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

## REPORT NO. 15 - 2002 ACTIVITIES

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**PREPARED FOR**
**U.S. SECTION TO NASCO**

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# 1. INTRODUCTION

## 1.1. EXECUTIVE SUMMARY

*Documented adult Atlantic salmon returns to USA rivers totaled 962 fish in 2002, 9.5% less than observed in 2001. Most returns occurred in Maine, with the Penobscot River accounting for 81% of the total return. Overall, 45% of the adult returns to the USA were 1SW salmon and 55% were MSW salmon. Most (88%) returns were of hatchery smolt origin and the balance (12%) originated from either natural reproduction or hatchery fry. In total 12,493,900 juvenile salmon (fry, parr, and smolts) and 3,576 mature adults were stocked. Eggs for USA hatchery programs were obtained from 259 sea-run females, 3,368 captive/domestic females, and 107 female kelts. The number of females (3,734) contributing was less than in 2001 (4,018), and total egg take (20,081,000) was equivalent to that of 2001 (20,081,100). About 373,260 salmon carrying a variety of marks and/or tags (e.g., PIT tags, visual implant elastomer tags, Petersen disc tags, fin clips etc.) were stocked in 2002. Production of farmed salmon in Maine was 6,804 metric tonnes in 2002. These data were compiled by the U.S. Atlantic Salmon Assessment Committee (USASAC).*

### Description of Fisheries

*Commercial and recreational fisheries for sea-run Atlantic salmon are closed in USA waters (including coastal waters). Salmon incidentally caught must be released immediately, alive and uninjured, without being removed from the water. A highly regulated recreational fishery for 2,271 surplus broodstock occurred in the Merrimack River.*

### Adult Returns

*The documented adult salmon return to USA rivers was 962 fish in 2002, representing only 1.7% of the estimated 2SW spawner requirement for the USA. Most returns were recorded in Maine, with the Penobscot River accounting for 81% of all USA returns. Overall, 45% of the adult returns were 1SW salmon and 55% were MSW salmon. Most returns (88%) originated from hatchery smolts and others (12%) originated from either natural spawning or hatchery fry. The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2000 was 0.10%.*

*Documented returns of 1SW salmon in 2002 (436) were greater than those in 2001 (266), however MSW returns in 2002 (526) decreased from those in 2001 (797). Total 2002 returns (962) decreased by 9.5% compared to 2001 (1063). Changes from 2001 by river were: Connecticut (+10%), Merrimack (-34%), Penobscot (-1%), Saco (-32%), Narraguagus (-75%), and St. Croix (0%).*

*In addition to catches at traps and weirs, returns were estimated using redd counts for the eight rivers that comprise the federally endangered Gulf of Maine Distinct Population Segment (DPS). Data on adult returns and redd counts collected from 1991-2000 on the Narraguagus River and on the Pleasant and Dennys rivers in 2000 were used to develop a return-redd model using a linear regression of the natural log of both values [ln (returns) = 0.6435 ln (redd count) + 1.0978]. This model and its associated error were used to simulate the most probable adult returns on a river-by-river basis (Table A).*

### Stock Enhancement Programs

*During 2002, about 12,494,000 salmon fry (94.6%) were released into 20 river systems. The number of fish released was less than that in 2001. Fry were stocked in the Connecticut (7.3 million), Merrimack (1.4 million), Saco (0.6 million), and Penobscot (0.7 million) rivers. The 750,000 parr released in 2002 were by-products of smolt production programs and included ages 0 and 1 fish. Smolts were stocked in the Penobscot (54,700), Merrimack (51,900), Connecticut (560), Saco (4,100), Dennys (49,000), and St. Croix (4,100) rivers. In addition to juveniles, 3,576 adult salmon were released into USA rivers. Most were spent broodstock or broodstock excess to hatchery capacity. In the Merrimack River excess broodstock were released to support a recreational fishery and to enhance spawning in the watershed.*

### Tagging and Marking Programs

*Tagging and marking programs facilitated research and assessment programs including: identifying the life stage and location of stocking, evaluating juvenile growth and survival, instream adult and juvenile movement, and estuarine smolt movement. A total of 373,259 salmon released into USA waters in 2001 was marked or tagged. Tags used on parr, smolts and adults included: Floy, Carlin, PIT, radio and acoustical, fin clips, and visual implant elastomer. Calcein immersion was used to experimentally mark fry. About 0.5% of all marked fish were released into the Connecticut River watershed, 1.6% into the Merrimack River watershed, 75.4% into the Penobscot River watershed, and 22.5% into other Maine rivers.*

**Databases and Geo-referencing Systems**

*Microsoft Access and Environmental Systems Research Institute (ESRI), GIS products have been employed to manage Atlantic salmon tabular and spatial data for Maine rivers in a common, standardized, compatible and expandable format. Standardized nomenclature and a shared linear geo-referencing system have been developed and are incorporated into a "hub and spoke" system of relationally linked databases. The first component of the system is an interagency GIS, utilizing dynamic segmentation to split Maine salmon rivers into coded 10 meter increments along the river centerline. This "river kilometer" is employed to register interagency research activities into "real space", and to enable linear distance analyses between locations. The second component of the system consists of several Access databases related through the use of a common "hub" database identified as "MaineSalmon.mdb" containing standardized location and operational codes. These databases are linked to the GIS through Simple Query Language (SQL) via the River Kilometer coding scheme.*

*The current USASAC database utilizes lookup tables from the "MaineSalmon" database in conjunction with several queries of databases supporting southern New England programs to produce summary tables for the USASAC annual report. Data from reporting agencies submitted to database stewards are collated and reformatted using automation tools within Microsoft Access.*

*The USASAC has focused on substantive aspects of the various databases in the context of USASAC/ICES reporting requirements, as well as overall database functionality, assessment products to be derived from the databases, and examples of future assessment products that could be obtained with additional database inputs. Improvements were identified and formulated into a USASAC, Term of Reference that would establish a context to streamline data flow from "field" databases and the USASAC database, and improve data quality. The USASAC determined that enhanced stock assessment rather than summary program reporting was desirable in the future, though many practical obstacles to enabling necessary data sharing and quality across programs were identified.*

*The USASAC also focused on the work being conducted to develop the NASCO Habitat Database. This database will support the development and implementation of habitat restoration and protection plans according to the NASCO Plan of Action. The Plan of Action identifies guiding principles and calls for the development of comprehensive salmon habitat protection and restoration plans by the Contracting Parties to NASCO and their relevant jurisdictions.*

*It was suggested that the USASAC could serve as a vehicle for bringing data together across USA salmon programs to continue to form a more comprehensive regional picture of existing stock conditions. There was consensus among committee members that this was desirable, though an number of obstacles including staff and funding constraints may make it difficult. The most practical approach would be incremental integration of standardized data management tools (metadata, relational databases, etc.) across programs, with the understanding that changes would be implemented within identified constraints. The USASAC agreed that data collection methods are impractical to standardize across all programs as appropriate methods vary with circumstance. However, using robust metadata and moving toward a compatible data management system would best facilitate more advanced data sharing and analyses than are currently possible.*

**Aquaculture Production**

*Production of farmed salmon was 6,804 metric tonnes in 2002, a decrease from the 13,154 tonnes produced in 2001. Depopulation of aquaculture operations in Cobscook Bay due to ISAv (Infectious Salmon Anemia virus) reduced production.*

*ISAv was detected in USA waters 2001, however it is suspected that the virus may have been present at least a year earlier; it had been detected in nearby Canadian waters in 1996. Since the confirmed outbreak in USA waters, the U.S. Department of Agriculture has implemented an aggressive control program involving the following components: Bio-security, Surveillance (including monthly mandatory veterinarian inspections), Testing, Disease Reporting, Quarantine, Depopulation and Indemnity.*

*Canadian and USA control programs have many similarities, but significant distinctions also exist. The USA program resulted in the depopulation in 2002 of 1.1 million fish, with subsequent equipment decontamination and site fallowing. Inspections of cod and lumpfish in the pen sites were negative for the pathogen. USA inspectors have recently visited a number of repopulated sites in nearby Canadian waters, and it is evident that the virus continues to persists at some sites. It has been documented in the 2002 year class of salmon in Canadian waters, and genetic material, often a pre-cursor of outbreaks has been detected in sampled fish from USA inspectors believe the Canadian outbreaks are too close to repopulated USA sites and are concerned with violations of Best Management Practices in Canadian waters, including the lack of expeditious* *response to mitigate impacts at sites known to be contaminated. Monitoring suggests that USA sites near Canadian waters may have been exposed again to the virus, and industry representatives and regulators remain highly vigilant for new occurrences of ISAv in USA waters.*

**Water Quality and Salmon Health/Physiology**

*Atlantic salmon in eight Maine rivers that comprise the federally endangered Gulf of Maine Distinct Population Segment under the USA Endangered Species Act have reached historic lows. Many of the rivers are located in areas where acid-neutralizing capacity of water is low, and precipitation is acidic as a result of acid rain. River pH may frequently reach values of 5.5 or less, and aluminum concentrations exceed 100 µg/L, conditions which have been shown to have adverse effects on smolt survival in Norwegian and Canadian rivers. Gill tissue has been collected from river-produced smolts in the Narraguagus and Dennys rivers in Maine, and from captive populations held at Craig Brook National Fish Hatchery, East Orland, Maine to determine if water acidity and aluminum are affecting Atlantic salmon smolt survival. Changes in smolt physiology, which are prerequisite for survival in seawater, indicate that in spring 2002 smolt physiology in fish from the two stated rivers was severely compromised for most of the smolt migration, suggesting that adult survival from this year class of smolts is likely to be very low. As such compromised smolt development due to poor water quality may be a factor in reduced Atlantic salmon populations in Maine rivers, and also in other southern New England salmon rivers.*

*In addition, previous research has shown that smolts in the Narraguagus River have abnormally low gill Na/K-ATPase activity and had lower survival in salt challenge tests than hatchery fish, demonstrating that they were less able to osmoregulate in seawater. Many of the salmon rivers in Maine receive pesticide runoff from nearby blueberry barrens. Nineteen chemicals are registered for use on blueberries, including insecticides, herbicides, and fungicides. Some of these chemicals are known endocrine disruptors. Estrogenic activity of these chemicals in cell-culture assays have been evaluated, however not withstanding published studies demonstrating effects of estrogenic compounds on enzyme activity and osmoregulatory ability of smolts, at present no effect from pesticide exposure on any metric has been identified. Recent study results suggest that pesticide exposure through the water had no effect on smoltification or predicted marine survival of fish. Similar studies will be repeated in 2003, using different pesticides, different concentrations, and different routes of exposure to confirm current findings.*

*Given known compromised smolt development due to poor water quality, the USASAC recommends examining the possibility of mitigation by raising the pH in one or more rivers, commonly referred to as liming.* ***.*** *Such an action would require broad collaboration with scientists with experience in liming watersheds, and development of a study plan. In addition, the USASAC will advocate support for action through a formal statement identifying adaptive management approaches to mitigation of the low pH seen in Maine rivers.*

**1.2. BACKGROUND**

*The U.S. became a charter member of the 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 of the United States and work under the auspices of the U.S. State Department. The Commissioners required advice and input from scientists involved in salmon research and management throughout New England and asked the NEASC to create such an advisory committee. NEASC, 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 Research Committee met semiannually to discuss the agendas (officially known as the "terms of reference") for upcoming meetings of the ICES (International Council for the Exploration of the Sea), North Atlantic Salmon Working Group and NASCO, as well as to respond to inquiries from the US Commissioners. In July of 1988, the Research Committee for the US Section to NASCO was restructured and renamed the US Atlantic Salmon Assessment Committee. The Committee was charged with the following tasks: 1) to conduct annual US Atlantic salmon stock assessments, 2) to evaluate ongoing US Atlantic salmon research programs and develop proposals for new research, and 3) to serve as scientific advisors to the US Section of NASCO. A key element in the organization of the Committee was the development of an annual US Atlantic Salmon Assessment Meeting with the goal of producing an annual US Atlantic salmon program assessment document for the US Commissioners. In addition, the annual assessment report could serve as guidance regarding research proposals and management recommendations to the various State and Federal fishery agencies throughout New England.*

