per recovery plan criteria. The GoM DPS rate for 2020 returns was 1.12 (95% CL 0.60-2.09); because error bounds around this rate overlap 1.0, this indicates relative stability. 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 natural reproduction in the wild but products of the US hatchery system (e.g., stocked fry and planted eggs). As such, the inclusion of hatchery products in the 10-year geometric mean replacement rate overestimates wild population growth rate. New methods are under development to evaluate the wild reared component (see Section 2.3.1). These newly calculated metrics of natural population growth suggest that wild population components have finite growth rates below 1 (declining population) for all 3 SHRU. This new method will be undergoing peer review in the coming year but is described in this report.

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. Spawner surveys in 2020 covered 1,220 units (11%) of 10,900 units of mapped spawning habitat representing a 2% decrease in effort over 2018. Coverage is limited in MMB and PNB habitat but does focus on priority management areas. In the DEC SHRU, redds were found in 21of 72 HUC12s (29%). In the MMB SHRU, redds were found in 15 of 75 HUC12s (20%) and in the PNB SHRU, redds were found in 23 of 148 HUC12s (16%). Overall survey coverage was limited to managed/focal areas so likely underrepresents WPA. This is especially true in PNB SHRU as total escapement was 1,212 adults but redd counts were only 165 due to survey coverage limitations and size of the watershed. Modeling of juvenile production areas from these spawner surveys suggest that of overall juvenile habitat 17% of the DEC SHRU and MMB SHRU will have wild production. This occupancy decreases to 10% in the PNB SHRU. These Wild Production Areas will be buffered from stocking in 2021 to minimize competition between wild and hatchery origin juveniles. In addition, in 2023 these areas will be targeted for broodstock electrofishing efforts in efforts to bring components of wild spawning into the captive reared brood program.

The 2020 assessment also modeled occupied freshwater production habitat in December and summarized the production area from both natural redds (WPA) and geo-referenced stocking locations. For this analysis, we assume that 3 cohorts of fish comprise the standing juvenile fish population (2018, 2019, and 2020). Using this method, we estimated December 2020 mean proportion occupancy for each of the 3 SHRUs at a HUC-12 resolution. While the 3 SHRU vary in size and number of HUC-12 units, the amount of occupied juvenile rearing area is typically between 8,800 to 13,600 units of habitat in each SHRU. Areas with greater than 0.01 occupancy are categorized as occupied. The DEC SHRU with 72 HUC-12 areas had cohort occupancy of between 9,800 and 10,300 units in 21 areas (29%). While still at only modest occupancy, the DEC SHRU has a generally broad distribution of juveniles in the Dennys, East Machias, Machias, Narraguagus, and Pleasant Rivers. The PNB SHRU with 148 HUC-12 areas had cohort occupancy of between 10,300 and 18,400 units in 22 areas (15%). Dispersal was relatively broad but mean proportion occupancy was lower. In addition, changing spatial management focus is notable with 14 HUC12 areas being occupied for all 3 cohorts and 8 being occupied in only 1 of the 3 years. Finally, the MMB SHRU with 75 HUC-12 areas had cohort occupancy of between 12,000 and 13,600 units in 16 areas (21%). The consistent focus on the Sheepscot and Sandy River has led to 12 HUC12 areas being occupied by all 3 cohorts and moderately high proportional occupancy in the core areas.

Genetic diversity of the DPS is monitored through assessment of sea-run adults for the Penobscot River and juvenile parr collections for 6 other populations. Allelic diversity has remained relatively constant since the mid-1990's. However, slight decreases have been detected in the Penobscot and Sheepscot populations. All populations are now above 10 of 18 monitored loci but stabilizing diversity is essential and genetic rescue methods could be further investigated. Estimates of effective population size have increased for the Penobscot, due to increased broodstock targets and equalized broodstock sex ratios, but for the remaining rivers effective population size estimates have either remained constant or slightly decreased. Implementation of pedigree lines have helped to retain diversity following bottleneck (Pleasant) and variable parr broodstock captures (Dennys) by retaining representatives of all hatchery families and supplementing with river-caught parr from fry stocking or natural reproduction.

Populations below 100 LDNe are at elevated risk and the upward trajectory of all these populations between 2016 and 2018 should be maintained.

3.2 Population Size

Overall stock health can be measured by comparing monitored adult abundance to management targets. Because juvenile rearing habitat has been measured or estimated accurately, these data can be used to calculate target spawning requirements from required egg deposition. The number of returning Atlantic salmon needed to fully utilize all juvenile rearing habitats is termed the Conservation Limit (CL). These values have been calculated for all US populations. The Conservation Limit for the GoM DPS is 29,192 adults (Atkinson 2020). In self-sustaining populations, the number of returns can frequently exceed this amount by 50–100%, allowing for sustainable harvests and buffers against losses between return and spawning. When calculating the CL for US populations in the context of international assessments by the ICES WGNAS, the metric focuses on only 2SW adult returns (hatchery and natural-reared). The 2SW CL is 22,134. These CL targets represent long-term goals for sustainable population sizes. Adult returns are partitioned into two categories. Hatchery returns are those adult salmon that are a product of an accelerated smolt program or released as fall parr or fall fingerlings. The other category, naturally reared returns are those adult salmon that are a product of natural spawning, egg planting, and fry stocking.

Given the endangered status of GoM Atlantic salmon, the first management target for downlisting from endangered to threatened is 500 naturally reared returns in each of the 3 SHRUs. For delisting, the next target is 2,000 naturally reared returns. This level of abundance is the minimum population required to have a less than 50 percent chance of falling below 500 spawners under another period of low marine survival. Estimates of both abundance and population growth rate can be corrected for the input of hatchery fish, but this requires differentiating between returns of wild origin and egg/fry-stocked salmon. That metric requires genetic determination of parentage, but the ability to adequately sample returning adults on all rivers is limited. The estimate of 2,000 spawners thus serves as a starting point for evaluating population status, but this benchmark and the methods by which it is calculated should be re-evaluated in the future as more data and better methods for partitioning returning adults become available. The threshold of 2,000 wild spawners per SHRU, totaling 6,000 wild spawners annually for the GoM DPS is the current recovery target for delisting.

Because the goal of the GoM DPS Recovery Plan is a wild, self-sustaining population, monitoring (counts and growth rates) of wild fish are desired metrics. However, with extensive and essential conservation hatchery activities (planting eggs and stocking fry and fingerlings), it is currently not feasible to enumerate only wild fish. Initially, NMFS (2009) attempted to minimize bias in estimating abundance (and mean population growth rates) by excluding the Penobscot River due to stocking of hatchery fish (smolts and marked parr). In subsequent years, managers have established an intermediate target – 500 naturally-reared adult spawners (i.e., returning adults originating from wild spawning, egg planting, fry stocking, or fall parr stocking). This is a helpful metric in the short-term to monitor recovery progress of wild fish combined with individuals that have had 20+ months of stream rearing before migrating to sea. However, full recovery will only be achieved with abundance from adult spawners of wild origin. All fish handled at traps are classified as to rearing origin by fin condition and scale analysis. For redd-based estimates, each population is pro-rated on an annual basis using naturally reared to stocked ratios at smolt emigration or other decision matrices to partition naturally reared and stocked returns (USASAC 2020).

Total adult returns to the GoM DPS in 2020 were 1,705 adults with 1,322 hatchery-origin fish returning to the Penobscot, Narraguagus, East Machias, and Sheepscot Rivers (Figure 2.2.1 and Table 2.2.1). Because of the abundance of the PNB SHRU smolt-stocked component, returns to that SHRU dominated (84%) total abundance with 1,439 returns. The additional 126 hatchery returns were documented in the DEC SHRU (115) and Merrymeeting Bay SHRU (11).

Naturally reared returns were also highest in Penobscot Bay at 243 (Table 2.2.1 and Figure 2.2.2). However, the Ducktrap River population had 0 documented returns for the third consecutive year. The 11-year average for this system was 3 adults with 0 returns in 7 of these years. The DEC SHRU had 79 documented naturally reared returns across 6 of 6 monitored river systems while the Merrymeeting Bay SHRU had 61 natural returns to 3 of the 3 monitored systems.

Table 2.2.1. Documented returns from trap and redd-count monitoring for GoM DPS Atlantic salmon by SHRU for return year 2020 and percentage of naturally reared fish relative to the interim 500 fish target (% of 500) by SHRU.

SHRU	**Hatchery**	**Natural**	**Sub Totals**	**% of 500**
Downeast Coastal	115	79	194	15.8%
Penobscot Bay	1,196	243	1,439	48.6%
Merrymeeting Bay	11	61	72	12.2%
Gulf of Maine DPS	**1,322**	**383**	**1,705**	**-**

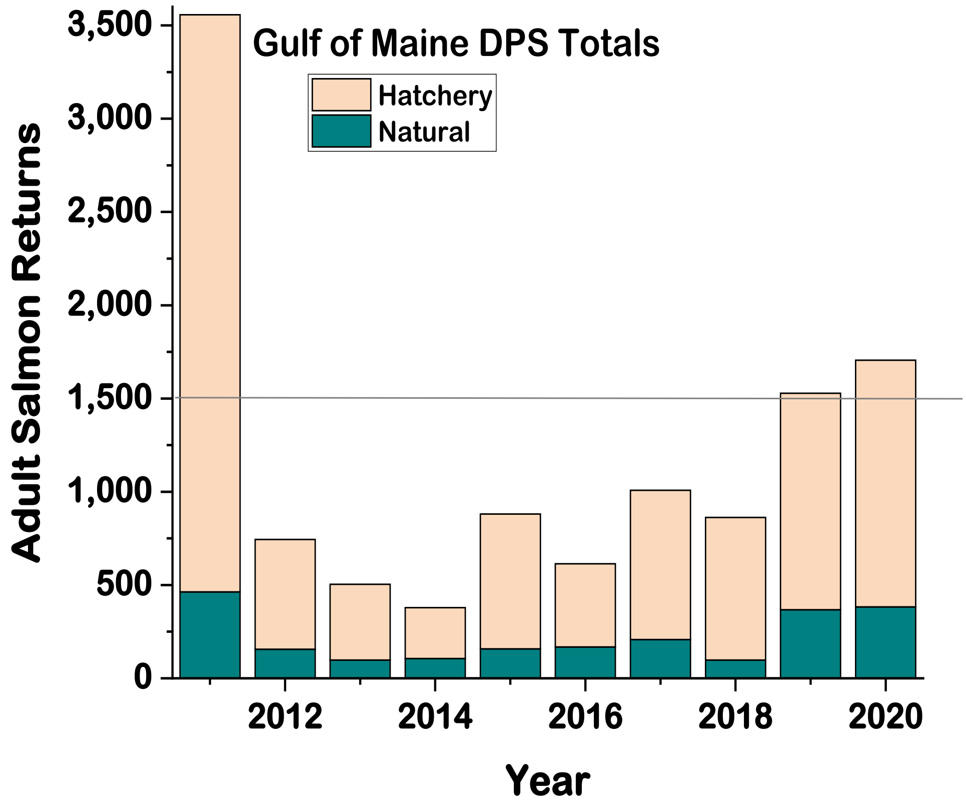

Figure 2.2.1. Time-series of total estimated returns to the GoM DPS of Atlantic salmon for the last decade illustrating the dominance of hatchery-reared origin (parr or smolt stocked; tan bars) Atlantic salmon compared to naturally reared (wild, egg stocked, fry stocked; teal bars) origin. Line at 1,500 represents downlisting level of 500 naturally reared fish per SHRU.

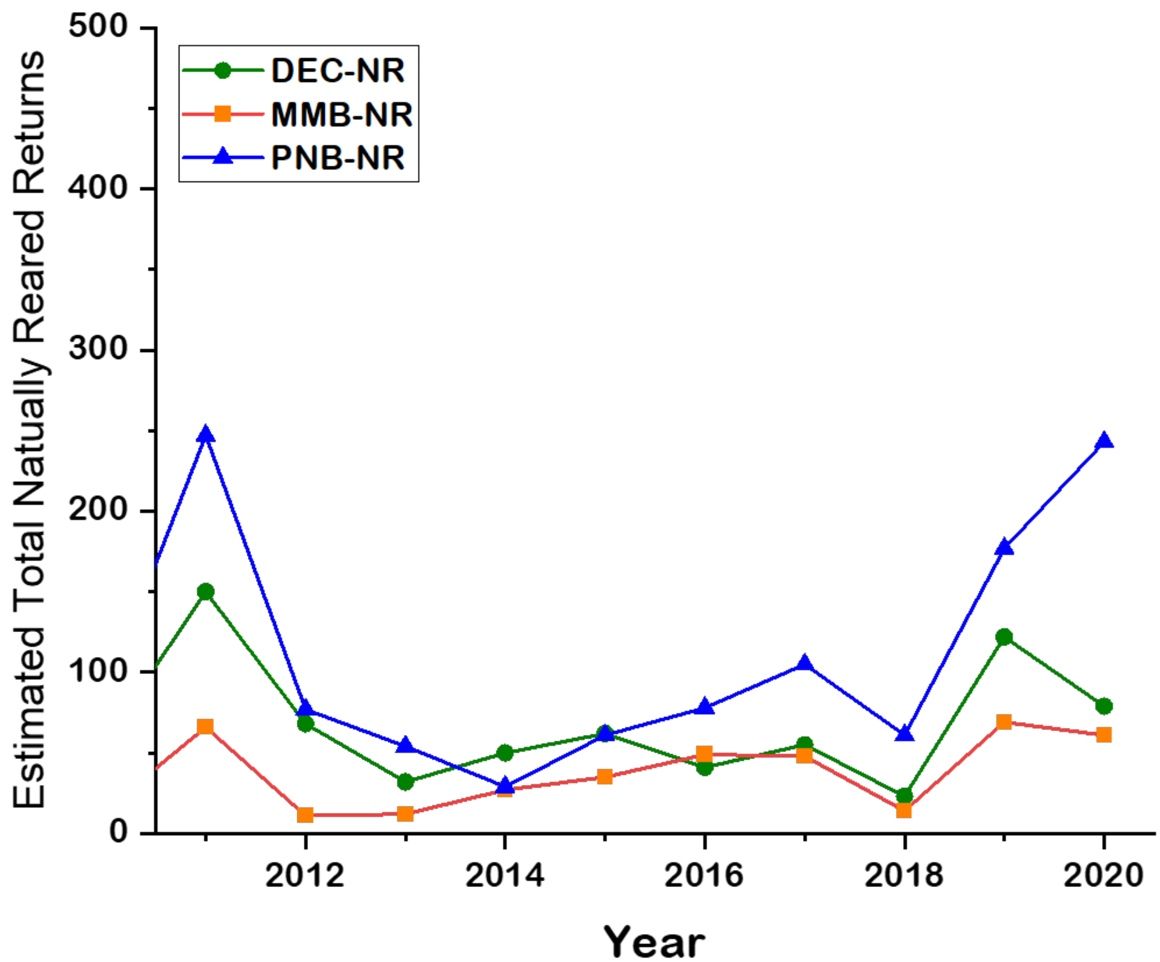

Figure 2.2.2. Time series of last decade of naturally reared adult returns to the Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) SHRUs. Note: naturally reared interim target of 500 natural spawners is maximum axis value.

3.3 Population Growth Rate

Another metric of recovery progress in each SHRU demonstrates a sustained population growth rate indicative of an increasing population. The mean life span of Atlantic salmon is 5 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 (GM_R) population growth rate is calculated as:

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

where GM_R is the geometric mean population growth rate of the most recent 10-year period and Rt is the natural log of the 5-year replacement rate in year t. The 5-year replacement rate in year t is calculated as:

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

where Nt is the number of adult spawners in year t and Nt-5 is the number of adult spawners 5 years prior. Naturally reared adult spawners are counted in the calculation of population growth rate in the current recovery phase (reclassification to threatened) objectives. In the future, only wild adult spawners 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 as a result of declining numbers of returning salmon. 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 2.3.1). In the most recent year (2020) the Merrymeeting Bay SHRU had the highest growth rate (1.71; 95% CI: 1.10 – 2.65) and the Downeast Coastal SHRU had the lowest growth rate (0.94; 95% CI: 0.52 – 1.69) (Table 2.3.1).

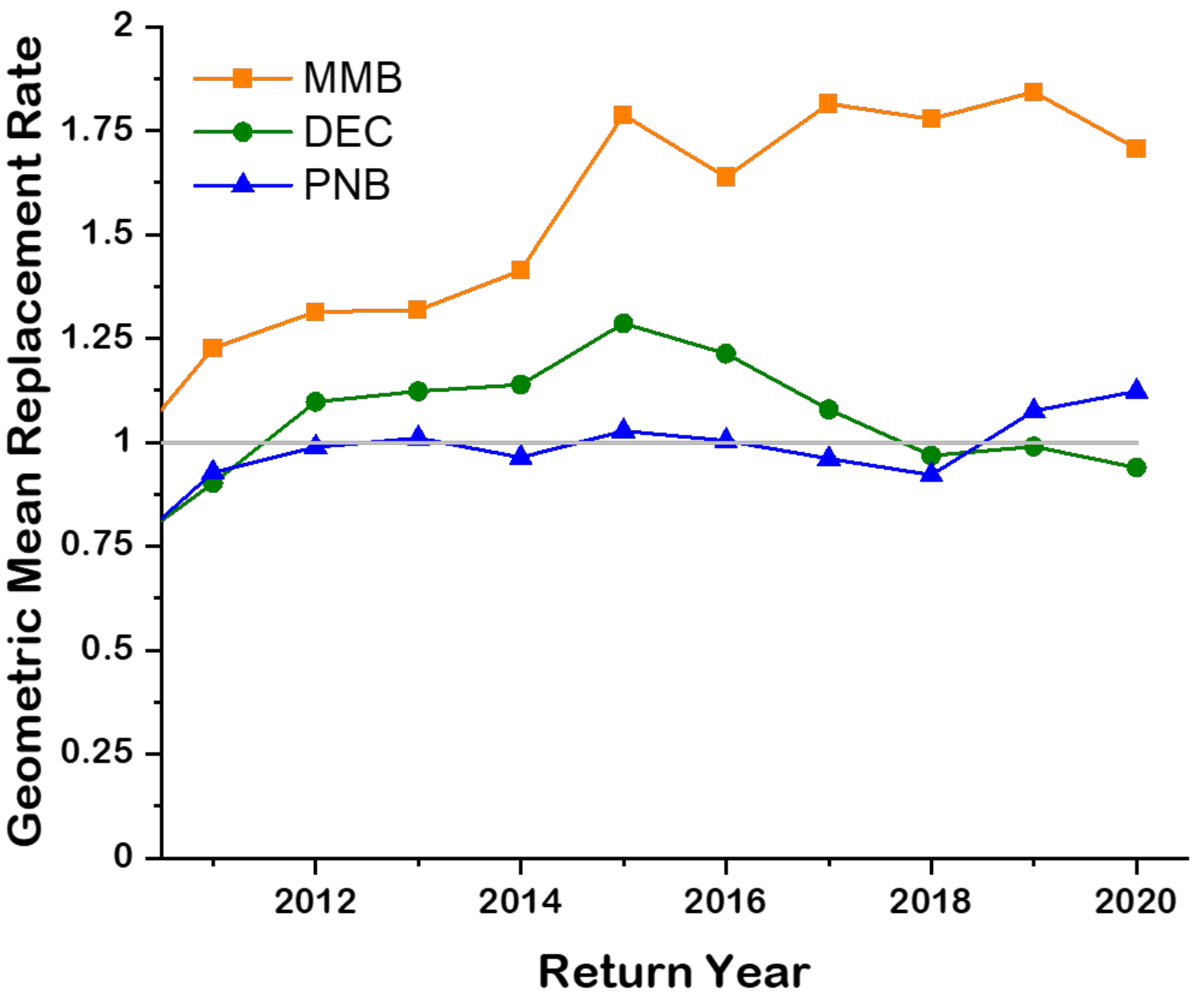

Figure 2.3.1. Annually calculated ten-year geometric mean replacement rates for the GoM DPS of Atlantic salmon for Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) for each SHRU individually for the last decade.

Table 2.3.1. Ten-year geometric mean replacement rates (GM_R) for GoM DPS Atlantic salmon as calculated for 2020 return year with 95% confidence limits (CL).			
SHRU	**GM_R**	**Lower 95% CL**	**Upper 95% CL**
Downeast Coastal	0.94	0.52	1.69
Penobscot	1.12	0.49	2.56
Merrymeeting Bay	1.71	1.10	2.65
Gulf of Maine DPS	**1.12**	**0.60**	**2.09**

The geometric mean population growth rate based on the 5-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 our 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.

3.3.1 Genetic Parentage Analysis

In order to remove this bias and gain an estimate of the true wild population growth rate, we need to be able to discern returns resulting from hatchery inputs from those resulting from natural reproduction in the wild. We can determine if a returning adult salmon was stocked as a parr or smolt through the presence of marks or scale analysis but determining if a returning adult was a result of natural reproduction or stocking at the fry or egg stage is problematic because these life stages are not marked by the time of stocking.

A solution to this problem is to use genetic parentage analysis. All hatchery broodstock are genotyped and matings between individuals in the hatchery are known. By genotyping salmon collected in the wild at later life stages, we can determine if they were the product of a known hatchery mating. If the individual cannot be matched to a known set of parents in the hatchery, it can be assumed that individual is the product of natural spawning. Since we genotype returning adult salmon that are captured in trapping facilities and parr that are collected for future broodstock, we can use parentage analysis of the individuals deemed to be naturally reared to determine the proportion of these individuals that are produced from natural reproduction (truly wild) and the proportion that are the product of fry stocking and/or egg planting. We can then partition the total number of returning adult salmon into true wild versus hatchery components of the population and use analytical methods to gain better estimates of the true wild population growth rates.

Model description

This new method for estimating the wild population growth rate is described by Sweka and Bartron (*manuscript in preparation*) and uses methods described by Holmes (2001) and McClure et al. (2003). Underlying this approach was an exponential decline model (Dennis et al 1991):

$$N_{t+1} = N_t e^{(\mu+\varepsilon)} \qquad [1]$$

where N_{t+1} is the number of salmon at time t+1, N_t is the number of salmon at time t, μ is the instantaneous population growth rate, and ε is normally distributed error with a mean of 0 and variance of σ^2. Total estimated adult returns were used as input data and were the combination of salmon observed in trapping facilities and salmon estimated from redd surveys. The use of raw return data presents problems when estimating μ because spawners only represent a single life stage and the delay between birth and reproduction can lead to large fluctuations in annual spawner numbers (McClure et al. 2003). Therefore, we used a running sum (R_t) of five consecutive years of spawning counts (S_{t+j-1}) as input data to estimate μ as recommended by Holmes (2001) and Holmes and Fagan (2002).

$$R_t = \sum_{j=1}^{5} \quad S_{t+j-1} \qquad [2]$$

Five consecutive counts were summed together because the majority of Atlantic Salmon in the GoM DPS will return to spawn five calendar years after their parents spawned. The population growth rate ($\hat{\mu}$) was estimated as:

$$\hat{\mu} = mean\left[ln\left(\frac{R_{t+1}}{R_t}\right)\right] \qquad [3]$$

We used a slope method (Holmes 2001; Holmes and Fagan 2002) to gain an estimate of the variance on the population growth rate ($\hat{\sigma}^2$)

$$\hat{\sigma}^2 = slope\ of\ variance\ of\ \left[ln\left(\frac{R_{t+\tau}}{R_t}\right)\right] vs. \tau \qquad [4]$$

for τ = 1,2,3,4, and 5 corresponding to time lags in the life history of Atlantic Salmon from spawning until offspring return to spawn.

The input of hatchery origin fish confounds estimates of the population growth rate (μ). If these hatchery origin fish successfully reproduce and contribute to the next cohort, which is the goal of stocking these hatchery fish, then estimates of μ based on total spawners is overestimated and subsequent extinction risks are underestimated. We estimated μ in two ways: (1) using running sums of total spawners as described in equation [3] (hereafter referred to as $\hat{\mu}_{Total}$) and (2) adjusting for the proportion of hatchery origin fish in the running sums of spawners (McClure et al. 2003; hereafter referred to as $\hat{\mu}_{Wild}$) as

$$\hat{\mu}_{Wild} = mean\left[\frac{1}{T} ln(\widehat{w}_t) + ln\left(\frac{R_{t+1}}{R_t}\right)\right] \qquad [5]$$

where T = an approximate 5 year generation time for Atlantic Salmon and $\widehat{w}_t$= the proportion of the running sum of adult returns that were born in the wild. The value of $\hat{\mu}_{Wild}$ assumes that hatchery fish that survive to spawn, reproduce at the same rate as wild fish and that wild spawners in the time series could have come from either hatchery or wild parents. We can view the value of $\hat{\mu}_{Total}$ as the population growth rate under stocking levels that produced the observed time series of total spawners and the value of $\hat{\mu}_{Wild}$ as the population growth rate of wild fish only, in the absence of stocking.

Input Data

Time series of adult return data were obtained from the U.S. Atlantic Salmon Assessment Committee database. Although the available data extended back to 1967, we restricted the data used in this analysis to 2010 - 2020 which represents the last 10 years of the running sum of adult returns.

Genetic parentage analysis of broodstock taken to the hatchery was used to differentiate wild and hatchery fish within the naturally reared component of returning salmon. Penobscot River broodstock were obtained by trapping adults and transporting them to Craig Brook National Fish Hatchery. Other rivers used a captive broodstock program whereby fish were captured as age 1+ parr in the rivers and transported to Craig Brook National Fish Hatchery for culture until they matured and could be spawned in the hatchery. We make the assumption that the broodstock collected and subsequently analyzed for parentage are representative of all salmon in the natural environment.

