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ASSESSMENT COMMITTEE

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1. INTRODUCTION

1.1. EXECUTIVE SUMMARY

The 1993 Annual Meeting of the U.S. Atlantic Salmon Assessment Committee was held during January 25-29, 1993 at the Silvio Conte Anadromous Fish Research Center, Turners Falls, Massachusetts. The committee addressed terms of reference established at the 1992 meeting including routine assessments, such as program reviews and database development, and special topics, such as models of fry survival and growth analysis based on scale data. In addition, a portion of the meeting was devoted to a discussion of Atlantic salmon disease management strategies. Discussion focused on the efficacy of breeding programs to develop disease resistance and vaccination strategies.

Stocking data, listed by age/life stage and river of release, and tagging and marking data are summarized for all New England programs. A total of 7.3 million juvenile salmon (fry, parr, and smolts) were stocked. Of these, 13 thousand parr and 611 thousand smolts carried coded wire tags (CWT) and 50 thousand smolts received Carlin tags. An additional 50 thousand smolts were released with fin-clips only.

A total of 3,647 salmon was documented to have returned to U.S. waters in 1992, of which 2949 was counted in Maine rivers. Since many of Maine's rivers do not have counting facilities, and facilities that do operate are not 100% effective, a system was implemented to estimate total adult returns in Maine and to New England rivers. The estimated returns using this method were 4,195 in Maine rivers and 5,039 in New England rivers. There were 1144 fish with CWT (860 2SW salmon) and 49 with Carlin tags (24 2SW salmon) which returned to U.S. rivers in 1992.

The angling catch in Maine waters reached 600 fish, which is an increase from the catch of 477 in 1991. Exploitation in the sport fishery on the Penobscot River was 6.4% in 1992.

Atlantic salmon egg production for the New England program approached 14 million (five million sea-run, nearly eight million captive/domestic, one million reconditioned kelts). The egg production was still far less than the desired number.

The committee reviewed a Monte Carlo simulation model to find optimal balance of fry stocking density among rearing habitat of different quality. The model results strongly suggest stocking strategies should be designed to fully utilize the most production habitat before juveniles are dispersed to less productive habitats. The shift to lower productivity habitat is governed by the properties of the stock recruitment relationship for fry established for the different habitat types.

An analysis of growth partitioned by age and environmental effects for salmon populations in the Merrimack River was discussed. River growth showed significant differences for cohorts during the period 1987 to 1991. Preliminary evaluation of river flow and temperature regime may prove to be important driving factors.

The committee discussed the role of disease management in hatcheries and smolt survival. The costs and benefits of disease resistance breeding and vaccine use, especially as they relate to the condition furunculosis, were reviewed. Strategies of disease management are documented and are potentially adaptable to conditions in New England. However, implementation of these strategies are not without risk which must be carefully considered in respect to restoration objectives.

1.2. BACKGROUND

The U.S. became a charter member of the North Atlantic Salmon Conservation Organization (NASCO) in 1984. NASCO is charged with the international management of Atlantic salmon stocks on the high seas. Three Commissioners for the U.S. are appointed by the President and work under the auspices of the U.S. State Department. The Commissioners felt they needed advice and input from scientists involved in salmon research and management throughout New England and asked the New England Atlantic Salmon Committee (NEASC) to create such an advisory committee. NEASC is comprised of State and Federal fishery agency chiefs who designated personnel from their staff to serve on the "NASCO Research Committee", which was formed in 1985.

The NASCO research Committee met semi-annually to discuss the terms of reference for upcoming meetings of the International Counsel for the Exploration of the Seas (ICES) and NASCO, as well as respond to inquiries from NASCO Commissioners.

In July of 1988, the Research Committee for the U.S. section to NASCO was restructured and called the U.S. Atlantic Salmon Assessment Committee, to focus on annual stock assessment, proposal and evaluation of research needs and serve the U.S. section to NASCO.

A key element of the proposal was the development of an annual Assessment Meeting with the main goal of producing an assessment document for the U.S. Commissioners. Additionally, the report would serve as guidance, with regard to research proposals and recommendations to the State and Federal fishery agency chiefs through the New England Atlantic Salmon Committee (NEASC).

1.3. RELATIONSHIP OF ICES TO NASCO

ICES, the official research arm of NASCO, is responsible for providing scientific advice to be used by NASCO members as a basis for formulating biologically sound management recommendations for the conservation of North Atlantic salmon stocks. ICES delegates responsibilities for the collection and analysis of scientific data on salmon to various study groups. The Working Group on Atlantic Salmon and the Anadromous and Catadromous Fish Committee, which are composed of representatives of member countries are examples.

"Terms of Reference" constitute the task assignments given to the Atlantic Salmon Working Group by ICES from recommendations received from NASCO, the EEC, member countries of ICES, the ANACAT Committee or the Working Group itself. Opportunities for development of Terms of Reference are available to the Atlantic Salmon Assessment Committee by submission of issues of interest through the U.S. Commissioners to NASCO or the appropriate channels.

1.4. CHAIRMAN'S COMMENTS

As a whole I believe that the meeting went well. There still remain problems in obtaining the information necessary for the development of the Status Of Program section of the document prior to the meeting. This problem will likely be eliminated for the 1994 meeting which will provide the time for more meaningful group exchange during the meeting.

The participation of Richard Comstock (U.S. Fish and Wildlife Service - state of Washington) and Howard Burge (U.S. Fish and Wildlife Service - Idaho) in the meeting as working **guests** was greatly appreciated by me and the entire Working Group. I believe the entire group benefited. In my opinion this kind of exchange would be welcomed in the future.

I believe that the committee continued to evolve as documented by the Terms of Reference established for the 1994 meeting and the number of sub-committees developed. The 1994 meeting will truly be a working meeting with a number of analyses performed during the session.

The Discussion portion of the meeting in 1994 will be devoted to a detailed description of the Atlantic salmon population model, ASAL. The committee's chairman will lead the discussion which was requested by the committee.

I and the entire committee thank those individuals who provided meeting support: Diane Soucy, Ted Meyers, and Dr. Henry Booke. In addition, I want to thank Dave Egan and the Connecticut River Atlantic Salmon Association for lodging/meals support for two members of the committee.

Lastly, the U.S. Atlantic Salmon Assessment Committee agreed to hold their sixth Working Group meeting from January 24 - January 28, 1994. **The committee also agreed to hold the meeting at the White Mountain National Forest headquarters in Laconia, New Hampshire.** I wish to thank the Forest Supervisor, Rick Cables, for his support in this area. Between the Forest headquarters conference room and the Laconia Office of Fishery Assistance (located in the same building) we should have adequate space and support. I look forward to seeing the entire committee next January in Laconia.

Lawrence W. Stolte, Chairman
U.S. Atlantic Salmon Assessment Committee

2. STATUS OF PROGRAM

2.1. STOCKING

2.1.1. TOTAL RELEASES

In 1992 approximately 7.3 million juvenile Atlantic salmon were released into 17 rivers in New England (Table 1). This total exceeds the number of juveniles released during 1991 (6.5 million) by 12%. Of the various life stages released, fry comprised 68%. Three rivers received the majority of the fish; the Connecticut River (36%), the Merrimack River (17%), and the Penobscot River (29%).

2.1.2. SUMMARY OF TAGGED AND MARKED FISH

Nearly 50% of all smolt (610,800) and one percent of the parr (12,800) released were marked with CWT or Carlin tags. Fish were tagged to address the contribution of salmon of U.S. origin to the ocean commercial fisheries and to carry out various research/management studies (Table 2). In addition, 50,300 smolts were fin-clipped to conduct program specific studies.

A more comprehensive look at the Atlantic salmon marking program is presented in Table 3. Information in this table also includes adult salmon releases marked with various external tags.

2.2. ADULT RETURNS

2.2.1. TOTAL DOCUMENTED RETURNS

Documented Atlantic salmon returns to rivers in the U.S. totalled 3647 in 1992 (Table 4), approximately 32% greater than recorded for 1991. Major decreases in returns from those recorded in 1991 occurred in the Merrimack and Narraguagus Rivers. Increases were observed for the Penobscot, Connecticut,and Aroostook Rivers. Adult returns to most other rivers declined or remained relatively unchanged when compared to 1991.

2.2.2. ESTIMATED TOTAL RETURNS

Many salmon rivers do not have trapping facilities and the existing fish passage and/or trapping facilities were not considered 100% effective in passing Atlantic salmon. As a result, the reported trap and sport fishery catches (Table 4) underestimate salmon returns.

The Assessment Committee made assumptions based on available data and adjusted the reported returns (Table 5). Using the adjustment estimators, approximately 5,039 salmon returned to rivers of New England in 1992.

ASSUMPTIONS AND ADJUSTMENT ESTIMATORS

On the Penobscot and St. Croix rivers, the re-release of trap caught salmon marked by fin clip and/or radio tags below the lowermost trapping facilities suggest that fish passage facilities at those dams capture approximately 75% of the adult salmon reaching the dam. On the Saco River, salmon were marked and released at a trap at the lowermost dam, but many salmon ascended the spillway and were captured unmarked at the next upstream dam. A Petersen estimate was determined for the Saco River, based upon the captures of marked and unmarked salmon at the second dam. Trap efficiencies of 90% and 50% were used for the Androscoggin and Aroostook, and the Union rivers, respectively.

The ICES Working Group uses sport fishery data to estimate adult returns to rivers without trapping facilities. The ICES method assumes a reporting rate of 80% and an exploitation rate of 20%. This method has limitations, especially on rivers with low sport fishery catches and/or reporting rates, such as the Machias and Pleasant.

Redd count data were collected on several smaller rivers, where accurate counts were possible. There were limited data from rivers in Maine and other areas to indicate that an assumption of two redds per female was reasonable, especially since 2SW females predominated among spawners. Where redd count data were available, they were believed to be a more valid index of run size than the sport fishery. A sex ratio of 1:1 was used among spawners, which approximates that observed at trapping facilities in Maine. For both the redd count and ICES methods, a 10% mortality rate was assumed for salmon caught and released by anglers. For the Kennebec River, a 40% exploitation rate was used, because the sport fishery occurred below a dam without fish passage facilities.

Relative to the Merrimack and Connecticut Rivers it was known that harvests (presently illegal) occurred downstream from the fish passage facilities/traps annually. In years since 1982, documented harvests (legal through 1984 but illegal thereafter) in the Merrimack River have been as high as 25% of the total run size and as low as 0%. Additional harvest is believed to occur based on anecdotal reports that fisheries observers receive. The Working Group agreed that it would be reasonable, based on the harvest information for the Merrimack River, to assume that the harvest represented at least 10% of the trap count at the Essex dam. Until additional information becomes available the 10% figure will also be used on the Pawcatuck, Connecticut, Cocheco, and Lamprey Rivers. Additionally, it was known that salmon were still downstream from the fish passage facilities/traps on the Connecticut and Merrimack Rivers after the fish passage/trapping operations have ceased. Studies in Maine indicated that fish passage/trapping operations could be as high as 90%. The Working Group agreed that, until appropriate data are available, a fish passage/trapping effectiveness rate of 90% is a reasonable assumption for the Merrimack, Pawcatuck, Connecticut, Cocheco, and Lamprey Rivers.

2.2.3. RETURNS OF TAGGED SALMON

Returns of CWT and Carlin-tagged Atlantic salmon to rivers in the U.S. in 1992 are shown in Table 6. The information has been sorted by river of return and sea-age.

A total of 860 2SW salmon with CWT returned. The rates of return (number of 2SW salmon with CWT per 1,000 smolts released with CWT two years earlier) varied among the three programs. The rate of return for fish entering the Penobscot River (1.2) was greater than the rate observed for salmon entering the Merrimack (0.5) and the Connecticut (0.6) Rivers. Return rates for the Penobscot and Connecticut Rivers were similar to 1991, however, the Merrimack return rate for 1992 (0.5) was much lower than that observed in 1991 (1.2). The committee recommended that in the future more descriptive material be included in this section.

2.2.4. SPAWNING ESCAPEMENT, BROODSTOCK COLLECTION, AND EGG TAKE

Egg sources for the New England Atlantic salmon program included sea-run salmon, captive/domestic broodstock, and reconditioned kelts. Sea-run broodstock were collected in Maine at the Veazie dam on the Penobscot River (574) and by a mainstem weir on the Dennys River (6). On the Merrimack River, 196 broodstock were collected at the Essex Dam. On the Connecticut River, broodstock were collected at three tributary sites, the Leesville Dam on the Salmon River (18), the Rainbow Dam on the Farmington River (97), the Westfield River (1), and one main stem location, Holyoke Dam (333). On the Pawcatuck River, five broodstock were taken at the Potter Hill Dam and on the Lamprey River two salmon were captured. The type and number of spawners and eggs supporting the hatchery programs are presented in Table 7.

The total egg take in New England for 1992 was nearly 14 million. This was close to last years record of 15.3 million eggs.

Salmon entering a counting/trapping facility, yet not captured (allowed to proceed upstream or escaped), included 36 in the Connecticut River (all on the main stem), four in the Union River, 1606 in the Penobscot River, and one fish in the Merrimack River. Also, one fish was observed in the Westfield River below all counting facilities. Of the fish released above the Veazie dam on the Penobscot River, 881 were grilse, 287 were 2SW females, and 445 were 2SW males.

2.2.5. SPORT FISHERY

The Maine rivers provide the only legal sport fishery for sea-run Atlantic salmon in New England. The documented sport catch of Atlantic salmon in Maine during 1992 was 600 fish (193 killed, 407 released)(Table 8). The catch represents an increase of 26% from the 1991 catch but a 58% decline from the 1990 catch. The angler harvest declined 19%, whereas the released component increased 70% relative to 1991. A reduction in the limit to one salmon per season and attitude changes among anglers probably accounted for the increase in released fish.

Exploitation rates in Maine rivers continue to be quite variable (0-13%), but were lower in 1992 than reported in many previous years. This would be expected, given the increase in the proportion of released salmon in the catch. The exploitation rate for the Penobscot river was approximately 6.4% for 1992, based upon the documented rod and trap catches.

2.3. GENERAL PROGRAM UPDATE

2.3.1. CONNECTICUT RIVER

ADULT RETURNS

The 1992 adult salmon return of 490 to the Connecticut River was the second highest in program history. A record number of adults (137) were of fry stocked origin. Returning salmon were trapped at Holyoke Dam on the main stem (370), Rainbow Dam on the Farmington River (97), and Leesville Dam on the Salmon River (18). Thirty six of the salmon reaching Holyoke were allowed to move upstream. Fourteen of these moved past Turners Falls Dam and continued past Vernon Dam at river mile 142. Four of the fourteen continued upstream past Bellows Falls Dam at river mile 173. No salmon continued beyond Wilder Dam at river mile 217.

Salmon were expected to return to the Westfield River for the first time in 1992 from smolt stocking. No fish passage is available at the first dam on the Westfield River, therefore, a temporary trap was installed and operated at that dam. Although no salmon were taken in the trap, they were documented in the area. Two salmon were taken from the Westfield River, one by electrofishing and one found dead.

HATCHERY PRODUCTION AND STOCKING

A total of 6.8 million eggs were taken in the basin. Captive/domestic broodstock contributed 57% of the total. Sea-runs provided 28% and reconditioned kelts 15 percent. In addition, 1.2 million green eggs were received from the Green Lake National Fish Hatchery (GLNFH) in Maine. A gamete mixing protocol established in 1990 for genetic purposes was followed to provide mixing between brood stock stations. Except where prohibited by fish health station classifications, sperm were transported between stations to achieve genetic mixing.

At White River National Fish Hatchery (WRNFH) egg incubation capacity was expanded from 2.5 to 5.7 million eggs. The Massachusetts Roger Reed State Hatchery also doubled its incubation capacity from 0.5 to one million eggs. Improvements made by Connecticut Department of Environmental Protection (CTDEP) to their 1992 prototype gravel incubators will accommodate a total of 0.5 million eggs. To meet expanded fry stocking objectives, additional incubation space will be added in 1993 in New Hampshire Fish and Game Department (NHFG) and Vermont Fish and Wildlife Department (VTFW) facilities.

Although the total egg take (including out-of-basin sources) was more than eight million eggs, that was not enough to meet program needs. A strategy has been developed to provide more eggs by expanding captive/domestic brood stock production. Captive/domestic broodstock programs were started at WRNFH and the VTFW Roxbury Fish Hatchery.

A total of 1.2 million unfed and 0.8 million fed fry were released. The Cold River in New Hampshire was stocked with fry for the first time since 1970. Age 0+ parr releases remained high at 313,900 and essentially equaled the production of age 1 smolts. Procedures are being developed to significantly reduce the numbers of age 0+ parr produced as a byproduct of the smolt program. The 1992 age 1 smolt production was reduced from the target due to uncertainty of a reliable water source at WRNFH. All smolts were released below Holyoke Dam, except for 25,100 released in the West River and a small number of study smolts. All smolts were marked with CWT.

Poor performance of the water intake/gravel filtration system has been a concern for years at WRNFH. In 1992 a new in-stream gravel infiltration water gallery was constructed. An outbreak of furunculosis occurred in August. It was documented in the rearing pool water, scale mucus, and systemic in a few fish. A special monitoring protocol being tested by USFWS researchers from the Leetown Center provided early confirmation of the disease and allowed prompt treatment. The treatment was successful, and all station smolts will be tagged early in 1993.

FISH PASSAGE

Studies continued and progress was made under the 1990 Memoranda of Agreement that called for downstream fish passage at five mainstem hydroelectric facilities by 1994. At Holyoke, construction of a fish bypass was completed in the power canal. The guiding structure is a louver array to a conduit that empties downstream of the dam. At the Turners Falls Cabot Station the trash racks were fitted with special panels and openings to move fish away from the turbine intakes and to the adjacent log sluice. A special fish sorting and monitoring facility was also constructed at the entrance to the log sluice.