**1.3. RELATIONSHIP OF ICES TO NASCO**

*ICES is the oldest (1902) intergovernmental marine science organization in the world, and is the leading forum for the promotion, coordination, and dissemination of research on the physical, chemical, and biological systems in the North Atlantic Ocean. The organization also provides advice on human impacts on the environment, especially with respect to fisheries in the Northeast Atlantic. In support of these activities, ICES facilitates data and information exchange through publications and meetings, and functions as a marine data center for oceanographic, environmental, and fisheries data. ICES works with experts from 19 member countries and collaborates with more than 40 international organizations. Each year, ICES holds more than 100 meetings of its various committees and working and study groups, as well as organizing symposia and Dialogue Meetings. These activities culminate each September when ICES holds its Annual Science Conference / Statutory Meeting. Proceedings of this conference and meeting, and other related activities, are published by ICES.*

*Since the 1970s, ICES has provided scientific information and advice in response to requests by international and regional regulatory commissions, the European Commission, and the governments of its member countries, for purposes of fisheries conservation and the protection of the marine environment. It is for these reasons that ICES was chosen as the official research arm of NASCO. ICES is responsible for providing scientific advice to be used by NASCO parties as a basis for formulating biologically sound management recommendations for the conservation of North Atlantic salmon stocks. ICES assigned the responsibility for the collection and analysis of scientific data for Atlantic salmon stocks in the North Atlantic to the North Atlantic Salmon Working Group. ICES also has an established Baltic Salmon Working Group, which provides scientific advice regarding salmon stocks in that area of the world. The advice provided by the North Atlantic Salmon Working Group is reviewed by the Advisory Committee on Fishery Management after which it is presented to the NASCO parties at an annual meeting each June.*

*The annual "Terms of Reference" constitute the tasks assigned to the North Atlantic Salmon Working Group by ICES from recommendations that are received from NASCO, the European Union, and member countries of ICES. Opportunities for development of the Annual Terms of Reference are available to the members of the US Section to NASCO through the US Commissioners or other appropriate channels.*

**1.4. CHAIRMAN'S COMMENTS**

*The U.S. Atlantic Salmon Assessment Committee convened the February 25-27, 2003 meeting at the Craig Brook National Fish Hatchery in East Orland, Maine. The annual assessment report and summary/data tables were reviewed and endorsed by Committee members. This was one of the most well attended Committee meetings in its history with greater than fifty people attending, and all Committee members present. The newly renovated hatchery is fully engaged in the recovery of the endangered Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon. The meeting location was truly an impressive setting for the Committee to conduct its work.*

*Most salmon rivers in New England again experienced low adult returns, and as a result, all sport fisheries for sea-run Atlantic salmon remained closed in New England. Atlantic salmon were listed as an endangered species in November 2000 under the Endangered Species Act, with populations in eight rivers in Maine identified as the Gulf of Maine DPS of Atlantic salmon. A review by the National Academy of Sciences (NAS), of the research and science that supported the listing, found that wild Atlantic salmon in the State of Maine are distinct genetically from salmon in Europe, and evidence suggests that salmon in Maine are genetically different from salmon in Canada. While the NAS report released in January 2002 was preliminary, a final report is expected in the near future that will comment on how best to recover the species, and how relevant the genetic findings are with respect to recovery of the species.*

*The Infectious Salmon Anemia virus (ISAv) continues to threaten the success of salmon recovery and restoration efforts, and the viability of the commercial aquaculture industry in New England. The industry was required to fallow sea pens in Cobscook Bay to prevent the spread of the ISAv. Accordingly, production of farmed salmon was 6,804 metric tonnes in 2002, a decrease from the 13,154 tonnes produced in 2001. ISAv was first detected in Cobscook Bay in February 2001, and the virus has continued to spread resulting in the enactment of emergency rules. Since the outbreak, the U.S. Department of Agriculture has implemented an aggressive control program at sites involving bio-security, surveillance and inspections, testing, disease reporting, quarantine, depopulation, and indemnity. USA inspectors recently visited a number of repopulated sites in nearby Canadian waters, and it was evident that the virus continues to persist. Recent outbreaks in Canadian waters are too close to repopulated USA sites, and inspectors are alarmed that violations of Best Management Practices at Canadian sites, including the lack of expeditious response to mitigate impacts at contaminated sites, may pose an extraordinary risk to both wild and farmed salmon.*

*The results of recent research presented at this meeting in conjunction with results published in the literature provides compelling evidence of the detrimental effect of low pH on Atlantic salmon, particularly juvenile life stages. Measurements for Maine rivers have found low pH levels on average and brief periods of very low pH. The Committee recommended that the feasibility of liming one or more rivers be explored and suggested that the Chairman craft a statement encouraging such an action. The intent of this statement or letter, to be distributed to policymakers, scientists, public and private interest groups, and funding sources, would be to exhibit and promote the support of the Committee for adaptive management approaches to mitigation of the low pH seen in many Maine rivers. It is intended that prior to distribution of the letter, its content and text would be reviewed and discussed at the Committee meeting scheduled for Summer 2003.*

# 2. STATUS OF PROGRAM

## 2.1. GENERAL PROGRAM UPDATE

### 2.1.1. CONNECTICUT RIVER

#### 2.1.1.a. Adult Returns

A total of 44 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed including: 34 at the Holyoke fishway on the Connecticut River; four at the Rainbow fishway on the Farmington River; and, five at the Decorative Specialties International (DSI) fishway on the Westfield River. One salmon was observed in the Salmon River without capture. The run lasted from May 4 to June 24. A total of 38 salmon was retained for brood stock: 35 were held at the RCNSS, and three were held at the WSS; an additional sea run died during capture. The brood stock was comprised of 26 females and 12 males.

Four salmon were radio-tagged and released from the Holyoke fishway (river km 138) and permitted to continue upstream. Three salmon passed Turners Falls (river km 198) and Vernon (river km 228). Tagged salmon were monitored in the Deerfield River in Massachusetts, Ashuelot River in New Hampshire, and West River in Vermont.

Scales were collected from 43 salmon and visual examinations provided some information on age and origin on the single uncaptured fish. Three of the returning adult salmon were stocked as hatchery smolts and the others were stocked as fry. All smolt-origin salmon were 2 SW fish. Sea-age of fry-stocked fish was comprised of 1 sea-winter/grilse (N=2), 2 sea-winter salmon (N=38), and 3 sea-winter (N=1). Known freshwater ages of wild salmon were age 2 (N=38) and age 3 (N=1).

The CTDEP benefitted from about 100 volunteer hours during which Connecticut fishways were monitored and maintained. The MAFW received about 223 hours of volunteer assistance from the Westfield River Watershed Association. Their members monitored and maintained the DSI fishway on the Westfield River.

#### 2.1.1.b. Hatchery Operations

The program achieved almost 79% of egg production goals and 73% of fry stocking goals in 2002. Smolt production goals were not realized but significant steps have been taken to address this aspect of hatchery production since smolt production was temporarily eliminated.

The PNFH began a smolt production program for the Connecticut River Program in 1998 but that was suspended in 2000 due to an outbreak of furunculosis and the need to disinfect the hatchery. Disinfection and the construction of a water treatment system was completed in 2002 and the PNFH resumed rearing smolts in July 2002. A total of 100,000 age 0 parr and 90,000 age 1 pre-smolts that had been held at the WRNFH was transferred to the PNFH to complete rearing. The age 1 pre-smolts were marked with an adipose fin clip and vaccinated in mid-November in preparation for spring stocking. They were vaccinated with a multi-valent vaccine for Vibrio and furunculosis.

**Egg Collection**

A grand total of 11.8 million green eggs was produced at six state and federal hatcheries within the basin. This is about 800,000 more eggs than produced in 2001. Kelt egg production was down slightly but domestic and sea-run egg production increased in 2002.

Sea-Run Brood Stock

Sea-run females produced 1.5% (181,355 eggs) of the total eggs from 25 sea-run females (1.2% of the total females spawned) held at the WSS and the RCNSS. A sample of the fertilized eggs from all sea-run crosses was again egg-banked at the WSS and WRNFH for disease screening and subsequent production of future domestic brood stock.

Domestic Brood Stock

Domestic females produced 91.5% (10.8 million eggs) of the total eggs from 1,974 domestic females (94.8% of the total females spawned) held at the WRNFH, RRSFH, and KSSH.

Kelts

Kelts produced 7% (827,369 million eggs) of the total eggs from 83 kelt females (4% of the total females spawned) held at the WSS and NANFH.

**2.1.1.c. Stocking**

Volunteers donated 4,416 hours of time to stock Atlantic salmon fry in the Connecticut River watershed including 437 hours for NHFG, 675 hours for CTDEP, 800 hours for VTFW, 2,376 hours for MAFW, and 128 hours for the USFS.

*Juvenile Atlantic Salmon Releases.* A total of 7.3 million Atlantic salmon was stocked into the Connecticut River watershed in 2002. A total of 6,523,844 unfed fry (86%) and 754,039 fed fry (14%) were stocked into 38 tributary systems.

*Surplus Adult Salmon Releases.* The CTDEP released a total of 1,151 adult, domestic brood stock in the Naugatuck (568) and Shetucket Rivers (583); the VTFW released 200 adults in Lakes Willoughby (100) and Seymour (100); and, the MAFW released 703 adult salmon in 15 different lakes and ponds throughout Massachusetts for the benefit of anglers.

**2.1.1.d. Juvenile Population Status**

**Smolt Monitoring**

Northeast Generation Services and the USFWS/SOFA contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2002. This was the tenth consecutive year that a study has been conducted by marking smolts at the Cabot Station bypass facility and recapturing them at the bypass facility in the Holyoke Canal. Unfortunately, high flows and low recapture rates prevented an estimate of emigrating smolts.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 304,000 smolts were produced in tributaries basin wide, of which 245,000 (81%) were produced above Holyoke in 2002. Actual overwinter mortality is unknown and the estimate does not include smolt mortality during migration. Most smolts have to travel long distances and pass multiple dams to reach Holyoke. Recent research in the Connecticut River tributaries and Maine suggests that overwinter survival is lower than assumed in the electrofishing smolt estimate.

**Index Station Electrofishing Surveys**

Juvenile salmon populations were assessed by electrofishing in late summer and fall at over 200 index stations throughout the watershed. Sampling was conducted by CTDEP, MAFW, NHFG, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production. All of the data have not been analyzed yet. Preliminary information indicates that while densities and growth of parr varied widely throughout the watershed as usual, it was generally an average survival and growth year. Most smolts produced are again expected to be two year olds, with some yearlings and three olds. The preliminary data analysis suggests that basin wide smolt production in 2003 will be down about 6% from last year's estimate.

### 2.1.1.e. Fish Passage

***Fish Passage.*** Holyoke Dam - The City of Holyoke Gas and Electric Department purchased the project from Holyoke Water Power and progress was initiated on implementing the new license fish passage requirements: the rubber dam/inflatable flashboard system was installed to improve passage efficiency and the system functions well; tailrace excavation on the west-side entrance was completed; spill configuration for downstream passage and zone of passage flows were assessed; new upstream passage designs are being developed; and, modeling of Hadley Falls downstream passage continues.

Fifteen Mile Falls - The FERC issued the new license for this project in March. The Connecticut River Atlantic Salmon Commission followed-up with a request that PG&E National Energy Group implement downstream fish passage at Moore and Comerford dams as specified in the Settlement Agreement and confirmed in the FERC Environmental Assessment. PG&E has modified the downstream bypass at McIndoes and will evaluate the change in 2003.

Westfield River - The DSI paper mill has closed and is offered for sale but the hydro unit is still operating - fish passage operations have not been affected to date. The FERC issued an Environmental Assessment and license for the Woronoco project (2$^{nd}$ dam). The downstream smolt bypass will need to be evaluated as part of the new license.

Deerfield River - The PG&E National Energy Group evaluated modifications made at the Number 4 station and a periodic big-spill made at the Number 2 station. Moderate passage efficiency at Number 4 and very poor efficiency at Number 2 are the ongoing concerns. Further evaluations will be undertaken in 2003.

Millers River - Downstream passage facilities are in place for salmon smolts at the New Home and Cresticon projects.

Mill River - Planning for a culvert replacement on the Mill River in Hatfield, MA is underway. This funded project will open the mouth of the river to adult salmon and other migratory fish within the coming year.

Sawmill River - Planning for a natural stream bypass around a small dam on the Sawmill River in Montague, MA is also underway. The project is fully funded.

Ashuelot River - The Winchester dam (5th dam) on the Ashuelot River in Winchester, New Hampshire, was removed in July 2002; The owners of the Fiske Mill project (1st dam), Ashuelot Paper project (3rd dam), and Lower Robertson project (4th dam) were notified that upstream passage facilities will be needed because of the McGoldrick dam (2nd dam) removal in 2001 and herring and shad transfers. Owners have been requested to submit design drawings; Feasibility of removing the West Swanzey dam (6th dam) is being investigated.