Growth rates were estimated for each SHRU and for the GoM DPS as a whole. Therefore, adult returns and the proportion of naturally reared returns that were wild origin were combined among rivers within a SHRU and among all rivers for the entire GoM DPS. Information from parentage analysis to determine the proportion of naturally reared returns that were wild origin was available for spawning runs from 2003 – 2018. In the Penobscot SHRU, the year of broodstock collection and parentage analysis corresponded to the year the adults returned. However, in other SHRUs the year of broodstock collection and parentage analysis did not correspond to the year these fish would have returned as adults because they were collected as parr (mostly age 1). Therefore, we made the assumption that the proportion of naturally reared fish that were wild origin found in the parr collected for broodstock would be the same for fish from these cohorts that remained in the river and would return as sea run adults three years later. [The majority of naturally reared returns in the GoM DPS become smolts at age 2 and return after two winters at sea.] Within this assumption, we assumed that any differential survival between hatchery and wild origin fish took place over the first year of life when the fish were at the fry and age 0 parr stages.

Within a year, the proportion of returns that were wild $(\widehat{w}_t')$ was estimated as

$$\widehat{w}_t' = \frac{\rho_t S_{NR,t}}{S_{T,t}} \qquad [8]$$

where ρ_t = the proportion of naturally reared returns that were of wild origin as estimated through parentage analysis at time t, $S_{NR,t}$ = the number of naturally reared spawners, and $S_{T,t}$ = the total number of spawners. The number of wild origin returns in year t $\left(S_{W,t}\right)$ was then

$$S_{W,t} = \widehat{w}_t' S_{T,t} \qquad [9]$$

and the number of hatchery origin spawners in year t $(S_{H,t})$ was

$$S_{H,t} = S_{T,t} - S_{W,t} \quad [10]$$

<u>Results</u>

Instantaneous population growth rates were near 0 and 95% confidence limits overlapped 0 for all SHRUs and the Gulf of Maine as a whole when we include all returning Atlantic salmon regardless of origin. These results indicate neither increasing nor decreasing populations. However, when we account for the proportion of adult returns that were of hatchery origin, all SHRUs had wild population growth rates that were less than 0 with the Penobscot SHRU being the most negative. The reason why the Penobscot SHRU has the lowest population growth rate is because the vast majority of adult returns to this SHRU are of hatchery origin. The negative growth rates for the wild component of these populations indicates that if stocking hatchery origin fish were to cease, these populations would show abrupt declines.

Table 2.3.1. Population growth rates of Atlantic Salmon in the GoM DPS estimated by the running sum method for both the total population and the wild component. Growth rates are presented as both instantaneous (μ) and finite (λ) rates. Numbers in parentheses represent 95% confidence limits.

SHRU	μ_{total}	μ_{wild}	λ_{total}	λ_{wild}
Downeast Coastal	0.0350 (-0.0320, 0.1021)	-0.2455 (-0.3125, -0.1784)	1.0356 (0.9685, 1.1075)	0.7823 (0.7316, 0.8366)
Penobscot	-0.0396 (-0.1798, 0.1005)	-0.6244 (-0.7645, -0.4842)	0.9611 (0.8354, 1.1058)	0.5356 (0.4655, 0.6162)
Merrymeeting Bay	0.0161 (-0.0310, 0.0631)	-0.2849 (-0.3320, -0.2378)	1.0162 (0.9695, 1.0652)	0.7506 (0.7175, 0.7883)
Gulf of Maine	**-0.0315** **(-0.1594, 0.0964)**	**-0.5546** **(-0.6824, -0.5054)**	**0.9690** **(0.8527, 1.1011)**	**0.5743** **(0.5054, 0.6527)**

3.4 Spatial Structure of DPS

For the GoM DPS, a sustained census population of 500 naturally reared adult spawners (assuming a 1:1 sex ratio) in each SHRU was chosen to represent the effective population size for down listing to threatened. In 2020, none of the three SHRUs approached this level of spawning in the wild. Trap counts provide some insights into the spatial structure of spawners at a watershed level, but the details provided by redd counts during spawner surveys enhance our understanding of escapement and wild production at a finer geographic scale. Spawning was documented in all three SHRUs and monitoring of both spawning activity and conservation hatchery supplementation programs allow an informative evaluation of habitat occupancy and juvenile production potential.

We evaluated the spatial structure of juvenile production by modeling occupancy at a sub drainage level - USGS Hydrologic Unit Codes (HUC)-12 level - to describe recruitment at a spatial scale proposed to better manage critical habitat. This evaluation informs managers relative to the most likely habitats where wild spawning or juvenile stocking has produced freshwater production cohorts. These summaries provide visual products to better evaluate production habitat use at a SHRU level while also providing quantitative estimates of occupancy in Critical Habitat management areas. These evaluations can assist in evaluation of the spatial structure of production and set expectation for natural-reared production based on modelled habitat use.

Our spatial assessment objectives this year were to 1) calculate first-year salmon distribution for wild production of spawners in 2020 and 2) visualize and quantify distribution of the likely juvenile distributions of 3 freshwater production cohorts across watersheds. These evaluations provide metrics to measure the relative impact of wild spawning and supplementation in each of the three SHRUs. This is the first year this method has been applied to multiple cohorts and should be considered provisional. This approach is evolving to provide a tool to allow a better understanding of spatial drivers and relative contributions of wild and stocked production on pre-smolt populations. Our goal was to further develop and vet these summary metrics as tools to both investigate both gaps in assessment data and inform hatchery stocking practices to reduce interactions between wild-spawned and hatchery fish. Overall, improved spatial data should help managers understand production shortfalls (wild and hatchery supplementation) to better optimize natural smolt production across critical habitat at a watershed level.

3.4.1 Wild Production Areas – Redd Distributions and the 2020 Cohort

Spawner surveys in 2020 covered 1,220 units (11%) of 10,900 units of surveyed spawning habitat (see Section 5). This coverage is similar to previous years since surveys are limited to managed drainages. Given the low spawner escapement relative to available habitat, monitoring is limited in MMB and PNB habitat but focused on priority management areas. In the DEC SHRU where redd surveys consistently exceed 80% coverage, estimates of wild production areas more accurately represent overall production. In MMB, redd counts generally capture expected redds related to documented escapement and likely closely represent overall wild production. In PNB, escapement and redd surveys are more variable and spawning areas are expansive and not well described nor well surveyed. As such, while provided for context, the PNB occupancy maps underrepresent wild production.

The geolocation of redds in 2020 were used to document Wild Production Areas (WPA) of the 2021-yearclass in these river systems. The spatial extent of WPA assumes an upstream distribution of juveniles of 0.5 km upstream and 1 km downstream (including tributary streams). In the DEC SHRU, redds were found in 21 of 72 HUC12s (29%). Within these 21 areas over, 38% of total rearing habitat (9,753 units) was documented as WPA. Within a HUC-12 the proportion occupancy ranged from 0 to 0.67 (Figure 2.4.1.1; Table 2.4.1.1) In the MMB SHRU, redds were found in 15 of 75 HUC12s (20%) and within these areas proportion occupancy ranged from 0 to 0.73. Although overall survey coverage was incomplete, coverage of actively managed areas was high. Within these 15 areas over, 38% of total rearing habitat (13,458 units) was documented as WPA. In the PNB SHRU, redds were found in 23 of 148 HUC12s (16%) and overall survey coverage was limited and likely underrepresents WPA.

These WPA will be buffered from stocking in 2021 to minimize competition between wild and hatchery origin juveniles. In addition, in 2023 these areas will be targeted for broodstock collection during electrofishing efforts to bring components of wild spawning into the captive reared brood program.

Table. 2.4.1. Estimates of total juvenile nursery habitat units (100 m2) occupied by wild Atlantic salmon in the 2021 cohort determined from 2020 spawning surveys.

SHRU	Total Habitat Units (# HUC12s)	Total Habitat in WPA with redds (#HUC12s)	WPA 2021 Cohort	% Occupied WPA in HUC12 with Redds	% Occupied WPA all HUC12
Downeast Coastal	57,634 (72)	25,769 (21)	9,753	38%	17%
Merrymeeting Bay	138,710 (75)	28,167 (15)	13,458	38%	17%
Penobscot Bay	238,008 (148)	52,273 (23)	15,072	48%	10%
Totals	434,353 (295)	106,209 (59)	38,283	36%	9%

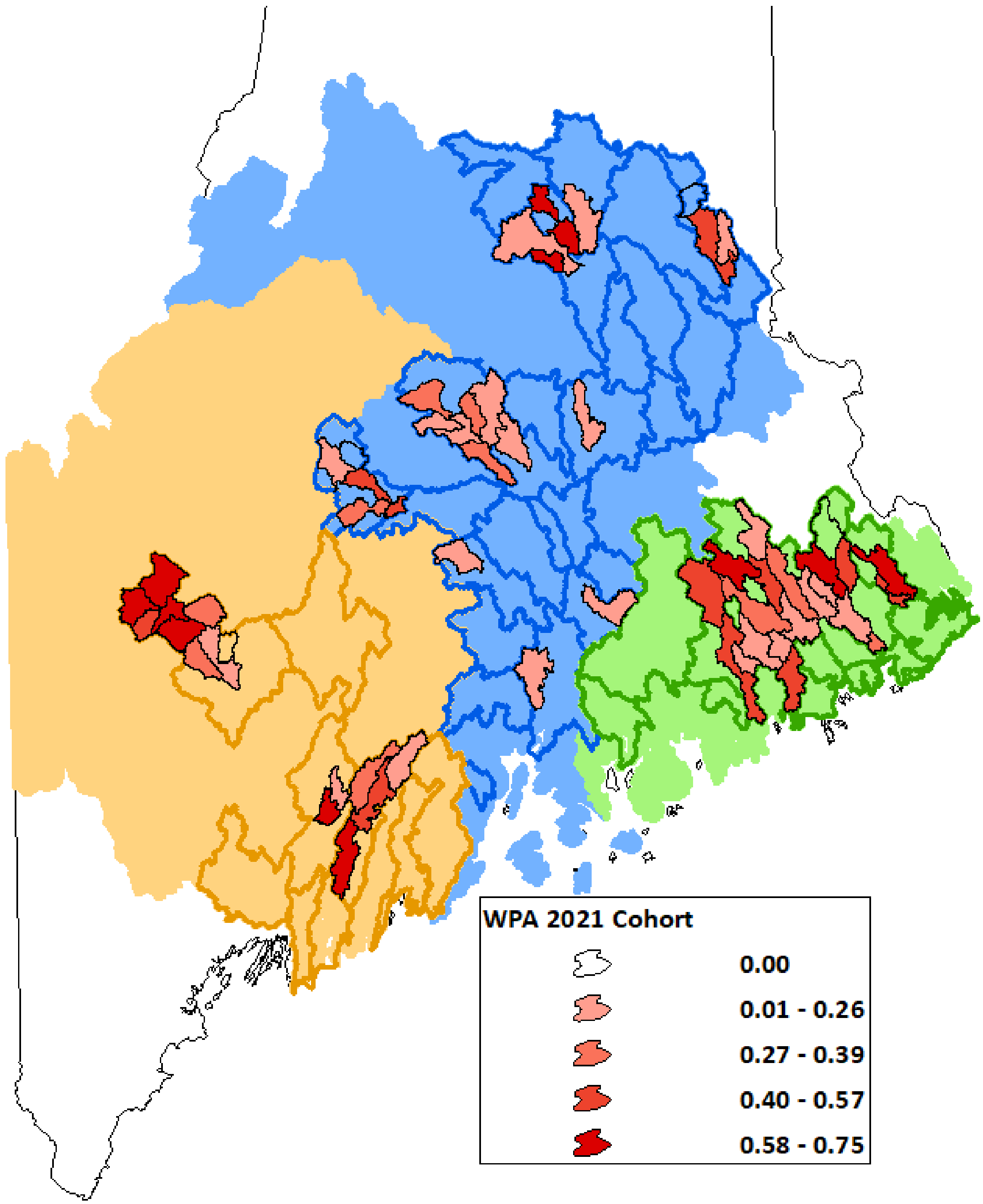

Figure 2.4.1.1 Map highlighting wild production for the 2021 cohort in individual HUC 12 areas where redds were documented and redd dispersion was modeled to indicate occupancy (fish present or absent). For example, for 100 units of habitat, if the distribution model predicted fish in 15 units – proportion occupancy would be 0.15.

3.4.2 Freshwater Cohorts and Hatchery Production Units

An important element of GoM DPS Atlantic salmon populations is their dependence on conservation hatcheries (Legault 2005). Since most US salmon are products of stocking, it is important to understand the magnitude, types, and spatial distribution of these inputs to understand juvenile spatial structure throughout Critical Habitat. Atlantic salmon hatcheries are operated by the FWS and the Downeast Salmon Federation (DSF). All egg takes occur at FWS facilities operating as conservation hatcheries that collect fish from remnant local stocks within the GoM DPS and produce products 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 production. For example, the Sandy River in the MMB SHRU has received donor stocking from the Penobscot and Dennys Rivers populations. From a management perspective, rebuilding Atlantic salmon populations will require increasing natural production of smolts in all available Critical Habitat (Recovery Plan). This management is focused on best use of hatchery production to optimally maintain population diversity, habitat occupancy, and effective population sizes. Examining the spatial contributions of multiple cohorts provides insights into likely gaps in freshwater production and where they occur on the landscape. This will provide an information base to further examine fish dispersal, optimal production areas, and site-specific stocking targets. Ultimately, these data should inform targeted management at a more refined spatial scale than an entire watershed and facilitate sub-drainage (HUC12) management.

The goal of this spatial analysis is to visualize and assess freshwater production at a HUC-12 level. This composite of freshwater production comes from a GIS Analysis of wild production from redds combined with naturally reared production resulting from spatially explicit stocking data for egg-planted, fry stocked, or parr stocked juveniles. This freshwater production yields both wild and naturally reared smolts that are an important conservation tool because these supplementation methods are designed to minimize selection for hatchery traits at the juvenile stage. Analyses show that these wild and naturally reared smolts typically have a higher (4-7 times) marine survival rate than hatchery reared smolts. The numbers of hatchery fish released, and eggs planted in the GoM DPS are presented in Section 5. The focus here is on the distribution of these fish throughout critical habitat and providing insights on densities relative to optimizing habitat use.

For the 2020 assessment, we modeled the occupied freshwater production habitat in December. This summary was based on production from both natural redds (WPA) and geo-referenced stocking locations. For this analysis, we assume that 3 cohorts of fish comprise the overall freshwater population. Numerically most juveniles would be age-0 (2020 cohort). By biomass, age-1 (2019 cohort) fish would dominate as they comprise most of the pre-smolt population and would be the second most abundant age class. Finally, a smaller number of age-2 (2018 cohort) fish would make up the balance of the river population. Occupancy was estimated by geospatial documentation of both WPA and egg planting and juvenile stocking for each cohort through November 2020. All input data were georeferenced and the Atkinson-Kocik occupancy model was used to document dispersal rates (Working Paper in Progress). We are continuing to develop these methods and metrics. As noted above, the spatial extent of WPA assumed an upstream distribution of juveniles of 0.5 km upstream and 1 km downstream (including tributary streams). Similar dispersions were calculated for all hatchery products as well. These hatchery production areas are Egg Planted Production Areas (EPA) that are based on point positions of artificial redds and similar diffusion models as WPA. For Fry or Parr stocked production areas (FPA or PPA), these areas are based on linear distances stocked and a similar diffusion model from both the upstream stocking point and downstream end of the reach. By combining all these production areas, we can estimate both occupancy and the amount of vacant CH (vacant CH = total CH – WPA – EPA- FPA-PPA). These values should be considered minimal occupancy areas because: not all redds are counted, assumptions on dispersion while well supported in literature and local data, need additional study, and weighting of redd survey areas needs further refinement.

Using this method, we estimated December 2020 mean proportion occupancy for each of the 3 SHRUs at a HUC-12 resolution (Figure 2.4.2.1). While the 3 SHRU vary in size and number of HUC-12 units, the amount of occupied juvenile rearing area is typically between 8,800 to 13,600 units of habitat in each SHRU. The DEC SHRU with 72 HUC-12 areas had cohort occupancy of between 9,800 and 10,300 units in 21 areas (29%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1). While still at only modest occupancy, the DEC SHRU has a generally broad distribution of juveniles in the Dennys, East Machias, Machias, Narraguagus, and Pleasant Rivers. The PNB SHRU with 148 HUC-12 areas had cohort occupancy of between 10,300 and 18,400 units for the 3 cohorts in 22 areas (15%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1.). Dispersal was relatively broad but mean proportion occupancy was lower (Figure 2.4.2.1). In addition, changing management focus is notable with 14 HUC12 areas being occupied for all 3 cohorts and 8 being occupied in only 1 of the 3 years. Finally, the MMB SHRU with 75 HUC-12 areas had cohort occupancy of between 12,000 and 13,600 units in 16 areas (21%) where these 3 cohorts had a proportion occupancy above 0.01 (Figure 2.4.2.1). The consistent focus on the Sheepscot and Sandy River has led to 12 HUC12 areas being occupied by all 3 cohorts and moderately high proportional occupancy in the core areas.

By organizing these data spatially, the Stock Assessment Team is providing a resource to further refine occupancy by targeting areas to conduct juvenile assessments and to further refine density and dispersion measures. Until there is significantly more wild production and/or greatly increased hatchery that would allow complete use of all HUC12 units in critical habitat, it is important to look at juvenile production spatially to examine effort and approaches to supplementation to maximize smolt production. This can be accomplished by considering production density at a HUC12 level and projecting climate impacts on habitats and distinct individual populations. The next steps of spatial stock assessment will work towards integrating density based on historic electrofishing and other sources. Independent efforts to look at climate resilience could then be merged with this spatial assessment to better manage Atlantic salmon habitat, hatchery supplementation, and passage priorities to support salmon conservation now and in the future.

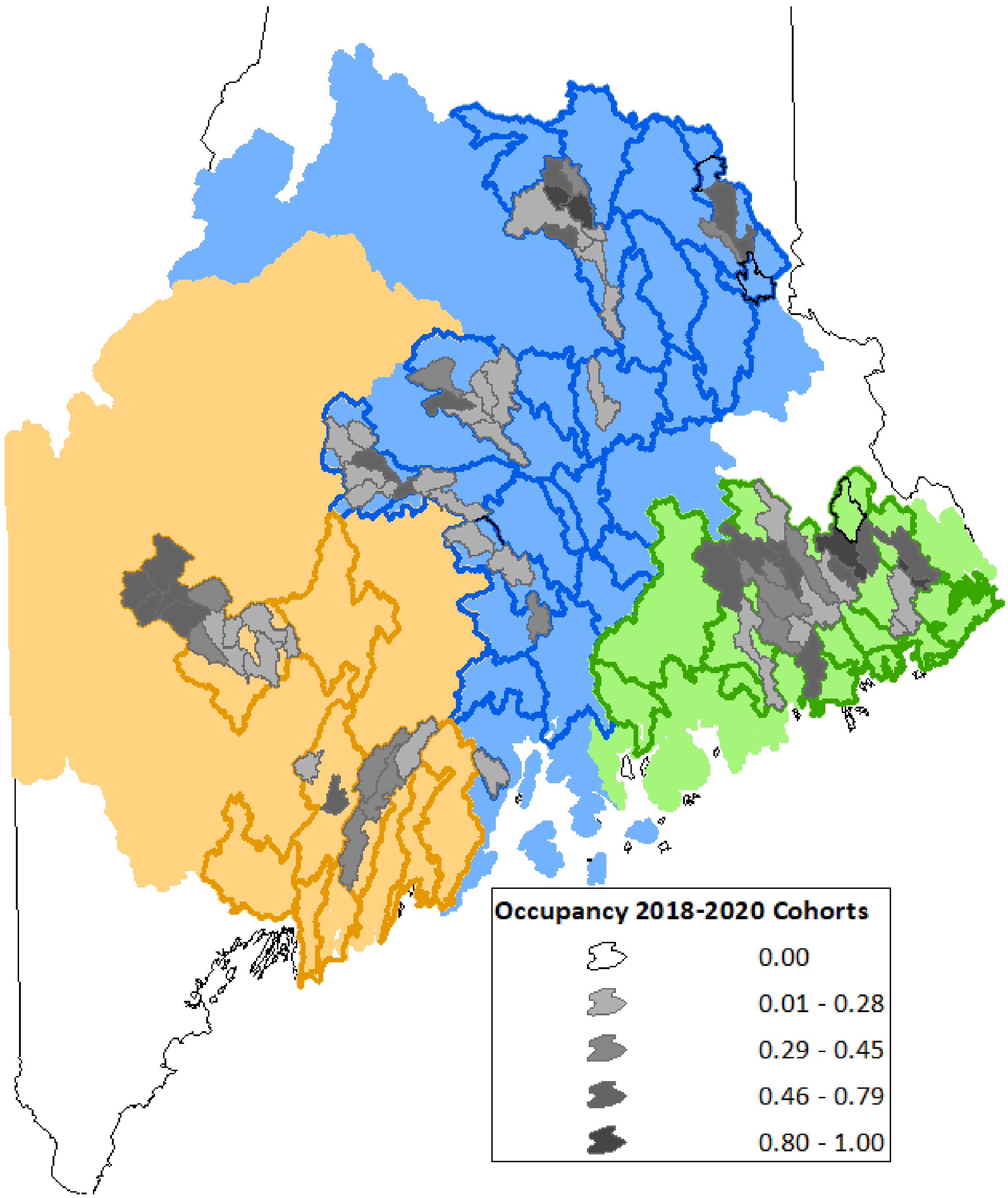

Figure 2.4.2.1 Map highlighting the relative proportion of river habitat occupied (see figure legend) by the 2018, 2019 and 2020 cohorts at a HUC-12 watershed summary level. Production is a synthesis of modeled distributions from spawning surveys of Atlantic salmon in the autumn proceeding the cohort year, cohort year egg planting, and fry and parr stocking.

3.5 Genetic Diversity

As part of the Atlantic salmon recovery program, maintenance of genetic diversity is a critical component of the process. Genetic diversity for the Atlantic salmon program is monitored through assessment of collected broodstock from the wild, 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 (N_e) 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 N_e, 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 N_e 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 N_e for a population. In Atlantic salmon, Palstra et al. (2009) identified a range of N_e to N ratios from 0.03 to 0.71, depending on life history and demographic characteristics of populations. Assuming a N_e to N ratio of 0.2 for recovery planning, the N_e for a GoM DPS of Atlantic salmon population should be approximately equal to the average annual spawner escapement, assuming a generation length of 5 years. Although precocious male parr can reproduce and therefore 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.

For the GoM DPS our diversity goals are to 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 8 extant stocks, 7 are in the conservation hatchery program. The Penobscot River is supported by capture of returning sea-run adult broodstock at Milford Dam, which are transported to Craig Brook National Fish Hatchery for spawning. A domestic broodstock, maintained at Green Lake National Fish Hatchery, also supports production in the Penobscot River, and is created annually by offspring from the spawned sea-run adults at Craig Brook National Fish Hatchery. Six other populations have river-specific broodstocks, maintained by parr-based broodstocks, comprising offspring resulting from natural reproduction which may occur, or primarily recapture of stocked fry.

3.5.1 Allelic Diversity

A total of 18 variables, microsatellite loci are used to characterize genetic diversity for all individuals considered for use in broodstocks (Figure 2.5.1.1). 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 Craig Brook NFH. Individuals represent those to be used for broodstock purposes following screening of any individuals to be removed based on screening to remove potential aquaculture origin individuals, or landlocked Atlantic salmon. Annual characterization allows for comparison of allelic diversity between broodstocks, and over time. A longer time series allows for comparison of allelic diversity from the mid 1990's, but with a subset of 11 of the 18 loci. For this report, evaluating allelic diversity based on 18 loci, between 2008 and 2018 collection years (or from 2008 to 2020 in the case of the Penobscot broodstock), the average number of alleles per locus ranged from 10.69 alleles per locus for the Pleasant River to 13.44 alleles per locus for the Penobscot River.

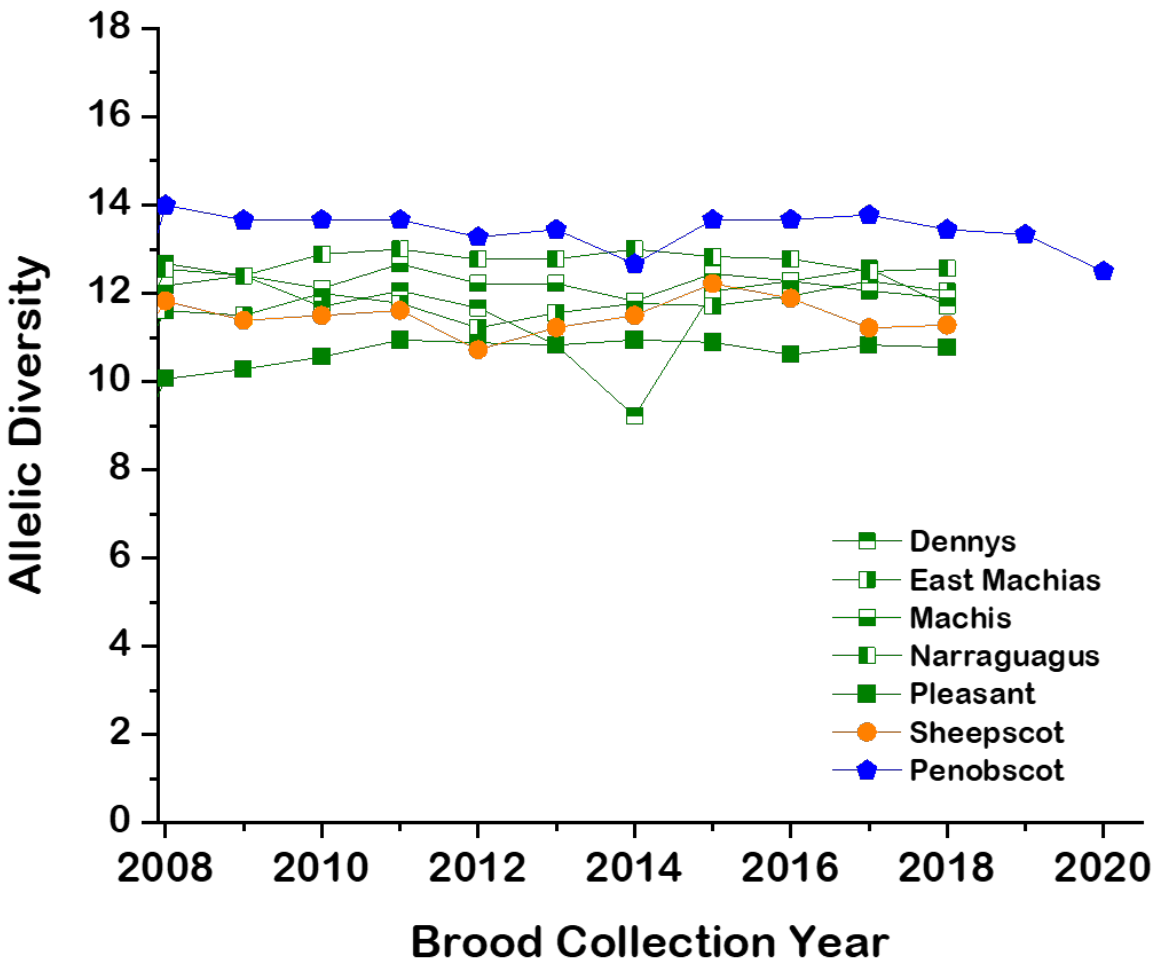

Figure 2.5.1.1. Allelic diversity time series for GoM DPS salmon populations, measured from 18 microsatellite loci. purposes (DE- Dennys, EM-East Machias, MA- Machias, NA-Narraguagus, PN-Penobscot, PL-Pleasant, SH-Sheepscot populations).