Testing of downstream fish guidance at Cabot Station will continue in 1993. The next upstream dam is Vernon, where a floating curtain wall will be constructed in 1993 to guide smolts to a fish bypass conduit entrance located between two turbine intakes. At Bellows Falls Dam a 15 foot deep curtain wall will be constructed in 1993 to guide fish across the power canal to an existing sluiceway and the downstream side of the power house. Downstream fish passage at Wilder Dam, the uppermost dam covered in the agreement, will be provided by spillage during migration periods. A study was conducted to evaluate entrainment of wild smolts at the Northfield Mountain Pumped Storage Facility. An agreement was reached by CTDEP and the owners of Rainbow Dam on the Farmington River, to provide downstream passage during 1993. Efforts continued on various tributaries to require upstream and downstream fish passage facilities at dams subject to FERC relicensing. The U.S. Army Corps of Engineers constructed a trap and truck upstream fish passage facility at the Townshend Dam on the West River which will be operational in 1993. The Corps also modified the Ball Mountain Dam on the West River to facilitate smolt passage.

MANAGEMENT EVALUATION AND RESEARCH

Many of the hatchery Atlantic salmon smolts stocked in the Connecticut River since 1982 have been marked with CWT. Analysis of these data allows evaluation of various management options. The data base includes all CWT recovered from home water returns through January 1993. Data on number of salmon sampled by CWT code in high seas fisheries from 1987-1991 by the National Marine Fisheries Service was also included. High seas recovery rates were highly correlated with home water rates ($r=0.57$ $P<0.00001$). Therefore, total recoveries were used for all analysis.

Hatchery and stocking location had highly significant effects ($P<0.00001$) on recoveries and together explained 57% of the variance. Broodstock type also had a significant effect ($P=0.02$) but explained little of the variance. Age, length, and strain had no significant effect ($P>0.05$). Current program policy of stocking most smolts in the lower mainstem is justified based on these data. As downstream fish passage facilities come on line (1994), upriver tributaries should be stocked.

The analysis shows significantly higher return rates for smolts released in late March and decreasing return rates for smolts released in April and May. Based on this information, a multi-year study has been initiated to provide similar data under more controlled conditions. Beginning in 1993, releases of age 1 smolts will occur in March, early April, and mid April. In addition, one group of smolts will be subject to an advanced photoperiod regime. These smolts will be maintained under an altered day length designed to advance the peak of smoltification to coincide with the March release date. Another study initiated in 1992 will compare return rates between one and two-year smolts.

Extensive monitoring of survival and densities of stocked fry and parr has occurred annually up to the autumn preceding smolt migration. The monitoring of wild smolt runs has been identified as a high priority need of the restoration program. The Green Mountain National Forest (GMNF), VTFW, and Northeast Utilities Service Company initiated a cooperative project of smolt trapping on the West River in Spring, 1992. The goals of the project were to provide needed data on smolt production, migration timing, size and ages in the West River system and to provide wild smolts for use in a telemetry study at the Northfield Mountain Pumped Storage Facility. A second study conducted by the GMNF, in two tributaries of the West and White Rivers was initiated in Fall, 1992. The objective of this work was to document if there is an autumn pre-smolt or smolt migration out of headwater rearing streams. In the spring study, smolts were collected in two fyke net weirs on Utley Brook, a tributary of the West River, and two floating smolt traps (one auger trap and one inclined-plane trap) in the mainstem West River from late April to early June. High water prevented continuous monitoring in the main stem. Total smolt captures in all gear was far lower than expected based on fall electrofishing surveys and assumed trap efficiencies. A total of 99 wild smolts were captured in the weirs and 61 were captured in the floating traps. The weir data from Utley Brook represent the most complete data set with only one day of 38 not sampled due to high flows. The first smolt was captured on May 2 at a daily maximum temperature of 8°C. A freshet prevented fishing from May 3-4. The peak of smolt captures were from May 9-13 at maximum temperatures of 11-15°C. The final smolt captured was on May 20 at a temperature of 14.5°C. The smolt run timing was somewhat later than expected, likely due to very cold weather. A far greater proportion (59%) of age 3 smolts was captured in Utley Brook than expected. Age composition in the mainstem West was 87% age 2 smolts. Average lengths of captured smolts were 152 mm in Utley Brook and 162 mm in the West River.

A total of 124 juvenile salmon was captured during fall sampling in Utley Brook. Based on total length greater than 120 mm, 27% (34) of the catch were assumed to be presmolts. Catches occurred throughout the October 6-23 sampling period, with peak catches on October 14 and 20. The trap was not fished on four days due to logistical problems. During the remaining 14 days, there was no trap down time. Temperatures were between 2-5°C for most of the period with a maximum of 8°C. Approximately 75% of salmon were captured between 2000 and 0630 hours. Of the remaining 31 salmon, 17 were captured during the day and 14 in the evening. Nearly as many pre-smolts were captured in this brief fall sampling as smolts at the same site in extensive spring sampling.

In the White River tributary, Bingo Brook, a total of 30 salmon was captured. Of this total 6 (20%) were presmolts with an additional 15 salmon (50%), nearly as large as the pre-smolt size cutoff. The trap was installed from October 1-19. The trap operated for only eight days for the entire 24 h period. Trap operations during the remaining 12 days were sporadic resulting from several breakdowns due primarily to leaf accumulation in this high gradient stream. Water temperatures ranged from 3-5.5°C for most of the sampling period with a maximum of 8°C. Trapping in the fall is feasible and necessary to fully evaluate smolt production. The GMNF plans to continue and expand fall trapping efforts.

GMNF, NHFG, VTFW, and the University of Massachusetts Cooperative Fish and Wildlife Research Unit (MCFWRU) continued habitat inventory work in several watersheds in the basin. These data will allow efficient allocation of stocked fry to maximize smolt production. GMNF implemented four salmon habitat restoration projects in the West and White River systems and continued to evaluate habitat improvement efforts.

The 1982 Strategic Plan is in the process of being updated with more current data. A study to evaluate the impact of riverine fish predation on smolt survival was commenced by the MCFWRU.

The Lamar Fish Technology Center, Larmar, Pennsylvania continued with studies at Richard Cronin Salmon Station (RCNSS). These studies were undertaken to define the reason for declining egg eye-up rates and to prescribe methods for improving egg and sperm performance. In 1992 a study was conducted to examine the effect of a delay in the use of milt to fertilize salmon eggs. Temporary storage and shipment of milt is required to conform to established gamete mixing protocol. Another study will test different sperm activators as a method for improving fertilization rates. A third study effort will test for heavy metals at RCNSS. In a separate study a team of Leetown researchers will look for "cold water" disease bacteria at RCNSS and the possibility of transmission of the disease from RCNSS to WRNFH.

2.3.2. MAINE PROGRAM

GENERAL

Despite previous year state funding reductions that resulted in layoffs and reassignment of many staff functions, the Maine Atlantic Sea-Run Salmon Commission (ASRSC) and the USFWS implemented a number of program improvements in 1992. Continued budget difficulties in state government have resulted in several reorganization proposals affecting natural resource agencies in Maine. The state legislature will act on these proposals during the winter and spring of 1993.

In response to a decline in salmon populations in the salmon rivers with wild runs and a need for additional protection of multi-sea-winter (MSW) salmon in the Penobscot River, the ASRSC promulgated in 1992 a regulation reducing the season limit to one salmon per angler. Catch and release angling was unaffected by the regulation. Angler compliance with the new regulation was generally good, and the proportion of released salmon increased on most rivers for 1992. Minor exceptions to the general season limit on Atlantic salmon in boundary waters with Canada are to be corrected in February, 1993.

The USFWS converted the Craig Brook National Fish Hatchery (CBNFH) from a single broodstock/smolt production hatchery to a multiple broodstock/fry production hatchery. The program will now decrease emphasis on smolt production, instead releasing the majority of fish at the fry stage.

With regard to the wild salmon (rehabilitation) rivers, the USFWS and the ASRSC agreed to end using Penobscot strain smolts, parr or fry in these rivers. River-specific stocks will be used in the future. Both adults and parr will be collected to provide eggs for this program.

PENOBSCOT RIVER

Prior to this year, Penobscot tributaries received an average of 250,000 fry annually. With the conversion of the (CBNFH) and the fabrication of new and sophisticated fry hauling equipment, project personnel were able to release approximately 925,000 fed fry throughout the major tributaries to the Penobscot in 1992. Fry were stocked from canoe at approximately 60 fish/unit, and fall sampling indicated age 0+ parr densities of 17 to 24 per unit.

A record number of fed fry was stocked in the Penobscot drainage during 1992 utilizing a newly-developed bulk distribution system. Each distribution unit incorporates a 178 liter insulated cooler fitted with a bottled oxygen diffuser, a bilge pump powered spray bar, and three perforated plastic fry containers. The cooler system provides a salubrious environment for large numbers of fry during extended journeys in hot weather and reduces the time and labor involved in loading and unloading fry. Post-stocking electrofishing surveys in 1992 indicate excellent survival of fry transported using the new system.

Adult salmon returns to the Veazie trap (2,233) were considerably higher than 1991 totals (1,576). The reduced season bag limit is thought to have contributed to a decreased angler harvest from

192 fish in 1991 to 153 in 1992, despite favorable water levels and temperatures throughout the fishing season.

The Veazie Project has been operating on an annual license since 1986. Bangor Hydro-Electric Co. (BHEC) has postponed the re-licensing of the Veazie Dam by combining that process with its application for a new dam at the Basin Mills site in Orono and Bradley, four miles upstream. The proposal includes a new 7 MW "C" plant on the east end of the Veazie dam, a new 38 MW dam at Basin Mills, and the decommissioning of an old hydro station on the Stillwater River in Orono, a tributary of the Penobscot River.

The public hearing process for 401 Water Quality Certification for the proposed Basin Mills Project (which includes relicensing of the Veazie Dam) will conclude in early February. Extensive testimony was presented by both proponents and opponents of the project, and the Maine Board of Environmental Protection has until late March, 1993 to render its decision. If water quality certification is received, the Federal Energy Regulatory Commission (FERC) will begin its licensing process. Additional permits will also be required from the Maine Public Utilities Commission and the Army Corps of Engineers.

BHEC and the resource agencies have been negotiating fish passage and other issues regarding the 85-year-old Milford Project (the third upstream dam) for several years. Specifically, the agencies have called for immediate improvements to the existing fishway at the east (powerhouse) end of the dam and a new fishway on the west end of the spillway. BHEC has yet to provide the enhancements to fish passage facilities at Milford. Final decisions on fish passage facilities for this projects rest with the FERC.

Radio telemetry studies were conducted by BHEC in 1991 and 1992 to evaluate the effectiveness of the new downstream bypass weirs at the West Enfield Dam. Results indicate that most smolts (86%) continue to be drawn through the turbines during no-spill conditions, but turbine-related mortality could not be assessed from the available data.

New downstream fish passage facilities were activated at the Weldon Dam in the fall of 1992 and may provide a means for refining future estimates of smolt production in the East Branch Penobscot River.

WILD SALMON RIVERS

Rod catches on the wild salmon rivers (Dennys, East Machias, Machias, Narraguagus, Ducktrap and Sheepscot) remained low in 1992. Partial redd counts on the Machias and Sheepscot Rivers confirmed angler observations of a small salmon run on these rivers. The redd counts for the Pleasant and Ducktrap Rivers also suggest below average returns of adult salmon in 1992.

Wild Atlantic salmon parr were collected by electrofishing from the Dennys (225), Machias (400), and Narraguagus (250) Rivers for use as captive broodstock at CBNFH. The progeny from these fish will be stocked as fry in their respective rivers of origin. Mortalities from the transfers were low, and the fish have adapted to hatchery diets. After numerous false starts, freeze-dried krill was found to be the transition diet of choice.

ASRSC and USFWS staff prepared a Prelisting Recovery Plan for the 5 Maine Rivers listed as Category 2, under the Endangered Species Act. The plan was presented for public comment in the summer of 1992, and was later accepted by the ASRSC, after revision. The plan outlines program goals, approaches, and resources needed to rehabilitate the salmon runs in the 5 listed rivers and the Ducktrap and Sheepscot Rivers. Prelisting recovery is based upon the concept that conservation efforts prior to listing as threatened or endangered could either alleviate the need for listing, or in the event of listing, help the species progress without delay toward full recovery. The plan's goal is to restore and maintain biologically and genetically viable self-reproducing populations of Atlantic salmon in the Category 2 rivers and provide suitable habitat to support these populations. Specific objectives for each river will be developed as part of the recovery process. The most important objectives will be to stabilize existing river populations (through protection of existing stocks and restocking with river-specific fry), maintain or improve habitat quality, determine status of stocks, and identify threats which may limit populations.

NARRAGUAGUS RIVER

The ASRSC is continuing research funded by NMFS on the Narraguagus River to evaluate the status of the salmon population and its habitat. A trapping facility was again operated in Cherryfield to enumerate adult returns. Redd counts provide additional data on the abundance and distribution of spawners within the drainage. The data indicate that the 1992 salmon run (estimated at 134 salmon) was the smallest in recent years, despite an improvement in the sport fishery. The redd count was the smallest recorded since counting began in the 1970's. Juvenile salmon were sampled at 98 sites, and 1193 large parr were marked with CWT in 1992. Parr abundance was generally low to moderate in 1992, as had been the case in 1991. A total of 250 age 1+ and 2+ wild parr were transferred to CBNFH to be reared as broodstock for future fry stocking in the Narraguagus River. Habitat work included completion of a habitat inventory, contaminant monitoring, and river pH monitoring. Two significant findings of the habitat studies were the widespread presence of the herbicide hexazinone (trade name Velpar) at low concentrations ($\leq$9 ppb) and the documentation of low pH episodes ($\leq$4.7) throughout the West Branch Narraguagus River subdrainage.

DENNYS RIVER

The ASRSC and USFWS built and operated a portable weir on the Dennys River to capture adult broodstock from the lower Dennys River in 1992. The weir was operated for 42 days between 6/1/92 and 8/3/92. A total of 18 salmon were captured, from which 5 wild origin female 2SW salmon were spawned at CBNFH. During October, nets and electrofishing gear were used to capture male salmon on or adjacent to spawning areas. One wild 1SW male and 15 wild precocious parr were used to fertilize the eggs. Juvenile salmon population assessments and redd counts for the ongoing stock-recruitment study on the Dennys were conducted in 1992. Parr populations were low to moderate in abundance. Parr were most abundant where redds had been abundant two years previous. A total of 225 age 1+ and 2+ wild parr were collected from the Dennys for captive rearing as broodstock.

ST. CROIX RIVER

Georgia-Pacific Corporation improved fish passage at the Woodland hydroelectric dam through attraction water modifications to the upstream fishway and construction of state-of-the-art downstream bypass facilities. The work was completed late in 1992, and the facilities will be operational in 1993. The construction of downstream bypass facilities at the Grand Falls Dam is scheduled for 1994. Salmon trapping facilities on the St. Croix were not operated in 1992, although seven adult salmon were captured during partial sampling of the alewife run.

SACO RIVER

The Saco River Fry Hatchery was completed this year and received 150,000 Penobscot strain eyed eggs from captive/domestic broodstock at the GLNFH. The eggs were hatched at this private facility (Saco River Salmon Club) and stocked by local volunteers in the Ossipee River, a lower tributary to the Saco River.

Fishway construction at the Cataract Project (four dams) commenced in 1993 and is proceeding on schedule. The lower east side dam will have a fish lift and the west side dam a denil fishway. The two upper dams, Spring and Bradbury, may be opened to allow unimpeded migration. This option was put forth by the dam owners who felt this was the least expensive solution to fish passage at these small dams, which have no turbines.

UNION RIVER

During April, interested citizens from the Ellsworth area formed the Union Salmon Association, with the main objective of involvement in the FERC process regarding fishways at the two BHEC dams on this river (Ellsworth and Graham Lake). When the Ellsworth dam was relicensed by FERC in 1987, BHEC was required to construct a fishway for alewife passage, but that requirement has not been met. BHEC's position has been that the present trap and truck operation is adequate, particularly in light of the fact that the agencies stopped stocking salmon into the Union River in 1991. FERC is presently reconsidering fish passage provisions of the operating licenses for these projects.

GENETIC IDENTIFICATION STUDY

In 1990, juvenile salmon were collected from three Downeast rivers, the Gander River in Newfoundland, Craig Brook NFH production fish (Penobscot River) and Penobscot River adults for DNA analyses. The purpose of the genetic analyses is to determine the status of the genetic composition of the Atlantic salmon populations in Maine, especially the Category 2 stocks located in Washington County. After several false starts, the contract for analyses was let to the University of Maine and sub-contracted to Dalhousie University in Nova Scotia. A preliminary report, based on the analyses of approximately one-half of the samples, resulted in inconclusive results. Additional parr samples were collected in 1992 from the Dennys, Machias, Narraguagus, Ducktrap and Sheepscot rivers. The agencies are now in the process of working with personnel in research to determine the future direction of the genetic program and may incorporate other techniques such as electrophoresis and meristic characteristics.

2.3.3. MERRIMACK RIVER

JUVENILE ATLANTIC SALMON RELEASES

FRY

For several years the program cooperators have been developing the capability to significantly increase the number of fry released. The spring of 1992 was to have been the first stocking of an expanded capability with an expected fry-release of 2,300,000. Because of a water problem that developed at the North Attleboro National Fish Hatchery (NNFH), the 1992 fry production was seriously reduced. Rather than the anticipated 2,300,000 fry, only 1,118,000 fry were released into the watershed.