Wells River - A downstream smolt bypass structure was installed at the Newbury project in Vermont.

### 2.1.1.f. Genetics

The U.S. Geological Survey - Biological Resources Division, through the Conte Anadromous Fish Research Center, again sampled tissue from all sea-run brood stock for genetic monitoring (microsatellite analysis). The work was conducted in cooperation with the National Fish Health Research Lab-Leetown.

All of the sea runs were PIT tagged to ensure individual identification at spawning. The population of spawning sea-run salmon did not meet the minimum requirement for 50 pairs of parents. The sex ratio of returning salmon was again skewed toward females. Consequently, wild male parr were collected in the Williams River in Vermont (151) and Pine Brook in Connecticut (72) for spawning with sea runs. Spawning was managed utilizing a 3 male:1 female breeding protocol and a mating scheme to maximize effective population size. It was also utilized to establish a known family mark for progeny. Similarly, marked sea-run families from last year's egg take were batched and stocked in the Williams (81,000) and Farmington (50,000) Rivers during the spring of 2002 to assess family survivability.

In addition to the sea-run eggs sent to the WRNFH, an aliquot of eggs from each sea-run female was set aside for the egg bank (at the WSS), divided into two groups, and fertilized with unique males. The purpose of the egg bank is to incubate appropriate quantities of high quality eggs to create future domestic brood stock ("banking" them while disease screening is completed). The objective is to use a minimum of 50 pairs of sea-run adults but since 50 pairs were not available to the program in 2002, a mix of 24 sea-run and 25 kelt females and 11 sea runs, five kelt and 62 mature parr males were used.

A 1:1 spawning ratio was observed for all domestic brood stock spawned at the WRNFH, KSSH, and RRSFH Previous to 2002, all genetically marked fry were of sea-run origin. Beginning in 1998, genetically identifiable domestic salmon brood stock have been maintained at the WRNFH. In 2001, these fish were spawned and families of domestic eggs were produced with known genetic marks. The resultant fry were stocked in 2002 to expand the marking and program evaluation efforts. This is expected to continue in 2003.

### 2.1.1.g. General Program Information

The Connecticut River Atlantic Salmon Compact (Public law 98-138) was re-authorized by Congress for another 20 years. The re-authorization did not include funding authorization or funding, both of which remain important to the program.

The Connecticut River Atlantic Salmon Commission was recognized with the Department of Interior Conservation Service Award in the Spring of 2002 for its cooperative commitment to restoring Atlantic salmon and other migratory fish to the Connecticut River.

The Connecticut River Salmon Association (CRSA) and the Deerfield/Millers River Chapter of Trout Unlimited are carrying conservation messages to over 2,000 students in 80 schools in the lower watershed annually by their sponsorship of salmon egg incubation activities (for educational purposes) in classrooms in Connecticut and Massachusetts. The CRSA assisted the Southern Vermont Natural History Museum and the Vermont Institute of Natural Science to establish a similar project for over 300 students in 18 schools in Vermont. This type of educational outreach is beyond the existing capacity of the CRASC but remains an important objective of the restoration program which is being successfully attained through partnerships.

### 2.1.1.h. Salmon Habitat Enhancement and Conservation

*Atlantic Salmon Habitat Restoration* Plans are ongoing for the funded removal of the Silk Mill dam on Yokum Brook, a Westfield River tributary in Becket, MA. Salmon habitat in Yokum Brook will be increased when the Town of Becket implements plans to remove two dams, the Ballou and Silk Mill Dams. Juvenile salmon are stocked upstream of these dams and one adult salmon is known to have reached habitat near the mouth of Yokum Brook, not far below the lowest dam on the brook.

## 2.1.2 MAINE PROGRAM

### 2.1.2.a. Adult Returns

Adult Atlantic salmon counts were obtained at fishway trapping facilities on the Androscoggin, Aroostook, Narraguagus, Penobscot, Saco, St. Croix, and Union rivers. Additionally, counts were made at semi-permanent weirs on the Dennys and Pleasant rivers. Post-spawn captive reared broodstock from Craig Brook National Fish Hatchery were stocked in the East Machias, and Sheepscot estuaries.

The summer of 2002 was dry, resulting in river discharges in July and August that were some of the lowest on record for all gage sites. However, there were substantial late fall rainstorms, with flows during and after spawning at or exceeding bankfull. These conditions afforded adults access to spawning areas throughout entire drainages. Unfortunately the high flows made redd counting difficult. Redds located during surveys used to monitor spawning activity and estimate numbers of spawners reflected considerable effort.

### Rivers with Native Atlantic Salmon

**Dennys River.** A weir, located at the head of tide in Dennysville, was operated from 20 April through 13 November 2002 to trap upstream migrating salmon for the purposes of evaluating the size of the wild run and to intercept escaped aquaculture fish. A total of six salmon was captured. Two one sea-winter fish originating from smolt stocking in spring 2001 were released upstream after measuring length, and taking scale and tissue samples. The other four salmon were suspected aquaculture escapees. Redd surveys conducted in fall 2002 on the Dennys River did not locate any Atlantic salmon redds. This is not unexpected because of the very low number of salmon captured at the adult weir.

**East Machias River.** Local permitting issues blocked the construction of a weir in the East Machias River near the head of tide. Alternate weir sites, one on the mainstem East Machias River and one on Chase Mill Stream, are being pursued. Both sites are necessary to ensure aquaculture escapees are excluded from spawning areas in the watershed. In 2002, the only way to assess spawning escapement within the East Machias River was to count redds. Although high water and poor visibility made these surveys difficult, 5 redds were located downstream from Round Lake. Due to these poor conditions, counts could not be made at other high quality spawning areas.

**Machias River.** The Machias River and its major tributaries were surveyed for redds in spite of high water levels and poor visibility. Only three redds were located throughout the entire drainage. Most of the known quality spawning areas were unused in 2002.

**Pleasant River.** A weir, located in the lower portion of the drainage near US Route 1 was operated from 16 May to 9 November 2002. No adult salmon were captured in the Pleasant River in 2002. Additionally, no redds were located during surveys on the lower reaches (from Saco Falls to the Route 1 bridge) of the Pleasant River, the Crebo Flats area on the mainstem, and lower Western Little River.

**Narraguagus River.** A fishway trap, at the Cherryfield ice control dam, was operated from 2 May through 4 November to capture upstream migrating adults, monitor the wild adult run and to intercept any escaped aquaculture fish that may enter the river. A total of 8 naturally produced sea-run salmon was captured. No salmon suspected to be aquaculture escapees were captured in the Narraguagus River in 2002. This year's trap catch represents a decrease of 22 salmon from the 2001 catch of 30 sea-run salmon.

A complete redd survey of the mainstem and two tributaries resulted in locating 6 redds on the mainstem. This count is consistent with expectations based upon the capture of three maturing female salmon at the Cherryfield trap. Three redds were located in the river reach between Beddington Lake and Rte. 193 (~35 km upstream of tidal waters) and 3 redds just upstream of Route 9 (at approx. 50 km upstream of tidal waters). No redds were observed in the two tributaries surveyed (Baker Brook and Gould Brook). This year's count is smaller than those in 2000 (21 redds) and 2001 (24 redds), and represents only about 1% of what is needed to assure full habitat utilization.

**Ducktrap River.** No salmon redds were observed during three attempts to document spawning in the Ducktrap River in the fall of 2002. These all followed fall rains that increased discharge to a range suitable for migration of adult salmon into the Ducktrap.

**Sheepscot River.** Surveys in 2002 were conducted on the West Branch of the Sheepscot River, above Sheepscot Pond, and on the mainstem. Four redds were found, one on the West Branch, one below the Palermo Fish Rearing Station and two at Coopers Mills.

**Cove Brook.** There were three attempts to find redds in Cove Brook in 2002. No salmon digging activity was observed during any of the survey periods. Summer long low flows in Cove Brook likely limited access for adult salmon to upriver spawning grounds. On October 17, fall rains increased discharge allowing the migration of adult salmon into Cove Brook.

Total Returns to DPS. Since 2001, scientists have made an estimate of the total number of returning salmon to the Gulf of Maine Distinct Population Segment. This estimate is calculated using capture data on all DPS rivers with trapping facilities (Dennys, Pleasant, and Narraguagus Rivers) combined with redd count data from the other 5 rivers of this group. Estimated returns are extrapolated from redd count data using a return-redd regression established from the 1991-2000 Narraguagus River and 2000 Pleasant River assessments by ASC (USASAC 2001). NMFS and ASC plan to update the regression model every three years; the next update of this model is slated for estimating the 2004 returns and retrospectively updating historical returns. The 90% probability estimate for returns to the DPS in 2002 ranged from 23 to 46. This range represents a 64-70% decline from 2001 return estimates (Table A). Additionally, this estimate is the lowest on record for the 1991-2002 time-series.

Table A. Redd based estimates of adult Atlantic salmon in the DPS rivers for 2002, with estimates from 2001 and 2000.

| River | Type | Estimate | 90% CL Low | 90% CL High |
|---|---|---|---|---|
| Cove Brook | redd | 0 | 0 | 0 |
| Ducktrap River | redd | 0 | 0 | 0 |
| East Machias River | redd | 9 | 5 | 14 |
| Machias River | redd | 6 | 4 | 10 |
| Sheepscot River | redd | 8 | 4 | 12 |
| Dennys River | trap | 2 | 2 | 2 |
| Narraguagus River | trap | 8 | 8 | 8 |
| Pleasant River | trap | 0 | 0 | 0 |
| 2002 | | 33 | 23 | 46 |
| 2001 | | 98 | 81 | 122 |
| 2000 | | 91 | 64 | 130 |

**Other Maine Atlantic Salmon Rivers**

**Penobscot River.** The portion of the Penobscot River in Veazie and Eddington closed to all angling effective July 1, 2000 remained closed in 2002.

ASC operated a fishway trap at the Veazie hydroelectric dam from 13 May through 1 November 2002 to capture upstream migrating adult Atlantic salmon. A total of 780 adult salmon was captured in 2002, a decrease of 6 fish from the 2001 catch and the second lowest trap catch on record. Scale samples were collected from 616 salmon to estimate the age and origin of the run, and non-lethal tissue samples obtained from 772 fish for DNA analysis. Of the 780 adults returning to the trap in 2002, 378 (48.5%) were 1 sea-winter (1SW) age-class fish. This is the highest observed percentage of 1SW fish for any year in the 1987-2002 time series and is approximately double the 15-year mean (24.8%). The observed increase in the 1SW component of the 2002 run may reflect improved survival of the 2001 smolt cohort, or a shift in the age structure of the salmon population. Only 4.2% of the 1SW fish were of wild (non-hatchery smolt) origin compared with 11.1% of the MSW fish. Four suspected aquaculture escapees were captured in the Penobscot River, and disposed of in accordance with ASC policy. Of the 402 fish (MSW salmon and grilse) passed above Veazie in 2002, only 30 were females. This represents approximately 1% of the spawning escapement required to meet the conservation target set for the Penobscot drainage.

The Great Lakes Hydro America, LLC (GLHA) (formerly Great Northern Paper Company) continued operation of an Atlantic salmon trap at the Weldon dam fishway, located 60 miles upstream from Bangor. The trap was operated daily from June 10 to October 31, 2002. The 2002 trap catch (99 salmon) was eighty per cent higher than last year’s catch (20 salmon). The 1SW component showed the largest increase (76 vs. 13) but the number of the large MSW fish also improved from 7 to 23 fish. All trapped fish were counted and permitted to swim from the trap without additional handling to minimize stress.

Annual redd count surveys are not usually conducted in the Penobscot watershed upstream of the Veazie dam due to the reliability of population data collected at the Veazie fishway trap, the relatively low spawning escapement, and the physical difficulties in obtaining an accurate estimate on such a large river. However, in 2002, PIT tag detections at fishways (see PIT tag study below) indicated that in November about 110 salmon were in the lower Piscataquis drainage. A survey targeting this portion of he Penobscot drainage resulted in locating six redds in the Pleasant River.

Surveys to locate and count redds were conducted on four tributaries to the Penobscot River estuary. Surveys included those conducted on Cove Brook and the following three streams:

Kenduskeag Stream. Five redd counts were conducted on the mainstem, each covering only portions of the spawning habitat. All areas were sampled at least twice and areas of highest interest were checked three times. No sign of spawning was observed throughout the drainage during the fall of 2002.

Souadabscook Stream. No redds or evidence of digging activity were noted during three attempts to find redds on Souadabscook Stream in 2002.

Marsh Stream. No redds were found during two surveys on Marsh Stream in 2002.