3.5.2 Observed and Expected Heterozygosity

Observed and expected heterozygosity is estimated for each broodstock. For the 2018 collection year parr broodstock and 2020 collection year Penobscot adult returns, average estimates starting in 2008 of expected heterozygosity based on 18 microsatellite loci ranged from 0.67 in the East Machias to 0.688 for the Penobscot broodstock. Observed heterozygosity estimates based on 18 loci ranged from 0.676 in the Machias to 0.707 in the Penobscot broodstock.

3.5.3 Effective Population Size

Estimates of effective population size, based on 18 loci, varies both within broodstocks over time, and between broodstocks (Figure 2.5.3.1). Estimates are obtained using the linkage disequilibrium method which 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 N_e from the 2018 collection year was estimated for the Dennys broodstock (N_e =44.6, 36.6-54.5 95% CI), and the highest was observed in the Narraguagus broodstock (N_e =137.6 (110.4-176.0 95% CI). N_e estimates fluctuate annually, so beginning with 2008, average N_e across the parr-based broodstocks ranges from N_e=69.1 in the Dennys to N_e =143.6 in the Narraguagus. Within the Penobscot River, adult broodstocks typically include three to four year classes (including grilse). N_e estimates for the Penobscot since 2008 have ranged from maximum N_e =546.5 (465.8-650.7 95% CI) in 2017 to the low N_e =287.6 in 2009 (265.7-312.0 95% CI), with an average N_e =417.3. The N_e estimate for the 2020 return the broodstock N_e = 417.9 (302.3-644.2 95% CI).

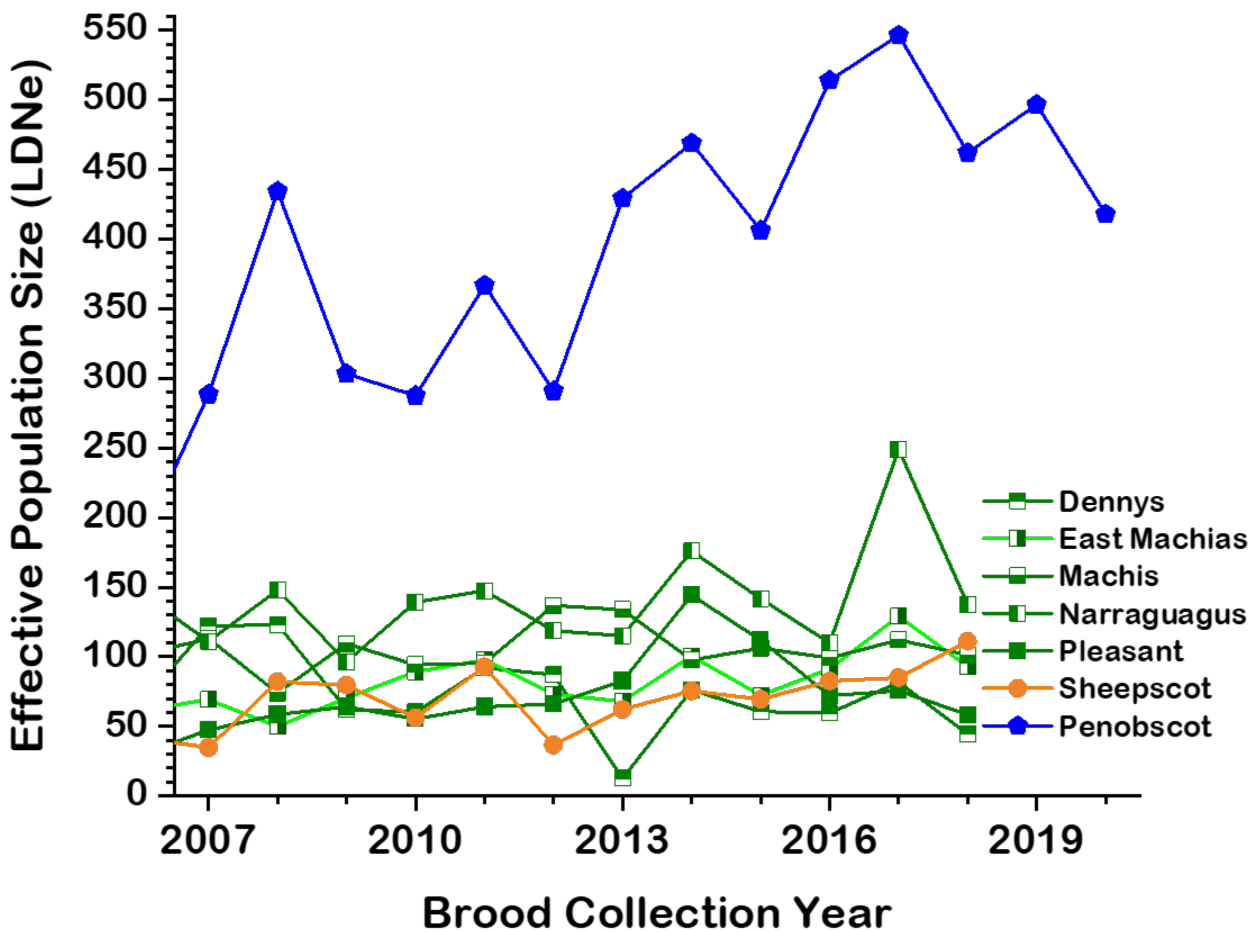

Figure 2.5.3.1. Time series of effective population size for 7 GoM DPS distinct individual populations. Estimates for the parr-based broodstock populations approximate the number of breeders, since estimates are obtained from primarily a single cohort, and are sampled as juveniles (parr), from each river. Estimates of effective population size for the Penobscot broodstock are obtained from returning

adults in a given year to the Penobscot River, and represent multiple cohorts (DE- Dennys, EM-East Machias, MA- Machias, NA-Narraguagus, PN-Penobscot, PL-Pleasant, SH-Sheepscot populations).

3.6 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 effective population 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 1990's, although there are concerns about slightly lower estimates of allelic diversity in the Sheepscot and Pleasant relative to the other broodstocks. 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 should continue to be monitored, as it indicates that populations are at a risk for loss of genetic diversity.

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4 Central New England

4.1 Merrimack River

4.1.1 Adult Returns

A total of four sea-run Atlantic salmon was counted in the Merrimack River at the Essex Dam fishway, Lawrence, MA. None of these fish were handled, sampled nor transported to the Nashua National Fish Hatchery (NNFH), NH. Instead all fish were allowed to continue to migrate up the river. There were no subsequent reports or observations of them.

The origin of these fish is unknown. They could have been products of natural spawning in the Merrimack by previously released adult salmon or they could have been strays from nearby rivers in Maine. No age or other data could be collected because they were not handled, but some presumptive data based upon past experience from this river were entered into the database to account for all returning fish.

4.1.2 Hatchery Operations

Atlantic salmon were not spawned at NNFH in 2020. The final year of spawning Merrimack strain salmon at NNFH occurred in the fall of 2018. There were no salmon broodstock nor juvenile salmon on station in 2020 that were designated for use in the Merrimack River.

4.1.3 Juvenile population status

No parr assessment was conducted in the watershed.

4.1.4 General Program

The USFWS and state partners previously terminated the program. There was no salmon program or activities in 2020.

Atlantic salmon Broodstock Sport Fishery

The last of the broodstock designated for a sport fishery were stocked in December of 2019 (total of 1,117). No fish were stocked in 2020.

Adopt-A-Salmon Family

This program was not active in 2020.

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 and the Denil fishway-sorting facility located on the West Channel in Saco and Biddeford, operated from 1 May to 31 October 2020. Only visual observations were recorded at the East Channel of Cataract. Three adults were observed to pass this facility. Four Atlantic salmon were captured, at a third passage facility upriver at Skelton Dam, which operated from 8 May to 31 October 2020. A total of six Atlantic salmon returned to the Saco River for the 2020 trapping season. However, the count could exceed six due to the possibility of adults ascending Cataract without passing through one of the counting facilities.

4.2.2 Hatchery Operations

Egg Collection

The Saco Salmon Restoration Alliance & Hatchery (SSRA) has ceased receiving eggs from Nashua National Fish Hatchery. The remaining broodstock (52) from Nashua were transferred and spawned at the University of New England (UNE). In the fall of 2020, the UNE staff spawned 18 adult salmon and transferred the eggs to the SSRA Hatchery. The eggs will be used to supplement the Saco River as well as support the Salmon in Schools Program.

Broodstock Collections

In October, 156 naturally reared and wild parr were taken from Swan Pond Stream, a tributary to the Saco River.

4.2.3 Stocking

Juvenile Atlantic salmon Releases

In 2020 the Saco River Salmon Restoration Alliance planted 24,000 eyed-eggs in two tributaries, Swan Pond Stream and Cooks Brook to the Saco River.

Adult Salmon Releases

In February 49 retired broodstock adult Atlantic salmon were stocked into the Saco River below the lowest dam in Saco.

4.2.4 Juvenile Population Status

Index Station Electrofishing Surveys

ME-DMR did not conduct any electrofishing surveys in the Saco River watershed in 2020.

Smolt Monitoring
There was no smolt monitoring in 2020.

Tagging
No salmon outplanted into the Saco were tagged or marked in 2020.

4.2.5 Fish Passage

No changes were made to any passage facilities on the Saco River in 2020.

4.2.6 Genetics

All adult returns captured at Skelton Dam are tissue sampled. Samples are persevered 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 the University of New England (UNE). The partnership relies on the UNE to rear broodstock and assist the SSRAH with spawning. UNE is holding the last Merrimack River broodstock adults which were spawned in the fall of 2020.

In addition, to maintain a source of broodstock the SSRA will collect parr. The parr will be taken annually from the Saco River drainage and be reared until spring in the SSRA hatchery and then transferred to the UNE. In the Fall of 2020, 156 parr were collected in from two tributaries to the Saco River.

4.2.8 Migratory Fish Habitat Enhancement and Conservation

No habitat enhancement or conservation projects directed solely towards Atlantic salmon were conducted in the watershed during 2020.

5 Gulf of Maine

Summary

Documented adult Atlantic salmon returns to rivers in the geographic area of the Gulf of Maine DPS (GoM DPS; U.S. Fish and Wildlife Service and NMFS 2018) in 2020 was 1,705. Returns are the sum of counts at fishways and weirs (1,608) and estimates from redd surveys (97). No fish returned "to the rod", because angling for Atlantic salmon is closed statewide. Counts were obtained at fishway trapping facilities on the Androscoggin, Narraguagus, Penobscot, Kennebec, and Union rivers. Severe drought conditions were experienced during the summer across most of Maine. This may have had an impact on movement of adults into spawning habitats. Spawning activity was documented in reaches that would not normally see spawning due to reduced flow conditions and the inability of adults to access better habitats.

Escapement to GoM DPS rivers in 2020 was 1,477 (Table 5.1). Escapement to the GOM DPS area equals releases at traps and free swimming individuals (estimated from redd counts) plus released pre-spawn captive broodstock (adults used as hatchery broodstock are not included) and recaptured downstream telemetry fish.

Naturally reared replacement rate to the DPS has varied since 1990 although the rate has been somewhat consistent since 1997 with a mean of 0.89 (0.64 – 1.25), (Figure 5.1). Most of these were 2SW salmon that emigrated as 2-year-old smolt, thus, cohort replacement rates are calculated assuming a five-year lifespan. To show sustained improvement, population growth is observed for at least two generations (10 years). The 10-year geometric mean naturally reared growth rate for the period 2011 to 2020 is 1.12 (0.60 – 2.09) for the GoM DPS. Breaking this down further by Salmon Habitat Recovery Units (SHRUs; U.S. Fish and Wildlife Service and NMFS 2018), Merrymeeting Bay (MMB) was 1.71 (1.10 – 2.65) saw the largest growth rate, Penobscot Bay (PN) was 1.12 (0.49 – 2.56) and Downeast Coastal (DEC) was 0.93 (0.52 – 1.69). This indicates that while the GoM DPS has an increasing replacement rate it is fairly slow. Despite this, naturally reared returns are still well below 500 (Figure 5.2). For more detail on population growth rates, see Section 2.3).

Table 5.1 Table of Sea-run returns versus escapement.

Drainage	Returns	Brood Stock	DOA	Escapement	Captive Pre-Spawn	Sea-run Pre-Spawn	Total Escapement
Androscoggin	5	0	0	5	0	0	5
Kennebec	53	0	0	53	0	0	53
Narraguagus	108	0	1	107	0	0	107
Penobscot	1,439	221	8	1,210	0	2	1,212
Union	3	0	0	3	0	0	3
Redds Estimate	97	N/A	N/A	97	0	0	97
	1,705	221	9	1,475	0	2	1,477

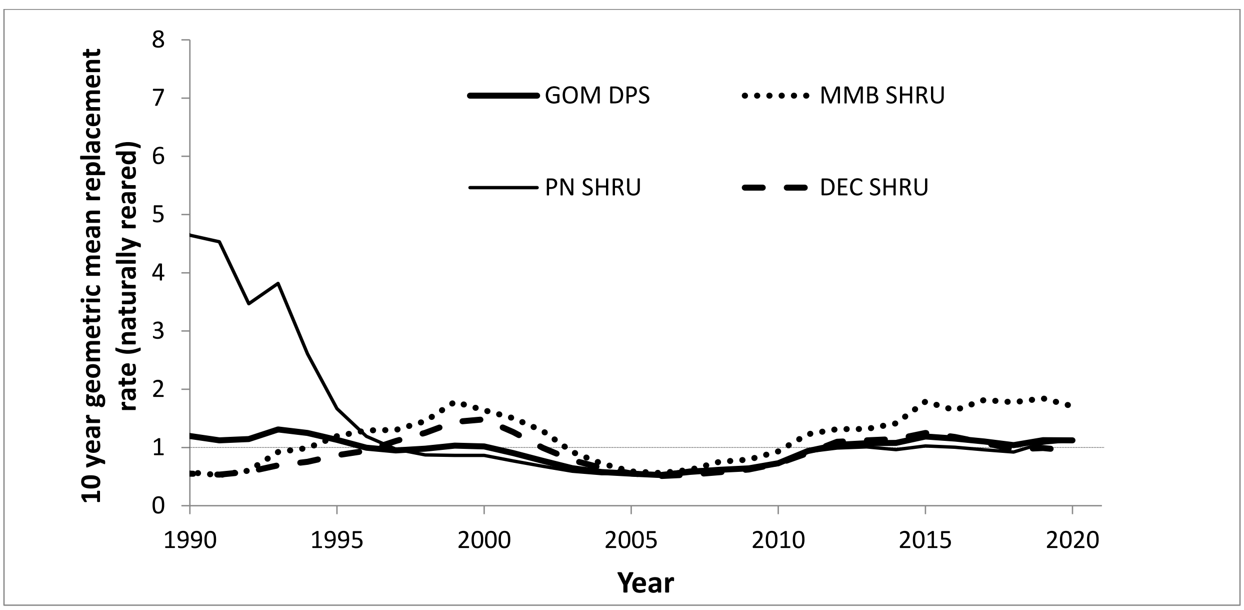

Figure 5.1. Ten-year geometric mean of replacement rate for returning naturally reared Atlantic salmon in the GOM DPS and the three Salmon Habitat Recovery Units (SHRU).

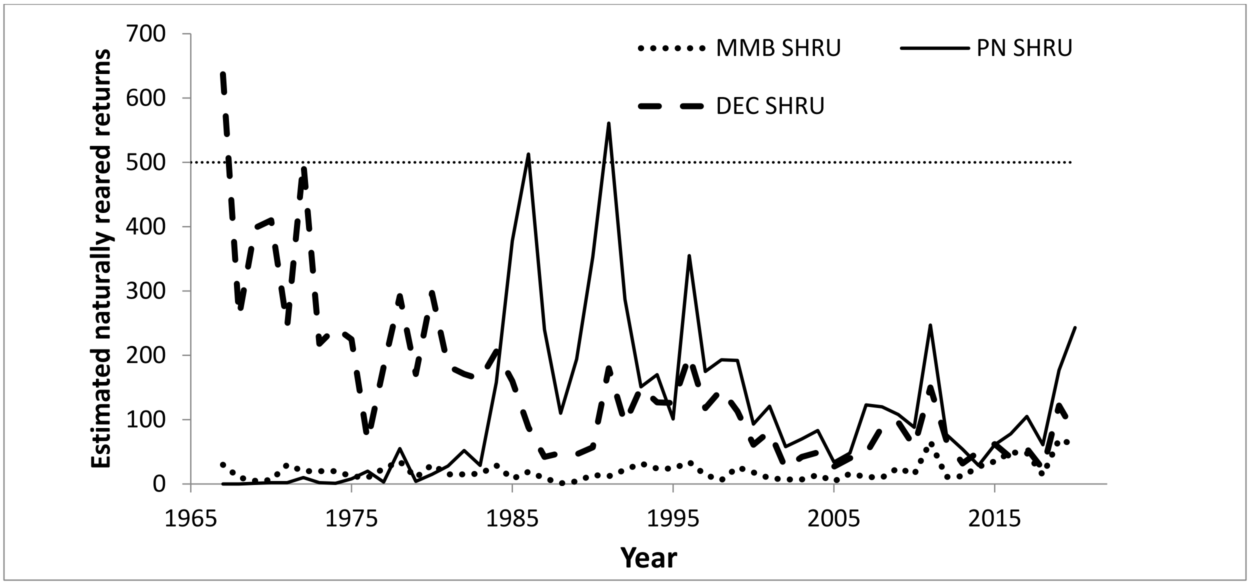

Figure 5.2 Estimated Naturally Reared Returns to the GOM 1965 to 2020

References:

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.

5.1 Adult returns and escapement

5.1.1 Merrymeeting Bay

Androscoggin River

The Brunswick fishway trap was operated from 1 June to 6 November 2020 (Table 5.1.1) by a combination of Maine Department of Marine Resources (MDMR) and Brookfield Renewable Partners (BRP) staff. Five adult Atlantic salmon were passed at the Brunswick fishway trap. These consisted of 3 hatchery reared 2SW and 2 naturally reared 2SW adults. BRP staff reported one multi-sea-winter adult passing Pejepscot fishway – this adult is presumed to be previously counted at Brunswick fishway. No mark was observed but given that only 1 out of the 5 fish were marked, it is assumed that this fish had already been counted at Brunswick fishway.

Occasionally an adult Atlantic salmon will pass undetected through the fishway at Brunswick during maintenance/cleaning, so a minimal redd count effort was conducted. Three small sections of the Little River where redds have been documented in the past were surveyed for redd presence, totaling 1.1 river kilometers. A Redd count was also conducted on the Sabattus River, which covered just shy of 0.95 river km. No redds or test pits were found in these sections of river.

Kennebec River

The Lockwood Dam fish lift was operated by BRP staff from 1 May to 31 October (Table 5.1.1). Fifty-one adult Atlantic salmon were captured at the lift. In addition, due to the dam's configuration, adults occasionally need to be rescued from a set of ledges in the bypass canal. In July one additional salmon was captured in the canal as well as one that was accidentally captured by an angler, bringing the total returns to the Kennebec River to 53. Biological data were collected from all returning Atlantic salmon in accordance with MDMR protocols, and the presence of marks and tags were recorded. Of the 53 returning Atlantic salmon, 49 (92.4%) were 2SW, 4 (7.5%) were grilse (1SW). All 53 were naturally reared in origin. Redd surveys were conducted in 57.13% of known spawning habitat primarily within the Sandy sub-drainage. Ninety-three redds were counted in the Sandy River and none in Bond Brook or Togus Stream also surveyed within the drainage.

Sebasticook River at Benton Falls fish lift facility was operated by MDMR staff from 01 May to 31 October 2020. No Atlantic salmon were captured (Table 5.1.1).

Sheepscot River

There were 10 redds observed in the Sheepscot River; eight were observed in the mainstem and two observed in the West Branch. The 10 redds were likely from sea-run adults. A total of 83.00% (66.31 km) of known spawning habitat was surveyed in the Sheepscot River drainage; Based on the Returns to Redds Model, between 5 and 36 with a mean of 14 salmon returns were estimated.

5.1.2 Penobscot Bay

Penobscot River

The fish lift at the Milford Hydro-Project, owned by BRP, was operated daily by MDMR staff from 22 April through 16 November. The fish lift was also used to collect adult sea-run Atlantic salmon broodstock for the U.S. Fish and Wildlife Service (USFWS). In addition to the Milford fish lift, BRP operated a fish lift daily at the Orono Hydro project. The counts of salmon collected at that facility are included in the Penobscot River totals.

A total of 1,439 sea-run Atlantic salmon returned to the Penobscot River (Table 5.1.1). Scale samples were collected from 465 salmon captured in the Penobscot River and analyzed to characterize the age and origin structure of the run. In addition, video monitoring in conducted at the Milford Dam to aide in counts when temperatures exceeded safe handling thresholds. The origins of the video counted and trapped Atlantic salmon that were not scale sampled were prorated based on the observed proportions, considering the size, presence of tags or marks observed and dorsal fin deformity. Of returning salmon, 19 were 3SW (1%), 1,219 were age 2SW (85%), 195 were age 1SW (14%), one was a domestic brood released the prior year (<0.1%), and six were a repeat spawners (0.4%). Approximately Eighty-three percent (83.1;1196) of the salmon that returned were of hatchery origin and the remaining 17% (243) were of wild or naturally reared origin. No aquaculture suspect salmon were captured.

Redd surveys in the Penobscot Drainage included the East Branch Penobscot River with 78.5% of the spawning habitat surveyed and 26 redds counted; the Mattawamkeag River had 33.8% of the spawning habitat surveyed with five redds counted (Table 5.1.2).

Ducktrap River

In the Ducktrap River spawner surveys covered 77% (~2.2km) of the available spawning habitat. Zero redds were counted (Table 5.1.2).

Cove Brook

Zero redds were counted in Cove Brook. Surveys covered 50% (1.5 km) of spawning habitat.

Souadabscook Stream

Souadabscook Stream was not surveyed in 2020.

5.1.3 Downeast Coastal

Dennys River

There were 20 redds counted in the Dennys River in 2020. Surveys covered 87.75% of the habitat and 19.89 km of river. Based on the Returns to Redds Model, estimated escapement was between eight and 53 with a mean of 21 salmon.

East Machias River

Twenty-six redds were counted during the 2020 redd surveys covering approximately 98.81% (67.47km) of known spawning habitat. This was the fourth cohort of adults to return from fall parr outplanted as part of the project by the Downeast Salmon Federation (DSF) to raise and release fall parr. There were 199,644 fall parr associated with the 2SW adult cohort. Based on the Returns to Redds Model, estimated escapement was between nine and 63 with a mean of 24 salmon.

Machias River

A total of 30 redds were counted. Surveys covered 60% of the habitat and 58.72 km of stream. Based on the Returns to Redds Model estimated escapement was between 11 and 77 with a mean of 29 salmon.

Pleasant River

There were 5 redds counted in 2020. Surveys covered 87.72% of the habitat and 19.8 km of stream. Based on the Returns to Redds Model estimated escapement was between thre and 24 with a mean of 94 salmon.

Narraguagus River

The Narraguagus adult trap located in Cherryfield was operated from 29 April to 20 October. Median catch date was 19 June. Returns to the fishway trap (108) were similar to 2019 (123). The majority of 2SW salmon returns are attributed to hatchery smolt released in 2018. Hatchery origin salmon returns (91; 84.3% of returns) were, 11 (12.1%) 1SW, 76 (83.5%) 2SW, 3 (3.3%) 3SW and 1 (1.1%) repeat spawners. For Naturally reared salmon returns (17; 15.7% of returns) were, 2 (11.8%) 1SW and 15 (88.2%) 2SW adults. Redd surveys accounted for 153 redds with surveys covering 83.4% and 43.8 km of known spawning habitat.

Union River

The fish trap at Ellsworth Dam on the Union River is operated by the dam owners, BRP, under protocols established by the DMR. The trap was operated from 15 May to 31 October 2020. Three 2SW females were captured and trucked around Graham Lake. Of these, two were adipose clipped and determined through genetic analysis to be strays from the Narraguagus River. These fish were stocked into the Narraguagus as smolts in 2018 after having been raised at Green Lake National Fish hatchery.