Three facilities contributed to the fry-release program. The Berlin State Fish Hatchery (BSFH) in New Hampshire contributed approximately 461,000 fry while the NNFH provided roughly 647,000 fry. In addition, the Nashua National Fish Hatchery (NANFH) distributed 10,000. Eighty-eight (88) percent of the total release was composed of unfed fry with the remainder being fed fry.

The fry were distributed in the spring throughout six tributary drainages within the Merrimack River basin as shown in the following table.

TRIBUTARIES INTO WHICH FRY WERE STOCKED	NUMBER OF FRY STOCKED
SOUHEGAN RIVER	95,000 FRY
PISCATAQUOG RIVER	185,000 FRY
SUNCOOK RIVER	11,000 FRY
SOUCOOK RIVER	1,000 FRY
CONTOOCOOK RIVER	113,000 FRY
PEMIGEWASSET RIVER	713,000 FRY

FALL PARR MONITORING

Evaluations of parr abundance and growth are conducted in the fall of each year. Seven index sites have been established where data is collected. The sites are located in the East Branch of the Pemigewasset, Pemigewasset, Mad, Baker, Smith, Soucook, South Branch Piscataquog, and Souhegan Rivers in New Hampshire. From 1985 to 1990, each of the seven index sites was stocked with the same number of fry, although the stocking density among sites was not similar.

The stocking density at sites ranged from a low of 17.9 fry per unit (one unit = 100 m^2) to a high of 59.8 fry per unit. The stocking density was increased from 17.9 to 35.9 fry per unit in the Mad River in 1991 and 1992. Fry were stocked in portions of the Pemigewasset River in 1991 and 1992 at twice the density than in previous years with an increase in the stocking level from 29.9 to 59.8 fry per unit. Age 0+ parr captures were poor at the upper basin index sites, but the abundance of age 0+ parr at the lower basin sites was similar to previous years. The extremely low captures of of age 0+ parr at sites located in the East Branch of the Pemigewasset, Pemigewasset, Mad, and Baker Rivers raises concern regarding year class strength for 1992.

SMOLTS

The NNFH produced 96,400 yearling smolts for release into the Merrimack River basin. The majority of the smolts (83,700) were released into the lower Merrimack River downstream from the Essex Dam in Lawrence, MA. As part of a downstream fish passage study at Garvins Falls Dam (Bow, NH), 2,000 smolts were provided to the Public Service of New Hampshire (PSNH). Three-hundred smolts were provided to Essex Hydro as part of a downstream fish passage study conducted on the lower Contoocook River. As part of a downstream fish passage study in the upper basin, 10,400 smolts were released into the Pemigewasset River system.

All smolts were marked with CWT and by removal of the adipose fin. Of the 96,400 smolts released by the NNFH, 1,100 were randomly sampled for CWT retention and total length distribution. The CWT retention rate was found to be greater than 97%. Of the total number of smolts released, approximately 20,000 were stocked at a period of low flow during late March and predation by gulls was evident. Subsequent releases were made at a point further downstream to alleviate this observed problem. The majority of the smolts were equal to or greater than the 16 centimeter total length minimum established for hatchery smolts produced for the Merrimack River program. Total length frequency of smolts was similar to that observed in 1991.

The 1992 hatchery smolt population was believed to have been of exceptional quality based on size as well as the physiological measurements recorded by the University of Rhode Island. This conclusion was similar to that arrived at in 1991.

ADULT ATLANTIC SALMON RETURNS

The number of adult salmon that returned to the Merrimack River in 1992 (199) was considerably less than the returns of 1991 (332). Sea-age composition was recorded as 31 grilse (16%), 166 2SW salmon (83%), and two 3SW salmon (1%). Fifty-seven percent (114) of the returns was of fry stocking origin.

The age distribution and release history for the adults of fry stocking origin are presented in the following table (adult salmon information in the table includes 1992 returns only). Adults of fry stocking origin were considerably less than the

YEAR OF FRY PLANT	NUMBER OF FRY RELEASED	NUMBER OF ADULTS RETURNED	SMOLT AGE	SEA-AGE
1986	524,600	2	4	2
1987	1,078,300	11	3	2
1988	1,717,800	86	2	2
1989	1,033,500	3	1	2
1989	1,033,500	13	2	1
1990	975,200	1	1	1

number observed in 1991 (114 versus 255). This decrease is primarily reflected in the age 2.2 salmon (86 in 1992 compared to 238 in 1991). The rate of return per 1,000 fry released reflects this decline. The rate of return in 1992 for 2.2 salmon was 0.05 while the rate of return in 1991 for 2.2 salmon was 0.22.

The age distribution and release history for the adults of smolt stocking origin are presented in the following table (adult salmon information in the table includes 1992 returns only). Unlike the adult returns of fry stocking origin, the number of adults of hatchery smolt stocking origin was greater than that

YEAR OF SMOLT PLANT	NUMBER OF SMOLTS RELEASED	NUMBER OF ADULTS RETURNED	Smolt Age	Sea-age
1989	58,600	2	1	3
1990	116,900	66	1	2
1991	62,000	17	1	1

observed in 1991 (85 versus 76). However, the rate of return per 1,000 smolts released for 2.2 salmon was considerably lower in 1992 (0.56) than the rate observed in 1991 (1.28). The decline is similar to the rate decline for the 2.2 salmon of fry stocking origin. This might suggest that the decline in the rate of return was marine-related rather than river-related since all hatchery smolts were released near the river mouth.

Scales from 192 of the adult salmon (80 adults of hatchery smolt stocking origin and 112 adults of fry stocking origin) were examined and length at smolt stage was determined by backcalculation. The adults of smolt stocking origin were considerably larger as smolts than those of fry stocking origin as smolts. The smolt size for the adults of smolt stocking origin ranged from 15 to 30 centimeters in total length. The majority of the smolts were in excess of 16 centimeters because the fish cultural minimum smolt size is 16 centimeters. Adults of fry stocking origin ranged in total length from 10 to 26 centimeters with the majority of the fish in the 15 to 16 centimeter total length category.

The majority of the salmon that were observed in the Merrimack River entered the trapping facility at the Essex Dam (41.6 km from the river mouth) in June (64%). Twenty-seven percent entered the trapping facility in May with eight percent recorded in July. Two fish (1%) were recorded in September. The number of fish recorded in July was considerably less than the long-term average (18%) for July.

CWT were detected in 78 of the adults of hatchery smolt stocking origin. Tags were not detected in seven salmon of hatchery smolt stocking origin (two 1SW salmon and five 2SW salmon). Salmon in which tags were detected included 15 1SW salmon, 61 2SW salmon, and two 3SW salmon).

EGG PRODUCTION

SEA-RUN SALMON

Since all salmon (except for a single 1SW salmon that escaped) were trapped at the Essex Dam fish-lift and transported to the NANFH for artificial spawning, no egg deposition occurred in the wild (upstream from the Essex Dam). Two salmon (one 2SW male and one 2SW female) died at the fish-lift prior to transportation. The 196 salmon transported and held for egg production included 93 females (four 1SW salmon and 89 2SW salmon) and 103 males (25 1SW salmon, 76 2SW salmon, and two 3SW salmon). Five salmon (one male 1SW salmon and four female 2SW salmon) died before artificial spawning occurred. This represented a mortality of 2.6%.

From the 191 salmon that survived to spawning (89 females and 102 males), eggs were obtained from 84 females (two 1SW salmon and 82 2SW salmon). The total egg-take was 538,100 eggs. The two 1SW females provided 5,800 eggs with the remainder (532,300 eggs) provided by the 82 2SW females.

CAPTIVE/DOMESTIC SALMON

Both the NNFH and the NANFH produced captive/domestic salmon for egg production. These salmon were derived from Merrimack River sea-run parents. A total of 536 females were spawned producing 2,432,800 eggs.

ADDITIONAL IMPORTANT ACTIVITIES

Hydroelectric Facilities: Fish Passage

During 1992 a comprehensive fish passage plan was developed by the cooperating agencies and Consolidated Hydro, Incorporated (CHI) and submitted to the FERC. The plan addressed fish passage issues, and fish passage maintenance at the Essex Dam complex in Lawrence, MA. A second fish passage plan, being developed by the cooperating agencies and CHI, will be completed early in 1993. This plan will address fish passage issues, and fish passage maintenance at Pawtucket Dam and associated power house in Lowell, MA (approximately 16 km upstream from the Essex Dam).

Work is still continuing with PSNH relative to the development of a comprehensive fish passage plan for the remaining three mainstem dams on the Merrimack River and two mainstem dams on the Pemigewasset River (principle tributary to the Merrimack River). It is expected that this plan will be completed in 1993 and will be appended to the existing fish passage agreement between the cooperating agencies and PSNH.

White Mountain National Forest: Fisheries Program

The Fisheries Program of the White Mountain National Forest (WMNF) was initiated in 1987, but suffered setbacks due to personnel turnover. In April 1992, the Fisheries Program Leader position was filled, and the program is once again firmly established on the Forest. The increasing complexity of land and resource management issues has resulted in the development of a diverse program which aggressively addresses the challenges fisheries and watershed resources are now facing. Program areas of emphases include (1) membership and full participation in the Merrimack River Anadromous Fish Program; (2) anadromous and inland fish habitat improvement planning and implementation; (3) Forest Plan and implementation monitoring; (4) recreational fishing, aquatic interpretation and education; (5) interagency coordination and cooperation; and (6) support to all other Forest resource programs as needed. Accomplishments in 1992 included the following:

* An existing software application called SMART (Stream Management, Analysis, Reporting and Tracking) was developed specifically for stream inventory data. This will facilitate the sharing of information among the WMNF offices and resource agencies. In addition, it will allow integration of stream inventory information into a GIS environment. Stream inventory data is used to determine where habitat improvement is needed, and whether or not streams are meeting Forest Plan standards.

* Warren Interpretive Center - Economic Vitality Through Forestry Challenge Grant Program. The Warren Fish Hatchery, owned and operated by the NHFG, is currently being renovated for the purpose of raising Atlantic salmon fry for the restoration effort. Fry will be stocked on the WMNF within short transporting distances from the hatchery. The Pemigewasset District submitted a grant proposal through the Economic Vitality Through Forestry Challenge Grant Program. The proposal was accepted and funds received to assist with the development of an interpretive center at the hatchery. The interpretive center will enhance public awareness of the Atlantic salmon restoration effort and the roles of the cooperating agencies. Current work includes conversion of the existing Warren Trout Hatchery into a salmon rearing facility. Hatchery modifications include installation of incubators, ultra-violet lighting, replacement of the main water supply line, and restoration of an existing pond for "natural" rearing and production. Interpretative center work is in the planning phase. A nature trail and existing historic buildings will be modified to provide barrier-free access to a self-guided tour of interpretative displays explaining the ecology of Atlantic salmon. Brochures will incorporate information about the multi-agency restoration effort, and management of riparian resources and ecosystems.

2.3.4. <u>PAWCATUCK RIVER</u>

ADULT RETURNS

A total of five sea-run salmon was trapped at the Potter Hill fish trap in May and June of 1992. A sixth salmon was observed upstream at another dam having eluded the trap. Additional escapees were reported by anglers during the summer and fall. It is possible that fishway efficiency has degraded since a dam control structure on the opposite bank has deteriorated allowing unwanted attraction water. It is not known if salmon can penetrate the high pressure breach below the water control structure. However, this and their demonstrated ability to leap over the dam may explain the increased incidence of escapee reports.

Four of the trapped fish were females and were spawned in November yielding 35,600 eggs. Low rates of return for adults have occurred since the 1985 smolt cohort returned in 1987. This low rate of return is associated with the use of captive/domestic broodstock instead of sea-run adults which gave larger returns from 1982-1984. In order to improve return rates, alternative sources of parr in addition to federal and state fish have been developed. Large numbers of parr for stockout were donated by private growers in Maine beginning in 1989. These fish first migrated as age 1 smolts in 1990 but the majority left as age 2 in 1991. The 1991 smolt run based on index stations was larger than average. Increased adult returns are expected in 1993. One adult return in 1992 could be traced to the 1990 smolt cohort and four returns were traced to the 1989 cohort. All salmon had spent two years in the sea. Mean total length (TL) of adults in the return was 776 mm (SE=24.0). The mean backcalculated TL at smolt migration was 180.8 (SE=7.8).

STOCKING

A total of 78,331 salmon (70,800 age 0+ parr, 2,500 age 1 parr and 5,000 age 1 smolt) was stocked into the Pawcatuck River watershed in 1992. Sources of fish included the NNFH (captive/ broodstock), the Arcadia State Fish hatchery (Pawcatuck sea-run returns), and Kennebec Aquaculture (Penobscot-St. John stock) a private grower in Maine. Most fish were age 0+ parr stocked in September and October. A total of 7,500 age 1 fish, of which 5,000 were large enough to smoltify, were stocked in March and April.

It is anticipated that 1992 was the last year for age 0+ parr plants in the fall. It is becoming clear that fry releases are superior in other New England rivers. With the recent change in Division administration, more flexibility will be allowed the field staff and principal investigator. The 1993 cohort of fish will be stocked as fry. Stocking rates will hinge on the number of fry available. Nearly 5,500 production units have been identified in the Pawcatuck river system. An analysis of southern New England data indicate that they could support some 500,000 fry (USASAC 1992). Index station monitoring will allow comparison of the performance of fry with parr.

RESEARCH INITIATIVES

In 1992, smolt sampling in the primary habitat was suspended so that efforts could be directed at estuarine studies where a predation problem was suspected. An inclined plane trap, courtesy of the MCFWRU was fished in April and May during the time of smolt out migration. The trap did not fish effectively, capturing only 1 smolt. Electofishing in the nursery habitat in late May indicated that the fish had left. It is unknown why the trap did not function better but may be related to positioning in the estuary or excessive intervals between checks. Smolt studies in the lower river will be continued in 1993, however, an electrofishing boat rigged for night sampling will be substituted. Salmon smolt will be marked in the nursery habitat in March and April and be recaptured by electrofishing in the lower river for a mark and recapture estimate. Potential fish predators will also be sampled. The boat shocker may also provide information on the actual number of adult salmon present below the trap. The University of Rhode Island Department of Zoology cooperative study was continued in 1992. In October, 6,000 age 0+ parr were released into the Beaver River for smoltification studies. Earlier in April, 2,500 age 1 smolt had been released. The objectives of this study are to compare the physiology and migration behavior of a cohort released as fall parr and spring pre-smolts. Results to date indicate that thyroxine dynamics surge in age 0+ parr stocked in the fall and age 1 smolt stocked in the spring but that age 0+ parr are more uniform in response. However, growth ceases in age 0+ parr so that they are considerably smaller by spring than their counterparts maintained in the hatchery. This leads to residualization of the small fish. At the urging of the Division of Fish and Wildlife, the studies will be extended to examine the performance of residuals at age 2 vs. hatchery at age 1.

2.3.5. NEW HAMPSHIRE COASTAL STREAMS

PROGRAM STATUS

BACKGROUND

Merrimack River program cooperators initiated their first stocking program in coastal New Hampshire (NH) waters in 1978 and continued until 1982. The primary intent was to obtain broodstock Atlantic salmon for the Merrimack River program utilizing a fishway and trap located on the Lamprey River watershed. During this period a total of 151,600 age 1 and age 2 smolts reared at the Milford State Fish Hatchery were released into the Lamprey River during the months of March and April. Parental origin was composed of landlocked salmon females from Lake Winnipesaukee and two-, three- and five-year Penobscot origin males obtained from the NNFH. Age 1 smolts averaged 15.0

cm TL and age 2 smolts averaged 18.0 cm TL. All smolts were marked with either adipose or ventral fin clips or were stocked as unmarked fish.

During the period 1978 to 1982, a total of 28 adult Atlantic salmon returned to the Lamprey River fish trap. Sea-age composition of the returning adults was recorded as 10 grilse (36%), 17 2SW (61%), and 1 3SW (3%) salmon. Sea-age was estimated based on the length or weight of the fish. No scale analysis was attempted on any of the returning fish. Of 24 salmon for which return data were recorded, 33% returned in the March-April period, 42% returned in the July-August period, and 25% returned in the September-October period. All returning adults were captured at the Lamprey River fishway at Newmarket, NH and later transferred and held at the Milford State Fish Hatchery. Most of the adults were inoculated with R04 vaccine but did survive to produce eggs in the fall.

Upon completion of the Essex fishway at Lawrence, Massachusetts in 1982, the program cooperators shifted all stocked Atlantic salmon to the Merrimack River.

In 1988 the NHFG reinitiated an Atlantic salmon stocking program in NH coastal rivers including both the Lamprey and Cocheco Rivers. This new program was created in order to supplement the Pacific (chinook) salmon program in an effort to provide an alternative recreational fishery. The Pacific salmon program stocks approximately 400,000 smolts annually from the Milford State Fish Hatchery.

During the period 1988 through 1992, 839,000 Atlantic salmon fry were stocked into the Lamprey (433,000) and Cocheco (406,000) Rivers. Age 0+ and 1 parr releases during that period totaled 238,800 with the Lamprey River receiving 179,300 and the Cocheco River 59,500. These parr were obtained from three sources: (1) New England Fish Farming Enterprises, (2) Connors Brothers, and (3) Kennebec Aquaculture Inc.. Parental origin of Atlantic salmon parr was composed of Penobscot River and St. John River stocks.

1992 INFORMATION AND ACTIVITIES

This was the fifth consecutive year in which Atlantic salmon fry have been stocked into the coastal rivers. In 1992 a total of 128,000 Atlantic salmon fry were stocked into the Cocheco River and 127,000 were stocked into the Lamprey River.