**St. Croix River.** Adult salmon are monitored via a fishway trap operated by the ST. Croix International Waterway Commission at the Milltown dam, near the head of tide. This facility provides an opportunity to enumerate and sample returning adults, collect broodstock, screen for ISAV (infectious salmon anemia virus), and prevent aquaculture escapees from entering the river. The 2002 Milltown trap catch of 20 sea-run salmon (13 1SW and 7 MSW) was 28% below the 5-year mean, and 72% below the 10-year mean. The decline is attributed to poor marine survival and reduced smolt stocking in recent years. Aquaculture escapees have been a component of the trap catch since 1994 (the first year these data were reported) and accounted for over 70% (56 fish) of the total catch in 2001. Only six aquaculture fish were observed in 2002 (Table B).

**Androscoggin River.** Two 2SW hatchery origin Atlantic salmon were captured at the Brunswick Dam fishway in 2002.

**Saco River.** Florida Power and Light (FPL) currently operate three fish passage-monitoring facilities on the Saco River. The Cataract fish lift, located on the East Channel in Saco was operational from early May to late October. This year 11 salmon were lifted and passed into the Cataract headpond from this facility. On the West Channel in Saco and Biddeford, the Denil fishway and fish sorting facility was also operational from early May to late October. This facility passed 36 salmon into the headpond. A third passage facility at Skelton Dam was used to capture adult salmon for transport to the Ossipee River. FPL transported and released 27 salmon from this facility.

**Union River.** The Ellsworth dam, although not equipped with an upstream fishway, has trapping facilities below the dam. Pennsylvania Power and Light (PPL), operates the trap from the end of the alewife season through fall to provide passage for Atlantic salmon. The ASC recommended that trapping (but not trucking) should continue when river temperature exceeded the 22/C threshold at the Union trap in 2002 to gain insight into trapping success and fish behavior during periods of high river temperature. A total of five sea-run salmon and six aquaculture escapees was captured in 2002. One of the five sea-run salmon was captured when water temperature exceeded 22/C, and was returned to the river immediately to avoid further stress. The other four sea-run salmon were captured during cooler periods and were trucked to spawning areas.

**Kennebec River.** The mainstem of the Kennebec River was not surveyed for redds due to high water conditions. No redds were found during surveys on Bond Brook, Togus Stream, Sevenmile Stream, and Messalonskee Stream.

**Passagassawakeag River.** No salmon digging activity was seen in the lower Passagassawakeag River where spawning activity had been observed in previous years.

**Aroostook River.** PDI Canada, Inc. operated a fish trapping and sorting facility at the Tinker Dam Hydro Project on the Aroostook River in New Brunswick under an agreement with Atlantic Salmon for Northern Maine (ASNM). The Tinker trap catch followed the 2002 decline observed at the Mactaquac trap with only seven salmon (1 MSW and 6 1SW) observed compared to 28 fish (14 MSW and 14 1SW) in 2001.

Table B. Numbers of suspected aquaculture escapes captured at traps on Maine Rivers. Blanks are no data.

| YEAR | St Croix | Dennys | Narraguagus | Penobscot | Pleasant | Union |
|---|---|---|---|---|---|---|
| 1997 | 42 | | 0 | 0 | | |
| 1998 | 25 | | 0 | 0 | | |
| 1999 | 23 | | 8 | 0 | | 63 |
| 2000 | 30 | 28 | 0 | 0 | 0 | 3 |
| 2001 | 58 | 62 | 1 | 1 | 0 | 2 |
| 2002 | 5 | 4 | 0 | 4 | 0 | 6 |

### 2.1.2.b. Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 5.9 million green eggs for the Maine program in 2002. Of these eggs, 2 million (34%) came from Penobscot sea-run fish; 2.6 million (44%) from six captive broodstock stocks; and 1.30 million (22%) from Penobscot stock domestic broodstock.

Progeny produced from captive broodstocks are released into their rivers of origin, primarily as fry. All three egg sources were used in Salmon in the Schools program, and domestics were transferred to the Saco River hatchery for rearing and release. Nineteen Pleasant River broodstock, which were collected as smolts and parr in 2000 and 2001, matured in 2002 produced approximately 70,000 green eggs.

Nate Wilke, MS candidate at University of Maine worked closely with program staff during the entire spawning season in a study to correlate DNA fingerprints with traits such as fecundity and morphometrics.

Program personnel continued to refine spawning protocols for spawning the captive broodstocks at Craig Brook in 2002 by incorporating a "life-time contribution" of each adult fish, and preliminary trials to look at selected paired matings.

Broodstock Collection

Collection of native parr from the Distinct Population Segment rivers, for broodstock development continued in 2002. Captive broodstock are collected from their native rivers as parr, and reared to maturity at CBNFH. The exception to this method in 2002 was Pleasant River broodstock, where smolts were collected. A total of 1274 parr and smolts was collected from the following rivers: Dennys (315 parr), East Machias (174 parr), Machias (353 parr), Pleasant (4 smolts), Narraguagus (260 parr), and Sheepscot (168 parr). These fish will be reared to maturity in order to provide river specific fry, parr and smolts for programs in these rivers. The numbers of parr targeted for collection were increased in 2002 in preparation for the single year class and lifetime contribution protocols being implemented and phased in to spawning protocols.

In an attempt to reduce handling stress, tag loss and tagging-related mortality, juvenile broodstock were not tagged at capture with Passive Integrated Transponder (PIT) tags in 2002. Tags will be applied at CBNFH when the fish reach an appropriate size to allow intramuscular insertion of the tags.

A total of 378 sea-run adult salmon were collected from the Penobscot River and brought to CBNFH for broodstock.

**2.1.2.c. Stocking**

During 2002, a total of 3.6 million Atlantic salmon were stocked into the rivers of Maine from within the state and from Canada. Of this number a total of 1.1 million salmon was stocked into six DPS rivers as river specific fry, as well as 750,000 fry into the Penobscot River (Table C).

It was necessary to release a total of 13,500 age 0 parr of Pleasant River origin from CBNFH in order to reduce the smolt production population to within limits of the CBNFH rearing capacity.

Table C. Summary of fry stocking in Maine rivers, each of which have been stocked since at least 1996.

| Stocking Year | Dennys River | E. Machias River | Machias River | Narraguagus River | Sheepscot River | Penobscot River |
|---|---|---|---|---|---|---|
| 1996 | 142,000 | 115,000 | 233,000 | 201,000 | 102,000 | 1,242,000 |
| 1997 | 192,000 | 113,000 | 236,000 | 196,000 | 64,000 | 1,472,000 |
| 1998 | 234,000 | 191,000 | 302,000 | 275,000 | 267,000 | 930,000 |
| 1999 | 172,000 | 210,000 | 169,000 | 155,000 | 302,000 | 1,500,000 |
| 2000 | 96,000 | 197,000 | 209,000 | 252,000 | 211,000 | 513,000 |
| 2001 | 59,000 | 242,000 | 267,000 | 353,000 | 171,000 | 364,000 |
| 2002 | 84,000 | 236,000 | 327,000 | 261,000 | 172,000 | 746,000 |

In addition to fry reared at CBNFH, seventeen schools contributed to the stocking effort by raising small amounts of river specific fry and stocking them into designated stretches of the parent river. These school activities are jointly organized and monitored by the CBNFH Salmon in Schools Program, and the Atlantic Salmon Federation Fish Friends Program.

Progeny from Penobscot River sea-run broodstock produce fry and smolts primarily for the Penobscot River, but are also released into the Merrimack (50,000 smolts) and other rivers such as the Saco and St. Croix for evaluation purposes.

The fry numbers allocated to the Dennys River have been reduced during the past two years to allow from the production of river specific 1 year old smolts at Green Lake NFH. In 2002, GLNFH successfully stocked 49,000 elastomer marked smolts into the Dennys River. A complete summary of stocking efforts by lifestage and river can be found in Table 2.2.1.

CBNFH maintains a broodstock population originating from native Atlantic salmon parr. Because of water constraints at the hatchery, and based on the number times the broodstock have contributed to spawning efforts, some of these fish are released back to their rivers of origin annually. In 2002, releases of the excess broodstock to the Sheepscot (120) and East Machias (107) occurred in December.

Approximately 282 Penobscot broodstock were released following spawning, and 80 were retained for fish health sampling (Table 2.2.1.b.).

### 2.1.2.d. Juvenile Salmon Population Status

Surveys to estimate density or relative abundance were conducted on most of the rivers in Maine with wild or stocked populations of Atlantic salmon. On the Narraguagus, median parr densities were 2.2 parr/100m$^2$ (Table D). However, there was considerable variability among the sites, with densities ranging from 0.03 parr/100 m$^2$ to 8 parr/100 m$^2$. Basin wide population estimates for the Narraguagus are being calculated. On the Dennys River parr densities ranged from 0 parr/100 m$^2$ to 13.4 parr/100 m$^2$ (Table D). Preliminary basin-wide analyses for 2001 and 2002 indicate that the standing crop of Atlantic salmon parr in the Dennys River was 4,833 in 2001, and 3,837 in 2002. However, in 2002, approximately 18% of the parr captured (678) were from a stocking of parr the previous fall. This indicates that production in the river is lower than the overall 2.2 parr/unit average. Density of young-of-the-year (YOY) has been extremely low in 2001 (median 0.3 YOY/unit) and 2002 (median 1.9 YOY/unit) in spite of stocking fry and releasing adults into the system.

Electrofishing in the other rivers (Table D) was conducted at standard index sites or used to survey drainages for the presence or absence of Atlantic salmon. ASC and Canadian biologists surveyed multiple sites on the St. Croix River in 2002 encompassing a 33 km section of prime salmon habitat where redds were observed in 2000 and 2001. Mean one-run densities of young-of-the-year (YOY) salmon remained low but did increase by 100% (0.62 vs. 0.32 YOY 100m$^2$) relative to 2001; parr were rare.

The data from the juvenile abundance surveys in 2002 are being entered into a standard database that will allow more thorough analysis of population trends relative to a variety of factors (i.e. stocking, spawning escapement, habitat conditions).

Table D. Summary of juvenile Atlantic salmon population densities (fish/100m$^2$) in Maine Rivers, 2002.

| Year | River | Young-of-the -Year | | | | Parr | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Median | Maximum | Sites | Minimum | Median | Maximum | Sites |
| SITES with sufficient numbers of salmon to use multi-pass removal estimates | | | | | | | | | |
| 2002 | Dennys | 0.0 | 1.9 | 16.3 | 24 | 0.0 | 1.9 | 13.4 | 24 |
| | East Machias | 0.0 | 5.5 | 32.9 | 8 | 0.0 | 4.2 | 9.5 | 8 |
| | Kennebec | 0.0 | 0.0 | 0.0 | 1 | 0.0 | 0.0 | 0.0 | 1 |
| | Machias | 0.0 | 3.8 | 26.1 | 11 | 0.0 | 3.4 | 19.6 | 11 |
| | Narraguagus | 0.0 | 4.3 | 18.6 | 28 | 0.3 | 2.2 | 8.0 | 31 |
| | Pleasant | 0.0 | 0.0 | 3.1 | 4 | 0.0 | 0.0 | 0.0 | 4 |
| | Saco | 0.0 | 11.3 | 78.7 | 9 | 0.0 | 3.5 | 14.5 | 9 |
| | Sheepscot | 0.4 | 15.9 | 34.6 | 4 | 4.9 | 5.8 | 51.5 | 4 |
| SITES where low numbers of salmon were estimated based on a single pass | | | | | | | | | |
| Year | River | Young-of-the -Year | | | | Parr | | | |
| | | Minimum | Median | Maximum | Sites | Minimum | Median | Maximum | Sites |
| 2002 | Cove | 0.0 | 0.0 | 0.0 | 3 | 0.0 | 0.0 | 0.0 | 3 |
| | Ducktrap | 0.0 | 0.0 | 0.0 | 3 | 0.3 | 0.4 | 0.8 | 3 |
| | Eaton | 0.0 | 0.0 | 0.0 | 1 | 0.0 | 0.0 | 0.0 | 1 |
| | Felts | 0.0 | 0.0 | 0.0 | 1 | 0.0 | 0.0 | 0.0 | 1 |
| | Kenduskeag | 0.0 | 0.0 | 0.0 | 86* | 0.0 | 0.0 | 3.6 | 86* |
| | N Br Marsh | 0.0 | 0.0 | 0.0 | 19 | 0.0 | 0.0 | 0.0 | 19 |
| | Passagassawakeag | 0.0 | 0.0 | 0.0 | 4 | 0.0 | 0.0 | 0.0 | 4 |
| | S Br Marsh | 0.0 | 0.0 | 0.0 | 4 | 0.0 | 0.2 | 1.8 | 4 |
| | Sedgunkedunk | 0.0 | 0.0 | 0.0 | 2 | 0.0 | 0.0 | 0.1 | 2 |
| | Souadabscook | 0.0 | 0.0 | 0.0 | 4 | 0.0 | 0.2 | 0.3 | 4 |

* parr were found at only 8 of the 86 sites in Kenduskeag Stream

**Basinwide Estimates of Large Parr Abundance.** Assessment scientists project the basinwide production of large Atlantic salmon parr (>age 1 fish) using a habitat-based stratification method for both the Narraguagus River (1991-2002) and more recently the Dennys Rivers (2001-2002). This method uses the ecological and geographical data to develop spatially discrete habitat-based strata that minimize differences within strata and maximize differences between strata (J.F. Kocik, NOAA Fisheries Personal Communication). In 2002, Atlantic salmon large parr abundance in the Narraguagus River was 10,883 ($\pm$ 1,115) while the Dennys River estimate was 3,837 ($\pm$ 614). Both these numbers represent substantive declines relative to 2001 abundance of 20% for the Narraguagus and 20.6% for the Dennys River. For the Narraguagus River time series this is the 11$^{th}$ lowest of 12 years of data. In addition, this abundance level represents the third straight year of decline for basinwide estimates of abundance in the Narraguagus.