Table 5.1.1. Returns to the Gulf of Maine in 2020. Counts are from traps at dams or redds based estimates. Age and origins are prorated based on observed catches at traps, cohort specific catches at smolt traps or historical age ratios.

			Hatchery					Naturally Reared					Totals		
SHRU	Drainage	Method	1SW	2SW	3SW	4SW	Repeat	1SW	2SW	3SW	4SW	Repeat	H	W	Total
Downeast Coastal	Dennys	Redd Estimate						4	17				0	21	21
	East Machias	Redd Estimate	4	18					2				22	2	24
	Machias	Redd Estimate						6	23				0	29	29
	Pleasant	Redd Estimate	0					2	7				0	9	9
	Narraguagus	Trap	11	76	3		1	2	15				91	17	108
	Union	Trap		2					1				2	1	3
Penobscot Bay	Penobscot	Trap	177	998	16		5	18	221	3		1	1,196	243	1,439
	Kenduskeag	Redd Estimate													0
	Souadabscook	Not surveyed													N/A
	Cove Brook	Redd Estimate											0	0	0
	Duck Trap	Redd Estimate											0	0	0
Merry-meeting Bay	Sheepscot	Redd Estimate	2	6				1	5				8	6	14
	Kennebec	Trap						4	49				0	53	53
	Androscoggin	Trap		3					2				3	2	5
		Totals	194	1,103	19	0	6	37	342	3	0	1	1,322	383	1,705

Table 5.1.2. Results of redd surveys by SHRU, Drainage and Stream for 2020. Effort is shown by both total kilometers surveyed and the proportion of the spawning habitat surveyed for Drainage and individual stream.

SHRU	Drainage	Drainage Total	% Drainage Spawn Habitat Surveyed	Total Drainage KM surveyed	Stream Name	Redds	% Stream Spawn Habitat Surveyed	Total Stream km Surveyed
Downeast Coastal	Dennys	20	87.75	19.89	Dennys River	20	87.82	19.89
					Cathance Stream	0	0	0
	East Machias	26	98.81	67.47	Barrows Stream	0	0	2.18
					Beaverdam Stream	0	100	6.38
					Chase Mill Stream	3	100	2.13
					Creamer Brook	0	40	0.37
					East Machias River	17	98.85	33.52
					Harmon Stream	0	69.12	0.13
					Long Lake Stream	0	0	0.81
					Northern Stream	6	100	15.25
					Richardson Brook	0	0	1.37
					Seavey Stream	0	100	5.33
	Machias	30	60	58.72	Crooked River	0	59.87	2.57
					Machias River	12	52.85	16.51
					Mopang Stream	0	47.84	4.75
					Old Stream	16	79.95	18.39
					WB Machias River	2	93.29	16.5
	Narraguagus	153	83.37	43.82	Baker Brook	0	0	0
					Bog Brook	0	0	0

					Narraguagus River	153	90.61	43.82
					West Branch Brook	0	0	0
	Pleasant	5	87.72	19.8	Eastern Little River	0	0	0
					Pleasant River	5	88.28	19.8
Merrymeeting Bay	Lower Androscoggin	0	NA	0.74	Little River	0	NA	0.74
	Lower Kennebec	93	35.47	249.45	Avon Valley Brook	0	0	4.3
					Barker Brook	0	0	0.78
					Bond Brook	0	98.63	3.68
					Conant Stream	0	0	0.06
					Cottle Brook	0	0	3.97
					Messalonskee Stream	0	0	0
					Mt Blue Stream	0	0	4.57
					Orbeton Stream	22	93.82	16.84
					Perham Stream	4	84.13	6.91
					Saddleback Stream	0	0	0.6
					Sandy River	59	99.14	197.19
					SB Sandy River	8	100	4.37
					Temple Stream	0	0	2.41
					Togus Stream	0	100	3.77
					Valley Brook	0	0	0
	Sheepscot	10	82.83	66.31	Ben Brook	0	100	0.35
					Choate Brook	0	100	1.07
					Sheepscot River	8	83.54	32.93
					Trout Brook	0	35.29	1.17
					WB Sheepscot River	2	93.04	30.79
Penobscot	Ducktrap	0	76.95	2.15	Ducktrap River	0	78.52	2.02
					Kendall Brook	0	18.18	0.13

EB Penobscot River	26	62.7	25.6	Big Seboeis River	6	78.05	17.59
				EB Penobscot River	20	42.4	8.01
Mattawamkeag	5	9.79	7.32	EB Mattawamkeag River	5	33.8	7.32
Penobscot	0	6.69	22.4	Cove Brook	0	50.48	1.54
				French Stream	0	62.21	1.75
				Great Works Stream	0	0	1.33
				Kenduskeag Stream	0	46.41	12.92
				Penobscot River	0	0	3.11
				Pollard Brook	0	0	0.55
				Sedgeunkedunk Stream	0	0	1.2
Piscataquis	26	23.25	26.83	EB Pleasant River	7	15.37	1.06
				Houston Brook	0	0	1.51
				MB Pleasant River	0	0	1.6
				Piscataquis River	9	12	10.31
				Pleasant River	10	67.57	4.01
				Schoodic Stream	0	0	0.97
				WB Pleasant River	0	0	7.37
DPS Totals	**394**		**610.5**				

Redd Based Returns to Small Coastal Rivers

Estimated returns to Maine are based on the total number of returning salmondata collected from rivers with both traps and spawner surveys to generate estimates. For small coastal rivers without traps, 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, Machias River, Pleasant River, and the Sheepscot River based on observed redd counts. Estimated returns based on redd counts are computed using the equation: lnAdults = 1.1986 +0.6098(lnRedds). With a total of 250 surveyed redds the total estimated returns for the small coastal rivers was between 154 and 182 adults with a total estimate of 168 (Table 5.1.3).

Table 5.1.3. Redds based regression estimates and confidence intervals of total Atlantic salmon escapement to Cove Brook, Dennys, Ducktrap, East Machias, Kenduskeag, Machias, Pleasant, Sheepscot and Soudabscook Rivers for 2020.

Drainage	Total Spawn Habitat	Surveyed Habitat	Surveyed Redds	Predicted Returns	L95	U95
Cove Brook	7.08	3.67	0	0	NA	NA
Dennys	238.51	209.29	20	21	8	54
Ducktrap River	43.77	33.66	0	0	NA	NA
East Machias	89.19	58.22	26	24	9	63
Kenduskeag Str.	66.04	30.65	0	0	NA	NA
Machias	388.44	269.86	30	29	11	77
Narraguagus	265.82	221.62	153	71	26	193
Pleasant	129.78	124.04	5	9	3	24
Sheepscot	315.12	269.48	10	14	5	36
Grand Total	1,543.75	1,220.49	250	168	154	182

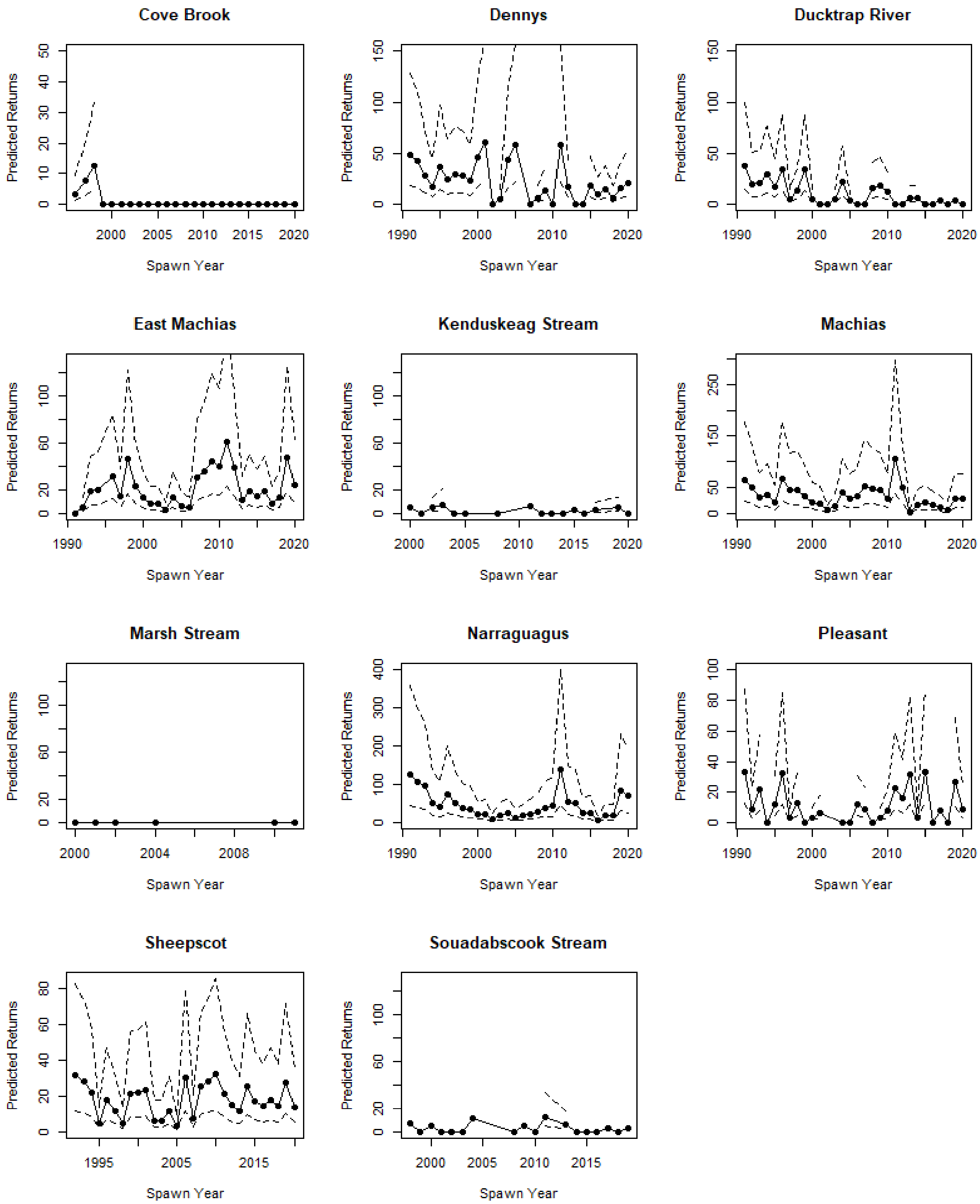

Figure 5.1.1. Annual Redds Based estimate of 2020 adult returns to managed drainages in the Gulf of Maine DPS.

5.2 Juvenile Population Status

Juvenile abundance estimates

A total of 238 sites were surveyed in 2020 using single pass removal electrofishing techniques. Of these, 84 sites were used to track status and trends (Figure 5.2.1). They were selected using the Geographic Randomized Tessellation Stratification (GRTS) technique (Stevens and Olsen 2004). Additional electrofishing efforts were used to evaluate hatchery products, habitat improvements and parr brood stock collections. A list of survey types for each drainage is presented in Table 5.2.1.

Parr abundance does not appear to be different across the time period from 2012 to 2020 with exception for the East Machias River. Abundance (Catch per Minute) has increased in the East Machias ($p > 0.05$) across the years 2012 to 2020. This increase is not likely the result of improvements in production or survival but rather due to an increase in biomass through the implementation of fall parr stocking by the DSF.

Looking at habitat effects on parr abundance, electrofishing survey sites are stratified by stream width class. There are four: A = 0 to 6 m, B = 6 to 12 m, C = 12 to 18 m and D = > 18 m. Results of an ANOVA using Catch per minute (CPUE) across width classes (Figure 5.2.3.) showed that abundance within A class stream reaches was significantly greater than the other width classes combined ($p < 0.01$). The B class stream reaches are more productive than C and D class reaches. This has implications on stock enhancement decisions when considering how and where to use limited resources of available fish.

Smolt Abundance

NOAA's National Marine Fisheries Service and the MDMR have conducted seasonal field activities assessing Atlantic salmon smolt populations using Rotary Screw Traps (RSTs) in selected Maine rivers since 1996 with many foci, including estimating migrating populations, as well as using the RST platform for enumerating individuals, tagging and sample collection.

No evaluation of smolt emigration took place in 2020 due to COVID-19. Expectations are that trapping activities will resume in 2021, with projects within the GoM assessments shifting in geography. The Sheepscot River tapping activities will discontinue ending the 18-year time series, with RSTs being reallocated to the Sandy River which is a tributary of the Kennebec River. The feasibility of trapping in the East Branch of the Penobscot River will be investigated, which will be part of a marine grow out project proposed by the Maine Department of Marine Resources beginning in 2022. The East Machias (seven-year time series) and Narraguagus (24-year time series) River evaluations will continue in their pre-COVID-19 operations.

Table 5.2.1 Summary of electrofishing effort within the Gulf of Maine DPS in 2020.

SHRU	Drainage	0+ PARR STUDY	Brood-stock	Egg Planting	GRTS	Habitat Evaluation	LWD	Fry Dispersal	Wild Spawning	Index	Other	Totals
DEC	Dennys		3									3
DEC	East Machias	5	3									8
DEC	Machias		2	1				22				25
DEC	Narraguagus		3		7		2	19				31
DEC	Pleasant		4					20				24
PNB	Ducktrap				5							5
PNB	Mattawamkeag				4	1						5
PNB	Penobscot				2							2
PNB	Piscataquis		1		24	3						28
MMB	Lower Androscoggin									2		2
MMB	Lower Kennebec			19	30				5	4	4	62
MMB	Sheepscot		22	1	12		4		4			43
	Totals	5	38	21	84	4	6	61	9	6	4	238

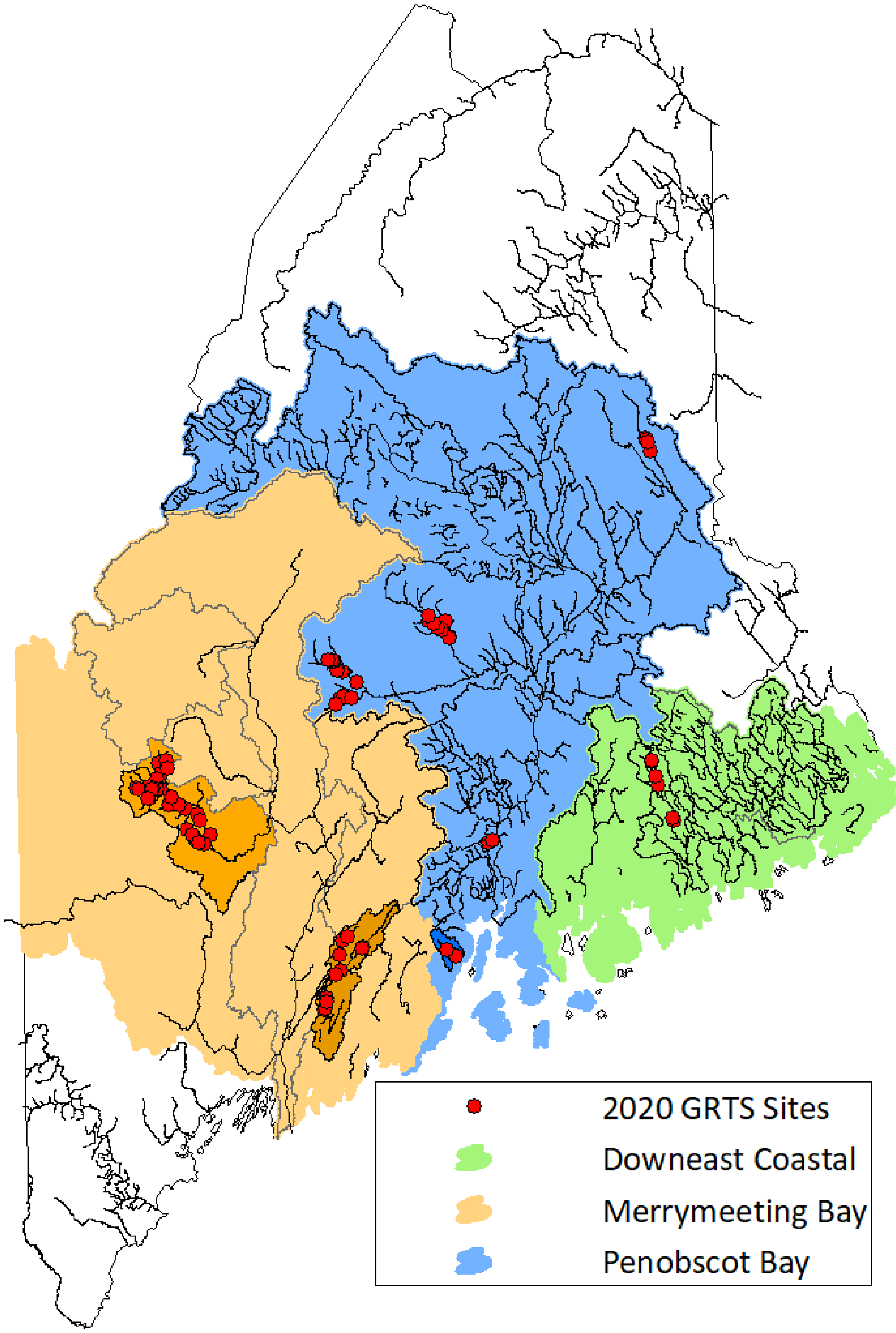

Figure 5.2.1. Location of 2020 sites (84) within each of the SHRUs surveyed using the GRTS selection criteria.

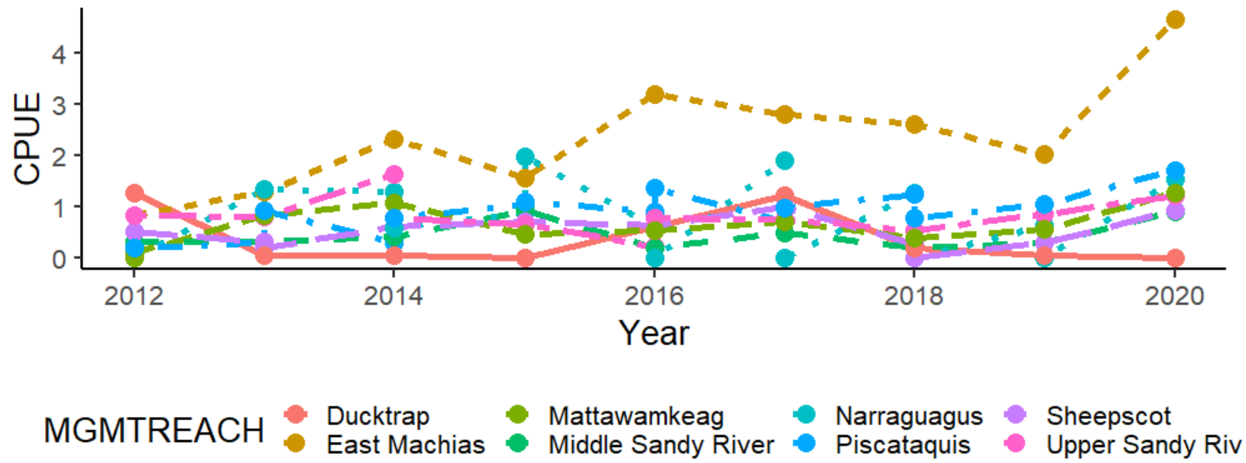

Figure 5.2.2. Mean Catch per minute by drainage 2012 to 2020 for index sites across managed drainages within the GOM DPS.

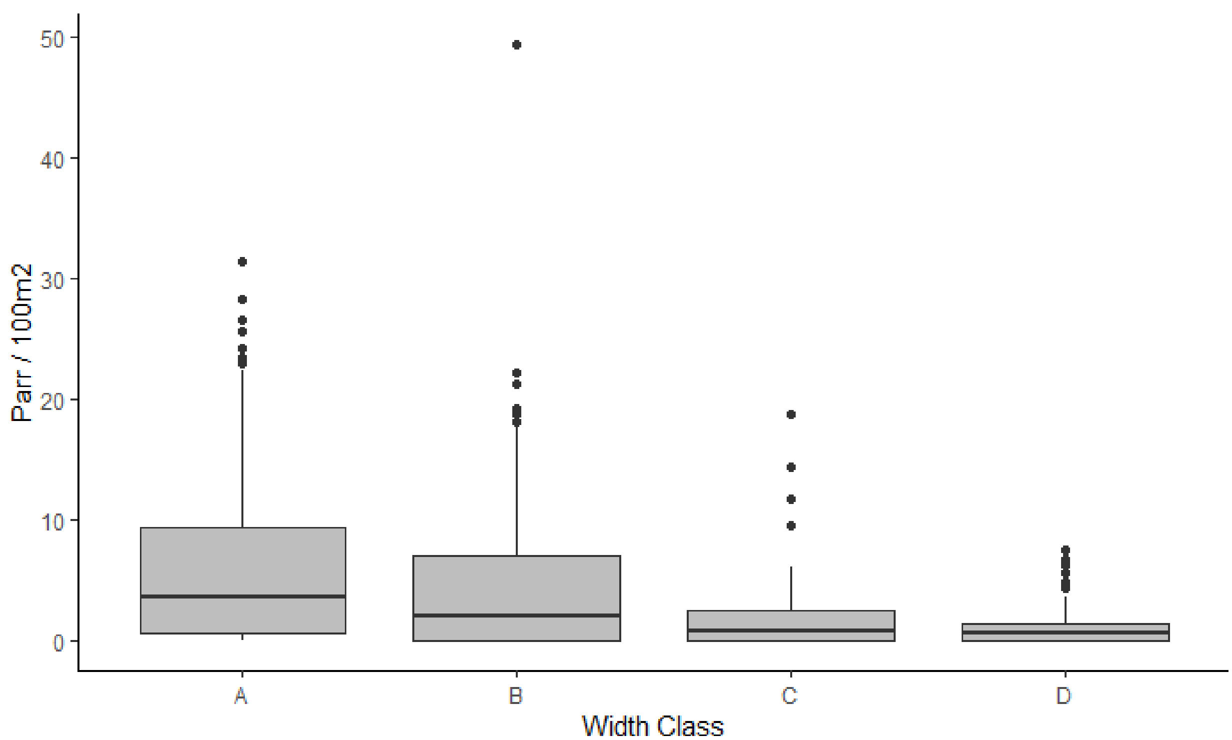

Figure 5.2.3. Boxplot showing relative abundance as catch per minute for large parr across four width classes. Width classes are as follows: A = 0 – 6m, B = 6 -12m, C = 12 – 18m and D = >18m.

5.3 Fish Passage and Migratory Fish Habitat Enhancement and Conservation

In the Spring of 2020, MDMR staff assisted the USGS Cooperative Fisheries and Wildlife Unit in radio-tagging adult Atlantic salmon to assess upstream migration timing of adult Atlantic salmon in the Penobscot River. Adult Atlantic salmon were collected by MDMR at the Milford Dam Fish Lift Sorting Facility. Ninety adult Atlantic salmon were tagged between 1 June and 8 June. Each Atlantic salmon was equipped with a PIT-tag in addition to a gastric implant of either a Lotek MCFT2-3L or Lotek MCFT2-3EM radio tag.

Forty radio-tagged salmon were transported approximately 18.5 km downstream and released at the Brewer Boat Launch to assess migration timing and behavior, with the remaining 50 radio-tagged salmon being released directly into the Milford head-pond to continue their upstream migration.

After release, tagged salmon were tracked using stationary receivers and intermittent mobile tracking efforts. In addition to radio data, PIT arrays located at the entrances and exits of fish ways on dams in the main stem Penobscot, Piscataquis, and Passadumkeag rivers tracked salmon movements.

Twenty-nine of the 40 fish released downstream passed Milford at least once. This means that 79 radio-tagged salmon were upstream of the dam at some point during the season. When tracking was concluded in December 2020, there were fifty-six radio-tagged fish that had their last detection above the dam.

Thirteen of 33 radio-tagged salmon (39%) that were detected near the downstream end of the Howland dam bypass were confirmed to have passed successfully.

Seventy-one radio-tagged fish approached the West Enfield Dam, and 64 (91.4%) passed. Thirty fish approached both Howland and West Enfield and 10 fish could be confirmed to have passed both dams at some point during their movements within the system.

On the Piscataquis River, three radio-tagged fish approached and likely passed Brownsmill Dam, although there is no confirmation of this.. There is data which suggests that of five fish approached Pumpkin Hill Dam on the Passadumkeag River, but there is no evidence that any of them passed upstream.

Fifty-seven radio-tagged salmon approached Weldon Dam and 37 (65%) passed.

In addition to the USGS study fish, MDMR staff PIT tagged 62 salmon throughout the trapping season during daily tending at the Milford Dam Sorting Facility. Of these, some contributed to upstream passage studies. Data from these fish will also be incorporated into information on the numbers of salmon using various reaches in the Penobscot drainage and the assessment of fish passage effectiveness. USGS is currently in the process of analyzing data and should soon know how many salmon were detected on the PIT arrays. USGS will calculate movement rates for each Atlantic salmon between dams.

Habitat Assessment

Quantitative Habitat Surveys

MDMR staff conducted habitat surveys in Temple Stream located in the MMB SHRU. Staff surveyed from Temple Rd bridge down to its junction with the Sandy River. This reach has Walton Mills dam which is a small non-hydro dam that is scheduled to be removed within the next few of years. Approximately 37.61 units of rearing and 5.50 units of spawning habitat to be made available as a result of this action. Data has been geo-referenced and will be appended to the current habitat geo-database. An updated GIS dataset will be issued in March 2021. Survey data will be utilized to establish broodstock requirements and direct habitat and/or connectivity improvements.

Thermal Refugia Surveys

In addition to the habitat survey MDMR crews conducted an adult Atlantic salmon thermal refugia survey on the mainstem Kennebec River. In anticipation of increasing numbers of adult Atlantic salmon returning to the Kennebec River, an effort was made to characterize water temperatures below the Lockwood Hydro Project Dam (Lockwood Dam). Lockwood dam is the first mainstem dam on the Kennebec River in Waterville, and resides approximately 100 km from the ocean. Adult salmon that are ascending the Kennebec River must find the fishlift located on the western side of Lockwood dam. Several passage studies have indicated that the fishway is difficult for salmon to find and has caused substantial delays in passage. Given passage delays and warm summer river temperatures it's likely that adults seek cool water refugia. Adult Atlantic salmon rely on thermal refugia as they ascend rivers in order to survive and minimize weight loss (Goniea et al. 2006). It is currently unknown where and how many sites below Waterville may offer thermal refugia.