Atlantic salmon fry were reared at the BSFH and released into these two rivers at a rate of 36 to 48 fish per 100 m2 during the month of April. Seasonal abundance of salmon parr originating from fry releases in these two coastal streams have been documented by annual assessments at index sites.

In November, 1992 a total of 12,700 age 0+ parr of St. John/Penobscot River origin were released into the Lamprey River.

Three age 2.2 adults returned in 1992, originating from the 1988 stocking of 2,000 fry in the Cocheco River. One fish, a female, 73 cm TL returned to the Cocheco River on June 8, 1992. The other two adults, one male, 86 cm TL, wt. 4.75 kg, and a female, 71 cm TL, wt. 2.75 kg, returned to the Lamprey River fishway on October 27 and 28, 1992.

The adult return from the Cocheco River was passed upstream of the fishway after measurements and scale samples were obtained. The adult female which returned to the Lamprey River was spawned and fertilized by the male at the fishway and later released upstream. The female, produced 2,400 eggs which were later transferred to the BSFH.

2.3.6. GENERAL PROGRAM INFORMATION

No information was provided for this category.

3. TERMS OF REFERENCE

3.1. PROGRAM SUMMARIES FOR CURRENT YEAR

a. current year's stocking program with breakdowns by time, location, marks and lifestage.
b. current year's returns by sea age, marked vs. unmarked, and wild vs. hatchery.
c. general summary of program activities including regulation changes, angling catch, and program direction.

This information can be found in Sections 2.1., 2.2, 2.3., and their sub-sections of this document.

3.2. DATA NEEDS FOR NASCO

a. summary of status of stocks for NASCO
b. summary of research for ANACAT

The information necessary to summarize the status of the New England Atlantic salmon stocks for NASCO can be found in Sections 2.1., 2.2., and their sub-sections of this document.

Research activities necessary for ANACAT are not available in this document.

3.3. HISTORICAL DATA - VALIDATE 1992 STOCKING AND RETURN DATA AND ADD TO HISTORIC DATABASE

The historical data were validated by the Assessment Committee and the information can be found in Tables 9 and 10, Section 6. (sub-sections 6.1. and 6.2.) of this document.

3.4. CONTINUE TO SYNTHESIZE AVAILABLE DATA AND MODEL FRY SURVIVAL RATES

INTRODUCTION

Fry stocking as a strategy in Atlantic salmon restoration programs has risen in priority in the past decade. Annual releases have increased from 412,000 in 1980 to 3,933,000 in 1991 (USASAC 1992). Some of the increase can be traced to broodstock availability which has increased the egg supply for production of fry. It is recognized as well that smolt produced from fry plants are superior to those reared in hatcheries and fry origin adults are increasing in number. In 1992, almost 60% of the adult return to the Merrimack River was produced from fry plants.

Synthetic analyses were used by Symons (1979) to examine optimal spawner escapement levels for maximum smolt production. Gibson (1992 a) used a similar approach to model fry stocking results from the New England restoration program. In the latter paper, it was shown that the densities of large parr at age 1+ in the fall were a dome-shaped function of stocked fry density. Similarly, age 2 smolt abundance in Rhode Island was a parabolic function of stocked age 0+ density in the fall. While there were system specific differences the general application of the Ricker curve across several systems and life stages was evident. A limitation to this analysis was that it considered only the density of fry which would produce the most parr 16 months later. It did not consider impacts of stocking densities on growth nor the impacts of size on marine survival and adult return. Growth in freshwater may be density dependent and this may impact optimal fry densities through size dependent mortality or delayed age of smoltification. In a second paper, it was clearly shown that sea survival is positively correlated to smolt size for a number of species and in a number of ecosystems in both hatchery and wild fish (Gibson 1992 b). If adult returns are to be maximized through the most efficient use of fry, then these factors will need to be considered. Also, if habitat quality varies so that the general curve has a local habitat effect, there will be a mix of stocking rates which makes the best use of available fry if they are limited.

In this paper, the fry-parr models are combined with growth and marine survival functions to examine the consequences of various stocking policies. A Monte Carlo simulation program is used to find the optimal balance of stocking rates among a gradient of habitat quality to maximize adult returns subject to constraints on fry availability.

METHODS

A computer program written in Basic conducts a search for the optimum mix of stocking rates in different habitat types which maximizes the adult return. Constraints are imposed in the form of the total number of fry available for stocking, the total number of production units in the system, and the distribution of habitat quality levels (degree days) within the units. For this exercise, the number of production units was set equal to 5,000, approximately the number identified in the Pawcatuck River, RI. Habitat types were set at three, corresponding to low production, average production, and high production. Degree day levels for these three classifications were 1,000, 1,350, and 1,700 respectively. This is close to the range for salmon nursery streams in New England. The fractional breakdown was 25% low, 50% average, and 25% high. A total of 10^5 trials were conducted at each level of fry availability which ranged from 10,000 to 1,500,000. One trial consisted of random selection of three stocking rates for the three habitat types subject to the constraint that total fry does not exceed that available for stocking. Large parr production, parr length, projected sea survival, and adult return were calculated from relationships derived from New England data. The combination which maximized adult return out of the 10^5 trials was then selected. Over-winter loss of large parr was ignored and all adults were assumed to be age 2SW. Variation in life history schedules and over-winter mortality can be added when data allow.

RESULTS

The updated fry-parr stocking curves strengthened those presented a year ago. In addition, a significant effect of density on growth of parr was detected.

The results indicate that fry should be concentrated in the best habitat until a level is reached such that density dependent mortality and growth erode stream and sea survival to a point below that for the next best grade of habitat under low density stocking (see table on following page). Analytically, the shift point is where the derivative of the Ricker curve for high grade habitat reaches the slope at the origin for the next lower grade of habitat. When fry are unlimited, the optimal policies converge to uniform distribution in all habitat at the apex point of the general curve.

DISCUSSION

These results unify and extend those in Gibson (1992 a, 1992 b) to address the objective of maximizing adult returns from fry releases. The New England restoration program has produced data which, when examined in a integrated fashion, can give a clearer picture of the dynamics of fry, wild smolt, and adult returns. There is clear evidence that stocked fry exhibit density dependent mortality with forcing by abiotic factors such as temperature regime and system productivity. A parabolic curve is evident in both pooled and system specific data. The management implications of these dynamics is that excessive fry releases may reduce smolt production and adult return.

Results of the Monte Carlo Simulation of Optimum Stocking Rates for Varying Habitat Quality Subject to Fry Availability Constraints for a 5,000 Production Unit System

NUMBER OF FRY	STOCKING RATE BY HABITAT GRADE TYPE 1	STOCKING RATE BY HABITAT GRADE TYPE 2	STOCKING RATE BY HABITAT GRADE TYPE 3	NUMBER OF ADULTS
10,000	0.00	0.06	9.88	4.79
20,000	0.07	0.32	19.30	8.66
50,000	0.21	7.65	34.33	17.24
100,000	1.43	24.46	49.55	27.85
200,000	25.20	51.03	72.60	40.80
500,000	109.80	106.90	107.60	49.70
750,000	106.60	109.80	111.30	49.70
1,000,000	105.20	109.70	109.00	49.70
1,500,000	108.60	105.20	106.10	49.60

The optimization runs indicate that fry dynamics are complex and sometimes counterintuitive. Stocking policies should be examined closely to see if more efficient use could be made of available resources. The model results indicate that when fry are very limited they are best used by stocking only in the best habitats. When in moderate abundance, they should be stocked in all habitat but not at uniform rates. The ratios are approximately geometric in favor of the most productive habitat. When in surplus, they should be stocked at the uniform rate corresponding to the peak of the Ricker curve. The best fits of the Ricker curve to region wide data were made with inclusion of temperature and older cohort densities as auxiliary variables. They indicate optimum stocking rates ranging from 70 to 111 fry per unit. System specific estimates are desirable and can be made where data allows.

GROUP DISCUSSION

1. The group concluded that data should continue to be added to the database from New England Rivers to refine the equations for individual rivers, and their subdrainages.

2. The committee agreed that there was a need for better definition of habitat types. The most promising indicator appears to be degree days for each index site. This data

needs to be systematically collected to better define index sites throughout New England. Daily minimum and maximum temperature data are needed.

3. The discussion indicated that fry stocking experiments should use a wide range of initial densities so that relationships can be detected within a background of environmental noise.

3.5. DEVELOP A METHODOLOGY TO CONFIRM SMOLT STATUS BASED ON EXAMINATION OF SELECTED CHARACTERISTICS IN POTENTIAL SMOLTS AND RETURNING ADULTS

The following information was presented in support of the Term of Reference:

LENGTH FREQUENCIES FOR MAINE HATCHERY PRODUCTION

Length-frequency data are presented (Figures 1 and 2) for the smolt year-classes released from GLNFH and CBNFH in 1992. This is the second year of such data collection, and was initiated to: 1) define the percentage of parr remaining among the smolts after final grading; 2) present more defined size information for management agencies; 3) compile statistics of value to aid future production strategies.

Samples at CBNFH were weighted to obtain a length-frequency representative of the 20 raceways and 2 ponds. Smolts are defined as fish reaching 15 cm or greater. Five 40 fish subsamples were obtained from five 15 pound samples of crowded fish per sample for a total sample of 2,000 fish. Sampling was conducted just prior to release. Samples were also taken at GLNFH separately for CWT, Carlin Tag, fin clip and unmarked lots using a procedure similar to that at CBNFH.

3.6. CONTINUE TO DEVELOP METHODOLOGY TO ESTIMATE HOMEWATER RETURNS TO U.S. RIVERS

No new information was presented. However, the committee agreed that this kind of information was important and Jay McMenemy was appointed sub-committee chairman to address this issue for the 1994 meeting.

3.7. RETROSPECTIVELY EXAMINE RIVER AND NEAR COASTAL ENVIRONMENTAL INTERACTIONS IN RESPECT TO MOVEMENT OF SMOLTS AND ADULTS

A computer program for analyzing the growth of fish (Weisberg 1989) was used to model the growth of juvenile salmon in the Merrimack River. Measurements of length at capture, increments between annuli of a scale from each fish, and the age of each fish were used to partition growth into age and environmental components. It was assumed that a record of the growth history of a fish was contained in the increments between annuli on a scale. A further assumption was that the size of annular increments [i.e. measurement from scale focus to first annulus (A_1); measurement from first annulus to second annulus (A_2); and so on to A_i] has two determinants: age of the fish and the environmental effects during the year denoted by the annulus. Growth was described or modelled as the sum of an age effect and a year/environmental effect where:

Expected Growth = Age Effect + Year/Environment Effect.

The model was used to examine growth characteristics of smolts captured at Ayers Island Dam in 1990 and 1991. The dam, located on the Pemigewasset River in Bristol, N.H., is the first of seven mainstem dams that smolts encounter during their seaward migration.

Analysis of variance between cohorts of the same age suggested that there was a difference in the growth of fish at age 1 and age 2 between years for smolts captured in 1990 and 1991. Results further suggested that growth in 1987 and 1988 was somewhat less than in 1989, growth in 1986 was similar to 1989, and growth in 1987 through 1989 was less than 1990. There appeared to be year to year variation in growth which may be explained by age class (age), environmental factors (year/environment), and also an age by year interaction (age by year). A larger model was necessary to explain growth for smolts captured at the dam in 1990 and 1991, where:

Expected growth = age + year/environment effect + age x year interaction.

Scales from adult salmon returning to the Merrimack River and captured near tidewater were analyzed using similar methods. An estimate of smolt length was backcalculated for adults and the effects of age and year/environment during riverine residence was modelled. The results of these analyses were different than those obtained for smolts. Riverine growth for fish that returned in 1990 through 1992 was explained by the simpler model of age and a year/environment determinants.

For the 1990 smolt captures, the partitioning of growth into age and year/environment components was not as evident, and age by year interaction was apparent. Although 1990 smolt captures and 1992 adult captures were both from the same cohort, it was assumed that the 1992 adult return was composed of basinwide smolt contributions. Lacking smolt captures from the lower-basin, it was not possible to conduct similar analyses to better understand age and environmental effects on growth for this component. Speculation arose regarding contributions from lower-basin smolts to the adult return. These fish may have contributed disproportionately to the adult run and masked the growth characteristics found in upper-basin fish. The Committee briefly explored factors including post-smolt and marine survival, predation, length when entering the sea and a combination of these and other factors that may have caused the observed difference in the growth of fish from the same cohort.

For adults captured near tidewater during the period 1990-1992, there appeared to be a generalized progression of improved riverine growth from 1985 to 1989 attributable to environmental factors. Factors that may have affected growth in these years were considered and included mean daily discharge at a site in the upper-basin and estimated numbers of parr at selected sites. The Committee discussed the fact that extended or prolonged periods of low flow may affect riverine growth, and river discharge, as reported, did not appropriately illustrate the low flow periods. Discussions relevant to riverine growth and its relationship to smolt size and subsequent marine survival ensued reflecting the Committee's continued interest in these topics. An expansion of these analyses using prior and future years data would be beneficial to examine trends in the riverine growth characteristics of migrating smolts and adult returns.

For the 1994 Working Group meeting, John Kosik (NMFS) has agreed to accept the lead for developing appropriate information.

3.8. CONDUCT A SURVEY OF THE LITERATURE AND SALMON RESEARCHERS TO DETERMINE WHETHER THE OCCURRENCE OF LATE MIGRANTS (SMOLTS) IS WIDESPREAD OR IS AN ARTIFACT OF HATCHERY PRACTICES

No information was presented in support of this Term of Refernce. The committee agreed that this Term of Reference would not be included in the 1994 Working Group meeting.

4. DISCUSSION TOPIC

4.1. ATLANTIC SALMON DISEASE STRATEGIES

4.1.1. TO RISK OR PLAY IT SAFE-WHAT IS BEST FOR SMOLT SURVIVAL TO ADULT

One morning of the working group meeting was devoted to a presentation on alternative furunculosis management strategies by Dr. Rocco Cipriano of the National Fish Health Research Laboratory and a discussion of the topic.

Fish health policies have been adopted that emphasize the importance of excluding Aeromonas salmonicida, the causative agent of furunculosis, from hatcheries. However, furunculosis is present in many salmon hatcheries, many returning adult salmon are infected with the disease, salmonids carrying furunculosis are routinely stocked throughout the region, and A. salmonicida has been isolated from White River water. The fact that furunculosis is enzootic in salmon rivers raises the question whether current program policy of rearing "pathogen-naive" smolts is practical and the most effective strategy for maximizing smolt to adult survival.

An alternative strategy would be to develop disease resistant salmon populations. There are both interspecific and intraspecific differences in the susceptibility of fishes to diseases and resistance has been enhanced through selection programs.

Two seperate breeding programs have established furunculosis resistant strains of trout. Brook trout at the Hackettstown (NJ) state fish hatchery were selected on the ability to survive natural epizootics of furunculosis. The first generation of fry had 98 percent mortality when exposed to furunculosis which was reduced to 31 percent mortality after four generations. However, there was a gradual decrease in egg viability and resistance to other diseases was not enhanced (Hayford and Embody 1930).

Studies at the New York Department of Environmental Conservation's Fish Disease Unit in Rome demonstrated great variation in resistance to furunculosis in several strains of brook and brown trout (Wolf 1953; Ehlinger 1977). Disease resistant brood stocks of both species were developed by breeding the strains with low or intermediate mortality when challenged with A. salmonicida. The brood stocks are currently maintained by an annual exposure to furunculosis to prevent regression. These strains of trout are widely utilized and have demonstrated furunculosis resistance.

Many specific factors may influence the ability of a species to resist disease. An initial barrier to infection is provided by the skin and mucus protease, and bacteriocidal properties of blood (leukocytes, phagocytes, antitoxins) defend against systemic infection. The natural resistance of certain rainbow trout strains has been correlated with the ability of serum to neutralize bacterial toxins. The mucus produced by some salmonids has the ability to precipitate extracellular antigens produced by A. salmonicida. The extent of the precipitation is species and strain dependent and correlated with resistance to disease.

Species and strains exhibiting high precipitation activity are associated with resistance to infection by furunculosis. Studies indicate that the offspring of low responders also had much lower mucus precipitation activity and were more susceptible to disease and infection than the progeny derived from high responders.

Heightened levels of serum cortisol, a consequence of acute environmental stress, have been correlated with increased susceptibility to disease. Studies suggest that selection for low cortisol response would minimize stress effects and decrease susceptibility to disease.

Despite the evident success of specific selection programs for some non-anadromous species, many valid criticisms exist. Selection of any sort reduces genetic variability and may inhibit resistance to other pathogens. Fish which acquire resistance via actual infection must be designated as presumptive carriers of A. salmonicida. Stressful spawning migrations could overpower any inherent resistance and fish would succumb to infection, threatening other stocks in the environment. Finally, resistance can be enhanced but never made absolute within any population. Evolutionary factors selecting for host resistance to disease also act upon the pathogen itself.

Discussion followed on the question of whether we already have a selection program for furunculosis resistance by exposing stocked fry to natural epizootics and whether we should emphasize this strategy. The relative disease resistance of wild smolts could be evaluated by comparison of mucus and serum samples with those of hatchery smolts.

The efficacy and feasibility of vaccination against furunculosis was discussed. There is currently no commercially licensed furunculosis immersion vaccine in the United States. Inoculation works to some extent, but has proven ineffective in sea-run adults. Vaccination may not confer immunity but may "prime the pump" of the immune system.

The need for integrated management of furunculosis was emphasized. This may include management practices, vaccination, breeding for disease resistance, etc. A holistic approach to the problem is necessary as no one strategy offers complete protection.