**Smolt Abundance.** NEC has estimated the abundance of smolt emigrating from the Narraguagus River system using Mark-Recapture methods since 1997. This estimate is based on one marking site with two traps located at river km 11.65 (Little Falls) and one recapture site with two traps located at river km 7.65 (Crane Camp). These sites are downstream of 82% of juvenile rearing habitat. The population estimate in the Narraguagus River was 1,526 ($\pm$ 291) smolts, the lowest in this 7-year time-series. The low catch marks the 3$^{rd}$ consecutive year of population decline on the Narraguagus River. In 2002, a Mark-Recapture estimate was conducted for the first time for the Penobscot River, this method used three rotary-screw traps below the Veazie Dam and a proportion of this catch was marked and then transported upstream to just below this dam in an effort to use recapture efficiencies to make a population estimate.

NEC preliminary analysis estimates that approximately 188,000 ± 52,000 of more than 500,000 hatchery-released smolts survived movement through the system and all dams downstream. Of 3,165 smolts handled there were 251 mortalities recorded during field operations with 207 dam-effect assignments (6.5%) and 44 handling effect assignments (1.4%). While this effort represents only one year of data, further quantification of the numbers released would be beneficial to management of this, the largest of US Atlantic salmon populations.

Index sampling of smolts was conducted on the Sheepscot, Pleasant, and Dennys rivers. On the Sheepscot River there were two rotary screw traps (RST) fished side by side at the Head Tide Dam. In 2002, 95 smolts were trapped, as compared to 54 smolts captured with the one trap design in 2001. No mortality was experienced and all fish were found to be in extremely good health upon handling and release. On the Pleasant River there was one RST fished, beneath the Addison Road bridge. There were a total of six smolts trapped, five of which were sent to Craig Brook National Fish Hatchery (CBNFH) for brood stock collection. The ASC monitored smolts on the Dennys River with one RST at river km 0.80. This trap also provided comparative data to assess the performance of a pair of weir-based smolt trap (WBST) installed at the adult salmon weir located at river km 0.38. This trap captured a total of 800 smolts. Of these, 82 were of wild origin, 694 were stocked as smolts, and 24 were stocked as 0+ parr the preceding fall. Catch rates between hatchery smolts released in the upper extent of the river did not differ from those released in the lower river, suggesting that survival was comparable between the two release sites. The weir-based smolt traps operated during the same time captured a total of 326 smolts. Of these, 323 were stocked as smolts, 2 were of wild origin, and one was unknown. The effectiveness of the WBST was highly dependent on flow, while the RST fished effectively across all flows during the season. Further development of the WBST was cancelled given the low performance relative to the RST.

**2.1.2.e. Fish Passage.**

ASC staff met with the owners (BPHA) of the West Enfield Dam to review results of their new computational flow dynamics (CFD) model. The model indicates that increasing flow may not be an effective solution to enhancing downstream fish passage there, and a variety of other alternative proposals are currently being considered. Staff also consulted with GLHA regarding downstream passage issues at the Weldon Dam. The ASC and other agencies agreed that studies should be post-phoned until 2003 due to mechanical problems with turbines that would have strongly biased study data. The Matagamon Lake Association was advised on repairs to the Matagamon Dam fishway, and ASC staff participated in repair efforts. Staff also participated in the planning of the Matagamon Lake level and East Branch Penobscot River flow plan.

ASC staff attended numerous meetings and field events associated with the hydro relicensings of Abenaki and Anson (Madison Paper Industries), Lockwood (Florida Power and Light), Sandy River (Town of Madison), Saccarappa, Little Falls, Mallison Falls, Gambo, Dundee, and Eel Weir (all S.D. Warren) projects. Staff were also heavily involved in meetings and site visits for the Fort Halifax Project (Florida Power and Light) license surrender whereby the dam owner has proposed partial dam removal to comply with terms of a 1998 agreement to provide fish passage at the site.

The ASC staff attended meetings concerning the operational protocol for the new Skelton fish passage facility and its dedication ceremony. We also attended relicensing meetings for the Bar Mills Hydro Project and commented on post-licensing passage studies for the Cataract and Skelton projects.

ASC staff participated in the Maine Department of Transportation’s (MDOT) development of a fish passage policy for transportation projects crossing Atlantic salmon waters. Staff also participated in several visits to discuss and brainstorm passage strategies at selected sites, including the potential to rehabilitate the Rte. 86 fishway at Marion Falls on the Dennys River, and to view culverts improved to provide enhanced fish passage.

Two major dam removals occurred in 2002: Smelt Hill Dam on the Presumpscot River and Sennebec Dam on the St. George River. ASC staff was involved with evaluation of dam removal applications and site visits. The Smelt Hill Dam was completely removed opening up approximately seven miles of riverine habitat in the lower Presumpscot River. On the St. George River, the Sennebec Dam was completely removed and a rock ramp was constructed approximately 2,000 feet upstream at the natural outlet of Sennebec Pond to ensure that the pond's water level would remain at historic levels and provide upstream and downstream fish passage.

Due to severe drought that Maine experienced in 2002, the fishway on Marsh Stream in Frankfort (at the head of tide) did not always have enough water to provide passage during summer months limiting all access to the stream from July through October. The dam in West Winterport is in the process of being decommissioned and its fishway was inoperative in 2002.

**2.1.2 f. Genetics Collections and Broodstock Evaluation**

Since 1999, all broodstock at CBNFH were PIT tagged and sampled for genetic characterization via fin clips either at the hatchery or as incoming juveniles. This activity allows for the establishment of genetically identifiable fry and smolt families, which can be tracked through non-lethal fin samples at various life stages. Genetic fingerprinting of broodstocks prior to spawning also allows program managers to eliminate undesirable genomes from the spawning population.

For the DPS, fin samples were taken from parr-broodstocks at CBNFH for the following rivers: Dennys (102), East Machias (141), Machias (249), Pleasant (6), Narraguagus (249) and Sheepscot (139). Fins from wild parr and smolts were collected on the Narraguagus (365 wild parr, 486 smolts), Ducktrap (9 wild parr), and Sheepscot (30 parr, 95 smolts).

**2.1.2.g. General Program Information**

**Calcein Marking Study 2002**

Comparison of mortality between calcein-marked and unmarked Atlantic salmon fry stocked in the Sheepscot River, Maine (2$^{nd}$ year study)

Trials to evaluate calcein as a tool for marking juvenile Atlantic salmon continued in 2002 with 28,000 fry of Sheepscot River origin being marked during the sac fry stage at CBNFH.

A major obstacle in evaluating the performance of Atlantic salmon fry stocked throughout river basins in Maine each year has been the lack of a practical technology for mass marking fry with subsequent non-lethal mark detection. Recent advance in the use of calcein to produce an externally-visible mark now potentially offers a solution. However, the calcein-marking technique must be field-tested for possible effects on mortality in stocked fish. The 2002 study represents a repeat of the 2001 assessment using similar numbers of calcein-marked and non-marked fry released into the West Branch Sheepscot River. Results of field recovery efforts in September 2002 showed that 7 sites yielded sufficient numbers of YOY (n= >5) to perform a replicated G-test analysis. Out of these 7 sites, 3 showed calcein-marked vs. unmarked fish were recovered at the expected 1:1 ratio ($P$<0.05). The other 4 sites yielded ratios in favor of unmarked fish, 2 of which were very skewed toward greater numbers of unmarked fish. Combined data showed a recovery ratio of 3:1 in favor of unmarked YOY which obviously did not fit the expected 1:1 ratio we found in 2001. Possible explanations for unequal capture ratios between unmarked and marked fish in 2002 include: presence of wild YOY, faded calcein marks, or post-stocking mortality. Analysis of variance procedures performed on YOY total length data showed mean total lengths (SE) of marked and unmarked fish were 64.9 (0.9) and 65.6 (0.9) mm, respectively with no significant difference ($P$=0.572) between treatments. A combined total of 99 age 1 and age 2 parr were captured with 16 individuals being positively identified as calcein-marked age 1 fish that had been stocked the previous year. Future evaluations must include some determination of numbers of wild fish captured before the efficacy of calcein marking can be determined when used in this manner.

**Penobscot PIT tag Project**

The year 2002 marked the beginning of a cooperative research project between the Maine Atlantic Salmon Commission (ASC), USGS (Conte Anadromous Fish Research Center), U. S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the Penobscot Indian Nation (PIN). The study is investigating the temporal and spatial movements of Atlantic salmon during their upstream migration in the Penobscot River basin using PIT tags (Passive Intermittent Transponder). PIT tag antenna arrays and data loggers were installed at the entrance and exit of fishways at five mainstem dams (Veazie, Great Works, Milford, West Enfield, and Mattaceunk) and three Piscataquis drainage dams (Howland, Dover-Foxcroft, and Browns Mills). Of the 402 salmon returned to the river following trap capture at the Veazie dam in 2002, 378 were tagged with 22 mm PIT tags using a safe method of injection that we developed. ASC contract personnel downloaded remote fishway PIT tag antenna data loggers twice weekly, imported data into a Microsoft Access relational database, and will be actively auditing and analyzing data for fish movement patterns during the winter months. Fish passage will be related to season timing, photoperiod, river flow, and temperature, along with final destinations tagged fish. The project's results so far have exceeded our expectations, showing this project to be a baseline study for future years.

**2.1.1.h. Salmon Habitat Enhancement and Conservation**

Kleinschmidt and Associates completed an Instream Flow Incremental Methodology (IFIM) study in 2002. Using the IFIM, ASC has adjusted water releases at the Meddybemps Dam to optimize salmon habitat and optimally manage the water budget of the system. This has resulted in an increased ability to hold water in the lake, as well as release optimal flows for Atlantic salmon.

A restoration project supported by NRCS, USFWS, NMFS, and ASC, at the old Bacon Mill site on Kenduskeag Stream, has been in the planning stages since 2001. It is anticipated that project work will take place over the summer of 2003. Jed Wright (USFWS) and John Parrish (Contractor) have completed a geomorphic assessment that will guide the stream channel restoration. Monies have been pledged to replace a 25-foot bridge crossing with a larger 65-foot bridge help restore the stream channel. The Engineering Department at the University of Maine, Orono, is designing the bridge. To date, $38,500 has been raised to replace the bridge: $25,000 from the Fish America Foundation and $12,500 from the Town of Exeter. An additional $25,000 is needed to finish this part of the project. In addition the town of Exeter has agreed to cooperate on the removal of a dam on French Mill Stream pending landowner permission. A total of $20,000 has been raised for its removal in the event that landowner permission is obtained.

The ASC has joined with The Nature Conservancy, the Department of Conservation, and International Paper to develop a permanent conservation easement along most of the main stem of the Machias River and several of its important tributaries. Negotiations are still underway. The ASC, in cooperation with the Lands for Maine's Future Program and International Paper Company closed on a deal in late 2001 whereby IP transferred ownership of most of the riparian habitat that they owned along the Dennys River and Cathance Stream to the ASC. This will allow the ASC to ensure the integrity of the streamside habitat along the Dennys River and will provide significant benefit to all fish and wildlife, particularly Atlantic salmon.