The survey consisted of two teams paddling downstream from the Lockwood dam in Waterville with Solinst Temperature loggers to aid in describing the thermal profile. The crew's location was logged with a handheld GPS unit. To aid in accounting for fluctuations in daily temperatures, a number of stationary temperature loggers were deployed along the survey corridor. Currently the data is undergoing georeferencing and will be available in future reporting.

Atlantic Salmon Ecosystem Restoration in Togus Stream, Kennebec River

In 2019 the MDMR initiated an experimental reintroduction of Atlantic salmon to Togus Stream intended to evaluate the Atlantic salmon habitat and potential for recovery. Three sites were chosen to receive Sheepscot River origin eyed eggs. The sites were planting in the winter of 2019 and fry traps were placed on each of the artificial redds in early May and tended daily. Unfortunately, of the three sites emergent fry were only captured in the upper site (9.69km). The upper site trap only produced 27 fry (1.68%). Given the poor emergence rate, no future juvenile assessments were made for this year class.

The project was reinitiated in 2020 with the selection of three new sites as well as a single release of fry. On 19 February crews from the MDMR transported 6,236 eyed Sheepscot River origin eggs to three locations in Togus Stream (Map 1) and buried with the hydraulic egg planter. Fry emergence traps were installed in late April and tended daily. The Upper site (11.65 rkm) trap did not capture fry. The Middle site (6.92 rkm) trap captured 50 fry (2.3%) and the Lower site (3.76 rkm) trap captured 308 fry, (14.8%) (Figure 5.3.1). On 5 May MDMR also released 2,092 Sheepscot River origin fry at river km 3.11 .

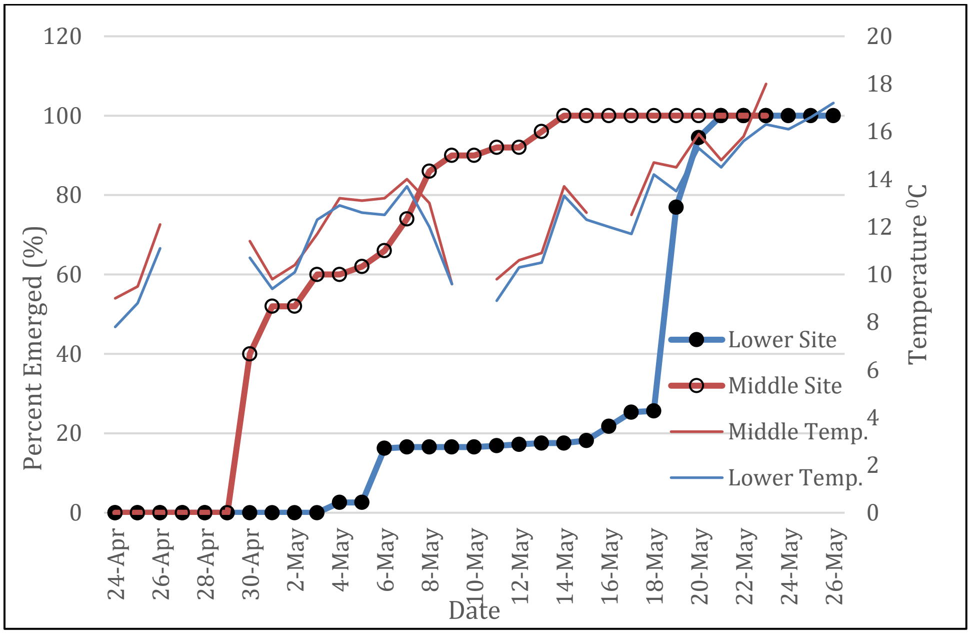

Figure 5.3.1. Percentage of emergent fry captured, and daily point temperatures at two sites in Togus Stream.

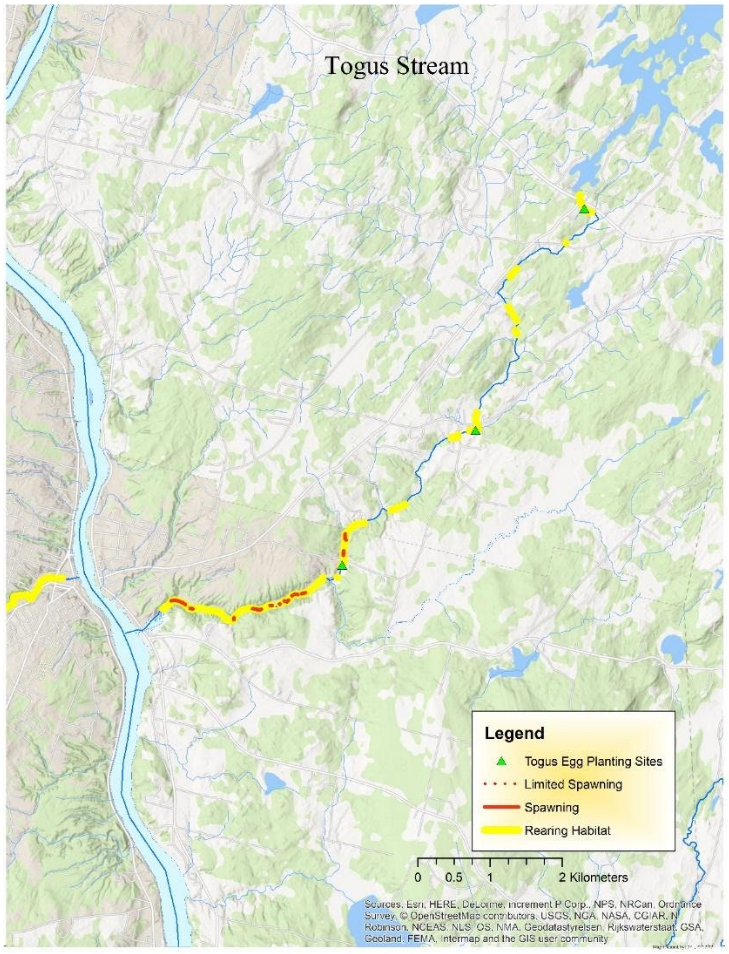

Figure 5.3.2. Togus Stream egg planting sites in 2020.

The summer survival and distribution of juveniles was evaluated in September of 2020. MDMR crews randomly choose a series of sites around each of the artificial redds that produced emergent fry as well as the fry release site. The sampling was conducted using CPUE methodology which consists of a single pass with an electrofishing backpack unit for approximately 5 minutes. MDMR crews found YOY at half of the 12 sites sampled (Figure 5.3.3.). CPUEs ranged from 0 to 2.8 YOY/minute. Samples downstream of the fry stocking site suggest YOY had traveled at least 200 meters below the release site. The lowest egg planting site which showed the best in-gravel survival had the highest density distribution with YOY found at least 450m downstream of the planting site. The middle egg planting site which had the poorest survival showed the least distribution from the artificial redd.

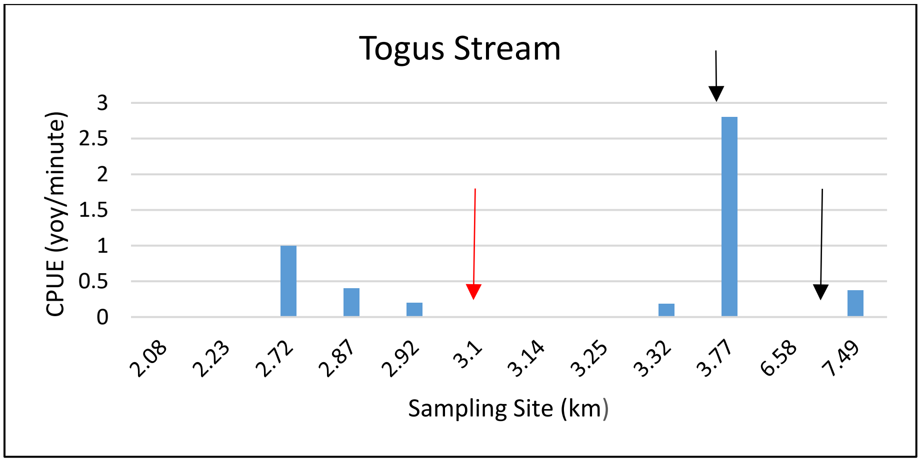

Figure 5.3.3. Catch Per Minute for young of the year upstream and downstream near both egg planting and fry release sites. Black arrows indicate approximate egg planting sites and red arrow indicates approximate fry release site.

The emergent fry trapping and juvenile sampling in Togus Stream indicates that both eggs and fry could be used to initiate Atlantic salmon reintroductions to this vacant habitat. Given the first year's limited success in collecting fry, a the poor results in upper site in 2020, this suggests habitat challenges associated with gravel condition. If a reintroduction program were planned for Togus Stream, it would be necessary to evaluate habitat within the watershed and initiate habitat restoration efforts.

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Habitat Connectivity

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

Highlighted Connectivity Projects: In 2020, 23 aquatic connectivity projects were completed across the GoM DPS (Table 5.3.1; Figures 5.3.4 and 5.3.5) with the primary goal of restoring aquatic organism connectivity and ecological stream processes by allowing the natural flow of materials (water, wood, sediment). Over 177 km of streams were made accessible as a result of these projects. These efforts were made possible due to strong partnerships between Natural Resources Conservation Service (NRCS), Penobscot Indian Nation, Project SHARE, Maine Department of Inland Fisheries and Wildlife, MDMR, Maine Department of Transportation (MaineDOT), Maine Department of Conservation, MFS, NOAA, Atlantic Salmon Federatoin, USFWS, The Nature Conservancy (TNC), municipalities, lake associations, towns, and numerous private landowners.

Table 5.3.1. Projects restoring stream connectivity in GOM DPS Atlantic salmon watersheds, indicating project type, lead partner, watershed, stream name, and distance (mi or km) of stream habitat access above the barrier that was restored.

Project Type	Lead Partner	Watershed	Stream	Stream Miles	Kilometers
Remnant Dam Removal	Project SHARE	East Machias	Northern Stream	6.50	10.46
AOP Crossing	MaineDOT	Lower Andro	Newton Brook	5.76	9.27
AOP Crossing	NRCS/TNC	Lower Kennebec	Trib to Orbeton Stream	0.60	0.97
AOP Crossing	NRCS/TNC	Lower Kennebec	Trib to Meadow Brook	0.71	1.14
Fishway	Maine Rivers	Lower Kennebec	Outlet Stream	1.70	2.74
AOP Crossing	NRCS/TNC	Lower Penobscot	Allen Stream	5.48	8.82
AOP Crossing	NRCS/TNC	Lower Penobscot	Allen Stream	12.50	20.12
AOP Crossing	MaineDOT	Lower Sandy River	Little Norridgewock Stream	0.50	0.80
AOP Crossing	MaineDOT	Lower Sandy River	Beales Brook	11.66	18.76
AOP Crossing	MaineDOT	Lower Sandy River	Trib to Wilson Stream	8.69	13.99
AOP Crossing	NRCS/TNC	Mattawamkeag	Trib to Baskahegan Lake	0.50	0.80
AOP Crossing	MaineDOT	Passagassawaukeag	Warren Stream	12.62	20.31
AOP Crossing	MaineDOT	Penobscot Bay	Trib to Pen Bay	10.00	16.09
AOP Crossing	NRCS/TNC	Piscataquis	Trib to Kingsbury stream	0.72	1.16
AOP Crossing	NRCS/TNC	Piscataquis	Trib to Thorn Brook	0.54	0.87
AOP Crossing	NRCS/TNC	Piscataquis	Trib to Marble Brook	1.47	2.37
AOP Crossing	TNC	Pleasant	Roaring Brook	13.70	22.05
AOP Crossing	MaineDOT	Pleasant	Trib to Branch Brook	2.23	3.59
AOP Crossing	NRCS/TNC/ Frenchman Bay Conservancy	Union/Maine Coastal	Jellison Meadow Brook	12.00	19.31
AOP Crossing	NRCS/TNC	West Branch Penobscot	Farrar Brook	0.86	1.38
AOP Crossing	NRCS/TNC	West Branch Penobscot	Trib to Farrar Brook	0.11	0.18

AOP Crossing	NRCS/TNC	West Branch Penobscot	Trib to Farrar Brook	0.69	1.11
AOP Crossing	NRCS/TNC	West Branch Penobscot	Trib to Penobscot Pond	0.74	1.19
			TOTAL	**110.28**	**177.48**

Figure 5.3.4. Jellison Meadow Brook crossing, before (left) and after (right), Mariaville, 2020. (photo credit: Ben Naumann, NRCS)

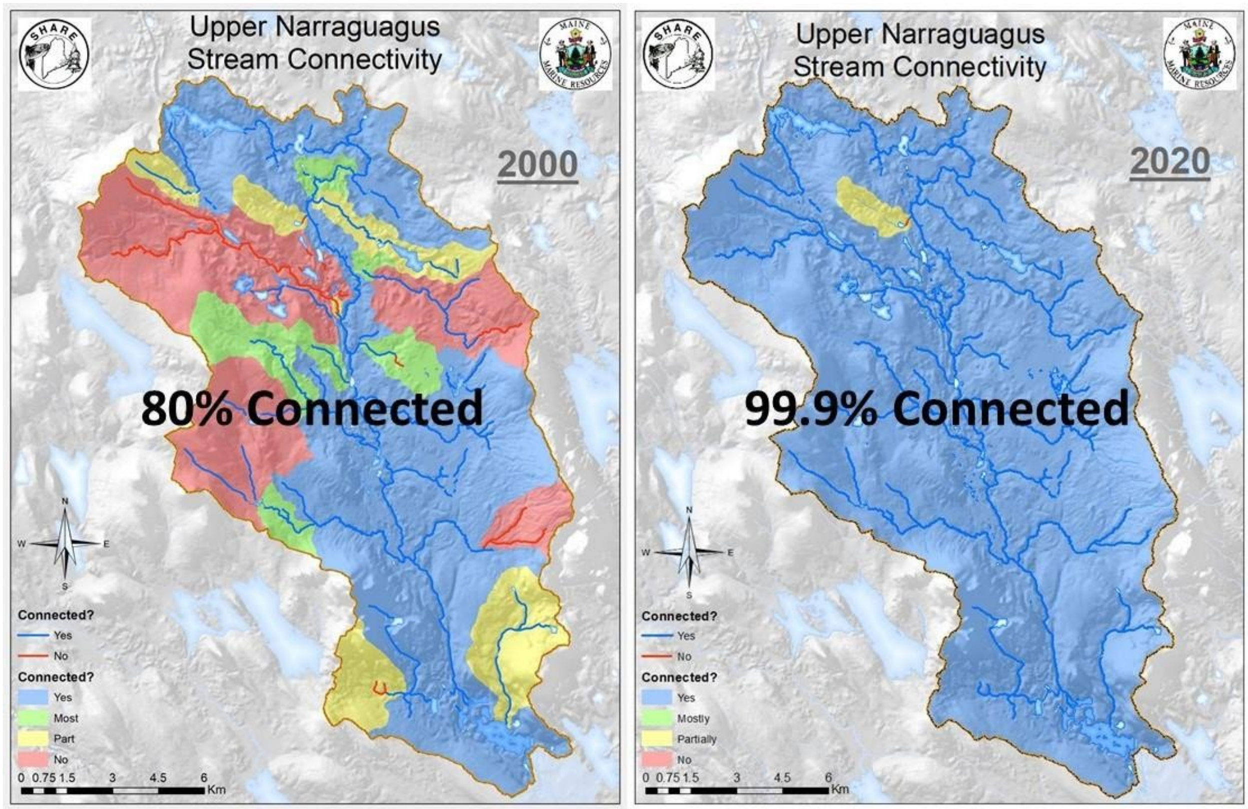

Figure 5.3.5. Comparison of stream habitat connectivity in the Upper Narraguagus sub-watershed, Narraguagus River (2000 and 2020). Maps produced by Project SHARE using data from Project SHARE, MDMR, Maine Office of GIS, and Ecosheds.org.

Habitat Complexity and Suitability

Upper Narraguagus Focus Area Restoration: 2020 Field Season Summary

Project SHARE has identified the Upper Narraguagus sub-watershed as a high priority focus area for salmonid habitat restoration. Other native fish species include Eastern brook trout (identified in steep decline throughout its range by the Eastern Brook Trout Joint Venture), American eel, alewife, shad, and sea lamprey will also be positively affected.

In collaboration with state and federal agencies, landowners, and nonprofit organizations, Project SHARE has developed a habitat restoration program with principal focus on the five Downeast Maine Atlantic salmon watersheds. The group has identified threats to habitat connectivity and function along with opportunities to restore cold-water refugia and rearing habitat. Cooperatively, projects have been done to mitigate those threats and/or restored connectivity and natural stream function. Watershed-scale threat assessments of the Narraguagus River have documented summer water temperatures in mainstem river reaches above sub-lethal stress levels, approaching acute lethal levels. Remnant dams and the associated legacy reservoirs are identified as heat sinks contributing to warmer temperatures.

Undersized culverts at road/stream crossings present stream connectivity threats and are barriers to upstream cold-water refugia.

Climate change predictions present threats in addition to legacy effects of past land use. Stream temperatures are expected to rise in most rivers; the threat to salmon recovery is high where temperatures are near sub-lethal or lethal thresholds for salmon (Beechie et al. 2013). Average air temperatures across the Northeast have risen 1.5° F (0.83° C) since 1970, with winter temperatures rising most rapidly, 4° F (2.2° C) between 1970 and 2000 (NECIA 2007). However, increased water temperature is not the only threat associated with climate change. Precipitation and timing of significant aquatic events (intense rain, ice-out, spring flooding, and drought, among them) are "master variables" that influence freshwater ecosystems and are predicted to change, according to all climate model predictions. Jacobson et al. (2009) provide a preliminary assessment summarizing impacts to Maine's freshwater ecosystems, predicting a wetter future, with more winter precipitation in the form of rain and increased precipitation intensity. Although it is not possible to predict specific changes at a given location, several 100- to 500-year precipitation events have occurred in recent years.

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

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

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

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

This project, a collaboration with the NOAA, USFWS, University of Maine, MDMR, Boston College, Connecticut College, and the Canadian Rivers Institute, will test the hypothesis that reconnecting river and stream habitat, improving habitat suitability, and reintroducing salmon to unoccupied habitat, will increase the number of salmon smolts leaving the sub-watershed in-route to the ocean.

In Township 39, another treatment of self-placing wood was added to the mainstem of the Narraguagus River (Table 5.3.2). This treatment involved using a truck-mounted grapple claw to place ~20 commercially harvested red pine trees into the river at the 31-00-0 road bridge (a commercial logging road crossing at River Km 62.49). The intent is for the trees to wash downstream during the fall and spring floods before hanging up and becoming key logs (i.e. self-placing). Two other self-placing wood additions also occurred in the upper Narraguagus; one in West Branch Brook and one above the 2019 PALS treatment area at River Km 52.17. These treatments will continue over the next 3-5 years with the hypothesis that multiple naturally formed log jams will develop.

Eighty trees were also added to various reaches along the mainstem using a Griphoist (Figures 5.3.6 and 5.3.7). Some of the trees were felled to form large wood jams; three of the jams were built in two reaches in Devereaux Township and one jam was constructed in Township 35. The remaining trees were felled either individually or in pairs in reaches flowing through Townships 39, 35, and 28 and Devereaux Township.

Table 5.3.2. Large wood additions implemented by Project SHARE in support of the Upper Narraguagus Watershed Restoration Project, Narraguagus River, Maine (2020).

River Reach/Tributary	Addition Type	Large Wood Pieces Added	Habitat Units Treated
Narraguagus Mainstem	Self-placing Wood	60	78.7
Narraguagus Mainstem	Griphoist Trees - Individual	62	78.5
Narraguagus Mainstem	Griphoist Trees - LW Jams	18	6.47
West Branch Brook	Self-placing Wood	12	12.98

In preparation for work to be completed in 2021 SHARE, USFWS, U.S. Army Corps of Engineers (USACOE), and MDMR staff spent approximately three days building boulder clusters and digging exploratory geotechnical pits in a reach just downstream of the Route 9 crossing in the Narraguagus River (Table 5.3.3; Figure 5.3.8). Two boulder clusters were constructed in the river to test their stability and effectiveness at breaking up ice flowing downstream. Seven geotechnical pits were excavated to determine depth of bedrock within the wetted channel. The purpose of this phase of the project is to aid in the design of large engineered log jams that will be constructed in the summer of 2021. The exploratory work was completed using equipment and operators from Moosehorn National Wildlife Refuge and was overseen by permit reviewers from USFWS and USACOE. Excavation and boulder placement was directed by SHARE staff and an independent hydrological engineer.

Figure 5.3.*6*. Large wood jam created using 3 larger trees, and 2 smaller *trees; felled* manually using a Griphoist, Narraguagus River (2020). (photo credit: Chris Federico, Project SHARE)

Figure 5.3.*7*. Project SHARE seasonal crew and a moderately-sized white pine tree that was felled manually using a Griphoist, Narraguagus River (2020). (photo credit: Chris Federico, Project SHARE)

Table 5.3.3. Habitat enhancement/planning projects completed by Project SHARE in the Upper Narraguagus sub-watershed, Narraguagus River (2020).

Watershed	Tributary	Restoration Project Type
Narraguagus	Narraguagus Mainstem	Exploratory Geotechnical Pits
Narraguagus	Narraguagus Mainstem	Boulder Clusters (2)
Narraguagus	Baker Brook, Gould Brook, 35 Brook, Rocky Brook	Large wood and remnant dam inventory

Figure 5.3.*8*. Restoration work completed at the Route 9 project site, Narraguagus River (2020). Completed boulder clusters and the excavator beginning on the second (A - Left). Engineer measuring the depth an exploratory geotechnical pit (B - Right). (photo credit: Chris Federico, Project SHARE)

Other Downeast SHRU Restoration Activities: 2020 Field Season Summary

Project SHARE completed restoration activities in the East Machias and Machias watersheds in 2020. A large wood jam was created using the Griphoist method on Northern Stream in the East Machias watershed treating 40 m^2 of habitat by adding three pieces of LW. This activity was completed to create a key-piece in the reach in advance of self-placing wood additions. In addition, side channel restoration activities occurred in Third Lake Stream in the Machias watershed where wing dams were breached (Figure 5.3.9). This reach of the Machias River has 13 rock walls (wing dams) blocking flow into 10 side channels. Additional side channel reconnections will be completed in 2021.

Figure 5.3.*9*. Reconnected side channel in Third Lake Stream, Machias River (2020). (photo credit: Chris Federico, Project SHARE)

Water Quality

The DSF, in collaboration with the Maine Department of Environmental Protection, continued their multi-year effort which began in 2017 in the East Machias River watershed to investigate the efficacy of using clam shells to lime streams that have been impacted by acid rain. The goal of the project is to increase macroinvertebrate abundance and diversity, and to increase juvenile salmon abundance. The first dose of clam shells was added to Richardson Brook in 2019, and a second dose was added in 2020 (Figure 5.3.10). An extremely dry summer in 2020 allowed for higher relative contributions from groundwater, which increased stream baseflow pH. Based on preliminary analysis, after the addition of the second dose of shells, the pH in the treated section of Richardson Brook was 0.9 units higher than during baseline years, and 0.8 units higher than the untreated upstream section. Biological data are not yet available for analysis. Periodic stressful conditions are still occurring in Richardson Brook, including low pH (minimum of 5.07), low calcium (minimum of 1.0 mg/L), and high exchangeable aluminum (maximum of 18.9 ug/l), however these conditions are of lesser magnitude and duration than observed during baseline monitoring. Preliminary analysis suggests that water quality has improved due to the addition of a second dose of shells, which was enhanced by low water conditions that allowed more shells to be spread on the stream bottom rather than just along the banks. Further data analysis is required to determine the extent of seasonal and yearly variations, as well as any impacts to biological communities. Additional shell treatments are planned for 2021, and monitoring will continue through at least 2023 to determine the efficacy of using clam shells to mitigate acidity.

Figure 5.3.10. Clam shells spread along the banks of Richardson Brook, Township 19 ED BPP, 2020. (photo credit: Emily Zimmermann, Maine DEP)

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5.4 Hatchery Operations

As a result of the 2020 Covid-19 pandemic hatchery operations underwent several changes in operations. Actions to ensure the health and safety of hatchery personnel, including the use of personal protective equipment (PPE), physical distancing of personnel during hatchery and field operations and limiting access to the hatchery were undertaken and remain in place at the time of writing this report. Prioritizing the health and safety of hatchery personnel led to modifications of the spring 2020 stocking season, sea-run and captive broodstock collection and spawning. Pandemic-related actions taken, and the effects, are described in each of the sections below.

Egg Production

Sea-run, captive and domestic broodstock reared at Craig Brook National Fish Hatchery (CBNFH) and Green Lake National Fish Hatchery (GLNFH) produced 5,779,386 eggs for the Maine program: 926,872 eggs from Penobscot sea-run broodstock; 1,900,498 eggs from domestic broodstock; 2,952,016 eggs from captive broodstock populations.

Spawning protocols for Atlantic salmon broodstock at CBNFH and GLNFH prioritize first time spawners and utilize 1:1 paired matings. In 2020, both facilities used year-class crosses to avoid spawning closely related individuals and documented each mating. In addition, CBNFH used Mate Matcher, a spawning optimization software.

A total of 122 Penobscot sea-run origin females and 680 captive females were spawned at CBNFH in 2020. Eggs produced at CBNFH contribute to egg planting, fry stocking, and educational programs, smolt and parr production at GLNFH, as well as private rearing programs at facilities operated by DSF. For egg transfers to GLNFH and DSF an equal aliquot of each family group per strain are transferred.