5. RESEARCH

5.1. CURRENT RESEARCH ACTIVITIES

No information for this category is inlcuded. However, the Maine Anadromous Fish Coordinator's office agreed to address this topic for the 1994 report.

5.2. RESEARCH NEEDS AND DATA DEFICIENCIES

The committee agreed that the information presented under Section 4 (Discussion) of the 1992 Working Group document directly related to this section and is as valid today as it was in 1992. Therefore, that information is included in this document also.

Approach to Future Research

Research with direct applicability to increasing returns of adult salmon should be given highest priority. Research which addresses the underlying causes of poor adult returns is recognized as important to the advancement to our basic understanding of Atlantic salmon and can play an important role in the development of management strategies to improve returns.

Research on the underlying mechanisms should be oriented toward the development of specific changes in stocking procedures that could be tested in large scale field programs. Research and management can aid each other, in this time of limited funding, by collaborating and sharing information/resources whenever possible. The following categories and their sub-categories are not necessarily listed in order of priority.

Fry

1. Food Availability - Food availability is an important component of habitat. The relationship between food quantity/quality and fry survival/growth needs to be investigated.

2. Habitat Structure - Habitat structure is important in providing quality territories for salmon. The relationship between physical habitat and density-dependent survival needs to be examined. The conditions that contribute to variation in fry growth and time of residence of resultant smolts in the river and estuary also need to be examined.

3. Optimal Stocking Strategies - In the future, fry stocking will be expanded and information on strategies that maximize returns are needed. Further retrospective assessments of the relationship between past stocking regimes and subsequent fry survival/growth are needed. Examining density-dependent relationship between fry stocking and subsequent survival can provide information on optimal stocking strategies such as preferred stocking density and feeding modes.

Parr

1. Interactions With Conspecifics - Density dependent factors may affect parr survival and smolt production. Alternative stocking strategies that could include adjustments in the density of fry stocked, differential stocking of cohorts (alternate year stocking), and point or scatter stocking should be explored.

2. Interactions with Other Species - Predator-prey interactions involving juvenile salmon are not well understood. Interactions with predators and concomitant learning experiences affect behavior and survival. A better understanding of the mechanisms involved in these interactions would be beneficial. Interaction with other, non-predatory species may be important and should be investigated.

Smolt

Many factors at the hatchery and in the river can inhibit or alter parr-smolt transformation. Topics requiring additional investigation to produce better smolts and increase adult returns included:

1. Functional smolts - Hatchery production of functional smolts that are capable of migrating and surviving in the marine environment is critical for restoration. Research is needed to determine which factors inhibit or alter smoltification and what remedial or preventative measures can be taken to correct them.

2. Abundance - Distribution and numbers of smolts must be measured to determine potential number of adult returns and to calculate adult return rates. Presently there is limited or no information on the number of individuals successfully migrating to estuaries and coastal waters.

3. Smolt Quality - Indicators are needed to assess the quality of smolts produced by hatcheries. Fin condition data have been collected but in most cases have not yet been related to return rate. Additional and more sensitive methods of assessment are necessary to monitor the effect of hatchery practices on fish health and quality.

4. Precociousness/Residualization - A certain percentage of individuals released from any hatchery are destined to become sexually precocious or residualize in freshwater. Although these fish may be an important component of the population structure they do not contribute to adult returns. Efforts should be made to determine the environmental factors or hatchery practices which might induce precociousness/residualization and how to alleviate this problem.

5. Behavioral Studies - Limited information is available on the behavioral aspects of parr-smolt transformation. Investigations are required to assess behavior patterns of smolts and how they relate to migration, dam passage and imprinting.

6. Age of Smolts - The merits of producing hatchery 1Smolts vs. 2Smolts were discussed. It was suggested that both groups be evaluated to determine which rearing regimen produces the best smolts and adult returns. Additionally, the potential differences in the window of smoltification were mentioned.

7. Behavioral Physiology - Studies to correlate the physiology and behavior of smolts were suggested. This information would be of greater value if both laboratory and field studies were conducted.

8. Timing of Smoltification - Comparative studies to examine spatial and temporal differences in smoltification in fry stocked and hatchery reared smolts would be of value. Additional areas that should be investigated are: optimizing dates of release to produce the greatest numbers of returning adults and examining date of release and actual time of outmigration.

Mortality Factors

1. Predation - Predation by fish, birds, and mammals in river and estuary could be an important cause of mortality. The magnitude of this factor needs to be studied. Coincident with field studies on predation, experiments should be conducted on hatchery fish to develop techniques which will increase the ability of smolts to avoid predators, capture prey, and endure variable flow conditions in the wild. Large scale field trials should be initiated to evaluate the efficacy of these hatchery-culture modifications. Such studies could lead to remedial measures that might alter stocking time and place. Control and manipulation of predator populations should also be considered.

2. Passage - Smolts suffer mortality during downstream migration over dams. Impediments to downstream migration may (1) kill fish, (2) prolong migration time, and (3) increase susceptibility to other sources of mortality. The relative importance of these and ways to mitigate this mortality need to be examined.

3. Residency - The effect of length of river, delays, and changes in behavior during river/estuary residence need to be examined.

Post-Smolt

1. Growth and Survival - The logistical difficulties to sample salmon in the ocean during the post smolt phase complicates study of this important life stage. Until estimates of total smolt output become available, survival must be inferred from patterns of growth and the rates of return of 1SW, 2SW, and 3SW salmon. Retrospective studies of post smolt scales, using image analysis techniques, has shown promise as a means of relating growth to oceanic conditions. Broad scale evaluations of sea surface temperatures have been shown to be related to variations in salmon growth in the North Atlantic. Such analyses have a high probability of explaining cyclical changes in salmon abundance coincident with changes in temperature.

2. Environmental Influences - Relationships between environmental conditions and survival of smolts upon initial entry into seawater are poorly understood. Temperature regimes in the near-shore region are thought to be critical for successful and rapid movement of post-smolts to feeding grounds. The duration of acceptable times for migration may be short. Temperatures in the river are also important determinants of successful smoltification. Unfortunately, little information has been assembled on either river or nearshore temperatures. A compilation of existing data from USGS monitoring stations, fixed buoys, and satellite data would be useful for identifying periods in which successful migrations could occur.

Adults

1. **Passage at Dams** - Determining the efficiency of passage at dams is problematic because of the low and unknown numbers of returning fish. Mark-recapture methodologies may provide conditional estimates of passage efficiency because of potential problems: capturing, tagging and releasing fish that were initially captured at the same location where they will be recaptured (i.e. they have prior experience of the migratory path). Alternative tagging methods and techniques to include the use of PIT tags may be employed to overcome this bias. The limitations of tagging methods and the inherent bias should not preclude the initiation of studies if the assumptions are made.

Broodstock Collection - Genetics

1. **Hatchery Protocols** - Broodstock selection at capture facilities and hatchery environment selection may affect genetic variability. Proper hatchery protocols at spawning may mitigate some of the unwanted problems resultant from the mixing of genetic material. Although some programs are developing methods that are thought to be useful in separating stocks or isolating genetic material, straying of salmon returning in New England rivers may have implications for maintaining river specific stocks.

2. **Genetic Background** - Retrospective and continuing examination of hatchery records should be undertaken to assess pedigrees, effective breeding numbers, inbreeding, and loss of alleles.

3. **Precocious Parr** - Use of precocious parr in the fish culture programs may ensure genetic variation within the fry, parr and smolt components. The use of parr in the programs may pose problems, particularly those related to disease because of introductions into the hatcheries, but their use in propagation should continue.

General

1. **Modeling** - Population modeling could provide a context for the evaluation of research efforts designed to improve return rates and meet restoration objectives. Sensitivity analyses of such models could assist in quantifying the relative magnitude of various mortality factors, and in identifying alternative managment strategies.

2. **Historical Assessments** - Another important category of investigation is an evaluation of historical data from each of the restoration programs and existing environmental databases. While such studies are often not strictly comparable, they provide a strong basis for the identification, and the preliminary testing of alternative hypotheses and design of experiments.

Technological Advances

1. Tags - Recent technological advances offer the promise of substantially improving field assessment and research programs. In particular, new types of tags could be used for non-lethal recovery and tracking of salmon movements and estimation of survival rates. Smaller PIT tags, less than half the size of today's models, would afford the opportunity to uniquely mark large numbers of smolts and adults without the drawbacks of external tags or the limited information content of CWT. Continued development of this type of tag should be a high priority.

2. Telemetry - Radiotelemetry studies are expensive, require specialized equipment, and cannot be used to simultaneously track large numbers of fish. A new type of data-logging tag, now under development at the Lowestoft Fisheries Laboratory, U.K., allows scientists to record information on temperature, depth and direction of fish. These tags could become a substitute for radio-telemetry in situations where a high recovery probability of tags was possible. Additional information, reductions in costs and increased samples sizes are among the substantial benefits of such tags.

3. Marking - Mechanical marking is not feasible for very small fish. Mass marking of batches with biological stains may provide a means of evaluating fry stocking programs. Research on this type of marking should continue. With this technique, site-specific survival can be compared.

4. Video - Advances in video technology may allow scientists to improve estimates of smolt emigration and numbers of returning adults. When interfaced with appropriate image analysis software, video records could be used to both enumerate the run and estimate its size structure. Pilot studies now underway should continue and be expanded to other river systems once the feasibility of video technology has been demonstrated. Video technology may also improve studies of fish passage and behavioral.

5.3. NEW RESEARCH PROPOSALS

No new research proposals were presented to the Working Group.

6. HISTORICAL DATA (1970 - 1991)

6.1. STOCKING

The historical stocking information is presented in Table 9. The table has been revised (from ealier formats) to include information beginning in 1970 by river. The information within the table is subject to change at this time but will be validated for inclusion in the 1994 Working Group document.

6.2. ADULT RETURNS

The historical return information is presented in Table 10. The table has been revised (from ealier formats) to include information beggginning in 1970. The information within the table is subject to change at this time but will be validated for inclusion in the 1994 Working Group document.

7. TERMS OF REFERENCE FOR 1994 MEETING

The U.S. Atlantic Salmon Assessment Committee agreed to address the following Terms of Reference for the 1994 meeting.

1. Program summaries for current year to include:
    a. current year's stocking program with breakdowns by time, location, marks and lifestage.
    b. current year's returns by sea age, marked vs. unmarked, and wild vs. hatchery.
    c. general summary of program activities including regulation changes, angling catch, and program direction.

2. Data needs for NASCO
    a. summary of status of stocks for NASCO
    b. summary of research for ANACAT

3. Historical data - validate 1992 stocking and return data and add to historic database.

4. Continue to synthesize available data and model fry survival rates.

Mark Gibson will have the lead for this term.

5. Develop a methodology to confirm smolt status based on examination of selected characteristics in potential smolts and returning adults.

Mark Gibson will have the lead for this term.

6. Continue to develop methodology to estimate homewater returns to U.S. river.

Jay McMenemy will have the lead for this term.

7. Retrospectively examine river and near coastal environmental interactions in respect to movement of smolts and adults.

John Kocik will have the lead for this term.

8. Provide a summary addressing progress in developing downstream fish passage for Atlantic salmon in New England

rivers. The summary should include types of downstream fish passage structures and measures of effectiveness.

9. Develop procedures for computing and reporting environmental variables and habitat classification relevant to habitat measurement for juvenile salmon survival and production modeling.

Mark Gibson will have the lead, as a sub-committee chairman, for this term.

10. Develop a means of comparing observed recruits per spawner for the Penobscot River with an appropriate year-class surival index. These data will be used to model the survivorship relative to dam and environmental effects.

Ken Beland will have the lead, as a sub-committee chairman, for this term.

8. U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE PARTICIPANTS

Ken Beland	Maine Atl. Sea-Run Sal.Comm.	Bangor, ME
Henry Booke	U.S. Fish & Wildlife Ser.	Turners Falls, MA
Kevin Friedland	National Marine Fish. Ser.	Woods Hole, MA
Steve Gephard	Conn. Dep/Marine Fish.	Waterford, CT
Mark Gibson	RI Div. of Fish & Wildlife	W.Kingston, RI
Jon Greenwood	NH Fish and Game Department	Concord, NH
Rusty Iwanowicz	MA Div. of Marine Fisheries	Salem, MA
Jerry Marancik	U.S. Fish & Wildlife Ser.	E. Orland, ME
Joe McKeon	U.S. Fish & Wildlife Ser.	Laconia, NH
Jay McMenemy	VT Dept. of Fish & Wildlife	N.Springfield, VT
Ted Meyers	U.S. Fish & Wildlife Ser.	Turners Falls, MA
John O'Leary	MA Div. of Fish & Wildlife	Westboro, MA
Steve Roy	Green Mt. Nat. Forest	Rutland, VT
Richard Seamans	National Marine Fish. Ser.	Gloucester, MA
Larry Stolte, Chairman	U.S. Fish and Wildlife Ser.	Concord, NH

9. PAPERS SUBMITTED

Booke, Dr. Henry. A listing of the 1991 & 1992 Atlantic salmon research publications from the Northeast U.S.

Cipriano, Dr. Rocco. To risk or play it safe - what is best for smolt survival to adult.

Gibson, Mark. Rhode Island Division of Fish and Wildlife Atlantic salmon restoration program summary - 1992.

Gibson, Mark. Stocking strategies for Atlantic salmon fry in New England streams of varying productivity, subject to availability constraints, for maximum adult returns.

Griffiths, Fred. Atlantic salmon smolt statistics for Craig Brook and Green Lake National Fish Hatcheries.

McKeon, Joseph. Preliminary review of the effects of environmental factors on parr aundance and growth in the Merrimack River basin.

McKeon, Joseph. Summary of Atlantic salmon parr densities and population estimates at index sites in the Merrimack River basin for the period 1984 - 1992.

McMenemy, James. Atlantic salmon smolt monitoring in the West River basin, 1992.

McMenemy, James. Preliminary results of coded-wire-tag recoveries from Atlantic salmon stocked in the Connecticut River.

Roy, Steve. Monitoring of Atlantic salmon pre-smolt movement in two Green Mountain National Forest streams during Autumn 1992.

Stolte, Lawrence. Atlantic salmon program summary - Merrimack River - 1992.

10. LITERATURE CITED

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11. APPENDICES

11.1. TERMS OF REFERENCE FOR 1993 MEETING

1. Program summaries for current year to include:
   a. current year's stocking program with breakdowns by time, location, marks and lifestage.

   b. current year's returns by sea age, marked vs. unmarked, and wild vs. hatchery.

   c. general summary of program activities including regulation changes, angling catch, and program direction.

2. Data needs for NASCO
   a. summary of status of stocks for NASCO

   b. summary of research for ANACAT

3. Historical data - validate 1991 stocking and return data and add to historic database.

4. Continue to synthesize available data and model fry survival rates.

5. Develop a methodology to confirm smolt status based on examination of selected characteristics in potential smolts and returning adults.

6. Continue to develop methodology to estimate homewater returns to U.S. rivers.

7. Retrospectfully examine river and near coastal environmental interactions in respect to movement of smolts and adults.

8. Conduct a survey of the literature and salmon researchers to determine whether the occurrence of late migrants (smolts) is widespread or is an artifact of hatchery practices.

11.2. TABLES SUPPORTING THE DOCUMENT

TABLE 1. ATLANTIC SALMON STOCKING SUMMARY FOR NEW ENGLAND IN 1992 BY RIVER SYSTEM AND BY PROGRAM. 1)

RIVER SYSTEM	NUMBER OF FISH 2)						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
St. John (USA)							
Aroostook	0	0	16400	0	0	0	16400
St. Croix	85000	56500	14900	0	50300	0	206700
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	14000	0	0	0	0	0	14000
Narraguagus	0	0	0	0	0	0	0
Union	0	0	0	0	0	0	0
Penobscot	925000	278200	106600	0	817000	8100	2134900
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	154000	50200	400	0	19800	0	224400
Cocheco	128000	0	0	0	0	0	128000
Lamprey	127000	12700	0	0	0	0	139700
Merrimack	1118000	0	100	0	96400	0	1214500
Pawcatuck	0	70800	2500	0	5000	0	78300
Connecticut	2011000	313900	11500	0	313300	0	2649700
TOTAL	4562000	782300	152400	0	1301800	8100	6806600
St. John (CANADA) 3)							
Upper St. John	400000	136100	0	0	0	0	536100
Aroostook	0	0	0	0	0	0	0
TOTAL	400000	136100	0	0	0	0	536100
PROGRAM							
Maine							
USA	1178000	384900	138300	0	887100	8100	2596400
CANADA	400000	136100	0	0	0	0	536100
Cocheco	128000	0	0	0	0	0	128000
Lamprey	127000	12700	0	0	0	0	139700
Merrimack River	1118000	0	100	0	96400	0	1214500
Pawcatuck River	0	70800	0	0	7500	0	78300
Connecticut River	2011000	313900	11500	0	313300	0	2649700
TOTAL	4962000	918400	149900	0	1304300	8100	7342700

1) The distinction between USA and Canadian stocking of the St. John River Basin is based on the sources of the fish. Fish received from hatcheries located in Canada are reported as Canada and hatcheries located in the U.S. are reported as USA.

2) The number of fry is rounded to the nearest 1000 fish. All other entries rounded to the nearest 100 fish.

3) In addition to juveniles, 340 adults were transferred by DFO to the Upper St. John and 315 were transported to the Aroostook.