**2.1.3. MERRIMACK RIVER**

### 2.1.3.a. Adult Returns

Fifty-six sea-run Atlantic salmon returned to the Essex Dam Fish Lift in the Merrimack River during 2002. Fifty-five salmon were captured and transported to the Nashua National Fish Hatchery (NNFH), one salmon escaped from the trap. The 2002 run total is 27 fish less than observed in the 2001 season with the majority of fish captured/counted in the spring (55 fish) as opposed to the fall (1 fish). Similar to last year, the 2002 run consisted primarily of hatchery origin adults (87%). The proportion of hatchery versus fry-origin adults has always been variable but the past two years have been the highest on record for the program for hatchery-origin adults.

Scale analysis of adult returns determined 48 fish (87%) to be of hatchery origin. Of these, 31 were 1SW and 17 were 2SW fish. Seven fish (13%) were determined to be of fry origin. Of these, one was a 1SW and six were 2SW fish. The total number of grilse to the river was 32 (58%) with the remaining 23 (42%) consisting of 2SW fish. The 2SW component was comprised of 27% males (n = 6) and 73% females (n = 16). The sex of the one fish (mortality) was not determined.

The rate of return (adults produced per 10,000 juveniles stocked) for fry-origin adults remains at low levels. The current rate of return for the 1998 fry cohort is 0.03 (grilse and 2SW returns, n = 8) compared to 0.02 for the 1997 fry cohort (n = 4). The rate of return for fry-origin adults for the cohorts of 1997 and 1998 have been the lowest in the time series for the program.

The rate of return (adults produced per 1,000 juveniles stocked) for smolt-origin adults decreased substantially from the last seven years that showed increasing rates of return. The rate of return of the 2000 hatchery smolt cohort was 0.4 (grilse and 2SW returns, n = 22), compared with the rate for the 1999 cohort of 1.8 (grilse and 2SW returns, n = 99) the highest in the available time series.

### 2.1.3.b. Hatchery Operations

The majority of the Atlantic salmon fry produced for release in the watershed was provided by the NANFH (45%) and the WSFH (55%). The parentage of fry stocked in 2002 were primarily from domestic broodstock (68%), followed by sea-runs (17%), and kelts (15%). Smolts produced for stocking purposes in 2002 were provided by the GLNFH and were of Penobscot River sea-run parentage.

#### Egg Collection

#### Sea-Run Broodstock

Sixteen females captured at the Essex Dam fishlift and transported to the NNFH produced 116,495 eggs in 2002, an average of 7,281 per female. The majority of the eggs were transported to the NANFH to be hatched and released as fry. Some eggs, approximately 2.5 %, were retained at the NNFH for broodstock development.

#### Captive/Domestic Broodstock

A total of 361 female broodstock (primarily age 3) reared at the NNFH provided an estimated 1,815,896 eggs. Eggs were transported to the NANFH and WSFH to be held for fry stocking within the Merrimack River basin. In addition to the domestic broodstock, a total of 21 female kelts produced 231,606 eggs at the NANFH. Kelt eggs were fertilized with milt from domestic broodstock from NNFH.Male and female kelts from NNFH were transferred to NANFH in February for reconditioning.

**2.1.3.c. Stocking**

Approximately 1.46 million juvenile Atlantic salmon were released in the Merrimack River basin during the period April - June of 2002. The release included approximately 1.41 million unfed fry, 1,900 parr, 1,200 two-year smolts, and 50,000 yearling smolts (GLNFH). Although the majority of the smolts were not marked or tagged, it is possible to determine the origin of adult returns by analyzing the pattern or signature on the scales of fish. Scale analyses are therefore used to differentiate between fish stocked as fry or smolts. Parr and two-year smolts from NNFH received a right ventral fin clip.

All major tributaries upstream from the Nashua River in NH, excluding the Winnipesaukee River, were stocked with fry. Numerous small tributaries to the Merrimack River and its principal tributary system, the Pemigewasset River watershed, also were stocked.

The majority of smolts were released into the mainstem of the Merrimack River a short distance downstream from the Essex Dam in Lawrence, MA in early April. Smolt stocking is timed to reduce the potential impacts to predation by striped bass that typically arrive in mid to late April. Approximately 500 smolts (Floy tagged) were released in the Contoocook River (NH) as part of a downstream fish passage study at a hydroelectric site.

**2.1.3.d. Juvenile Population Status**

**Yearling Fry / Parr Assessment**

Twenty-eight sites in 20 rivers, streams or brooks throughout the basin were sampled in 2002. A stratified sampling scheme was used to determine the abundance of yearling parr. Parr estimates were determined for the basin, regions, and geostrata. Habitat was stratified into four regions, where each region has different characteristics that included climate, geography, geology, hydrology, and land use. Estimates derived for geostrata involved sampling within regions in; 1) very large rivers (drainage area > 200,000 ha), in 2), large river (44,289 $\geq$ da $\leq$ 200,000 ha), and 3) small rivers and brooks (da < 40,500 ha). Sampling was directed at yearling parr (age-1) and involved electrofishing during late summer and early fall. Data collection involved a cooperative effort and included staff from the NHFG, USFS, USFWS, and volunteers.

The 28 sample sites included a total of approximately 400 units (one unit = 100 $m^2$) of juvenile habitat. The estimated number of available habitat units in the basin is 68,800 and of the total units available, approximately 55,600 were stocked with fry in 2002. Units sampled represent about 0.6% of the total available and 0.7% of those stocked with fry.

Results of assessments in 2002 showed abundance of yearling parr improved in nearly all 28 sites compared with 2001, which produced very low levels of parr abundance. For the period 1994 - 2002, fourteen sites have been sampled annually, the remaining sites have been sampled inconsistently over this time frame. The mean age 1 parr/unit density for these 14 sites was 2.8 in 2002, compared with 1.1 in 2001 and 1.4 in 2000 with an overall nine-year mean of 2.5 (age-1 parr/unit). The remaining 14 sites also exhibited improved parr densities consistent with the other sites indicating improved environmental conditions on a large scale, relative to the past several years.

A time series of estimated parr abundance is available for the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers. In recent years the stocking density of fry has been decreased ~50% in these rivers to compare population level responses to previous high stocking rate results. Stocking densities had previously ranged from 36 fry/unit to 96 fry/unit, but in recent years the numbers have ranged from 18 fry/unit to 48 fry/unit. The results of evaluations of yearling parr abundance at these and other sites in the watershed suggest that past high stocking densities have resulted in density dependent factors that adversely affected the growth and survival of parr. Given the shift in stocking densities, direct comparisons to past years levels of abundance need to be interpreted with caution.

### Stream-Reared Parr (age-1) Health Study

In July 2002, a study to determine the presence of four viruses, four bacterial diseases, and one parasite known as harmful to salmonid populations was conducted in the Merrimack River basin (Table E). The study targeted age-1 parr of sea-run, kelt, and domestic origin in all primary and selected secondary fry stocked waters. Samples were also taken from different areas in the basin due to the fact that hatchery trout plants come from four different state hatcheries with different fish health concerns and histories.

A sample of 447 parr was collected and initially tested using an Enzyme-Linked Immunosorbent Assay (ELISA). This method is less expensive than some tests and may produce false positives. In the event a positive was detected, a Polymerase Chain Reaction (PCR) analysis was conducted for confirmation. Several false positives were identified by this approach with the PCR analysis showing all samples clean for tested pathogens. Warren State Fish Hatchery (WSFH) has tested positive for Infectious Pancreatic Necrosis (IPN) and receives ~ 50% of the eyed eggs for incubation and hatch-out. Additionally, the WSFH produces a large number of catchable trout that are stocked over juvenile salmon in the Baker, Pemigewassett, Mad, Smith Rivers and numerous smaller tributaries. An incidental take of four hatchery trout produced one positive for the virus IPN in the Baker River.

Table E. Summary of age 1 Atlantic salmon parr sampled for four bacteria, four viruses, and one parasite throughout the Merrimack River basin in July 2002. All parr samples were negative for tested pathogens.

| Location | Town | Date | Hatchery Origin | Parentage | N | Bacteria[A] / Viruses[B,C] |
|---|---|---|---|---|---|---|
| Souhegan River | Wilton | 7/15/02 | NANFH | sea-run | 60 | negative |
| S. B. Piscataquog River | New Boston | 7/16/02 | NANFH | sea-run | 60 | negative |
| Smith River | Alexandria | 7/16/02 | NANFH | kelt | 60 | negative |
| Mad River | Waterville Valley | 7/17/02 | WSFH | domestic | 60 | negative |
| Beebe River | Campton | 7/18/02 | WSFH | domestic | 30 | negative |
| Mill Brook | Thorton | 7/18/02 | WSFH | domestic | 20 | negative |
| S. B. Baker River | Warren & Wentworth | 7/18/02 | WSFH | domestic | 60 | negative |
| Moosilauke Brook | Woodstock | 7/18/02 | WSFH | domestic | 20 | negative |
| Pemigewasset River | Woodstock | 7/18/02 | WSFH | domestic | 44 | negative |
| Pemigewasset River | Lincoln | 7/18/02 | WSFH | domestic | 33 | negative |

[A] *Aeromonas salmonicida* (furunculosis)
*Yersinia ruckeri* (eneteric redmouth)
*Flexibacter psychrophilus* (coldwater disease)
*Renibacterium salmoninarum* (bacterial kidney disease)
[B] Infectious pancreatic necrosis
Infectious hematopoietic septicemia
Viral hemorrhagic septicemia
Infectious salmon anemia
[C] Parasite for *Myxobolus cerebralis* (whirling disease)

### 2.1.3.e. Fish Passage

**Downstream Fish Passage**

The Upper Penacook Falls hydroelectric facilities (Contoocook River) continued smolt bypass studies utilizing flow inducers to direct fish to a collection and bypass area. Results of passage efficiency ranged from 43-74%. Flow models are being developed to examine flow fields that could further improve passage efficiency.

**Upstream Fish Passage**

The Amoskeag Dam (Public Service Company of New Hampshire) is preparing to renew its FERC license and as a result is being examined for operational and structural improvements to benefit a number of fish species. Studies in the spring of 2002 focused on video monitoring of the fish ladder specifically targeting American shad. The results have not been made available but additional work is scheduled for 2003. In addition the de-watered bypass reach is being considered for additional instream flows. This development may lead to competing attraction water and subsequently require the installation of upstream fish passage on the east side of the dam, opposite the powerhouse (existing ladder entrance, west side).

**Impacts of River Obstructions**

Approximately 60% of the juvenile production habitat in the Merrimack River basin is located in the Pemigewasset River watershed, a major headwater tributary. Smolts migrating from this region encounter seven hydroelectric facilities and one earthen flood control dam. Tributaries throughout the basin also have numerous obstructions impeding the migration of fish with more than 100 dams located in these smaller watersheds. The number of smolts that successfully exit the Merrimack River and enter the ocean is based in large part on the survival of fish as they pass successive dams. Studies and evaluations of fish passage efficiency and effectiveness at most mainstem and a number of tributary dams is ongoing, and these studies have demonstrated that smolt mortality occurs at dams and that seaward migration is impeded or delayed at dams. Water flow regimes, also altered during the period of seaward migration due to the presence of dams, are a factor that can negatively impact migrating smolts. Considerable work is required at both mainstem and tributary dams to improve the effectiveness and efficiency of downstream fish passage facilities.

All returning adult salmon are currently captured at the first dam upstream from tidewater, and the construction of upstream fish passage facilities at dams to provide fish access to spawning habitat is not likely in the near term. The number of adult returns has been low and target levels have not been reached to trigger the need for construction of upstream fish passage facilities. Fishery resource agencies will continue to consult and coordinate with hydroelectric facility owner/operators and water resource users to construct and improve upstream and downstream fish passage facilities and to ensure the survival of migrating salmon.

### 2.1.3.f. Genetics

In 2002 funding was secured for a genetic analysis of domestic broodstock, sea-runs, and kelts. Fin samples from all sea-runs and kelts and a sub-sample of the domestic broodstock (all age classes) were taken for analysis by the USFWS Northeast Fishery Technology Center. Paired matings in the fall of 2002 were tracked by tissue samples with eggs/fry segregated in hatcheries to enable the identification of parent origin and point of initial stocking in defined geographic regions. These regions are primarily broken into lower (sea-run parentage fry), middle (kelt parentage fry), and upper basin (domestics parentage fry). Sea-run fry develop at an earlier date due to their time of spawning, which subsequently leads to targeting lower basin tributaries for this group in the early spring. The primary question of interest is if fry-origin adult returns are from areas in proportion to stocking rates or if other mechanisms (improved fitness of sea-run fry) or impacts (more barriers for upper basin) are affecting stream-reared smolt production in the basin and subsequently the proportion of adult returns from these areas.