As CBNFH relies solely on ambient water sources eggs taken early in the spawning season may be exposed to water temperatures above optimal levels (<10° C) for egg development which may negatively affect egg and fry survival. To overcome this challenge, CBNFH is using a photoperiod treatment to modify spawn timing. The treatment is administered using a predetermined schedule and time clocks to extend the light available during the summer solstice (June 21) for approximately ten days. Fluorescent or LED lighting is used to supplement ambient light. The treatment delays spawning and allows eggs to be collected in more favorable water temperatures.

The treatment was initially used for Penobscot sea-run broodstock beginning in 2010 after observing both an advance in spawn timing of sea-run adults and an increased frequency of warm fall water temperatures. In 2018, the photoperiod treatment was administered to the Narraguagus and Machias captive broodstock. After successfully implementing the photoperiod treatment for those two populations it was applied to the remaining captive populations in 2020.

At GLNFH, 704 Penobscot-origin domestic females were spawned to provide eggs for egg planting, smolt production, domestic broodstock and educational programs.

In response to the 2020 Covid-19 pandemic, personnel at both facilities used recommended PPE and physical distancing during spawning operations. In typical years personnel may participate in spawning at both facilities but in 2020 travel between CBNFH and GLNFH was prohibited. In addition, no outside assistance from either state and private partners or the university could be accepted. Spawning protocols at CBNFH were modified to limit close contact between personnel when spawning broodstock; some protocols, such as staggering the spawning pans different, were recognized as beneficial and will likely be carried forward in future years. There were no negative impacts to spawning or egg collection as a result of the pandemic.

Egg Transfers

CBNFH and GLNFH transferred 2,852,000 eyed eggs from seven strains to various partners (Table 5.4.1). All 2020 transfers occurred prior to the 2020 Covid-19 pandemic so no changes to protocols were required.

Table 5.4.1. Eyed egg transfers from Craig Brook National Fish Hatchery and Green Lake National Fish Hatchery in 2020. MDMR = Maine Department of Marine Resources, DSF = Downeast Salmon Federation, FF = Fish Friends, educational program. *Egg numbers rounded to the nearest 1,000.

Facility	Strain	Rearing History	Receiving Entity	Purpose	Number*
CBNFH	Dennys	Captive/domestic	MDMR	Egg planting	40,000
CBNFH	East Machias	Captive/domestic	DSF	Private rearing	145,000
CBNFH	Machias	Captive/domestic	MDMR	Egg planting	102,000
CBNFH	Machias	Captive/domestic	GLNFH	Smolt production	21,000
CBNFH	Narraguagus	Captive/domestic	MDMR	Egg planting	66,000
CBNFH	Penobscot	Sea-run	GLNFH	Smolt production	932,000
CBNFH	Penobscot	Sea-run	FF	Education	3,000
CBNFH	Pleasant	Captive/domestic	DSF	Private rearing	114,000
CBNFH	Pleasant	Captive/domestic	MDMR	Egg planting	85,000
CBNFH	Sheepscot	Captive/domestic	MDMR	Egg planting	163,000
CBNFH	Sheepscot	Captive/domestic	FF	Education	1,000
GLNFH	Penobscot	Captive/domestic	MDMR	Egg planting	1,170,000
GLNFH	Penobscot	Captive/domestic	FF	Education	10,000
					2,852,000

Broodstock Collection

Broodstock are collected, or created, from three sources: Penobscot River sea-run adults for the Penobscot River; captured age 1+ parr for the Dennys, East Machias, Machias, Narraguagus, Pleasant and Sheepscot Rivers; Penobscot River domestic origin broodstock, created from sea-run origin eggs, for the Penobscot and Kennebec River drainages.

Penobscot River Sea-run Broodstock

The greatest impact of the 2020 Covid-19 pandemic was on the collection of Penobscot sea-run adults from the Milford Dam. Collection was delayed while contingency plans were developed by all the involved parties (MDMR, CBNFH and Brookfield Power). CBNFH agreed to accept approximately 200 sea-run adults for broodstock beginning on June 15th; the final number collected, over 26 trips, was 221. In addition to establishing the approximate 200 collection limit a daily cap of 40 adults per day was imposed to facilitate the Infectious Salmon Anemia (ISA) virus screening and analysis processes. It was determined the work area at the Milford dam was not conducive to physical distancing during the pandemic, so sea-run adults were tagged and sampled for genetics and scales at the hatchery instead of at the dam. MDMR and CBNFH biologists collaborated to develop data collection methods that would meet the needs of both agencies as well as shared resources such as tags, tagging needles and other materials. Collection of sea-run adults continued until August 26th. Although CBNFH intended to continue to transport broodstock in September it was determined the hatchery did not have the resources to do so.

Captive Broodstock

Captive broodstock targets have varied over the course of the Atlantic salmon program in Maine (Table 5.4.2). Initial river-specific targets, developed in collaboration between MDMR, NOAA, and FWS, were based on the number of broodstock required to seed available fry habitat with the equal of 240 eggs per habitat unit. An additional number of parr, over the established target, would be collected to account for any losses prior to their first spawn at age three. The number of 'extra' parr was not established and often led to dramatic increases in population size.

Ongoing assessment of family recapture rates and other diversity metrics led to an increase to parr collections beginning in 2008, although the primary driver of collection targets remained fry production goals. Targets for the Machias and Narraguagus were increased to 300 parr each. Targets for all the remaining rivers increased to 200 each. In addition to efforts to increase parr collections for each population, greater attention was given to ensuring parr were collected in a manner that equalized the distribution of hatchery-origin products and those of wild reproduction.

In 2018 the FWS opted to equalize broodstock numbers across the populations with the focus on using the available rearing space at CBNFH effectively, maintaining a minimum effective population size of 50 and managing biomass. Parr targets for all rivers are set at 200 with up to 15 extra fish to make up for potential losses.

Table 5.4.2. Parr collection targets for captive broodstock by population and years.

	Parr Targets by Year		
Populations:	<2006	2008-2017	>2018
Dennys	150	200	200 ± 15
East Machias	150	200	200 ± 15
Machias	250	300	200 ± 15
Narraguagus	250	300	200 ± 15
Pleasant	100	200	200 ± 15
Sheepscot	150	200	200 ± 15

In 2020, parr collections totaled 1,282: Dennys, 215; East Machias, 215; Machias, 215; Narraguagus, 215; Pleasant, 207; Sheepscot, 215. Due to the failure of an oxygen system during the initial isolation post-capture 215 Sheepscot origin parr perished; an additional 215 were captured to make up the loss.

Modifications to parr collection protocols due to the 2020 Covid-19 pandemic included the use of PPE during travel to and from collection sites as well as during collection. The number of personnel permitted per vehicle was limited to two with the use of PPE and open windows; this increased the number of vehicles in use for the season. Parr collected by MDMR were transferred to CBNFH personnel with as little close contact as feasible. No significant impacts to collections occurred.

Penobscot Domestic Broodstock

GLNFH retained approximately 960 fish from the 2018-spawn year of sea-run Penobscot-strain Atlantic salmon; a reduction of previous population size of 1,200. This management action aligns egg production with the incubation capacity, avoids production of excess green eggs, and encourages 1:1 spawning ratio for the age three domestic brood. These fish will be used for F2 domestic egg production at GLNFH for 2 years.

Disease Monitoring and Control

Disease monitoring and control was conducted at both hatcheries in accordance with hatchery broodstock management protocols and biosecurity plans. All incidental mortalities of future or adult broodstock reared at CBNFH were necropsied for disease monitoring. Analysis, conducted at the Lamar Fish Health Center (LFHC), indicated that incidental mortalities were not caused by infectious pathogens. All lots of fish to be released from either facility were sampled in accordance with fish health protocols at least 30 days prior to release. Samples of reproductive fluids are collected from each female and male spawned at CBNFH. Additionally, ovarian fluid is collected from 150 females at GLNFH. All reproductive fluids are analyzed at LFHC.

No fish health issues were detected in any captive or domestic broodstock or in any other hatchery product at CBNFH or GLNFH. Three cases of Infectious Salmonid Anemia (ISA) were detected in Penobscot sea-run adults during the screening process at CBNFH. Two cases of the ISA detections were determined to be the non-pathogenic strain of ISA (HPR0) and one case was determined to a pathogenetic strain. Details of the ISA detections are provided below.

Infectious Salmonid Anemia

ISA is an orthomyxovirus first reported among Norwegian salmon farms. ISA is extremely infectious and may result in high mortalities in aquaculture settings. Due to the proximity of aquaculture installations to Maine rivers sea-run adults returning to the Penobscot River are monitored for the disease.

Sea-run adults are isolated in a screening facility at CBNFH to undergo sampling procedures and await the results of PCR testing. Blood samples are analyzed by the LFHC using Polymerase Chain Reaction (PCR) testing. Adult passing the PCR test are accepted into the sea-run brood program and transferred to the holding area for future spawning.

In the event of a positive ISA result additional tests are conducted on the affected individual. Should the individual be affected by HPR0 that individual is released into the Penobscot at an upriver location above the Milford dam. Any adults initially isolated in the same tank with the HPR0 individual (cohort) are allowed to join the general hatchery population. In 2020 two HPR0 positive adults were released to the Penobscot River.

In the event a positive result for a pathogenic strain of ISA is detected the affected individual is euthanized. The affected individual's cohort is isolated for an additional 28 days and resampled. In 2020 one individual was identified by LFHC as being positive for pathogenic ISA. LFHC collaborated the Animal and Plant Health Inspection Service (APHIS). Samples of blood and tissues were collected and sent to both LFHC and APHIS; the individual was euthanized. APHIS confirmed the presence of HPR6 in spleen tissue and HPR8 in blood samples and heart tissue. The individual did not demonstrate any clinical signs of ISA prior to being euthanized. The cohorts of the affected individual were quarantined for 28 days and resampled. No additional positive results were found, and the fish were allowed to join the general population.

Stocking

Stocking activities within the GOM DPS resulted in the release of 3,758,221 Atlantic salmon. These releases included Atlantic salmon from all life stages and were initiated by federal and state agencies, NGOs, researchers and educational programs.

Considerable coordination and collaboration was undertaken by all partners to accomplish stocking activities during the 2020 Covid-19 pandemic. At GLNFH smolt stocking vehicles were assigned to specific personnel to reduce potential contamination. Personnel were divided into 'crews' to further reduce the possibility of disease transmission. Minimal interaction of personnel between the two hatcheries was permitted. Fry stocking from CBNFH was accomplished with limited staff as the hiring of seasonal interns was delayed over pandemic concerns. Two hatchery personnel carried out all transport and distribution of fry to state partners; PPE, physical distancing, use of assigned vehicles and frequent sanitation were employed when interacting with MDMR personnel.

Despite many challenges no negative affects to the release of Atlantic salmon occurred.

Juvenile Stocking

CBNFH, GLNFH, NNFH and two DSF hatcheries (Pleasant River Hatchery and Peter Gray Hatchery) and ASF's Fish Friends program released 3,756,000 juveniles (eyed eggs, fry, parr, and smolts) throughout the GOM DPS (Table 5.4.3).

Table 5.4.3. Stocking activities in the Gulf of Maine Distinct Population Segment for 2020.

Drainage	Parr	Smolt	Egg Eyed	Fry	Total
Androscoggin				2,000	2,000
Dennys			40,000	149,000	189,000
East Machias	68,000				68,000
Kennebec		89,000	679,000	3,000	771,000
Machias	16,000		102,000	181,000	299,000
Narraguagus			66,000	164,000	230,000
Penobscot	70,000	648,000	498,000	614,000	1,830,000
Pleasant			85,000	89,000	174,000
Sheepscot			163,000	28,000	191,000
Union				2,000	2,000
Totals	154,000	737,000	1,633,000	1,232,000	3,756,000

Adult Stocking

A total of 2,241 adults were stocked into GOM drainages (Table 5.4.4). No significant impacts from the 2020 Covid-19 pandemic occurred during the release of adult Atlantic salmon.

Table 5.4.4. Adult and sub-adult broodstock released pre- and post-spawn from Craig Brook and Green Lake National Fish Hatcheries in 2020.

Drainage	**Stock Origin**	**Pre/Post Spawn**	**Lot**	**Number Stocked**
Dennys	DE	Post-Spawn	Captive/Domestic	198
East Machias	EM	Post-Spawn	Captive/Domestic	220
Machias	MC	Post-Spawn	Captive/Domestic	198
Narraguagus	NG	Post-Spawn	Captive/Domestic	291
Penobscot	PN	Post-Spawn	Captive/Domestic	750
Penobscot	PN	Post-Spawn	Sea Run	203
Penobscot	PN	Pre-Spawn	Sea Run	2
Pleasant	PL	Post-Spawn	Captive/Domestic	169
Sheepscot	SHP	Post-Spawn	Captive/Domestic	190
			Total	2,221

5.6 General Program Information

GOM DPS Recovery Plan

The Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon has been completed by the USFWS and NOAA in close collaboration with MDMR and the Penobscot Indian Nation and was released on February 12th, 2019. This document is available at: https://www.fisheries.noaa.gov/action/final-atlantic-salmon-recovery-plan?utm_medium=email&utm_source=govdelivery

A new format for integrating communication and restoration efforts was put in place in 2019. This is called the Collaborative Management Strategy (CMS) and is comprised of both upward and outward components. The CMS replaces the previous Atlantic Salmon Framework. At its base, the CMS has three SHRU specific coordinating committees that are charged with development of recommended recovery actions that are tailored to each SHRU. Above these committees is the Implementation Team (IT) which is made up of the SHRU team chairs and the Management Board. This is the interface between on the ground managers and upper level decision makers. Finally, the Management board is the group of agency leads representing FWS, NOAA, MDMR and the PIN.

One task undertaken by the SHRU Coordinating Committees has been the development of SHRU specific workplans. Draft 5-year SHRU based recovery plans and stock enhancement plans are currently under consideration by the management board. Recognizing that each SHRU has different priorities in the lens of triaging threats to Atlantic salmon recovery, this process provides detailed actions in a list format for agencies and NGO's to reference.

6 Outer Bay of Fundy

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

6.1 Adult Returns

The Tinker fishway trap on the Aroostook River was operated by Algonquin Power Company from 02 July to 30 October 2020. Three Atlantic salmon were captured and released upstream in 2020. The salmon captured consisted of 3 2SW females. Of these fish all 3 were hatchery origin.

6.2 Hatchery Operations

Stocking

No juvenile lifestages were stocked.

Adult Salmon Releases

No adults were stocked.

6.3 Juvenile Population Status

Electrofishing Surveys

There were no population assessments in the Aroostook River watershed.

Smolt Monitoring

No smolt monitoring was conducted for the Aroostook River program.

6.4 Tagging

No tagging occurred in the Aroostook River program.

6.5 Fish Passage

No projects or updates.

6.6 Genetics

No tissue samples were collected.

6.7 General Program Information

No updates or information.

7 Emerging Issues in US Salmon and Terms of Reference

7.1 Summary

This section provides an overview of information presented or developed at the meeting that identifies emerging issues or new science or management activities important to Atlantic salmon in New England. 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 assessment 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.

7.2 Scale Archiving and Inventory Update

The USASAC 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 Databases. However, storage details and the condition of fish scales has not been adequately summarized. The USASAC supports 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.

In 2020, the USASAC was briefed on the recent ICES workshop entitled ICES Workshop on Biochronology Archives (WKBioArc) which was held in Galway Ireland February 2020. R. Haas-Castro (NOAA) participated in this meeting and provided the group a detailed summary. Workshop topics included: sample handling, management and accessibility of data, research opportunities, and collaboration and funding. A constructive discussion ensued with some urgency expressed to identify existing biomineral inventories across agencies and throughout the historical range of Atlantic salmon in the USA. With the geography of assessments shrinking and storage facilities limited, the urgency of understanding what there is for inventory (data and samples) and how it is presently stored was the focus of much of the discussion. An ad hoc-group was formed and charged with identifying steps to secure and inventory samples, as well as finding adequate long term storage. Members of the USASAC including S. Gephard (representing LIS and CNE), as well as NOAA and MDMR staff (representing CNE and GoM) will work collaboratively to move this time-critical action forward. Their findings and activities in 2021 will be reported in the TOR for 2022.

7.3 Juvenile Assessment Update

An update on the development of a synthesis document that describes both the long-term index sites through 2012 (J.Sweka) and new Generalized Random - Tessellation Stratified (GRTS; Stevens and Olsen 2004) design (2013-2017) for Maine was presented by E. Atkinson. The USASAC concurred that a document with lessons learned and the best path forward for monitoring juvenile production status and trends in the index river system within each SHRU is needed. Historical datasets will be utilized to support research needs and support management applications related to climate and restoration based questions. Plans for 2021 include continuing the use of GRTS sampling efforts to focus on the priority of fish safety and coverage with single pass sampling efforts. This provides a sound estimate of abundance and distribution and also allows sampling coverage to be optimized throughout these managed watersheds. The randomized 5-year sample rotation as part of the GRTS sampling guidelines will aid in representative sampling within the target watersheds. An update on sampling activities will be provided in 2022 reporting.

7.4 Fall Fingerling Evaluation - Across Drainages in Maine

An evaluation of the fall fingerlings within the GoM was presented and was in response to the previous years' presentations highlighting the low smolt production on two of the three rivers. In 2019, the Narraguagus naturally-reared population estimate was the second lowest observed in the 23-year time-series and the Sheepscot River naturally-reared population experienced a similar decline with a 35% decrease from the previous year. Estimates for 2020 are not available due to COVID-19 restrictions. Unlike these two rivers, the East Machias has experienced a relatively steady input of age 0 parr from the streamside Peter Gray Hatchery smolt production has increased in recent years, with an age distribution similar to what is expected for a Maine natural population(more age 2 and 3 fish). Although numbers from the East Machias are encouraging, there was some discussion that there may be an over saturation of the habitat and the same results could be accomplished with fewer fish, which prompted the ongoing assessment.

Included within the findings of age 0 parr throughout the GoM was the presentation by C. Bruchs of a detailing the 5-year stocking plan for the Downeast SHRU. This plan provides suggestions on how to best utilize habitats and optimize efforts within the GoM. Many of the smaller class streams (A; <6m) within the upper-reaches of salmon watersheds are appropriately sized for fry stocking, which should be the primary focus. Within larger habitats and in vacant or sub-optimal habitats, there needs to be consideration for ramping up age 0 parr supplementation. Efforts on the Sheepscot and East Machias support these findings, with consideration for other rivers (and their habitats) like the Union, Machias, etc. that could produce substantially more smolts. The USASAC encourages continued dialogue and analysis to help guide future management action to optimize underutilized habitats within the GoM.

7.5 Hatchery Product Comparison - Sheepscot River

The effectiveness and productivity of different rearing techniques can be compared and contrasted by standardizing the number of stocked individuals to a 'common currency' (e.g. number of eggs). Once standardized, different productivity measures can be more appropriately compared across rearing and stocking techniques. These comparisons will help inform optimization of egg resources.

Information was presented comparing the effectiveness of two stocking strategies on the Sheepscot River over a 20 year period (1995 – 2015). One strategy was dominated by fry stocking and the other was a combination of fry stocking and age 0 parr stocking. Sheepscot River specific eggs were predominantly used to stock fry in the Sheepscot River from 1995 – 2002. Poor parr production from fry stocking in the lower reaches of the Sheepscot River was noted and beginning in 2003 a portion of the eggs were retained beyond the fry stage and stocked as age 0 parr in the lower reaches of the Sheepscot River. Analysis to compare adult returns on a per-egg basis between these two time-periods was presented in an attempt to determine which hatchery supplementation strategy resulted in greater escapement of spawning salmon in the Sheepscot River. The results demonstrated that within the Sheepscot River the strategy of stocking fry and age 0 parr resulted in a greater number of adult returns per egg. If the production and stocking of age 0 parr ceased, lower numbers of returning salmon would be expected in the Sheepscot River in future years.

7.6 Updating Marine Survival Rates to Remove In-River Mortality

The USASAC reviewed the smolt-to-adult return rate (SAR) and the final rollout for the newly developed postsmolt-to-adult return rate (PSAR) metrics. It was recommended by the group to adopt the PSAR metric for use in marine survival work as this metric removes the impact of stocking location, dams and other river/estuary impacts in generating estimates into the GoM. Going forward, the SAR will continue to be used on previously reported rivers with an addition of the PSAR used for the Penobscot River. Data tables that report smolts stocked, postsmolts estimated and marine survival estimates from 1970 to 2020 adult returns are provided in the USASAC annual report which can be referenced within this document and going forward.

7.7 USASAC Dataflow

An emerging issue of efficiency of data collection and workflow was brought to the USASAC by E. Atkinson. He is leading an interagency effort to examine the state of databases, data standards, and quality control – quality assurance as well as database use and utility. Specifically the USASAC reviewed data input to both the USASAC database and used for analyses and assessment summaries conducted by the committee. J. Kocik presented an overview of annual Atlantic salmon adult returns monitoring, databases, and proration as an example of data flow. The USASAC reviewed this summary and commented on details. After a more detailed sub-group discussion, data flow diagrams were developed for marine survival, escapement, stocking, and tagging. Three specific data flow topics were identified related to smolt production and stocking products and needed to be addressed and reported on in 2022 reporting. First, it was revealed that US smolt population estimates were not stored in the USASAC or

Smolt Archive databases. The subgroup recommended adding them to the Smolt Archive, which could be fed into the USASAC database. Second, the data flow for adult traps would be improved if the original Access structure was used as staging and prior to importing to the Oracle database maintained by MDMR. Finally, it was recommended that stocking data flow could be improved by merging versions of the Maine Broodstock database and directly into the Maine Stocking database [including Nashua National Fish Hatchery]. These data should also include tags/marks applied, although a mechanism for tracking marking/tagging of non-stocked fish should also be developed. Then MDMR would enter egg and fry stocking, stocking events from outside sources (DSF, ASF, researchers), and non-DPS activities into the Maine Stocking database. All these data would be georeferenced by latitude-longitude and/or river kilometer. This information would need to be queried by database stewards as appropriate and provided by USASAC as part of their annual data call. These recommendations and updates to the general database list will be reported back to the Maine group along with the PPT dataflow summaries and recommendations for further action. It is recommended that processes in data efficiencies be tracked annually through evaluation of the timeliness and effectiveness of data consolidation for USASAC databases.

7.8 Glossary Update – Naturally Reared Smolt Definition

Working with managers on the Cooperative Management Strategies reports for the 3 salmon habitat recovery units (SHRUs), an issue was raised relative to the definition of naturally-reared adult returns. With the release of the recovery plan in 2018, the evaluation criteria for naturally reared fish was changed from wild production, egg planting, and fry stocking to include fall stocking (age 0 parr). The USASAC glossary definition (Section 8.5) has been updated to include age 0 parr along with the previous lifestage/origin groups of fry stocking, egg planting and wild reproduction. It was decided that a retrospective reclassification of adult returns will not be made, but the new definition of naturally-reared will be consistently applied to all adult return data starting in 2022.

7.9 USASAC Draft Terms of Reference for 2022 Meeting

Terms of reference identified at the 2021 USASAC annual meeting will be revisited during the summer 2021 videoconference and pursued intersessionally. These draft TOR will be integrated with any applicable ToRs originating from the ICES WGNAS (March 2021), NASCO Meetings (June 2021) and the Maine Collaborative Management Strategy Annual Report (April 2021) to develop Final TORs for 2022.

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

> *Describe the key events of the 2021 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.

Update framework of indicators – what it is, how it works, what the US has contributed in the past

Compilation of Tag releases

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

Abundance, Distribution and Productivity of US Populations for each SHRU and for the GoM DPS including:

Adult Returns Estimate (Hatchery and Naturally Reared)
Freshwater Production Summaries – Smolts and pre-smolt production indicies
Marine Survival – hatchery index Penobscot and naturally-reared Narraguagus
Baseline Genetic Monitoring – Effective Population Size and Allelic frequency
Hatchery production by lifestage

In support of ongoing **USASAC** activities, we anticipate reporting on the following

Scale Archiving - Continue efforts to foster retention of all US Atlantic salmon scales, tissue, and associated databases for future analysis by seeking funding and capacity to both complete the task and secure long-term storage. Continued work on inventorying, securing and safe storage of scale samples with a report on activities in 2022.

Smolt age distribution - To better inform international stock assessment activities, there is opportunity to provide more detailed population dynamics information for US populations within ICES WGNAS assessment models. Detailed information on age-specific adult abundance, estimates of annual escapement, estimates of annual smolts ages, etc. would be welcomed by the ICES WGNAS. To support this effort, estimates of US annual smolt age distributions will be developed, reviewed and provided to ICES WGNAS as appropriate. Progress continues on this project and an update will be provided in 2022.

USASAC Dataflow Reporting - In an effort to improve data collection, auditing and distribution for USASAC reporting, dataflow was identified as an emerging issue. The USASAC will be continuing to refine and improve critical links to foster the flow of data from sources to reporting. Annual reporting of effectiveness and timeliness of data flow will be reported with expectations that efficiency will improve. An update to databases, flow and recommendations for further actions will be reported on in 2022.