TABLE 2. SUMMARY OF JUVENILE ATLANTIC SALMON MARKING PROGRAMS FOR NEW ENGLAND IN 1992. 1)

PROGRAM	NO. CODED WIRE TAGS 2)		NO. CARLIN TAGS		NO. FIN CLIPS ONLY	
	PARR	SMOLTS	PARR	SMOLTS	PARR	SMOLTS
Maine Program	1200	201100	0	50000	0	50300
Merrimack River	100	96400	0	0	0	0
Pawcatuck River	0	0	0	0	0	0
Connecticut River	11500	313300	0	0	0	0
TOTAL	12800	610800	0	50000	0	50300

1) All numbers rounded to nearest 100 fish.
2) All fish marked with coded wire tags were also given adipose fin clips and some parr were given adipose and ventral fin clips.

TABLE 3. ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND – 1992.											
MARKING AGENCY	AGE	LIFE STAG	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Connecticut	CWT	21500	7/18/33	AD	3/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	19400	7/18/29	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22500	7/18/34	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21700	7/18/35	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21000	7/18/36	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22200	7/18/37	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21400	7/18/38	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22700	7/18/39	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	5000	7/19/03	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	4800	7/19/04	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	15700	7/19/05	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	17900	7/19/06	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	5800	7/19/07	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23100	7/19/25	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	3300	7/19/34	AD	4/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22100	7/18/40	AD	5/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22000	7/18/41	AD	5/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	2700	7/19/04	AD	5/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	16700	7/19/08	AD	5/92	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	2000	7/19/25	AD	5/92	Connecticut R.	
SUBTOTAL (SMOLT)						313300					
USFWS	1	parr	H	Connecticut	CWT	4900	7/19/05	AD	4/92	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	1100	7/19/34	AD	4/92	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	500	7/19/06	AD	4/92	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	5000	7/19/08	AD	5/92	Connecticut R.	
SUBTOTAL (PARR)						11500					
TOTAL – CWT, CONNECTICUT RIVER						324800					
USFWS	1	smolt	H	Merrimack	CWT	21000	7/19/18	AD	3/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	19400	7/19/19	AD	3/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	21300	7/19/20	AD	3/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	11000	7/19/21	AD	3/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	7000	7/19/21	AD	4/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	400	7/19/21	AD	5/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	14200	7/19/22	AD	5/92	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	2100	7/19/22	AD	6/92	Merrimack R.	
SUBTOTAL (SMOLT)						96400					
USFWS	1	parr	H	Merrimack	CWT	100	7/19/22	AD	5/92	Merrimack R.	
SUBTOTAL (PARR)						100					
TOTAL – CWT, MERRIMACK RIVER						96500					

TABLE 3. ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND – 1992.

MARKING AGENCY	AGE	LIFE STAG	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Penobscot	CWT	24985	7/19/10	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25022	7/19/11	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25221	7/19/12	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25052	7/19/13	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25117	7/19/14	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25005	7/19/15	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25363	7/19/16	AD	4/92	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25363	7/19/17	AD	4/92	Penobscot R.	
TOTAL – CWT, PENOBSCOT RIVER						201128					
ASRSC	ALL	parr	W	Narraguagus	CWT	1193	Sequential	AD	6–9/92	Narraguagus R.	
							4575–7261				
TOTAL – CWT, NARRAGUAGUS RIVER						1193					
USFWS	1	smolt	H	Penobscot	Carlin	25200	850001		5/92	Penobscot R.	Green
							875200				
USFWS	1	smolt	H	Penobscot	Carlin	24800	875201		4/92	Penobscot R.	Green
							900000				
ASRSC	All	adult	H	Penobscot	Carlin	16	292072		6/92	Penobscot R.	Green
							292089				
TOTAL – CARLIN TAGS PENOBSCOT RIVER						50016					
ASRSC	All	adult	U	Penobscot	Floy	16	9202–9224		4/92	Penobscot R.	Orange
ASRSC	All	adult	U	Penobscot	Floy	36	9225–9285		7/92	Penobscot R.	Orange
ASRSC	All	adult	W	Narraguagus	Streamer	7	27–33		10/92	Narraguagus R.	Green
ASRSC	All	adult	H	Narraguagus	Streamer	7	3052–3071		7/92	Narraguagus R.	Blue
ASRSC	All	adult	W	Narraguagus	Streamer	40	2065–2110		6/92	Narraguagus R.	Orange
TOTAL – FLOY & STREAMERS						106					
USFWS	1	smolt	H	Penobscot		50342		LV	5/92	St. Croix R.	
TOTAL – FIN CLIPS						50342					

TABLE 4. DOCUMENTED ATLANTIC SALMON RETURNS TO NEW ENGLAND RIVERS IN 1992. 1)

RIVER	NUMBER OF ATLANTIC SALMON BY SEA AGE 1SW	2SW	3SW	RS	TOTAL FOR 1992		TOTAL FOR 1991	
Penobscot River	959	1410	1	9	2379	a)	1757	
Aroostook River	335	103	0	0	438	b)	139	b)
Union River	0	4	0	0	4		8	
Narraguagus River	17	51	0	5	73	c)	95	c)
Pleasant River								
Machias River	0	3	0	0	3		2	
East Machias River	0	6	0	0	6		5	
Dennys River	4	19	0	0	23	d)	7	
St. Croix River	1	0	0	0	1	e)	189	
Kennebec River	0	0	0	0	0		4	
Androscoggin River	3	12	0	0	15		21	
Sheepscot River	2	4	1	0	7		4	
Ducktrap River	0	0	0	0	0		0	
Saco River	0	0	0	0	0	f)	4	
Cocheco River	0	1	0	0	1		0	
Lamprey River	0	2	0	0	2		0	
Merrimack River	31	166	2	0	199		332	
Pawcatuck River	0	6	0	0	6		5	
Connecticut River	8	480	2	0	490		203	
TOTAL	1360	2267	6	14	3647		2775	

1) These are considered minimum numbers; reflecting only trap counts and rod catches.

a) Does not include 7 salmon angled above Veazie counting station.

b) 1992 data includes Tinker Trap catch (110 1SW, 13 MSW) and salmon trucked above Tinker Dam (225 1SW, 90 MSW). 1991 data was revised to include 100 fish (50 1SW, 50 MSW) trucked above Tinker Dam in 1991.

c) Incomplete count at Cherryfield trap, salmon were observed bypasssing fishway.

d) Includes 18 salmon (3 1SW, 15 MSW) captured in 1992 with a portable weir.

e) Does not include 7 salmon (all MSW) captured during abbreviated (May 1 - June 15) 1992 trapping program.

f) No trap in 1992, rod catch only.

TABLE 5. ESTIMATED TOTAL NUMBER OF ATLANTIC SALMON RETURNS TO THE RIVERS IN NEW ENGLAND IN 1992.

RIVERS WITH TRAPPING FACILTIES

	ROD CATCH			TRAP CATCH			
RIVER	REL.	HARVEST 1)	EST. TOTAL 2)	TOTAL	ADJ. TOTAL 3)	GRAND TOTAL	
Aroostook	0	0	0	123	452	452	
St. Croix	1	1	1	7	132	133	4)
Union	0	0	0	4	8	8	
Narraguagus	45	17	22	56	112	134	
Penobscot	344	146	180	2233	2977	3157	
Androscoggin	0	0	0	15	17	17	
Saco	0	0	0	0	8	8	4)
Cocheco	0	0	0	1	1	1	
Lamprey	0	0	0	2	2	2	
Merrimack	0	0	20	199	221	241	
Pawcatuck	0	0	1	5	6	7	
Connecticut	0	0	49	490	544	593	
SUB-TOTAL	390	164	273	2438	3706	4753	

RIVERS WITHOUT COUNTING FACILITIES

	ROD CATCH			REDD	NO. OF		
RIVER	REL.	HARVEST 1)	EST. TOTAL 2)	COUNT	SPAWNERS		
Dennys	7	5	6	63	64	77 (77)	5)
East Machias	3	6	6			38	6)
Machias	7	3	4	83	84	88	7)
Pleasant	0	0	0	17	18	18	7)
Ducktrap	0	0	0	18	18	18	7)
Sheepscot	0	7	7	40	40	47	
Kennebec	0	0	0				8)
Saco	0	0	0				8)
SUB-TOTAL	17	21	23			286	
GRAND TOTAL	407	185	296			5039	

1) Rod kill below lowest trapping facility.

2) Assume 100% reporting rate for sport fish and 10% delayed mortality for released fish except in the case of the Cocheco, Lamprey, Merrimack, Pawcatuck, and Connecticut Rivers where the estimated harvest represents 10% of trap counts.

3) Assumed fish passage efficiencies of: 90% for Androscoggin, Aroostook, Cocheco, Lamprey, Merrimack, Pawcatuck, and Connecticut Rivers, 75% for Penobscot and St. Croix Rivers, and 50% for Narraguagus, Union, and Saco Rivers.

4) St. Croix trap operated intermittently May 1 - June 15, 1992 for alewives and resulted in incidental catch of 7 MSW salmon. Total based on 1990 smolt releases and expected returns rates.

5) The (77) figure includes removed broodstock (1-1SW, 5-MSW females) and one MSW (weir) trap mortality.

6) Estimated run size computed using ICES method from rod catch (80% reporting rate and 20% exploitation rate)

7) Incomplete redd count data for these rivers.

8) No basis for estimate, lack data for trap catch, redd counts, or angling.

TABLE 6. SUMMARY OF 1992 CODED WIRE TAGGED (CWT) AND CARLIN TAGGED ADULT ATLANTIC SALMON RETURNS TO USA RIVERS.

RIVER	TAG TYPE	AGE GROUP 1SW	2SW	3SW	RS	TOTAL
Connecticut River						
Trap	CWT	2	310	1	0	313
Merrimack River						
Trap	CWT	15	61	2	0	78
Rod	CWT	0	0	0	0	0
Penobscot River 1)						
Trap	CWT	266	471	0	2	739
Rod	CWT	5	16	0	0	21
Trap	Carlin	25	22	0	0	47
Rod	Carlin	0	2	0	0	2
Other Rivers in Maine 1)						
Trap	CWT	0	2	0	0	2
Rod	CWT	0	0	0	0	0
TOTAL	CWT	288	860	3	2	1153
	Carlin	25	24	0	0	49

1) It is assumed that any Atlantic salmon in Maine with an adipose finclip also carried a CWT.

TABLE 7. SUMMARY OF ATLANTIC SALMON EGG PRODUCTION IN NEW ENGLAND FACILITIES IN 1992.

SOURCE RIVER	ORIGIN	NO. OF FEMALES	TOTAL EGG TAKE	NO. OF EGGS PER FEMALE
Penobscot River	Sea-run	363	2500000	6887
Dennys River	Sea-run	5	38000	7600
Lamprey River	Sea-run	1	2400	2400
Merrimack River	Sea-run	84	538100	6406
Pawcatuck River	Sea-run	4	35600	8900
Connecticut River	Sea-run	236	1890800	8012
TOTAL SEA-RUN		693	5004900	7222
Penobscot River	Domestic	614	1518700	2473
Merrimack River	Domestic	536	2432800	4539
Connecticut River	Domestic	650	3924800	6038
TOTAL DOMESTIC		1800	7876300	4376
Connecticut River	Kelts	96	1013000	10552
TOTAL KELTS		96	1013000	10552
GRAND TOTAL		2589	13894200	5367

TABLE 8. DOCUMENTED 1992 SPORT CATCH OF ATLANTIC SALMON IN MAINE.

RIVER	NO. SALMON HARVESTED 1SW	2SW	3SW	RS	TOTAL HARVEST	EST. NO. RELEASED	TOTAL ANGLED 1992	TOTAL ANGLED 1991
St. Croix	1	0	0	0	1	1	2	3
Dennys	1	4	0	0	5	7	12	9
East Machias	0	6	0	0	6	3	9	5
Machias	0	3	0	0	3	7	10	2
Pleasant	catch and release					0	0	0
Narraguagus	2	15	0	0	17	45	62	28
Union	0	0	0	0	0	0	0	0
Penobscot 1)	48	105	0	0	153	344	497	422
Ducktrap	0	0	0	0	0	0	0	0
Sheepscot	2	4	1	0	7	0	7	4
Kennebec	0	0	0	0	0	0	0	4
Saco	0	0	0	0	0	0	0	0
Misc	0	1	0	0	1	0	1	0
TOTAL	54	138	1	0	193	407	600	477

1) The Penobscot sport catch includes salmon (7 fish) previously captured in fishway trapping facilities.

2) Misc. includes one MSW salmon angled from the Upper St. John River.

TABLE 9. ATLANTIC SALMON STOCKING SUMMARY FOR NEW ENGLAND BY RIVER 1970 THROUGH 1991

NUMBER OF FRY ROUNDED TO NEAREST 1000 - ALL OTHER ENTRIES ROUNDED TO NEAREST 100

	NUMBER OF FISH						
YEAR / RIVER	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1970							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	0	10700	10700
Narraguagus	0	0	0	0	0	11800	11800
Union	0	0	0	0	0	0	0
Penobscot	0	25000	0	0	0	28500	53500
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	0	0	0	0	0	0	0
Pawcatuck	0	0	0	0	0	0	0
Connecticut	0	0	0	0	0	0	0
TOTAL	0	25000	0	0	0	51000	76000
1971							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	5100	3400	8500
Narraguagus	0	0	0	0	0	2900	2900
Union	0	0	0	0	8100	0	8100
Penobscot	0	0	15800	0	52600	0	68400
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	1000	0	1000
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	0	0	0	0	0	0	0
Pawcatuck	0	0	0	0	0	0	0
Connecticut	60000	15000	7800	2900	5600	12400	103700
TOTAL	60000	15000	23600	2900	72400	18700	192600

YEAR / PROGRAM	NUMBER OF FISH						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
1972							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	8500	4400	12900
Narraguagus	0	0	0	0	0	15700	15700
Union	0	0	0	0	0	7700	7700
Penobscot	129000	0	0	0	0	73800	202800
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	0	0	0	0	0	0	0
Pawcatuck	0	0	0	0	0	0	0
Connecticut	0	0	2700	2300	4600	13100	22700
TOTAL	129000	0	2700	2300	13100	114700	261800
1973							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	2000	2000
Machias	0	0	0	0	0	6100	6100
Narraguagus	0	0	0	0	0	5600	5600
Union	0	0	0	0	0	19600	19600
Penobscot	0	0	0	0	12400	95800	108200
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	1000	1000
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	0	0	0	0	0	0	0
Pawcatuck	0	0	0	0	0	0	0
Connecticut	0	15000	1000	21100	1400	31900	70400
TOTAL	0	15000	1000	21100	13800	162000	212900

YEAR / PROGRAM	NUMBER OF FISH						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
1974							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	0	6500	6500
Narraguagus	0	0	0	0	0	0	0
Union	0	0	0	0	9900	20400	30300
Penobscot	0	0	35100	9100	34300	65900	144400
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	0	0	0	0	0	0	0
Pawcatuck	0	0	0	0	0	0	0
Connecticut	16000	0	9400	15600	10400	44000	95400
TOTAL	16000	0	44500	24700	54600	136800	276600
1975							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	3000	0	0	4200	7200
Pleasant	0	0	0	0	0	3000	3000
East Machias	0	0	0	0	0	3000	3000
Machias	0	0	0	0	0	0	0
Narraguagus	0	0	0	0	0	5000	5000
Union	0	0	0	0	0	31300	31300
Penobscot	0	0	12300	0	15800	94800	122900
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	2500	2500
Saco	0	0	0	0	0	9500	9500
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	36000	0	0	0	0	0	36000
Pawcatuck	0	0	0	0	0	0	0
Connecticut	31900	0	1700	16400	2800	70000	122800
TOTAL	67900	0	17000	16400	18600	223300	343200

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1976							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	8900	8900
Pleasant	0	0	0	0	0	1000	1000
East Machias	0	0	0	0	0	3900	3900
Machias	0	0	0	0	5300	11100	16400
Narraguagus	0	0	0	0	0	8400	8400
Union	0	0	0	0	1800	31800	33600
Penobscot	0	0	83800	0	54700	180100	318600
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	3000	0	3000
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	63000	75900	0	16600	0	2100	157600
Pawcatuck	0	0	0	0	0	0	0
Connecticut	26600	0	5000	24200	4000	30500	90300
TOTAL	89600	75900	88800	40800	68800	277800	641700
1977							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	3100	0	3100
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	0	0	0
Narraguagus	0	0	0	0	0	0	0
Union	0	0	0	0	13000	22500	35500
Penobscot	0	0	0	0	113800	224700	338500
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	72000	0	0	700	0	31000	103700
Pawcatuck	0	0	0	0	0	0	0
Connecticut	49500	0	0	15400	0	99200	164100
TOTAL	121500	0	0	16100	129900	377400	644900

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1978							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	5200	0	5200
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	30200	0	30200
Pleasant	0	0	0	0	3100	0	3100
East Machias	0	0	0	0	12200	0	12200
Machias	0	0	0	0	10200	0	10200
Narraguagus	0	0	0	0	0	0	0
Union	0	0	0	0	0	31900	31900
Penobscot	0	0	126800	0	61100	141400	329300
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	19600	0	19600
Merrimack	106000	0	0	0	21300	25900	153200
Pawcatuck	0	0	0	0	0	0	0
Connecticut	50000	0	0	36600	0	94300	180900
TOTAL	156000	0	126800	36600	162900	293500	775800
1979							
Upper St. John	0	2100	0	0	0	0	2100
Aroostook	0	3100	0	0	0	0	3100
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	10200	0	10200
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	5200	0	5200
Machias	0	0	0	0	10200	0	10200
Narraguagus	0	0	0	0	10100	0	10100
Union	0	0	0	0	12900	29900	42800
Penobscot	95000	0	0	0	50000	246300	391300
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	8600	5800	14400
Merrimack	77000	0	0	0	15000	24700	116700
Pawcatuck	0	136000	0	0	0	0	136000
Connecticut	53500	0	0	38400	0	145100	237000
TOTAL	225500	141200	0	38400	122200	451800	979100