### 2.1.3.g. General Program Information

**Domestic Atlantic Salmon Broodstock Releases**

A total of 2,271 surplus broodstock from the NNFH was released to provide angling opportunities in the mainstem of the Merrimack River and a small reach of the Pemigewasset River in the spring and fall of 2002. Broodstock released for the fishery consisted of age-3 and 4 fish.

**Habitat Restoration**

In 2002 the multi-agency NH River Restoration Task Force (RRTF established in 1999) continued to work on identifying dams for removal in the state and pursuing the removal of 6 dams already targeted. As reported in 2001, several proposals target Atlantic salmon habitat in the Merrimack River basin. On the Contoocook River (Henniker,NH) an abandoned mill dam is scheduled for removal in 2003. On the Pemigewasset River (Woodstock, NH) another abandoned dam has been targeted for removal with little progress to date. Lastly, on the Souhegan River (Merrimack, NH) the first upstream barrier is being investigated for removal. The Souhegan River project will require a substantial amount of work but could be scheduled for removal as soon as summer 2004.

**Atlantic Salmon Domestic Broodstock Sport Fishery**

The NHFG via a permit system manages the Atlantic salmon broodstock fishery in the mainstem Merrimack River and a lower portion of the Pemigewasset River. Angled Atlantic salmon that are harvested must be tagged. Creel limits are one fish per day, five fish per season with a minimum length of 15 inches. The season for taking salmon is April 1 through September 30 with a catch and release season from October 1 to March 31. In the spring of 2002, 1,893 age-3 and age-4 domestic broodstock were released for the fishery. In the fall of 2002 another 378 age-3 and age-4 broodstock were released for a combined total release of 2,271 fish to support the fishery.

There is lag time in reporting from angler diaries which results in this summary characterizing the 2001 fishery. There were 1,375 permits sold in 2001 from which an estimated 695 actually fished for salmon. The majority of the anglers were NH residents, 10% were nonresidents. Anglers fished an estimated 12,084 hours during 4,156 fishing trips. They caught an estimated 870 fish, released 744, and kept 126 salmon. Catch per unit effort was 0.07 salmon per hour (anglers fished approximately 13.9 hours before catching a salmon). The spring/early summer fishery received the majority of angler effort (79%) with 55% of the catch reported for this time frame. This compares with the smaller fall fishery effort of 21% that took a disproportionate 45% of the catch.

**Education / Outreach**

**Adopt-A-Salmon Family**

The current year, 2003, marks the tenth anniversary of the Adopt-A-Salmon Family program at the Central New England Fishery Resources Office. Although the Outdoor Recreational Planner position remains vacant, a fishery biologist hired in April 2002 has assumed some of the responsibilities in implementing the program. Even with limited staffing, the Adopt-A-Salmon Family program has had many highlights over the past year. In the spring of 2002, a participant school was featured in the national telecast of the Service's "Wild Things 2002" program. November 2002, marked the resumption of providing tours of the Nashua National Fish Hatchery for school groups participating in the program. Twelve hundred students from 24 schools were able to visit the hatchery. Eleven volunteers were honored for their work in the program at an "Volunteer Appreciation Day" ceremony held January 30, 2003. Forty three participating schools will receive salmon eggs and they will rear the salmon in their classroom until they are released as fry in the late spring. Although enrollment in the program has been capped for the past two years, there is a strong demand from schools wanting to become new participants. Staff and volunteers are attempting to develop methods of meeting this demand in spite of budget and staffing constraints.

**Amoskeag Partnership**

The migratory fish program continued to be represented in the Amoskeag Fishways Partnership. The partners that include Public Service Company of New Hampshire, Audubon Society of New Hampshire, New Hampshire Fish and Game Department, and the U.S. Fish and Wildlife Service continued to create and implement a broad-based educational outreach program, based at the Amoskeag Fishways Visitor and Learning Center (Fishways) in Manchester, NH. With the Merrimack River as a general focus, the partnership is offering educational outreach programming to school groups, teachers, the general public, and other targeted audiences. Visitation in 2002 was 23,315 people with 12,852 students and 10,468 adults. Of these visitors, 14,459 attended a program, fish season tour or special event, 8,590 were walk-ins, 266 attended a meeting at the center, and 987 attended an outreach program that was partially at the center or off-site. The Fishways continues to be an exciting, educational place to attend programs, see wildlife and fish up-close, and to carry out environmental education and conservation programs. All agencies now participate as active members of the Management and Program committees that provide oversight for the Partnership. The Partnership was formed to create, manage, and oversee educational activities at the Fishways. The four-way collaboration among partners was formed in 1995 to increase visitation to the Fishways by creating new and improved educational programs, expanded year-round hours of operation, and an innovative, hands-on exhibit hall; by strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire; and by broadening the educational focus of the visitor center to encompass more than just the fish passage facility.

### 2.1.4. PAWCATUCK RIVER

#### 2.1.4.a. Adult Returns

No sea-run Atlantic salmon were captured in the fish ladder at Potter Hill in 2002.

### 2.1.4.b. Hatchery Operations

**Egg Collection**

Sea-Run Broodstock

A total of 9,800 eggs was collected from three female kelts. The eggs were fertilized with pooled milt obtained from Nashua National Fish Hatchery, which was taken from CT river returns. All of the eggs will be retained for subsequent release as age 1 smolts.

Captive/Domestic Broodstock

The NANFH incubated 400,000 eggs for stocking in the Pawcatuck River in spring 2002, and gave an additional 100,000 eggs to Rhode Island's salmon program for incubation at Arcadia Warmwater Research Hatchery for stocking in 2003.

### 2.1.4.c. Stocking

Stocking of fry throughout the Pawcatuck River Watershed was performed by volunteers and RI Division of Fish and Wildlife (RIFW) personnel on two separate occasions. In addition, two local schools volunteered to stock fry which they had hatched in their classrooms.

**Juvenile Atlantic Salmon Releases**

NANFH provided 403,000 fry for the stocking effort in May.

**Adult Salmon Releases**

There were no adult salmon releases in 2002.

### 2.1.4.d. Juvenile Population Status

Index Station Electrofishing Surveys

Parr were collected by electrofishing at 13 sites in the Pawcatuck River Watershed in the fall of 2002. The 13 sites included a total of 66 units (one unit = 100 $m^2$) of juvenile habitat. Units sampled represent about 1.3% of the 4792 total units of available habitat. Densities of age 1 parr ranged from 0 to 7.9 parr/unit at the sampled sites, and averaged 2 parr/unit. Sampling of age 0 parr indicated an average abundance in 2002 with a mean density of 6.6 parr/unit. The sizes of the juveniles sampled were similar to those in past years, with age 0 parr averaging 65.5 mm and 1+ parr averaging 153.1 mm.

**Smolt Monitoring**

No work was conducted on this topic during 2002.

**Tagging**

No work was conducted on this topic during 2002.

### 2.1.4.e. Fish Passage

Problems with upstream fish passage exist at Potter Hill Dam. Although the existing fish ladder seems to work well at normal and low flows, extremely high water levels in early spring completely flood the ladder, rendering it useless until the water level drops.

In addition, broken gates on the opposite side of the dam are creating attraction flow which draws fish away from the fish ladder. The dam is under private ownership, and the owner is unwilling to make the necessary repairs. RI DEM is investigating its legal options regarding this issue.

### 2.1.4.f. Genetics

No work was conducted on this topic during 2002.

### 2.1.4.g. General Program Information

#### Dam Removal/Fishway Construction

No work was conducted on this topic during 2002.

#### Habitat Restoration

No work was conducted on this topic during 2002.

## 2.1.5. NEW HAMPSHIRE COASTAL RIVERS

### 2.1.5.a. Adult Returns

The Lamprey River and Cocheco River fish ladders were monitored for returning adult salmon from mid-April until the end of June. The Lamprey River fishway was operated during the fall from late-September to mid-November. The Cocheco River fishway was monitored in the fall from mid-October to mid-November for the first time since 1993.

No wild adult Atlantic salmon returned to fish ladders in 2002.

### 2.1.5.b. Hatchery Operations

No adult Atlantic salmon were transported to hatcheries in 2002.

### 2.1.5.c. Stocking

In April of 2002, approximately 285,000 Atlantic salmon fry were scatter stocked by volunteers into the Lamprey (103,500 fry) and Cocheco (181,400 fry) River systems. Fry were stocked at a density of 36 fry/100 $m^2$ unit in the Lamprey and 60 fry/100 $m^2$ unit in the Cocheco.

In addition to the stocking of fry approximately 60,000 salmon smolts were also stocked in the Lamprey River on March 11th and 12th. The fish were received as a donation from D.E. Salmon, Inc. in Bristol, NH.

Eggs for the 2002 fry stocking were obtained in the fall of 2001 from USFWS. The eggs were taken at the Nashua NFH in fall of 2001. The eggs were reared at the North Attleboro NFH until mid-January 2002. Approximately 430,000 eggs were delivered to the Warren State Fish Hatchery on January 14th to complete the rearing.

### 2.1.5.d. Juvenile Population Status

Electrofishing surveys for juvenile salmon at four index sites on the rivers produced population estimates for young-of-the-year (YOY) fry ranging from 0 – 9 fish/100 $m^2$ unit. Mean length and weight of YOY at the Mad River index site was 69 mm and 3 gms while there were no YOY captured at the other index sites for mean lengths and weights. Estimates of parr abundance at index sites ranged from 1.2 –11 fish/unit. Mean size and weight of parr at the Mad River was 135 mm and 21 gms. No mean lengths and weights were taken at the other index sites due to insufficient captures.
Population estimates at the two index sites in the Cocheco River contrasted significantly. The population estimate for YOY at the Mad River site was 9 fish/100 $m^2$ unit as compared to 0 fish/100 $m^2$ unit at the Cocheco River location. Parr population estimates at the two index sites were 11fish/100 $m^2$ unit for the Mad River and 1.2 fish/100 $m^2$ unit for the Cocheco. All population estimates except for parr in the Mad River were below the long term average.

Population estimates for YOY and parr at both index sites in the Lamprey River system were below the long term mean. This has been the case each year since 1999 when stocking densities were reduced from 60 to 36 fry/100 $m^2$ unit. At both the Lamprey and North River index sites the population estimate for YOY was 0 fish/100 $m^2$ and the population estimate for parr was 1.2 fish/100 $m^2$. There were insufficient captures to determine mean length and weights.

### 2.1.5.e. Fish Passage

On September 24, 2002 the FERC issued an order modifying the operating license of Southern New Hampshire Hydroelectric Development Corporations (SNHHDC) hydroelectric facility at Cocheco Falls on the Cocheco River. The three major amendments to the license include:

1) providing for fall operation of the NHFG fish ladder at Cocheco Falls with sufficient attraction water for a period of one month, 2) increasing the required operation time of the SNHHDC's downstream fish passage facility from April 15 until ice forms on the river to allow for downstream migration of Atlantic salmon smolts, and 3) modification of the downstream passage facility to increase the passage efficiency. In addition, NHFG and USFWS, have been working with other agencies and organizations to work towards fish passage construction or dam removal at Wiswall Dam in Durham on the Lamprey River.

### 2.1.5.f. Genetics

No work was conducted in this area in 2002.

### 2.1.5.g. General Program Information

As has been done in the past, volunteers were used to conduct all fry plantings in the spring. We draw from a database of more than 200 individuals that have expressed an interest in assisting us and generally 50 to 100 individuals show up to work on a given day of stocking during the spring.

## 2.2. STOCKING

### 2.2.1. TOTAL RELEASES

During 2002, the participating agencies released approximately 12,493,100 juvenile salmon into 20 river systems (Table 2.2.1.a in Appendix 8.4). The number of juvenile fish released was about 16% less than the number released in 2001.

In addition to juveniles, adult fish were also stocked in some river systems (Table 2.2.1.b in Appendix 8.4). In general, these fish were spent domestic broodstock excess to hatchery capacity, and were of river-specific origin. In 2002, 3,576 adult salmon were released into the rivers of New England.

### 2.2.2. SUMMARY OF TAGGED AND MARKED FISH

A total of 373,259 salmon released into New England waters in 2002 was marked or tagged in some manner. Tag types included: Floy, Carlin, PIT, radio and acoustical, fin clips, fin punches, and elastomer visual implants. Parr, smolts and adults were marked. About 0.5% of the marked fish were released into the Connecticut River watershed, 1.6% into the Merrimack River watershed, 75.4% into the Penobscot River, and 22.5% into other Maine rivers.