8 List of Attendees, Working Papers, and Glossaries

8.1 List of Attendees

Last Name	First Name	Email	Agency	Location
Atkinson	Ernie	Ernie.Atkinson@maine.gov	ME DMR	Jonesboro, ME
Bruchs	Colby	Colby.W.B.Bruchs@maine.gov	ME DMR	Jonesboro, ME
Buckley	Denise	denise_buckley@fws.gov	USFWS	Orland, Maine
Christman	Paul	Paul.Christman@maine.gov	ME DMR	Hallowell, ME
Cox	Oliver	oliver_cox@fws.gov	USFWS	Ellsworth, ME
Gephard	Steve		CTDEEP-retired	Deep River, CT
Hawkes	Jim	James.Hawkes@noaa.gov	NOAA	Orono, ME
Valliere	Jason	jason.valliere@maine.gov	ME DMR	Bangor, ME
Kircheis	Dan	Dan.Kircheis@noaa.gov	NOAA	Orono, ME
Kocik	John	John.Kocik@noaa.gov	NOAA	Orono, ME
Noll	Jennifer	Jennifer.B.Noll@maine.gov	ME DMR	Augusta, ME
Saunders	Rory	Rory.Saunders@noaa.gov	NOAA	Orono, ME
Sheehan	Timothy	Tim.Sheehan@noaa.gov	NOAA	Woods Hole, MA
Simpson	Mitch	Mitch.Simpson@maine.gov	ME DMR	Bangor, ME
Sweka	John	John_Sweka@fws.gov	USFWS	Lamar, PA
Tierney	Dan	Dan.Tierney@noaa.gov	NOAA	Orono, ME
Haas-Castro	Ruth	Ruth.Haas-Castro@noaa.gov	NOAA	Woods Hole, MA
Drew	Bryan		USFWS	Orland, ME
Craig	Scott	Scott_Craig@fws.gov	USFWS	Orland, ME

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

Number	Authors	Title
WP21-01	John Kocik, Christopher Tholke and Timothy Sheehan	Annual Bycatch Update for Atlantic Salmon, 1989 through September 2020 (WP)
WP21-02	David Bean	Maine and neighboring Canadian Commercial Aquaculture Activities and Production (WP)
WP21-03	Ruth E. Haas-Castro,Brandon Ellingson, Graham S. Goulette, Justin Stevens, Colby Bruchs	Review of Atlantic Salmon Age & Image Analysis Studies: 2020 (PART 1) and Work Plan for2021 (Part 2) - (WP)
WP21-04	John Sweeka	Hatchery Product Comparison – Sheepscot River (WP/PP)
WP21-05	Ruth Haas-Castro	Scale Archiving (PP)
WP21-06	Tim Sheehan	Report of the Working Group on North Atlantic Salmon (WGNAS) (PP)
WP21-07	Dan Kircheis	Nasco Update (PP)
WP21-08	Steve Gephard	Long Island Sound Update (PP)
WP21-09	Ernie Atkinson	Gulf of Maine Update (PP)
WP21-10	Ernie Atkinson	Proposed GRTS plan (PP)
WP21-11	Denise Buckley, Ernie Atkinson, John Kocik, John Sweka and Jason Valliere	US Atlantic Salmon Assessment Committee - Special Topics - Summary of Data Flow (PP)
WP21-12	Colby Bruchs	Maine Atlantic Salmon Stock Enhancement Plan - Downeast Coastal Rivers SHRU (PP)

8.3 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
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

8.4 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
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
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

PIT - Passive Integrated Transponder
PGE - PG&E National Energy Group
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
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

8.5 Glossary of Definitions

Domestic Broodstock	Salmon that are progeny of sea-run adults and have been reared entirely in captivity for the purpose of providing eggs for fish culture activities.
Freshwater Smolt Losses	Smolt mortality during migration downstream, which may or may not be ascribed to a specific cause.
Spawning Escapement	Salmon that return to the river and successfully reproduce on the spawning grounds. This can refer to a number or just as a group of fish.
Egg Deposition	Salmon eggs that are deposited in gravelly reaches of the river. This can refer to the action of depositing eggs by the fish, a group of unspecified number of eggs per event, or a specific number of eggs.
Fecundity	The reproductive rate of salmon represented by the number of eggs a female salmon produces, often quantified as eggs per female or eggs per pound of body weight.
Fish Passage	The provision of safe passage for salmon around a barrier in either an upstream or downstream direction, irrespective of means.
Fish Passage Facility	A man-made structure that enables salmon to pass a dam or barrier in either an upstream or downstream direction. The term is synonymous with fish ladder, fish lift, or bypass.
Upstream Fish Passage Efficiency	A number (usually expressed as a percentage) representing the proportion of the population approaching a barrier that will successfully negotiate an upstream or downstream fish passage facility in an effort to reach spawning grounds.
Goal	A general statement of the end result that management hopes to achieve.
Harvest	The amount of fish caught and kept for recreational or commercial purposes.
Nursery Unit / Habitat Unit	A portion of the river habitat, measuring 100 square meters, suitable for the rearing of young salmon to the smolt stage.
Objective	The specific level of achievement that management hopes to attain towards the fulfillment of the goal.
Restoration	The re-establishment of a population that will optimally utilize habitat for the production of young.

Salmon	A general term used here to refer to any life history stage of the Atlantic salmon from the fry stage to the adult stage.
Captive Broodstock	Adults produced from naturally reared parr that were captured and reared to maturity in the hatchery.
Sea-run Broodstock	Atlantic salmon that return to the river, are captured alive, and held in confinement for the purpose of providing eggs for fish culture activities.
Strategy	Any action or integrated actions that will assist in achieving an objective and fulfilling the goal.
Life History related	
Green Egg	Life stage from spawning until faint eyes appear.
Eyed Egg	Life stage from the appearance of faint eyes until hatching.
Sac Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Feeding Fry	Life stage from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year.
Fed Fry	Fry 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 until the commencement of migration to the sea as smolts.
Age 0 Parr	Life stage occurring during the period from August 15 to December 31 of the year of hatching, often referring to fish that are stocked from a hatchery during this time. The two most common hatchery stocking products are (1) parr that have been removed from an accelerated growth program for smolts and are stocked at lengths >10 cm and (2) parr that have been raised to deliberately produce more natural size-at-age fish and are stocked at lengths ≤10 cm.
Age 1 Parr	Life stage occurring during the period from January 1 to December 31 one year after hatching.
Age 2 Parr	Life stage occurring during the period from January 1 to December 31 two years after hatching.

Parr 8	A parr stocked at age 0 that migrates as 1 Smolt (8 months spent in freshwater).
Parr 20	A parr stocked at age 0 that migrates as 2 Smolt (20 months spent in freshwater).
Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
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 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 searun 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	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31four times since becoming a smolt.
Kelt	Life stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to home waters to spawn again.
Reconditioned Kelt	A kelt that has been restored to a feeding condition in captivity.
Repeat Spawner	A salmon that returns numerous times to the river for the purpose of reproducing. Previous spawner.

****** NOTE: These revised definitions are provisional and may be modified upon review by USASAC and partners at the 2021 meeting.***

Appendix 1. Juvenile Atlantic salmon stocking summary for New England in 2020.

United States

Number of fish stocked by lifestage

River	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
Connecticut	0	222,000	0	1,000	0	0	0	223,000
Total for Connecticut Program								**223,000**
Androscoggin	0	2,000	0	0	0	0	0	2,000
Dennys	40,000	149,000	0	0	0	0	0	189,000
East Machias	0	0	68,000	0	0	0	0	68,000
Kennebec	679,000	3,000	0	0	0	89,000	0	771,000
Machias	102,000	181,000	16,000	0	0	0	0	299,000
Narraguagus	66,000	164,000	0	0	0	0	0	230,000
Penobscot	498,000	614,000	70,000	0	0	648,000	0	1,830,000
Pleasant	85,000	89,000	0	0	0	0	0	174,000
Saco	24,000	0	0	0	0	0	0	24,000
Sheepscot	163,000	28,000	0	0	0	0	0	191,000
Union	0	2,000	0	0	0	0	0	2,000
Total for Maine Program								**3,780,000**
Total for United States								**4,003,000**
Grand Total								**4,003,000**

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 2020.

Drainage	Purpose	Captive/Domestic Pre-Spawn	Captive/Domestic Post-Spawn	Sea Run Pre-Spawn	Sea Run Post-Spawn	Total
Dennys	Restoration	0	198	0	0	198
East Machias	Restoration	0	220	0	0	220
Machias	Restoration	0	198	0	0	198
Narraguagus	Restoration	0	291	0	0	291
Penobscot	Restoration	0	750	2	203	955
Pleasant	Restoration	0	169	0	0	169
Saco	Restoration	0	49	0	0	49
Sheepscot	Restoration	0	190	0	0	190
Total		0	2,065	2	203	2,270

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 2020

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
EMARC		0_Parr	H	East Machias	AD	68,030		Oct	East Machias
USFWS	3	Adult	H	Dennys	PIT	34	DUCP	Dec	Dennys
USFWS	5	Adult	H	Dennys	PIT	117	DUCP	Dec	Dennys
USFWS	4	Adult	H	Dennys	PIT	47	DUCP	Dec	Dennys
USFWS	4	Adult	H	East Machias	PIT	93	DUCP	Dec	East Machias
USFWS	3	Adult	H	East Machias	PIT	46	DUCP	Dec	East Machias
USFWS	5	Adult	H	East Machias	PIT	81	DUCP	Dec	East Machias
MEDMR		Adult	W	Kennebec	AP	52		Jun	Kennebec
USFWS	3	Adult	H	Machias	PIT	47	DUCP	Dec	Machias
USFWS	4	Adult	H	Machias	PIT	63	DUCP	Dec	Machias
USFWS	5	Adult	H	Machias	PIT	88	DUCP	Dec	Machias
MEDMR		Adult	W	Narraguagus	UCP	88		Jun	Narraguagus
MEDMR		Adult	W	Narraguagus	AP	19		Jun	Narraguagus
USFWS	3	Adult	H	Narraguagus	PIT	69	DUCP	Dec	Narraguagus
USFWS	5	Adult	H	Narraguagus	PIT	132	DUCP	Dec	Narraguagus
USFWS	4	Adult	H	Narraguagus	PIT	90	DUCP	Dec	Narraguagus
MEDMR		Adult	W	Penobscot	AP	95		Jun	Penobscot
MEDMR		Adult	W	Penobscot	AP	4	UCP	Jun	Penobscot
MEDMR		Adult	W	Penobscot	PIT	62	AP	Jun	Penobscot
MEDMR		Adult	W	Penobscot	RAD	90	PIT	Jun	Penobscot
USFWS		Adult	W	Penobscot	PIT	22	AP	Aug	Penobscot
USFWS		Adult	W	Penobscot	PIT	203	AP	Dec	Penobscot
USFWS	3	Adult	H	Penobscot	PIT	100	DAP	Nov	Penobscot
USFWS	4	Adult	H	Penobscot	PIT	650	DAP	Nov	Penobscot
USFWS	4	Adult	H	Pleasant	PIT	71	DUCP	Dec	Pleasant

Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Mark or Tag	Number Marked	Secondary Mark or Tag	Release Date	Release Location
USFWS	5	Adult	H	Pleasant	PIT	71	DUCP	Dec	Pleasant
USFWS	3	Adult	H	Pleasant	PIT	27	DUCP	Dec	Pleasant
USFWS	5	Adult	H	Sheepscot	PIT	73	DUCP	Dec	Sheepscot
USFWS	3	Adult	H	Sheepscot	PIT	43	DUCP	Dec	Sheepscot
USFWS	4	Adult	H	Sheepscot	PIT	74	DUCP	Dec	Sheepscot

TAG/MARK CODES: AD = adipose clip; RAD = radio tag; AP = adipose punch; RV = RV Clip; BAL = Balloon tag; VIA = visible implant, alphanumeric; CAL = Calcein immersion; VIE = visible implant elastomer; FLOY = floy tag; VIEAC = visible implant elastomer and anal clip; DYE = MetaJet Dye; PIT = PIT tag; VPP = VIE tag, PIT tag, and ultrasonic pinger; PTC = PIT tag and Carlin tag; TEMP = temperature mark on otolith or other hard part; VPT = VIE tag and PIT tag; ANL = anal clip/punch; HI-Z = HI-Z Turb'N tag; DUCP = Double upper caudal punch; 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 2020.

Origin	Total External Marks	Total Adipose Clips	Total Marked
Hatchery Adult	2,016	0	2,016
Hatchery Juvenile	68,030	68,030	68,030
Wild Adult	545	0	635
Total			**70,681**

Appendix 4. Estimates of Atlantic salmon returns to New England in 2020 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	2016-2020 Average
Androscoggin	Trap	0	0	3	2	0	0	0	0	**5**	3
Connecticut	Trap	0	0	0	0	0	0	0	0	**0**	6
Cove Brook	Redd	0	0	0	0	0	0	0	0	**0**	0
Dennys	Redd	0	4	0	17	0	0	0	0	**21**	14
Ducktrap	Redd	0	0	0	0	0	0	0	0	**0**	1
East Machias	Redd	4	0	18	2	0	0	0	0	**24**	21
Kennebec	Trap	0	4	0	49	0	0	0	0	**53**	41
Machias	Redd	0	6	0	23	0	0	0	0	**29**	20
Merrimack	Trap	0	1	0	3	0	0	0	0	**4**	3
Narraguagus	Trap	11	2	76	15	3	0	1	0	**108**	64
Penobscot	Trap	177	18	998	221	16	3	5	1	**1439**	953
Pleasant	Redd	0	2	0	7	0	0	0	0	**9**	11

	Assessment Method	1SW Hatchery	1SW N.R.	2SW Hatchery	2SW N.R.	3SW Hatchery	3SW N.R.	Repeat Hatchery	Repeat N.R.	Total	2016-2020 Average
Saco	Trap	0	2	0	4	0	0	0	0	**6**	5
Sheepscot	Redd	2	1	6	5	0	0	0	0	**14**	15
Union	Trap	0	0	2	1	0	0	0	0	**3**	1
Total		**194**	**40**	**1,103**	**349**	**19**	**3**	**6**	**1**	**1,715**	**1,158**

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

Appendix 5. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2020.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	116	630,000
Penobscot	Domestic	704	1,898,000
Dennys	Captive	100	429,000
East Machias	Captive	137	653,000
Machias	Captive	106	439,000
Narraguagus	Captive	140	591,000
Pleasant	Captive	91	422,000
Sheepscot	Captive	106	417,000
Total	**Captive/Domestic**	**1,500**	**5,479,000**
Penobscot	Sea Run	122	927,000
Total	**Sea Run**	**122**	**927,000**
Grand Total for Year 2020		**1,622**	**6,406,000**

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															
1993-2010	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															
1977-2010	1,945	20,329,000	7,700	32,054	198,013,000	5,800	0	0		2,365	28,721,000	10,300	36,364	247,063,000	6,300
2011	47	376,000	8,000	707	4,389,000	6,200	0	0		24	176,000	7,300	778	4,941,000	6,400
2012	33	234,000	7,100	721	4,564,000	6,300	0	0		6	37,000	6,200	760	4,835,000	6,400
2013	46	325,000	7,100	77	556,000	7,200	0	0		0	0		123	881,000	7,200
2014	0	0		103	830,000	8,100	0	0		0	0		103	830,000	8,100
2015	0	0		60	534,000	8,900	0	0		0	0		60	534,000	8,900
2016	0	0		70	535,000	7,600	0	0		0	0		70	535,000	7,600
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
Total Connecticut	2,071	21,264,000	7,500	34,260	212,098,000	6,600	0	0		2,395	28,934,000	7,900	38,726	262,296,000	6,700
Dennys															
1939-2010	26	214,000	7,600	125	687,000	4,600	1,324	5,678,000	4,300	40	330,000	7,700	1,515	6,909,000	5,000
2011	0	0		0	0		0	0		0	0		0	0	
2012	0	0		0	0		0	0		0	0		0	0	
2013	0	0		0	0		46	111,000	2,400	0	0		46	111,000	2,400
2014	0	0		0	0		40	148,000	3,700	0	0		40	148,000	3,700

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
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
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
Total Dennys	26	214,000	7,600	212	1,079,000	4,600	1,914	7,934,000	3,978	40	330,000	7,700	2,192	9,558,000	4,100
East Machias															
1995-2010	0	0		0	0		1,279	5,339,000	4,300	0	0		1,279	5,339,000	4,300
2011	0	0		0	0		52	210,000	4,000	0	0		52	210,000	4,000
2012	0	0		0	0		65	160,000	2,500	0	0		65	160,000	2,500
2013	0	0		0	0		70	252,000	3,600	0	0		70	252,000	3,600
2014	0	0		0	0		99	452,000	4,600	0	0		99	452,000	4,600
2015	0	0		0	0		110	468,000	4,300	0	0		110	468,000	4,300
2016	0	0		0	0		113	473,000	4,200	0	0		113	473,000	4,200
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
Total East Machias	0	0		0	0	0	2,257	9,155,000	3,900	0	0		2,257	9,155,000	3,900
Kennebec															
1979-2010	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 No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
1992-2010	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															
1941-2010	456	3,263,000	7,300	0	0		2,296	9,688,000	4,300	8	52,000	6,400	2,760	13,003,000	5,900
2011	0	0		0	0		100	361,000	3,600	0	0		100	361,000	3,600
2012	0	0		0	0		113	288,000	2,500	0	0		113	288,000	2,500
2013	0	0		0	0		114	342,000	3,000	0	0		114	342,000	3,000
2014	0	0		0	0		141	640,000	4,500	0	0		141	640,000	4,500
2015	0	0		0	0		108	354,000	3,300	0	0		108	354,000	3,300
2016	0	0		0	0		114	165,000	1,400	0	0		114	165,000	1,400
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
Total Machias	456	3,263,000	7,300	0	0	0	3,433	13,601,000	3,500	8	52,000	6,400	3,897	16,916,000	3,600
Merrimack															
1983-2010	1,398	10,826,000	8,000	11,058	55,855,000	4,700	0	0		540	5,709,000	10,800	12,996	72,390,000	6,000
2011	107	935,000	8,700	103	408,000	4,000	0	0		0	0		210	1,343,000	6,400
2012	72	510,000	7,100	231	746,000	3,200	0	0		0	0		303	1,255,000	4,100
2013	5	36,000	7,200	295	853,000	2,900	0	0		0	0		300	889,000	3,000
2014	0	0		293	1,244,000	4,200	0	0		0	0		293	1,244,000	4,200
2015	0	0		234	761,000	3,300	0	0		0	0		234	761,000	3,300
2016	0	0		363	946,000	2,600	0	0		0	0		363	946,000	2,600
2017	0	0		307	946,000	3,100	0	0		0	0		307	946,000	3,100

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
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	12,307,000	7,800	13,169	62,838,000	3,400	0	0		540	5,709,000	10,800	15,291	80,853,000	3,900
Narraguagus															
1962-2010	0	1,303,000		0	0		2,352	9,507,000	4,100	0	0		2,352	10,810,000	4,100
2011	0	0		0	0		124	485,000	3,900	0	0		124	485,000	3,900
2012	0	0		0	0		145	433,000	3,000	0	0		145	433,000	3,000
2013	0	0		0	0		118	279,000	2,400	0	0		118	279,000	2,400
2014	0	0		0	0		112	355,000	3,200	0	0		112	355,000	3,200
2015	0	0		0	0		124	447,000	3,600	0	0		124	447,000	3,600
2016	0	0		0	0		112	393,000	3,500	0	0		112	393,000	3,500
2017	0	0		0	0		134	322,000	2,400	0	0		134	322,000	2,400
2018	0	0		0	0		102	375,000	3,700	0	0		102	375,000	3,700
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
Total Narraguagus	0	1,303,000		0	0	0	3,544	13,501,000	3,445	0	0		3,544	14,804,000	3,400
Orland															
1967-2010	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															
1992-2010	18	152,000	8,300	6	6,000	1,100	0	0		13	76,000	5,400	37	234,000	6,500
2012	2	5,000	2,500	550	2,000	0	0	0		0	0		552	7,000	0
Total Pawcatuck	20	157,000	5,400	556	8,000	600	0	0		13	76,000	5,400	589	241,000	3,200
Penobscot															

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
1871-2010	20,087	172,098,000	7,900	7,943	22,607,000	3,000	329	1,400,000	4,300	0	0		28,359	196,106,000	7,300
2011	313	2,626,000	8,400	351	1,216,000	3,500	0	0		0	0		664	3,842,000	5,800
2012	259	1,950,000	7,500	373	1,101,000	3,000	0	0		0	0		632	3,051,000	4,800
2013	174	1,258,000	7,200	517	1,713,000	3,300	0	0		0	0		691	2,971,000	4,300
2014	102	775,000	7,600	557	1,653,000	3,000	0	0		0	0		659	2,428,000	3,700
2015	348	2,640,000	7,600	381	780,000	2,000	0	0		0	0		729	3,420,000	4,700
2016	134	885,000	6,600	635	1,530,000	2,400	0	0		0	0		769	2,415,000	3,100
2017	310	2,289,000	7,400	581	1,760,000	3,000	0	0		0	0		891	4,048,000	4,500
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
Total Penobscot	22,378	188,902,000	7,400	13,451	38,113,000	2,900	329	1,400,000	4,300	0	0		36,158	228,415,000	4,500
Pleasant															
2001-2010	0	0		47	271,000	5,800	409	1,630,000	4,600	0	0		456	1,902,000	4,800
2011	0	0		4	35,000	8,800	26	124,000	4,800	0	0		30	159,000	5,300
2012	0	0		68	133,000	2,000	55	145,000	2,600	0	0		123	278,000	2,300
2013	0	0		4	29,000	7,300	78	262,000	3,400	0	0		82	291,000	3,500
2014	0	0		0	0		74	259,000	3,500	0	0		74	259,000	3,500
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

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Total Pleasant	0	0		123	468,000	6,000	1,110	4,202,000	3,800	0	0		1,233	4,671,000	3,800
Sheepscot															
1995-2010	18	125,000	6,900	0	0		1,129	4,531,000	3,900	45	438,000	9,900	1,192	5,095,000	4,300
2011	0	0		0	0		72	253,000	3,500	0	0		72	253,000	3,500
2012	0	0		0	0		89	231,000	2,600	0	0		89	231,000	2,600
2013	0	0		0	0		81	230,000	2,800	0	0		81	230,000	2,800
2014	0	0		0	0		56	164,000	2,900	0	0		56	164,000	2,900
2015	0	0		0	0		85	317,000	3,700	0	0		85	317,000	3,700
2016	0	0		0	0		133	109,000	800	0	0		133	109,000	800
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
Total Sheepscot	18	125,000	6,900	0	0	0	1,996	7,135,000	3,173	45	438,000	9,900	2,059	7,699,000	3,200
St Croix															
1993-2010	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															
1974-2010	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	7,500	34,260	212,097,000	6,700	0	0		2,395	28,935,000	7,900	38,726	262,296,000	6,700
Dennys	26	214,000	7,600	212	1,080,000	4,600	1,914	7,934,000	4,000	40	330,000	7,700	2,192	9,558,000	4,100
East Machias	0	0		0	0		2,257	9,155,000	3,900	0	0		2,257	9,155,000	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		3,433	13,600,000	3,500	8	52,000	6,400	3,897	16,916,000	3,700
Merrimack	1,582	12,306,000	7,800	13,169	62,837,000	3,500	0	0		540	5,709,000	10,800	15,291	80,852,000	3,900
Narraguagus	0	1,303,000		0	0		3,544	13,501,000	3,400	0	0		3,544	14,804,000	3,400
Orland	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Pawcatuck	20	157,000	5,400	556	8,000	500	0	0		13	76,000	5,400	589	241,000	3,200
Penobscot	22,378	188,902,000	7,400	13,451	38,112,000	2,800	329	1,400,000	4,300	0	0		36,158	228,414,000	4,500
Pleasant	0	0		123	468,000	5,900	1,110	4,202,000	3,800	0	0		1,233	4,670,000	3,900
Sheepscot	18	125,000	6,900	0	0		1,996	7,135,000	3,200	45	438,000	9,900	2,059	7,699,000	3,200
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	**27,243**	**232,809,000**	**8,500**	**61,771**	**314,602,000**	**5,100**	**14,583**	**56,927,000**	**3,900**	**3,041**	**35,540,000**	**11,700**	**106,638**	**639,880,000**	**6,000**

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								
2001-2010	0	12,000	0	0	0	0	0	12,000
2011	0	1,000	0	0	0	0	0	1,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	1,000	0	0	0	500	0	1,500
2014	0	1,000	0	0	0	0	0	1,000
2015	0	2,000	0	0	0	0	0	2,000
2016	0	2,000	0	0	0	0	0	2,000
2020	0	2,000	0	0	0	0	0	2,000
Totals:Androscoggin	**0**	**22,000**	**0**	**0**	**0**	**500**	**0**	**22,500**
Aroostook								
1978-2010	0	4,783,000	317,400	38,600	0	32,600	29,800	5,201,400
2011	0	237,000	0	0	0	0	0	237,000
2012	0	731,000	0	0	0	0	0	731,000
2013	0	580,000	0	0	0	0	0	580,000
2014	0	569,000	0	0	0	0	0	569,000
2015	0	1,000	0	0	0	0	0	1,000
Totals:Aroostook	**0**	**6,901,000**	**317,400**	**38,600**	**0**	**32,600**	**29,800**	**7,319,400**
Cocheco								
1988-2010	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								
1967-2010	0	138,926,000	2,838,200	1,819,700	50,700	3,771,300	1,575,900	148,981,800
2011	0	6,010,000	5,200	9,500	10,000	0	81,700	6,116,400
2012	0	1,733,000	3,100	7,500	4,000	0	71,000	1,818,600
2013	0	1,857,000	3,200	0	0	600	99,500	1,960,300
2014	0	199,000	0	0	0	0	0	199,000
2015	0	391,000	0	0	0	0	0	391,000
2016	0	64,000	0	0	0	0	0	64,000
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
Totals:Connecticut	**0**	**150,129,000**	**2,858,200**	**1,837,700**	**64,700**	**3,771,900**	**1,828,100**	**160,489,600**
Dennys								
1975-2010	0	3,425,000	225,400	7,300	0	532,700	30,000	4,220,400
2011	0	539,000	0	0	0	0	0	539,000
2014	0	84,000	0	0	0	0	0	84,000
2015	0	110,000	0	0	0	0	0	110,000
2016	0	343,000	0	0	0	0	0	343,000
2017	0	126,000	0	0	0	0	0	126,000