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1980							
Upper St. John	0	0	0	0	0	2700	2700
Aroostook	0	0	0	0	0	2600	2600
St. Croix	0	0	0	0	0	0	0
Dennys	0	0	0	0	0	15200	15200
Pleasant	0	0	0	0	200	10000	10200
East Machias	0	0	0	0	0	15900	15900
Machias	0	0	0	0	0	0	0
Narraguagus	0	0	0	0	0	20400	20400
Union	0	0	0	0	30600	0	30600
Penobscot	0	0	0	0	369000	215600	584600
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	39900	8400	48300
Merrimack	126000	0	0	0	2300	28700	157000
Pawcatuck	0	1000	0	0	0	0	1000
Connecticut	286000	0	0	11500	0	51800	349300
TOTAL	412000	1000	0	11500	442000	371300	1237800
1981							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	25200	20400	0	0	0	45600
St. Croix	0	0	0	0	0	20000	20000
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	0	4100	4100
East Machias	0	0	0	0	0	0	0
Machias	0	0	0	0	0	0	0
Narraguagus	0	0	0	0	0	4100	4100
Union	0	0	0	0	0	29400	29400
Penobscot	202000	25400	50300	0	24700	174800	477200
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	0	0	0	0	0	0	0
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	19500	12200	31700
Merrimack	57000	0	0	0	2600	98300	157900
Pawcatuck	0	2000	108000	0	800	0	110800
Connecticut	168000	182700	1900	3600	5300	73300	434800
TOTAL	427000	235300	180600	3600	52900	416200	1315600

YEAR / PROGRAM	NUMBER OF FISH						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
1982							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	101000	20900	50000	0	19900	100	191900
Dennys	0	0	0	0	0	0	0
Pleasant	0	0	0	0	5000	0	5000
East Machias	0	0	0	0	0	5600	5600
Machias	0	0	0	0	5500	0	5500
Narraguagus	0	0	0	0	0	5200	5200
Union	0	0	0	0	5900	26500	32400
Penobscot	248000	50900	206400	0	107400	222300	835000
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	5300	0	5300
Saco	0	47100	0	0	0	0	47100
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	30700	6400	37100
Merrimack	50000	81600	0	95500	5400	65600	298100
Pawcatuck	2000	1000	0	0	0	0	3000
Connecticut	294000	9400	25100	9600	28100	180800	547000
TOTAL	695000	210900	281500	105100	213200	512500	2018200
1983							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	25500	0	20000	0	45500
Dennys	20000	0	0	0	5200	0	25200
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	0	12500	0	0	0	0	12500
Narraguagus	0	7800	0	0	0	0	7800
Union	0	0	0	0	41600	0	41600
Penobscot	0	0	31900	0	275300	161400	468600
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	5200	0	5200
Saco	0	0	0	0	20300	0	20300
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	8000	5000	15000	5000	47000	62900	142900
Pawcatuck	0	700	0	0	0	0	700
Connecticut	226000	115400	293800	400	89100	8900	733600
TOTAL	254000	141400	366200	5400	503700	233200	1503900

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1984							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	54000	0	13800	0	92500	0	160300
Dennys	0	0	0	0	3300	0	3300
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	8700	0	0	0	8700
Machias	0	0	0	0	15800	0	15800
Narraguagus	0	0	0	0	5200	0	5200
Union	0	0	0	0	50200	0	50200
Penobscot	80000	34400	0	0	481500	135600	731500
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	5000	0	5000
Saco	0	0	0	0	5100	0	5100
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	526000	0	23300	9800	24400	43800	627300
Pawcatuck	0	23000	0	0	0	0	23000
Connecticut	625000	178600	241200	11400	312300	0	1368500
TOTAL	1285000	236000	287000	21200	995300	179400	3003900
1985							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	178000	46400	12900	0	59600	0	296900
Dennys	0	0	0	0	4500	0	4500
Pleasant	33000	0	0	0	4100	0	37100
East Machias	13000	0	0	0	4500	0	17500
Machias	0	0	7000	0	5100	0	12100
Narraguagus	10000	0	0	0	4500	0	14500
Union	7000	0	0	0	45800	0	52800
Penobscot	144000	59500	17600	0	476500	104400	802000
Ducktrap	15000	0	0	0	0	0	15000
Sheepscot	20000	0	0	0	3900	3600	27500
Saco	0	0	23600	0	5100	0	28700
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	148000	0	5800	0	64000	125300	343100
Pawcatuck	8000	51000	1400	0	0	0	60400
Connecticut	422000	130500	110700	0	255000	0	918200
TOTAL	998000	287400	179000	0	932600	233300	2630300

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1986							
Upper St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	0	0	0	0	73500	0	73500
Dennys	0	8300	0	0	5400	0	13700
Pleasant	0	0	0	0	6500	0	6500
East Machias	8000	0	0	0	5300	0	13300
Machias	8000	8000	0	0	0	0	16000
Narraguagus	0	0	0	0	7500	0	7500
Union	7000	0	0	0	48400	0	55400
Penobscot	94000	25700	0	0	520200	69000	708900
Ducktrap	8000	0	0	0	0	0	8000
Sheepscot	0	11600	0	0	7500	0	19100
Saco	0	0	0	0	35200	0	35200
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	525000	0	31500	0	39900	64100	660500
Pawcatuck	0	50700	15000	0	0	0	65700
Connecticut	176000	188400	267100	0	290500	0	922000
TOTAL	826000	292700	313600	0	1039900	133100	2605300
1987							
Upper St. John	0	0	0	0	0	0	0
Aroostook	41000	0	0	0	0	0	41000
St. Croix	266000	0	41000	0	59800	0	366800
Dennys	24000	0	0	0	9000	0	33000
Pleasant	25000	0	0	0	7500	0	32500
East Machias	0	0	0	0	9000	0	9000
Machias	0	12500	12300	0	13600	0	38400
Narraguagus	15000	0	0	0	9000	0	24000
Union	7000	0	0	0	40100	0	47100
Penobscot	335000	58100	101100	0	456800	82400	1033400
Ducktrap	15000	0	0	0	0	0	15000
Sheepscot	15000	8200	0	0	9000	0	32200
Saco	0	0	0	0	22000	0	22000
Cocheco	0	0	0	0	0	0	0
Lamprey	0	0	0	0	0	0	0
Merrimack	1078000	0	99300	0	141600	0	1318900
Pawcatuck	3000	46200	4700	0	1000	0	54900
Connecticut	1180000	383200	345100	0	206000	0	2114300
TOTAL	3004000	508200	603500	0	984400	82400	5182500

YEAR / PROGRAM	NUMBER OF FISH						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
1988							
Upper St. John	0	0	0	0	0	0	0
Aroostook	43000	0	0	0	0	0	43000
St. Croix	0	0	0	0	78700	0	78700
Dennys	20000	0	0	0	25700	0	45700
Pleasant	25000	0	0	0	10500	0	35500
East Machias	10000	0	0	0	20700	0	30700
Machias	15000	0	6800	0	30900	0	52700
Narraguagus	20000	13000	5600	0	15700	0	54300
Union	0	0	0	0	30600	0	30600
Penobscot	201000	0	1900	0	599900	87100	889900
Ducktrap	0	0	0	0	0	0	0
Sheepscot	40000	12300	0	0	10200	0	62500
Saco	0	0	0	0	25100	0	25100
Cocheco	2000	0	0	0	0	0	2000
Lamprey	0	0	0	0	0	0	0
Merrimack	1718000	0	129600	0	94400	0	1942000
Pawcatuck	150000	59600	7100	0	5400	0	222100
Connecticut	1310000	72200	75200	0	395300	0	1852700
TOTAL	3554000	157100	226200	0	1343100	87100	5367500
1989							
Upper St. John	0	0	0	0	0	10300	10300
Aroostook	313000	242200	0	0	0	10000	565200
St. Croix	0	0	0	0	50600	0	50600
Dennys	12000	0	0	0	12100	0	24100
Pleasant	26000	2500	0	0	7300	0	35800
East Machias	30000	6500	8000	0	15300	0	59800
Machias	49000	13800	28000	0	23100	0	113900
Narraguagus	29000	9500	7000	0	22100	4900	72500
Union	0	0	0	0	20400	0	20400
Penobscot	77000	104100	179600	0	351300	65300	777300
Ducktrap	17000	0	0	0	0	0	17000
Sheepscot	29000	13600	10000	0	10200	0	62800
Saco	0	37800	49600	0	9900	0	97300
Cocheco	106000	0	0	0	0	0	106000
Lamprey	146000	0	0	0	0	0	146000
Merrimack	1034000	60000	88600	0	58600	0	1241200
Pawcatuck	0	379900	35800	0	6500	0	422200
Connecticut	1243000	268700	76800	0	217700	0	1806200
TOTAL	3111000	1138600	483400	0	805100	90500	5628600

YEAR / PROGRAM	NUMBER OF FISH FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
1990							
Upper St. John	110000	21000	9900	0	0	9600	150500
Aroostook	69000	0	0	0	27400	7600	104000
St. Croix	255000	0	0	0	65800	0	320800
Dennys	20000	0	0	0	25800	0	45800
Pleasant	30000	0	0	0	10500	0	40500
East Machias	42000	0	10100	0	10100	0	62200
Machias	75000	10100	17600	0	26100	0	128800
Narraguagus	0	0	0	0	16800	0	16800
Union	0	0	0	0	20400	0	20400
Penobscot	317000	166500	155300	0	413200	15900	1067900
Ducktrap	18000	0	0	0	0	0	18000
Sheepscot	27000	10100	10000	0	17500	0	64600
Saco	0	30100	47800	0	10600	0	88500
Cocheco	32000	50000	9500	0	0	0	91500
Lamprey	50000	87000	11400	0	0	0	148400
Merrimack	975000	0	5600	29700	116900	0	1127200
Pawcatuck	0	83500	55000	0	7500	0	146000
Connecticut	1271000	341600	25400	0	475900	0	2113900
TOTAL	3291000	799900	357600	29700	1244500	33100	5755800
1991							
Upper St. John	228000	139300	0	0	5100	5100	377500
Aroostook	74000	0	0	0	0	9600	83600
St. Croix	51000	40000	0	0	60200	0	151200
Dennys	25000	0	400	0	11700	0	37100
Pleasant	23000	0	0	0	0	0	23000
East Machias	27000	0	8300	0	15300	0	50600
Machias	13000	30000	21400	0	21100	0	85500
Narraguagus	0	0	0	0	15200	0	15200
Union	0	0	0	0	0	0	0
Penobscot	398000	202600	104100	0	657800	15000	1377500
Ducktrap	0	0	0	0	0	0	0
Sheepscot	18000	15000	600	0	14400	0	48000
Saco	111000	0	0	0	10300	0	121300
Cocheco	138000	0	0	0	0	0	138000
Lamprey	110000	68200	0	0	0	0	178200
Merrimack	1458000	0	0	0	62000	58100	1578100
Pawcatuck	0	101000	1000	0	2000	500	104500
Connecticut	1725000	306200	33100	0	351000	0	2415300
TOTAL	4399000	902300	168900	0	1226100	88300	6784600
GRAND TOTAL	23121500	5182900	3751900	375800	10439100	4567400	47438600

GRAND TOTAL BY RIVER (1970 THROUGH 1991)

RIVER	NUMBER OF FISH						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
Upper St. John	338000	162400	9900	0	5100	27700	543100
Aroostook	540000	270500	20400	0	32600	29800	893300
St. Croix	905000	107300	143200	0	580600	20100	1756200
Dennys	121000	8300	3400	0	143100	28300	304100
Pleasant	162000	2500	0	0	57800	18100	240400
East Machias	130000	6500	35100	0	97600	30400	299600
Machias	160000	86900	93100	0	180500	42200	562700
Narraguagus	74000	30300	12600	0	106100	84000	307000
Union	21000	0	0	0	379700	251000	651700
Penobscot	2320000	752200	1122000	9100	5128300	2500100	11831700
Ducktrap	73000	0	0	0	0	0	73000
Sheepscot	149000	70800	20600	0	92200	7100	339700
Saco	111000	115000	121000	0	143600	9500	500100
Cocheco	278000	ERR	9500	50000	0	0	337500
Lamprey	306000	ERR	11400	155200	118300	32800	623700
Merrimack	8057000	222500	398700	157300	695400	630500	10161400
Pawcatuck	163000	935600	228000	0	23200	500	1350300
Connecticut	9213500	2206900	1523000	209400	2655000	855300	16663100

TABLE 10. HISTORICAL ATLANTIC SALMON RETURNS TO NEW ENGLAND RIVERS
1970 THROUGH 1991
INCLUDES TRAP AND / OR ROD CAUGHT SALMON

RETURNS FROM JUVENILES OF HATCHERY ORIGIN INCLUDE 0+PARR, 1PARR, 1+PARR, 1SMOLT, AND 2SMOLT RELEASES -- RETURNS OF WILD ORIGIN INCLUDE ADULTS PRODUCED FROM NATURAL REPRODUCTION AND ADULTS PRODUCED FROM FRY RELEASES

STREAM SYSTEM /	HATCHERY ORIGIN				WILD ORIGIN				
YEAR	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
PENOBSCOT									
1970	7	124	1	2	0	2	0	0	136
1971	21	89	1	1	0	2	0	0	114
1972	11	311	4	1	0	10	0	0	337
1973	10	290	2	7	0	2	0	0	311
1974	31	516	24	9	0	1	0	0	581
1975	45	917	11	19	0	8	0	0	1000
1976	75	563	4	6	0	20	0	0	668
1977	44	581	4	12	0	3	0	0	644
1978	123	1547	12	26	0	55	0	0	1763
1979	203	671	3	15	0	8	0	0	900
1980	652	2570	2	38	0	18	2	0	3282
1981	888	2454	12	24	3	18	2	0	3401
1982	155	3886	20	20	13	55	1	3	4153
1983	179	705	6	13	5	51	1	1	961
1984	239	1387	6	45	25	107	2	0	1811
1985	244	2868	6	9	22	202	1	4	3356
1986	534	3620	14	8	17	332	3	1	4529
1987	749	1477	29	49	19	162	5	20	2510
1988	716	1993	6	52	14	64	0	10	2855
1989	867	2005	4	36	67	103	1	4	3087
1990	430	2520	14	26	93	254	3	2	3342
1991	176	1085	4	21	40	427	0	4	1757
TOTAL	6399	32179	189	439	318	1904	21	49	41498
UNION									
1970									
1971									
1972									
1973	3	72	0	0	0	0	0	0	75
1974	6	13	1	0	0	0	0	0	20
1975	23	56	0	0	0	0	0	0	79
1976	90	158	0	0	0	0	0	0	248
1977	13	222	1	8	0	0	0	0	244
1978	4	147	2	4	0	0	0	0	157
1979	6	38	0	1	0	0	0	0	45
1980	42	197	0	1	0	0	0	0	240
1981	10	284	1	0	0	0	0	0	295
1982	30	118	1	7	0	0	0	0	156
1983	25	116	1	2	0	4	0	0	148
1984	3	37	0	0	0	0	0	0	40
1985	3	79	0	0	0	0	0	0	82
1986	7	59	1	0	0	0	0	0	67
1987	19	43	0	1	0	0	0	0	63
1988	0	45	0	0	0	2	0	0	47
1989	4	25	1	0	0	0	0	0	30
1990	1	20	0	0	0	0	0	0	21
1991	1	1	0	0	1	5	0	0	8
TOTAL	290	1730	9	24	1	11	0	0	2065

STREAM SYSTEM / YEAR	HATCHERY ORIGIN				WILD ORIGIN				
	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
NARRAGUAGUS									
1970	1	13	0	0	0	120	7	5	146
1971	2	33	0	0	3	67	3	0	108
1972	1	81	7	0	3	211	17	13	333
1973	2	22	2	2	1	135	3	3	170
1974	3	20	2	1	1	118	6	12	163
1975	0	2	0	0	0	103	2	4	111
1976	0	4	0	0	0	25	0	3	32
1977	2	5	0	0	1	105	0	11	124
1978	0	35	0	0	0	94	2	2	133
1979	0	9	0	0	0	49	0	0	58
1980	0	0	0	0	0	112	0	3	115
1981	1	20	0	1	0	49	0	2	73
1982	0	11	0	1	0	57	0	10	79
1983	2	17	0	0	0	69	0	2	90
1984	0	10	0	0	0	57	0	1	68
1985	0	0	0	0	0	56	0	1	57
1986	0	20	0	0	2	23	0	0	45
1987	0	11	0	0	0	24	0	2	37
1988	1	10	0	0	2	24	0	1	38
1989	3	9	0	0	1	26	0	0	39
1990	1	22	0	0	0	27	0	1	51
1991	3	19	0	5	8	53	0	7	95
TOTAL	22	373	11	10	22	1604	40	83	2165
PLEASANT									
1970	0	0	0	0	0	1	0	0	1
1971	0	0	0	0	0	1	0	0	1
1972	0	0	0	0	0	1	0	0	1
1973	0	0	0	0	0	2	0	0	2
1974	0	0	0	0	2	27	1	0	30
1975	0	0	0	0	1	6	1	0	8
1976	0	0	0	0	0	1	0	0	1
1977	0	0	0	0	0	3	0	0	3
1978	0	0	0	0	0	16	0	0	16
1979	0	0	0	0	0	8	0	0	8
1980	0	0	0	0	0	5	0	0	5
1981	0	0	0	0	0	23	0	0	23
1982	4	8	0	0	0	6	0	1	19
1983	0	0	0	0	2	35	0	1	38
1984	0	0	0	0	1	16	0	0	17
1985	0	0	0	0	3	28	0	0	31
1986	0	0	0	0	0	19	0	0	19
1987	0	4	0	0	0	5	0	0	9
1988									
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0
TOTAL	4	12	0	0	9	203	2	2	232