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total

Number of fish stocked by life stage

	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
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
Totals:Dennys	**40,000**	**5,185,000**	**235,400**	**7,600**	**0**	**532,700**	**30,400**	**6,031,100**
Ducktrap								
1986-2010	0	68,000	0	0	0	0	0	68,000
Totals:Ducktrap	**0**	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias								
1973-2010	0	3,449,000	7,500	42,600	0	108,400	30,400	3,637,900
2011	0	180,000	0	0	0	0	0	180,000
2012	0	88,000	53,200	0	0	0	0	141,200
2013	0	20,000	77,600	0	0	0	0	97,600
2014	0	16,000	149,800	0	0	0	0	165,800
2015	0	11,000	192,000	0	0	0	0	203,000
2016	0	12,000	199,700	0	0	0	0	211,700
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
Totals:East Machias	**0**	**3,796,000**	**1,304,900**	**42,600**	**0**	**108,400**	**30,400**	**5,282,300**
Kennebec								
2001-2010	1079000	318,000	0	0	0	200	0	1,397,265
2011	810000	2,000	0	0	0	0	0	811,500
2012	921000	2,000	0	0	0	0	0	922,888
2013	654000	2,000	0	0	0	600	0	656,682
2014	1151000	2,000	0	0	0	0	0	1,153,330
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	89,000	0	770,600
Totals:Kennebec	**8,781,000**	**334,000**	**0**	**0**	**0**	**89,800**	**0**	**9,203,609**
Lamprey								
1978-2010	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								
1970-2010	0	5,820,000	99,300	122,400	0	191,300	44,100	6,277,100
2011	0	347,000	0	500	0	0	0	347,500
2012	0	231,000	0	1,400	0	0	0	232,400
2013	0	172,000	800	1,400	0	59,100	0	233,300
2014	27000	210,000	400	0	0	0	0	237,387
2015	49000	503,000	500	0	0	0	0	552,732

	Number of fish stocked by life stage							
	Egg	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Total
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
Totals:Machias	**454,000**	**8,165,000**	**117,000**	**125,700**	**0**	**250,400**	**44,200**	**9,157,167**
Merrimack								
1975-2010	0	39,756,000	316,000	617,000	0	1,871,900	638,100	43,199,000
2011	0	892,000	93,800	0	0	34,900	0	1,020,700
2012	0	1,016,000	22,000	0	0	33,800	0	1,071,800
2013	0	111,000	0	41,200	0	40,900	0	193,100
2014	0	12,000	0	0	0	0	0	12,000
2015	0	4,000	0	0	0	0	0	4,000
2016	0	4,000	0	0	0	0	100	4,100
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								
1970-2010	0	5,778,000	117,100	14,600	0	277,100	84,000	6,270,800
2011	0	465,000	0	0	0	64,000	0	529,000
2012	0	389,000	0	0	0	59,100	0	448,100
2013	0	288,000	0	0	0	0	0	288,000
2014	79000	263,000	0	0	0	0	0	342,145
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
Totals:Narraguagus	**211,000**	**8,180,000**	**169,900**	**15,000**	**0**	**791,700**	**84,700**	**9,452,445**
Pawcatuck								
1979-2010	0	6,276,000	1,209,200	268,100	0	127,500	500	7,881,300
2011	0	6,000	0	0	0	0	0	6,000
2012	0	6,000	0	0	0	0	0	6,000
2013	0	8,000	0	0	0	0	0	8,000
2014	0	5,000	0	0	0	0	0	5,000
2015	0	7,000	0	0	0	0	0	7,000
2016	0	7,000	0	0	0	1,200	0	8,200
2017	0	4,000	0	0	0	0	0	4,000
2019	0	16,000	0	0	0	0	0	16,000
Totals:Pawcatuck	**0**	**6,335,000**	**1,209,200**	**268,100**	**0**	**128,700**	**500**	**7,941,500**
Penobscot								
1970-2010	0	24,031,000	5,847,100	1,394,400	0	16,063,600	2,508,200	49,844,300
2011	0	952,000	298,000	0	0	554,000	0	1,804,000
2012	353000	1,073,000	325,700	0	0	555,200	0	2,306,679

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2013	233000	722,000	214,000	0	0	553,000	0	1,722,193
2014	89000	815,000	0	0	0	557,700	0	1,461,360
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
Totals:Penobscot	**3,198,000**	**31,933,000**	**7,841,900**	**1,394,400**	**0**	**21,559,900**	**2,508,200**	**68,434,902**
Pleasant								
1975-2010	0	1,234,000	16,000	1,800	0	63,400	42,400	1,357,600
2011	0	124,000	0	0	0	61,000	0	185,000
2012	0	40,000	0	0	0	60,200	0	100,200
2013	0	180,000	0	0	0	62,300	0	242,300
2014	46000	114,000	0	0	0	0	0	159,500
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
Totals:Pleasant	**468,000**	**2,288,000**	**16,000**	**1,800**	**0**	**246,900**	**42,400**	**3,061,813**
Saco								
1975-2010	0	6,493,000	447,800	219,200	0	372,300	9,500	7,541,800
2011	0	238,000	16,000	0	0	12,000	0	266,000
2012	0	396,000	0	12,800	0	11,900	0	420,700
2013	0	319,000	10,100	0	0	12,100	0	341,200
2014	0	366,000	16,000	0	0	12,100	0	394,100
2015	0	702,000	25,000	0	0	11,700	0	738,700
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
Totals:Saco	**266,000**	**9,524,000**	**518,900**	**232,000**	**0**	**444,100**	**9,500**	**10,994,810**
Sheepscot								
1971-2010	27000	3,125,000	178,300	20,600	0	92,200	7,100	3,450,000
2011	0	129,000	15,000	0	0	0	0	144,000
2012	70000	50,000	15,700	0	0	0	0	136,069
2013	122000	18,000	14,000	0	0	0	0	154,476
2014	118000	23,000	15,000	0	0	0	0	155,668
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

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2020	163000	28,000	0	0	0	0	0	191,000
Totals:Sheepscot	**1,544,000**	**3,462,000**	**313,100**	**20,600**	**0**	**92,200**	**7,100**	**5,439,210**
St Croix								
1981-2010	0	1,268,000	498,000	158,300	0	808,000	20,100	2,752,400
2014	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0
Totals:St Croix	**0**	**1,268,000**	**498,000**	**158,300**	**0**	**808,000**	**20,100**	**2,752,400**
Union								
1971-2010	0	532,000	371,400	0	0	379,700	251,000	1,534,100
2011	0	19,000	0	0	0	0	0	19,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	2,000	0	0	0	0	0	2,000
2014	0	24,000	0	0	0	0	0	24,000
2015	0	25,000	0	0	0	0	0	25,000
2016	0	26,000	0	0	0	0	0	26,000
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
Totals:Union	**0**	**658,000**	**371,400**	**0**	**0**	**379,900**	**251,000**	**1,660,300**
Upper StJohn								
1979-2010	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	21,000	0	0	0	500	0	**21,900**
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	150,128,000	2,858,200	1,837,700	64,800	3,771,900	1,828,200	**160,424,100**
Dennys	40,000	5,185,000	235,400	7,600	0	532,800	30,400	**6,031,400**
Ducktrap	0	68,000	0	0	0	0	0	**68,000**
East Machias	0	3,795,000	1,304,800	42,600	0	108,400	30,400	**5,281,000**
Kennebec	8,780,000	334,000	0	0	0	89,900	0	**9,203,900**
Lamprey	0	1,593,000	427,700	58,800	0	201,400	32,800	**2,313,700**
Machias	455,000	8,166,000	116,900	125,600	0	250,400	44,200	**9,157,800**
Merrimack	0	41,797,000	431,700	658,100	0	1,981,400	638,300	**45,506,500**
Narraguagus	211,000	8,181,000	169,900	15,000	0	791,900	84,700	**9,453,400**
Pawcatuck	0	6,334,000	1,209,200	268,100	0	128,700	500	**7,941,000**
Penobscot	3,198,000	31,932,000	7,842,000	1,394,400	0	21,559,800	2,508,200	**68,433,700**
Pleasant	467,000	2,288,000	16,000	1,800	0	247,000	42,400	**3,062,300**
Saco	266,000	9,523,000	518,800	232,000	0	444,000	9,500	**10,994,000**
Sheepscot	1,544,000	3,463,000	313,100	20,600	0	92,200	7,100	**5,439,800**
St Croix	0	1,270,000	498,000	158,300	0	808,000	20,100	**2,754,200**
Union	0	657,000	371,400	0	0	379,900	251,000	**1,659,200**
Upper StJohn	0	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**14,961,000**	**285,760,000**	**18,137,300**	**4,884,400**	**64,800**	**31,431,200**	**5,585,200**	**360,759,100**

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									
1983-2010	55	572	6	2	9	92	0	1	**737**
2011	2	27	0	0	1	14	0	0	**44**
2012	0	0	0	0	0	0	0	0	**0**
2013	0	1	0	0	0	1	0	0	**2**
2014	0	2	0	0	0	1	0	0	**3**
2015	0	0	0	0	0	1	0	0	**1**
2016	0	0	0	0	0	6	0	0	**6**
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**
Total for Androscoggin	57	606	0	2	10	118	0	0	**800**
Cocheco									
1992-2010	0	0	1	1	6	10	0	0	**18**
Total for Cocheco	0	0	0	1	6	10	0	0	**18**
Connecticut									
1974-2010	56	3,590	28	2	100	2,119	14	3	**5,912**
2011	2	17	0	0	31	61	0	0	**111**
2012	0	1	0	0	0	53	0	0	**54**
2013	0	4	0	0	3	85	0	0	**92**
2014	0	0	0	0	2	30	0	0	**32**
2015	0	0	0	0	4	18	0	0	**22**
2016	0	0	0	0	0	5	0	0	**5**
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**
Total for Connecticut	58	3,612	16	2	140	2394	16	16	**6,253**
Cove Brook									
2018	0	0	0	0	0	0	0	0	**0**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2019	0	0	0	0	0	0	0	0	**0**
2020	0	0	0	0	0	0	0	0	**0**
Total for Cove Brook	0	0	0	0	0	0	0	0	**0**
Dennys									
1967-2010	42	349	0	1	75	905	5	35	**1,412**
2011	0	1	0	0	2	5	1	0	**9**
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**
Total for Dennys	42	350	6	1	94	982	6	6	**1,510**
Ducktrap									
1985-2010	0	0	0	0	59	259	0	0	**318**
2013	0	0	0	0	1	6	0	0	**7**
2014	0	0	0	0	1	6	0	0	**7**
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**
Total for Ducktrap	0	0	0	0	62	274	0	0	**336**
East Machias									
1967-2010	22	254	1	2	66	545	1	10	**901**
2011	0	0	0	0	5	20	0	0	**25**
2012	0	0	0	0	2	9	0	0	**11**
2013	0	0	0	0	2	9	0	0	**11**
2014	0	0	0	0	4	15	0	0	**19**
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**
Total for East Machias	40	332	1	2	83	615	1	1	**1,084**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Kenduskeag Stream									
2017	0	0	0	0	2	7	0	0	**9**
2019	0	0	0	0	1	5	0	0	**6**
Total for Kenduskeag Stream	0	0	0	0	3	12	0	0	**15**
Kennebec									
1975-2010	24	233	6	7	7	29	0	0	**306**
2011	0	21	0	0	2	41	0	0	**64**
2012	0	1	0	0	0	4	0	0	**5**
2013	0	1	0	0	0	7	0	0	**8**
2014	0	2	0	0	3	13	0	0	**18**
2015	0	2	0	0	3	26	0	0	**31**
2016	0	0	0	0	1	38	0	0	**39**
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**
Total for Kennebec	26	262	2	7	30	301	2	2	**635**
Lamprey									
1979-2010	10	17	1	0	13	16	0	0	**57**
Total for Lamprey	10	17	0	0	13	16	0	0	**57**
Machias									
1967-2010	40	363	9	2	138	2,017	41	131	**2,741**
2011	0	0	0	0	10	42	0	0	**52**
2012	0	0	0	0	6	23	0	0	**29**
2013	0	0	0	0	1	3	0	0	**4**
2014	0	0	0	0	3	12	0	0	**15**
2015	3	11	0	0	1	5	0	0	**20**
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**
Total for Machias	43	374	41	2	179	2180	41	41	**2,959**
Merrimack									
1982-2010	371	1,510	24	8	141	1,075	31	0	**3,160**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2011	128	155	12	1	11	90	5	0	**402**
2012	0	81	15	0	1	27	3	0	**127**
2013	0	6	0	3	0	12	0	0	**21**
2014	4	25	1	0	0	10	0	0	**40**
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**
Total for Merrimack	504	1,788	40	12	155	1227	40	40	**3,779**
Narraguagus									
1967-2010	135	687	20	57	114	2,549	72	167	**3,801**
2011	55	96	2	1	20	21	0	1	**196**
2012	5	24	3	0	0	13	0	0	**45**
2013	7	33	0	0	0	9	0	0	**49**
2014	0	13	0	0	0	6	0	6	**25**
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**
Total for Narraguagus	312	963	74	61	153	2694	74	74	**4,461**
Pawcatuck									
1982-2010	2	150	1	0	1	18	1	0	**173**
2011	0	1	0	0	0	3	0	0	**4**
2012	0	0	0	0	0	2	0	0	**2**
2013	0	0	0	0	0	2	0	0	**2**
2014	0	0	0	0	0	0	0	0	**0**
2015	0	0	0	0	0	0	0	0	**0**
2016	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	151	1	0	1	25	1	1	**181**
Penobscot									
1968-2010	12,603	48,212	290	725	784	4,049	36	99	**66,798**
2011	696	2,167	3	12	45	201	1	0	**3,125**

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
2012	8	531	6	2	5	69	0	3	**624**
2013	54	275	3	2	3	44	0	0	**381**
2014	82	153	2	2	1	21	0	0	**261**
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**
Total for Penobscot	14,803	54,729	40	751	906	5010	40	40	**76,683**
Pleasant									
1967-2010	11	33	0	0	43	336	3	2	**428**
2011	0	0	0	0	5	18	0	0	**23**
2012	0	0	0	0	3	11	0	0	**14**
2013	5	20	0	0	1	5	0	0	**31**
2014	0	2	0	0	0	2	0	0	**4**
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**
Total for Pleasant	21	76	3	0	61	407	3	3	**570**
Saco									
1985-2010	149	654	5	7	39	101	6	0	**961**
2011	30	36	0	0	11	17	0	0	**94**
2012	0	12	0	0	0	0	0	0	**12**
2013	0	2	0	0	0	1	0	0	**3**
2014	0	3	0	0	0	0	0	0	**3**
2015	1	4	0	0	0	0	0	0	**5**
2016	0	0	0	0	0	2	0	0	**2**
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**
Total for Saco	183	716	6	7	55	129	6	6	**1,101**
Sheepscot									

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
1967-2010	18	71	0	0	68	480	13	0	**650**
2011	2	9	0	0	2	6	0	0	**19**
2012	2	7	0	0	1	6	0	0	**16**
2013	1	5	0	0	1	3	0	0	**10**
2014	3	12	0	0	2	8	0	0	**25**
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**
Total for Sheepscot	36	142	13	0	82	533	13	13	**806**
Souadabscook Stream									
2017	0	0	0	0	1	3	0	0	**4**
2019	0	0	0	0	1	2	0	0	**3**
Total for Souadabscook Stream	0	0	0	0	2	5	0	0	**7**
St Croix									
1981-2010	720	1,124	39	12	880	1,340	78	34	**4,227**
Total for St Croix	720	1,124	78	12	880	1340	78	78	**4,227**
Union									
1973-2010	274	1,841	9	28	1	16	0	0	**2,169**
2013	0	0	0	0	0	1	0	0	**1**
2014	0	1	0	0	0	1	0	0	**2**
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	2	0	0	**2**
2020	0	2	0	0	0	1	0	0	**3**
Total for Union	274	1,844	0	28	1	21	0	0	**2,177**

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	57	606	6	2	10	118	0	1	**800**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	58	3,612	28	2	140	2,394	16	3	**6,253**
Cove Brook	0	0	0	0	0	0	0	0	**0**
Dennys	42	350	0	1	94	982	6	35	**1,510**
Ducktrap	0	0	0	0	62	274	0	0	**336**
East Machias	40	332	1	2	83	615	1	10	**1,084**
Kenduskeag Stream	0	0	0	0	3	12	0	0	**15**
Kennebec	26	262	6	7	30	301	2	1	**635**
Lamprey	10	17	1	0	13	16	0	0	**57**
Machias	43	374	9	2	179	2,180	41	131	**2,959**
Merrimack	504	1,788	53	12	155	1,227	40	0	**3,779**
Narraguagus	312	963	28	61	153	2,694	74	176	**4,461**
Pawcatuck	2	151	1	0	1	25	1	0	**181**
Penobscot	14,803	54,729	340	751	906	5,010	40	104	**76,683**
Pleasant	21	76	0	0	61	407	3	2	**570**
Saco	183	716	5	7	55	129	6	0	**1,101**
Sheepscot	36	142	0	0	82	533	13	0	**806**
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	1,844	9	28	1	21	0	0	**2,177**

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 2015 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 2015 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 2015 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	100	0	
2016	6	0	0.000	0	0	0	0	0		0				0	0	0		
2017	19	0	0.000	0	0		0							0	0			
2018	20	0	0.000	0										0				

Means includes year classes with complete return data (year classes of 2015 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 .

Total	**14,944**	**2,550**																	
Mean			**0.351**	**0**	**12**	**0**	**4**	**68**	**2**	**0**	**4**	**0**	**0**	**0**	**16**	**69**	**6**	**0**	

Means includes year classes with complete return data (year classes of 2015 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 2015 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	
2016	4	0	0.000	0	0	0	0	0		0				0	0	0		
2017	11	0	0.000	0	0		0							0	0			
2018	11	0	0.000	0										0				
Total	**2,426**	**376**																
Mean			**0.235**	**0**	**21**	**0**	**4**	**55**	**0**	**0**	**6**	**0**	**0**	**0**	**24**	**55**	**6**	**0**

Means includes year classes with complete return data (year classes of 2015 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 2015 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	
2016	0	3	7.528	0	0	0	0	100		0				0	0	100		
2017	0	1	5.405	0	0		100							0	100			
Total	**4,183**	**1,422**																
Mean			**1.915**	**0**	**3**	**0**	**11**	**64**	**4**	**2**	**7**	**0**	**0**	**0**	**14**	**66**	**11**	**1**

Means includes year classes with complete return data (year classes of 2015 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 2015 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	
2016	1	0	0.000	0	0	0	0	0		0				0	0	0		
2017	0	0	0.000	0	0		0							0	0			
Total	**633**	**27**																
Mean			**0.110**	**0**	**3**	**1**	**1**	**30**	**0**	**0**	**4**	**0**	**0**	**0**	**4**	**31**	**4**	**0**

Means includes year classes with complete return data (year classes of 2015 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 2015 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	
2016	2	0	0.000	0	0	0	0	0		0				0	0	0		
2017	7	0	0.000	0	0		0							0	0			
2018	9	0	0.000	0										0				
Total	**581**	**122**																
Mean			**0.212**	**0**	**16**	**0**	**5**	**57**	**0**	**0**	**0**	**0**	**0**	**0**	**21**	**57**	**0**	**0**

Means includes year classes with complete return data (year classes of 2015 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 2015 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 2015 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 2015 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	6	81	14	
2016	102	200	1.952	0	0	0	2	98		0				0	2	98		
2017	41	18	0.440	0	0		100							0	100			
2018	114	0	0.000	0										0				
Total	**3,056**	**5,479**																
Mean			**4.461**	**0**	**0**	**0**	**16**	**73**	**1**	**3**	**8**	**0**	**0**	**0**	**16**	**76**	**9**	**0**

Means includes year classes with complete return data (year classes of 2015 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		1.952
2017	5.405	0.000	0.000		0.000	0.000		0.440
2018			0.000		0.000	0.000		0.000
Mean	**1.944**	**0.115**	**0.357**	**0.452**	**0.220**	**0.242**	**0.174**	**4.574**
StDev	**5.030**	**0.382**	**0.442**	**0.684**	**0.254**	**0.296**	**0.168**	**6.220**

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	13	0	4	76	2	0	4	0	0	0	17	77	6	0
Farmington	0	24	0	4	64	0	0	7	0	0	0	28	64	7	0
Merrimack	0	3	0	14	71	4	2	8	0	0	0	17	73	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	76	9	0
Salmon	0	21	0	6	73	0	0	0	0	0	0	27	73	0	0
Westfield	4	4	0	9	74	3	0	6	0	0	4	12	74	9	0
Overall Mean:	**1**	**10**	**0**	**8**	**74**	**2**	**1**	**6**	**0**	**0**	**1**	**18**	**75**	**8**	**0**

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

Appendix 15: Estimates of Atlantic salmon escapement to Maine rivers in 2020.

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.

					Pre-Spawn Stocking		
Drainage	**Estimated Returns**	**Broodstock Take**	**Observed Mortalities**	**Natural Escapement**	**Captive/ Domestics**	**Sea Run**	**Total Escapement**
Androscoggin	5	0	0	5	0	0	5
Cove Brook	0	0	0	0	0	0	0
Dennys	21	0	0	21	0	0	21
Ducktrap	0	0	0	0	0	0	0
East Machias	24	0	0	24	0	0	24
Kennebec	53	0	0	53	0	0	53
Machias	29	0	0	29	0	0	29
Narraguagus	108	0	0	108	0	0	108
Penobscot	1,439	221	8	1,210	0	2	1,212
Pleasant	9	0	0	9	0	0	9
Saco	6	0	0	6	0	0	6
Sheepscot	14	0	0	14	0	0	14
Union	3	0	0	3	0	0	3
Totals	**1711**	**221**	**8**	**1482**	**0**	**2**	**1484**

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.

						Pre-Spawn Stocking		
Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Captive/ Domestic	Sea Run	Total Escapement
Androscoggin	1983 - 2010	737	0	0	737	0	0	737
	2011	44	0	0	44	0	0	44
	2012	0	0	0	0	0	0	0
	2013	2	0	0	2	0	0	2
	2014	3	0	0	3	0	0	3
	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
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
Dennys	1967 - 2010	1412	0	5	1407	0	0	1407
	2011	9	0	0	9	299	0	308
	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
Ducktrap	1985 - 2010	318	0	0	318	0	0	318
	2013	7	0	0	7	0	0	7
	2014	7	0	0	7	0	0	7
	2017	4	0	0	4	0	0	4

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Ducktrap	2018	0	0	0	0	0	0	0
	2019	0	0	0	0	0	0	0
	2020	0	0	0	0	0	0	0
East Machias	1967 - 2010	901	0	0	901	281	0	1182
	2011	25	0	0	25	41	0	66
	2012	11	0	0	11	52	0	63
	2013	11	0	0	11	0	0	11
	2014	19	0	0	19	0	0	19
	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
Kenduskeag Stream	2017	9	0	0	9	0	0	9
	2019	6	0	0	6	0	0	6
Kennebec	1975 - 2010	306	0	7	299	106	0	405
	2011	64	0	0	64	90	0	154
	2012	5	0	0	5	0	0	5
	2013	8	0	0	8	0	0	8
	2014	18	0	0	18	0	0	18
	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
Machias	1967 - 2010	2741	0	0	2741	261	0	3002
	2011	52	0	0	52	109	0	161
	2012	29	0	0	29	81	0	110
	2013	4	0	0	4	0	0	4
	2014	15	0	0	15	0	0	15
	2015	20	0	0	20	0	0	20
	2016	17	0	0	17	0	0	17

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Machias	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
Narraguagus	1967 - 2010	3801	0	1	3800	0	0	3800
	2011	196	0	0	196	0	0	196
	2012	45	0	0	45	0	0	45
	2013	49	0	0	49	0	0	49
	2014	25	0	0	25	0	0	25
	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
Penobscot	1968 - 2010	66798	17005	210	49583	0	233	49816
	2011	3125	737	7	2381	0	177	2558
	2012	624	481	0	143	0	7	150
	2013	381	372	0	9	0	0	9
	2014	261	214	2	45	0	0	45
	2015	731	660	5	66	741	7	814
	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	1196	599	1	596	0	97	693
	2020	1439	221	8	1210	0	2	1212
Pleasant	1967 - 2010	428	0	0	428	0	0	428
	2011	23	0	0	23	0	0	23
	2012	14	0	0	14	56	0	70
	2013	31	0	0	31	0	0	31
	2014	4	0	0	4	0	0	4
	2015	26	0	0	26	0	0	26
	2017	9	0	0	9	0	0	9
	2018	0	0	0	0	0	0	0

Drainage	Year	Estimated Returns	Broodstock Take	Observed Mortalities	Natural Escapement	Pre-Spawn Stocking Captive/ Domestic	Pre-Spawn Stocking Sea Run	Total Escapement
Pleasant	2019	26	0	0	26	0	0	26
	2020	9	0	0	9	0	0	9
Saco	1985 - 2010	961	0	5	956	0	0	956
	2011	94	0	0	94	0	0	94
	2012	12	0	0	12	0	0	12
	2013	3	0	0	3	0	0	3
	2014	3	0	0	3	0	0	3
	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
Sheepscot	1967 - 2010	650	0	0	650	302	0	952
	2011	19	0	0	19	0	0	19
	2012	16	0	0	16	35	0	51
	2013	10	0	0	10	0	0	10
	2014	25	0	0	25	0	0	25
	2015	12	0	0	12	0	0	12
	2016	9	0	0	9	0	0	9
	2017	19	0	0	19	0	0	19
	2018	6	0	0	6	63	0	69
	2019	26	0	0	26	0	0	26
	2020	14	0	0	14	0	0	14
Souadabscook Stream	2017	4	0	0	4	0	0	4
	2019	3	0	0	3	0	0	3
St Croix	1981 - 2010	4227	0	0	4227	0	0	4227
Union	1973 - 2010	2169	0	32	2137	0	0	2137
	2013	1	0	0	1	0	0	1
	2014	2	0	0	2	0	0	2
	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