STREAM SYSTEM / YEAR	HATCHERY ORIGIN				WILD ORIGIN				
	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
MACHIAS									
1970	0	13	1	0	0	211	6	9	240
1971	2	26	1	0	1	137	5	4	176
1972	5	69	4	0	3	180	5	3	269
1973	0	7	0	0	0	28	0	0	35
1974	4	6	0	0	0	26	0	0	36
1975	0	10	0	0	5	36	0	0	51
1976	2	5	0	0	0	18	0	0	25
1977	2	8	0	0	0	15	0	0	25
1978	0	15	0	0	0	87	0	3	105
1979	0	8	0	0	0	58	0	0	66
1980	0	13	0	0	0	58	0	7	78
1981	0	19	0	0	0	31	0	3	53
1982	0	0	1	0	1	52	0	2	56
1983	0	0	0	0	0	16	0	1	17
1984	0	8	0	0	2	21	0	2	33
1985	0	5	0	0	0	25	0	2	32
1986	2	16	0	0	2	24	0	2	46
1987	0	0	0	0	0	4	0	0	4
1988	0	0	0	0	0	6	0	2	8
1989	3	4	0	0	4	5	0	0	16
1990	0	1	0	0	0	1	0	0	2
1991	1	0	0	0	1	0	0	0	2
TOTAL	21	233	7	0	19	1039	16	40	1375
EAST MACHIAS									
1970	0	0	0	0	0	1	0	0	1
1971	0	1	0	0	0	5	0	0	6
1972	0	1	0	0	0	3	0	0	4
1973	0	1	0	0	0	5	0	0	6
1974	0	1	0	0	0	1	0	0	2
1975	0	8	0	0	0	20	0	2	30
1976	2	16	0	2	0	0	0	0	20
1977	0	9	1	0	0	19	0	1	30
1978	0	13	0	0	0	46	0	0	59
1979	0	7	0	0	0	18	0	0	25
1980	0	24	0	0	2	34	0	2	62
1981	4	67	0	0	4	24	0	1	100
1982	0	15	0	0	0	22	0	0	37
1983	0	3	0	0	0	5	0	0	8
1984	0	9	0	0	3	33	0	2	47
1985	0	0	0	0	0	30	0	0	30
1986	0	5	0	0	0	8	0	0	13
1987	0	8	0	0	0	5	1	0	14
1988	1	8	0	0	0	5	0	0	14
1989	12	10	0	0	2	6	0	1	31
1990	1	30	0	0	0	16	0	1	48
1991	1	2	0	0	1	1	0	0	5
TOTAL	21	238	1	2	12	307	1	10	592

STREAM SYSTEM / YEAR	HATCHERY ORIGIN				WILD ORIGIN				
	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
DENNYS									
1970	0	0	0	0	0	49	0	0	49
1971	0	0	0	0	0	19	0	0	19
1972	0	0	0	0	0	61	0	0	61
1973	1	0	0	0	0	40	0	0	41
1974	0	0	0	0	3	43	0	3	49
1975	0	0	0	0	0	40	0	0	40
1976	0	0	0	0	2	13	0	5	20
1977	0	0	0	0	0	26	0	0	26
1978	0	37	0	0	0	38	0	0	75
1979	0	0	0	0	0	36	0	2	38
1980	0	117	0	0	0	73	0	0	190
1981	6	74	0	0	0	43	3	0	126
1982	3	15	0	0	6	14	0	0	38
1983	0	0	0	0	0	28	0	0	28
1984	0	0	0	0	7	61	0	0	68
1985	0	6	0	0	0	14	0	0	20
1986	0	7	0	0	0	8	0	0	15
1987	0	0	0	0	0	1	0	0	1
1988	0	3	0	0	0	6	0	0	9
1989	1	10	0	0	0	1	0	0	12
1990	1	20	0	1	0	11	0	0	33
1991	1	0	0	0	0	6	0	0	7
TOTAL	13	289	0	1	18	631	3	10	965
ST. CROIX									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981	25	14	1	0	24	14	1	0	79
1982	28	1	0	0	56	13	1	0	99
1983	14	62	4	0	11	28	3	0	122
1984	138	50	5	0	39	11	1	0	244
1985	28	144	14	0	28	122	14	0	350
1986	34	116	13	0	33	116	13	0	325
1987	108	63	1	0	94	103	6	0	375
1988	76	229	0	3	18	61	0	1	388
1989	78	66	0	1	44	44	0	8	241
1990	6	59	0	7	12	26	0	2	112
1991	41	90	0	0	16	38	0	4	189
TOTAL	576	894	38	11	375	576	39	15	2524

STREAM SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
KENNEBEC									
1970									
1971									
1972									
1973									
1974									
1975	2	30	0	0	0	1	0	0	33
1976	0	2	2	0	0	0	0	0	4
1977	0	2	0	0	0	0	0	0	2
1978	0	2	0	0	0	0	0	0	2
1979	0	18	0	0	0	2	0	0	20
1980	1	3	0	0	0	0	0	0	4
1981	1	13	0	0	0	0	0	0	14
1982	1	22	1	0	0	0	0	0	24
1983	1	16	1	0	0	0	0	0	18
1984	0	1	0	0	0	0	0	0	1
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	0	2	1	0	0	2	0	0	5
1988	4	15	0	1	0	0	0	0	20
1989	1	16	0	0	0	0	0	0	17
1990	1	41	0	0	0	4	0	0	46
1991	0	4	0	0	0	0	0	0	4
TOTAL	12	187	5	1	0	9	0	0	214
ANDROSCOGGIN									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983	1	16	0	0	0	3	0	1	21
1984	4	79	1	0	0	7	0	0	91
1985	1	18	0	0	0	2	0	0	21
1986	0	72	1	0	0	8	0	0	81
1987	2	20	3	0	0	1	0	0	26
1988	2	11	0	0	1	0	0	0	14
1989	1	17	0	0	0	1	0	0	19
1990	6	168	0	1	1	9	0	0	185
1991	0	9	0	0	0	12	0	0	21
TOTAL	17	410	5	1	2	43	0	1	479

STREAM SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
SHEEPSCOT									
1970	0	0	0	0	1	5	0	0	6
1971	0	0	0	0	2	27	1	0	30
1972	0	0	0	0	1	18	1	0	20
1973	0	0	0	0	1	18	1	0	20
1974	0	0	0	0	1	18	1	0	20
1975	0	0	0	0	1	10	0	0	11
1976	0	0	0	0	1	9	0	0	10
1977	0	0	0	0	1	22	1	0	24
1978	0	0	0	0	2	32	1	0	35
1979	0	0	0	0	1	7	0	0	8
1980	0	0	0	0	2	27	1	0	30
1981	0	0	0	0	1	14	0	0	15
1982	0	0	0	0	1	14	0	0	15
1983	0	0	0	0	1	11	0	0	12
1984	0	0	0	0	1	20	1	0	22
1985	0	0	0	0	1	5	0	0	6
1986	0	0	0	0	1	10	0	0	11
1987	2	7	0	0	1	5	0	0	15
1988	1	0	0	0	0	0	0	0	1
1989	1	1	0	0	2	1	0	0	5
1990	1	8	0	0	0	0	0	0	9
1991	0	4	0	0	0	0	0	0	4
TOTAL	5	20	0	0	23	273	8	0	329
DUCKTRAP									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983									
1984									
1985	0	0	0	0	0	15	0	0	15
1986	0	0	0	0	3	12	0	0	15
1987	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	3	0	0	3
1991	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	3	30	0	0	33

STREAM SYSTEM / YEAR	HATCHERY ORIGIN				WILD ORIGIN				
	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
SACO									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983									
1984									
1985	2	58	0	0	0	0	0	0	60
1986	0	36	1	0	0	0	0	0	37
1987	4	34	1	0	0	1	0	0	40
1988	1	37	0	0	0	0	0	0	38
1989	2	16	0	1	0	0	0	0	19
1990	4	68	0	0	0	1	0	0	73
1991	0	4	0	0	0	0	0	0	4
TOTAL	13	253	2	1	0	2	0	0	271
COCHECO									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983									
1984									
1985									
1986									
1987									
1988									
1989									
1990									
1991									
TOTAL	0	0	0	0	0	0	0	0	0

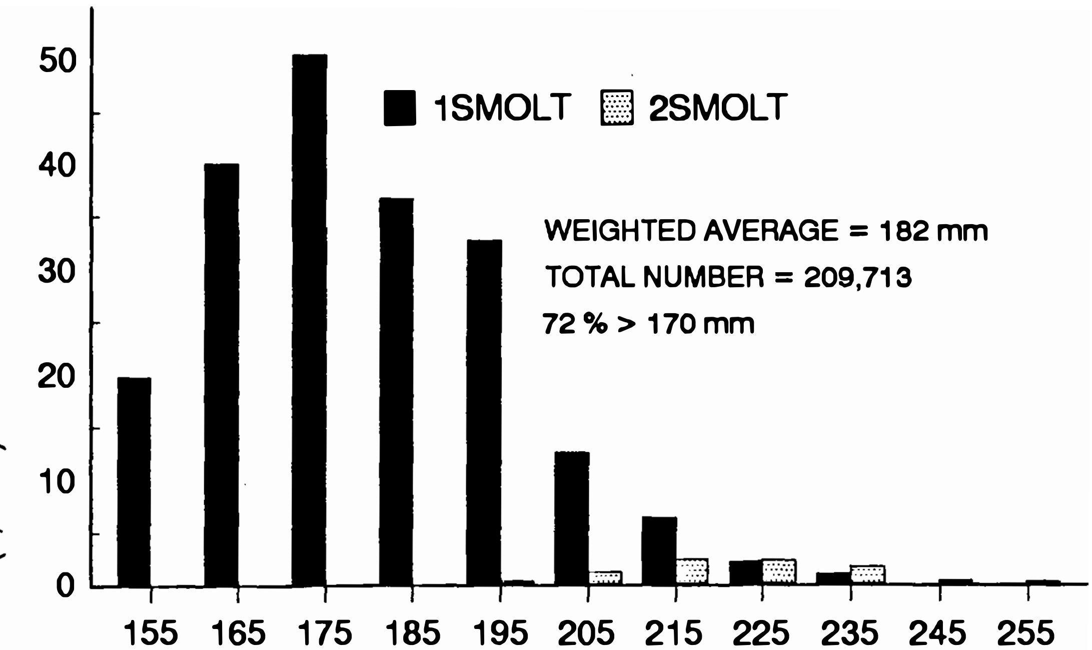
STREAM SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
LAMPREY									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979	2	0	0	0	0	0	0	0	2
1980	2	5	0	0	0	0	0	0	7
1981	2	0	0	0	0	0	0	0	2
1982	2	9	0	0	0	0	0	0	11
1983	2	0	1	0	0	0	0	0	3
1984	0	3	0	0	0	0	0	0	3
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0
TOTAL	10	17	1	0	0	0	0	0	28
MERRIMACK									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982	3	14	0	0	4	2	0	0	23
1983	7	54	5	0	1	41	6	0	114
1984	64	20	0	0	16	12	3	0	115
1985	8	112	1	0	5	85	2	0	213
1986	19	33	0	0	4	44	3	0	103
1987	8	94	4	0	2	26	5	0	139
1988	4	16	2	0	4	38	1	0	65
1989	3	24	1	0	0	55	1	0	84
1990	3	115	1	0	24	104	1	0	248
1991	1	76	0	0	0	254	1	0	332
TOTAL	120	558	14	0	60	661	23	0	1436

STREAM SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	2-S-W	3-S-W	REPEAT	WILD ORIGIN 1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
PAWCATUCK									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982	0	38	0	0	0	0	0	0	38
1983	1	37	0	0	0	0	0	0	38
1984	0	26	0	0	0	0	0	0	26
1985	0	1	0	0	0	0	0	0	1
1986	0	0	0	0	0	0	0	0	0
1987	0	1	0	0	0	0	0	0	1
1988	0	5	1	0	0	0	0	0	6
1989	0	6	0	0	0	0	0	0	6
1990	0	8	0	0	0	0	0	0	8
1991	0	5	0	0	0	0	0	0	5
TOTAL	1	127	1	0	0	0	0	0	129
CONNECTICUT									
1970									
1971									
1972									
1973									
1974	0	1	0	0	0	0	0	0	1
1975	0	3	0	0	0	0	0	0	3
1976	0	2	0	0	0	0	0	0	2
1977	0	7	0	0	0	0	0	0	7
1978	3	90	0	0	0	0	0	0	93
1979	4	50	4	0	0	0	0	0	58
1980	4	164	7	0	0	0	0	0	175
1981	6	513	10	0	0	0	0	0	529
1982	3	57	0	0	0	10	0	0	70
1983	0	39	0	0	0	0	0	0	39
1984	7	65	0	0	2	18	0	0	92
1985	0	293	0	0	0	17	0	0	310
1986	0	275	0	0	0	43	0	0	318
1987	0	343	5	0	0	0	5	0	353
1988	1	93	0	0	0	1	0	0	95
1989	1	58	0	0	1	48	1	0	109
1990	1	226	0	0	0	36	0	0	263
1991	0	168	1	0	0	34	0	0	203
TOTAL	30	2447	27	0	3	207	6	0	2556
GRAND TOTAL	7544	39950	309	490	865	7500	159	210	56863

GRAND TOTAL BY RIVER

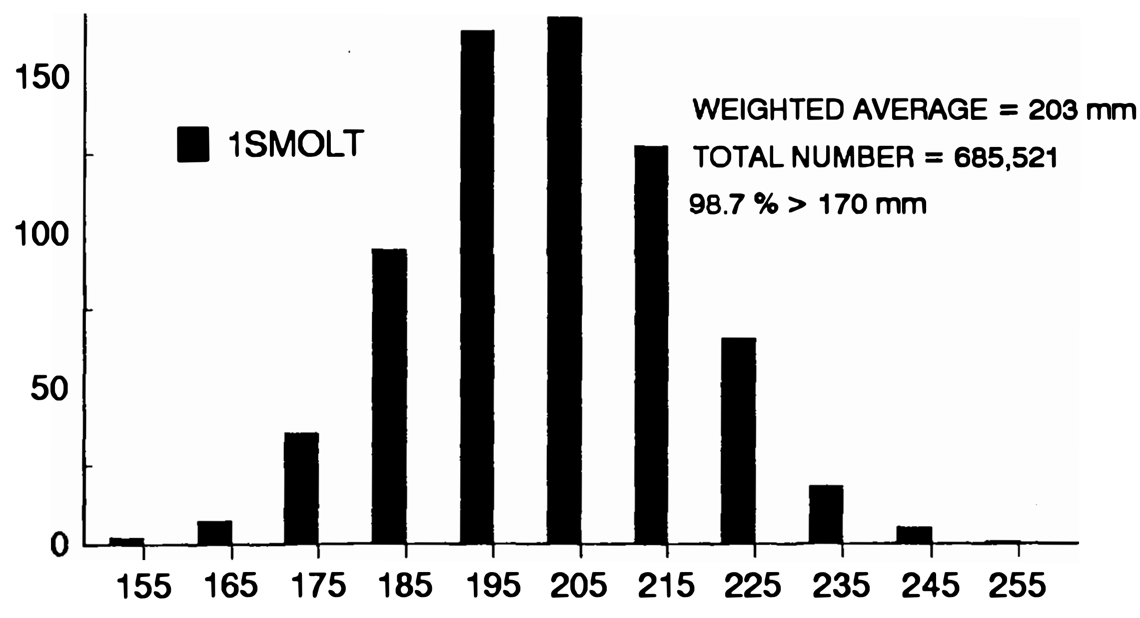
RIVER SYSTEM	HATCHERY ORIGIN				WILD ORIGIN				
	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
PENOBSCOT	6399	32179	189	439	318	1904	21	49	41498
UNION	290	1730	9	24	1	11	0	0	2065
NARRAGUAGUS	22	373	11	10	22	1604	40	83	2165
PLEASANT	4	12	0	0	9	203	2	2	232
MACHIAS	21	233	7	0	19	1039	16	40	1375
E. MACHIAS	21	238	1	2	12	307	1	10	592
DENNYS	13	289	0	1	18	631	3	10	965
ST. CROIX	576	894	38	11	375	576	39	15	2524
KENNEBEC	12	187	5	1	0	9	0	0	214
ANDROSCOGGIN	17	410	5	1	2	43	0	1	479
SHEEPSCOT	5	20	0	0	23	273	8	0	329
DUCKTRAP	0	0	0	0	3	30	0	0	33
SACO	13	253	2	1	0	2	0	0	271
COCHECO	0	0	0	0	0	0	0	0	0
LAMPREY	10	17	1	0	0	0	0	0	28
MERRIMACK	120	558	14	0	60	661	23	0	1436
PAWCATUCK	1	127	1	0	0	0	0	0	129
CONNECTICUT	30	2447	27	0	3	207	6	0	2556
TOTAL	7554	39967	310	490	865	7500	159	210	56891

FIGURE 1. CUMULATIVE ATLANTIC SALMON LENGTH-FREQUENCY, CRAIG BROOK NFH, 1992



NO. OBSERVATIONS (1,000s)

FIGURE 2. CUMULATIVE ATLANTIC SALMON LENGTH-FREQUENCY, GREEN LAKE NFH, 1992



TOTAL LENGTH (mm)

11.3. LIST OF ALL PARTICIPANTS

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