A comprehensive summary of marked and tagged Atlantic salmon released in New England rivers during 2002 is presented in Table 2.2.2.a (Appendix 8.4).

## 2.3. ADULT RETURNS

### 2.3.1. TOTAL DOCUMENTED RETURNS

Documented adult Atlantic salmon returns to USA rivers totaled 962 fish in 2002 (Table 2.3.1. in Appendix 8.4), 9.5% less than observed in 2001. Most of the returns occurred in the rivers of Maine with the Penobscot River accounting for nearly 81%, the Merrimack River 6.0% and the Connecticut River 4.0% of the total New England returns. Overall, 45% of the adult returns to New England were 1SW salmon and 55% were MSW salmon. Most of these fish (88%) originated from hatchery smolts and the others (12%) were of wild origin (natural reproduction and fry plants).

Documented returns of 1SW salmon to New England rivers (436) were greater than those in 2001 (266). MSW returns in 2002 (526) decreased from those in 2001 (797). Total 2002 returns (962) decreased by 9.5% compared to 2001 (1,063). Changes from 2001 by river were: Connecticut (+10%), Merrimack (-34%), Penobscot (-1.0%), Saco (-32%), Narraguagus (-75%), and St. Croix rivers (0%).

### 2.3.2. RETURNS OF TAGGED SALMON

No marks or tags were reported on adult sea-run salmon that returned to New England waters in 2001.

### 2.3.3. SPAWNING ESCAPEMENT, BROODSTOCK COLLECTION, AND EGG TAKE

Connecticut River. A total of four wild sea-run adult salmon was permitted to ascend the rivers upstream of fishway traps where broodstock are captured. All were radio tagged as part of a utility company sponsored study on the main stem. The movements of these fish are summarized in Section 2.1.1.

Maine Rivers. Natural reproduction was documented by redd counts in four rivers with natural populations and in tributaries of the Penobscot River. Details can be found in Section 2.1.2. There is no consistent trend relative to last year, but the redd counts remain well below appropriate levels.

Egg sources for the New England Atlantic salmon culture programs included sea-run salmon, captive salmon (fish collected as wild parr and grown to maturity in hatcheries), domestic broodstock (fish grown to maturity in hatcheries from eggs), and reconditioned sea-run kelts. The total number of females spawned in 2002 from each category is as follows: sea-run 259; captive 549; domestic 2,819; and kelts 102. The grand total of salmon spawned (3,734) was less than that in 2001 (4,018). The total egg take (20,081,119) was similar to that in 2001 (20,081,100). A more detailed accounting of the egg production is contained within Table 2.3.3 in Appendix 8.4.

### 2.3.4. SPORT FISHERY

Directed fishing for sea-run Atlantic salmon is not allowed in New England waters.

## 3. TERMS OF REFERENCE

### 3.1. TERM OF REFERENCE NO. 1 - Review and Discussion of Program Summaries

This information is found in Sections 2.1, 2.2, and 2.3 of this report.

Historical data was validated by the Committee and the information is provided in Tables 3.2.a. and 3.2.b. in Appendix 8.4, and in Section 5 of this report.

**UAASAC Database/Table Format/Queries** *Abstract by John Sweka (John_Sweka@fws.gov) and Mike Millard*

The current USASAC database utilizes lookup tables from the MaineSalmon database, in conjunction with several queries, to produce the summary tables for the USASAC annual report. Data from reporting agencies submitted to the database stewards are manipulated and reformatted using automation tools within Microsoft Access. Data format and data flow concerns were outlined for the Committee, including the discrepancies encountered between "raw" stocking numbers and those derived through aggregation into more general categories. New Microsoft Access forms were presented which may be used by interagency staff in the future to enter data in a standardized format, allowing easy inclusion into database tables which are the basis for producing tables found in each annual report.

In a discussion session the Committee addressed the issue of data discrepancies in fry stocking data. A consensus was reached that stocking data currently summarized as lifestage "fry" should instead be submitted in the form of a more specific characterization: "fed fry" and "unfed fry". Total fry stocking numbers would then be derived by summing these two categories. A Term of Reference was profferd to programmatically review historic stocking records to correct inconsistencies and attempt to reclassify "generic" records into the above categories. All future data would also adhere to this more specific data model. The group agreed that this approach would provide the most flexibility when analyzing and querying data.

Further discussion resulted in a decision to remove the "+" identifier from all juvenile lifestages of Atlantic salmon classification. A new lifestage lookup table will be produced to accommodate these changes in designation and description. Also, until exporting problems between Microsoft Access and Adobe Acrobat Reader are resolved, each report table will remain in a separate downloadable file, in addition to the database containing the tables used to generate the report tables.

**Maine Program ATS Database/Queries** *Abstract by Ken Beland (ken.beland@maine.gov)*

Microsoft Access and Environmental Systems Research Institute (ESRI), Geographic Information System (GIS) products have been employed to manage Atlantic salmon tabular and spatial data for Maine rivers in a common, standardized, compatible and expandable format. Standardized nomenclature and a shared linear geo-referencing system were developed and incorporated into a "hub and spoke" system of relationally linked databases. The first component of the system is an interagency GIS, utilizing dynamic segmentation to split Maine salmon rivers into coded 10 meter increments along the river centerline. This "river kilometer" is employed to register interagency research activities into "real space", and to enable linear distance analyses between locations. The second component of the system consists of several Access databases related through the use of a common "hub" database (MaineSalmon.mdb) containing standardized location and operational codes. These databases are linked to the GIS through Simple Query Language (SQL) via the river kilometer coding scheme.

An example of a database in the above system, the Veazie Adult Trap database, was presented as an example. Use of double entry accounting, standardized queries, and read-only archival tables were presented to demonstrate the robustness of this data model.

Group discussion focused on particular substantive aspects of the demonstrated database in the context of USASAC /ICES reporting requirements and overall database functionality. Improvements were identified which would streamline data flow from "field" databases and the USASAC database, and to improve data quality:

- Adding a "-" to the alpha tag identifier field to indicate whether a tag number included a leading (e.g. "A-") or following (e.g. "-A") alpha prefix or suffix, to aid in sorting.
- Ensure mechanisms exist to prevent double reporting of data to the USASAC database.

- C Include metadata explaining data quality when storing/submitting data.
- C Submit data to USASAC using the smallest available "grain size", allowing aggregation without sacrificing data resolution.

In addition, the Committee agreed to include a table summarizing aquaculture escapees in the text of this annual report, and to add a "five year mean" column to the existing Table 2.3.1.

**Assessment Products from USASAC Database** *Abstract by Tim Sheehan (Tim.Sheehan@noaa.gov) and Chris Legault*

The USASAC was formed in July 1988. Previously this group met under the title of Research Committee for the U.S. Section of NASCO. The Research Committee met semi-annually to discuss the terms of reference for the upcoming meeting(s) of ICES and to respond to the inquiries of NASCO commissioners. With the formation of the USASAC came the institutionalization of an annual assessment meeting with the main goal of producing an assessment document for the U.S. commissioners and to provide guidance regarding research proposals and recommendations to state and federal fishery agencies throughout New England. Some committee members have expressed concern that the USASAC has moved away from actually assessing the status of the New England Atlantic salmon stocks, but have rather been reporting population abundance measures and documenting ongoing research to the U.S. NASCO delegates. Databases currently available to the USASAC, some possible assessment products that can be derived from these, and some examples of future assessment products that can be obtained with additional database inputs were outlined. The examples provided corresponded to products that the NOAA-Fisheries, Northeast Salmon Team expressed interest in seeing. This presentation was provided to facilitate discussion among Committee members relative to this subject.

**Current Options for USASAC Assessment Products are outlined below:**

General Information

1. Time series of tags/marks at large
    a. Data is available and compiled for Years 2000 - 2001 only (Table: *TagsMarks* - Annual Report 2002/14 - Table 2.2.2.a)
        i. Could update *Tags/Marks* with historical records

Stock Differences

2. Differences in mean fecundity within and between drainages
    a. Data is available and compiled (Table: *EggProd* - Annual Report 2002/14 - Table 5.1.a)
        i. Could bring in *Biological* data or *Environmental* data to further analysis

Stocking Success and Adult Returns

3. How do return rates (grilse and salmon) differ across all drainages in terms of stage(s) stocked (Completed for SNE rivers – fry stocking only (Annual Report 2002/14 - Tables 5.3.c.1 and 5.3.d))
    a. Good historical time series for stocking numbers by stage (Table: *Juvstock* - Annual Report 2002/14 - Table 5.2.a)
    b. Good historical time series for adult returns by source (Table: *AdultReturns* - Annual Report 2002/14 - Table 5.3.a)
        i. Could bring in other stocked stage analysis (*parr and smolts*)
4. Replacement rates (i.e. the number of returns at time t relative to the number of returns at time t+5 by stocking type
    a. Similar to Number 3

**Note:** All analysis on fry stocked returning adults assumes no natural production within the system, and it is for this reason that Maine stocks have not been summarized as thoroughly as the Southern New England populations.

## Future Options for USASAC Assessment Products

Stock Differences

1. Grilse/salmon ratios by drainage and by stocking type
    - i. Data in hand:
    - ii. Adult returns (Table: *AdultReturns*)
    - iii. Juvenile stocking data (Table: *JuvStock*)

   Data needed:
    - i. Full age of adult returns
    - ii. Stocking time/location

Stocking success and Adult returns

2. Smolt stocking success in terms of 1+ versus 2+ and time/location of stocking
    - i. Data in hand:
    - ii. Adult returns (Table: *AdultReturns*)
    - iii. Juvenile stocking data (Table: *JuvStock*)

   Data needed:
    - i. Full age of adult returns
    - ii. Stocking time/location

3. How do juvenile production and return rates differ over time in terms of stocking method
    - i. Data in hand:
    - ii. Fry stocking density (Table: *FryStockDist*)
    - iii. Juvenile stocking (Table: *Juvstock*)
    - iv. Adult return (Table: *AdultReturns*)

   Data needed:
    - i. Stocking time/location
    - ii. Stocking method
    - iii. Juvenile abundance data
    - iv. Smolt abundance data
    - v. Full age of adult returns
    - vi. Genetics data
4. Stage specific survival estimates compared across drainages
    - i. Data in hand:
    - ii. Stocking data (Table: *JuvStock*)

   Data needed:
    - i. Redd data
    - ii. Juvenile abundance data
    - iii. Smolt abundance data

5. Stage specific survival related to stocking strategy
    - i. Data in hand:
    - ii. Fry stocking density (Table: *FryStockDist*)

iii. Juvenile stocking (Table: *Juvstock*)
iv. Adult return (Table: *AdultReturns*)

Data needed:

i. Stocking time/location
ii. Stocking method
iii. Juvenile abundance data
iv. Smolt abundance data
v. Genetics data

6. Production from adult stocking

i. Data in hand:
ii. Adult stocking data *(*Table: *AdultStock)*

Data needed:

i. Redd data
ii. Large parr abundance data
iii. Smolt abundance data
iv. Genetics data

Extensive discussion among Committee members followed this presentation and it was generally agreed that enhanced assessment rather than summary reporting was desirable, though many practical obstacles to enabling the necessary data sharing and quality across programs were identified. Obstacles include lack of adequate staffing to develop the necessary data management tools; lack of GIS capabilities to match the geo-referenced data model utilized in the Maine rivers program; and lack of funding.

It was suggested that the Committee could serve as a vehicle for bringing data together across programs to form a more complete regional picture of existing stock conditions. There was consensus that this was desirable, though the above obstacles may make it difficult. The most practical approach would be incremental integration of standardized data management tools (metadata, relational databases, etc) across programs, with the understanding that changes will be implemented within the identified constraints. After discussion, it was agreed that data collection methods are impractical to standardize across all programs, as appropriate methods vary with circumstance. Using robust metadata and moving toward a compatible data management system would best facilitate more advanced data sharing and analyses than are currently possible.

## 3.2. TERM OF REFERENCE NO. 2 - Optimum Fry Stocking Densities - New England Rivers

**A Model for Optimum Fry Stocking Levels Throughout New England** *Presentation by Christine Lipsky (clipsky@mindspring.com), Ben Letcher, and Gabe Gries*

Throughout New England, agencies stock fry at a variety of densities. An analysis based on stocking data and resulting densities was initiated to determine relations between age 0 and age 1 parr densities and size of parr as a function of stocking densities. Data from the West River Basin, Vermont, 1992-2001 were analyzed and optimum fry stocking density was found to be approximately equal to that found by Gibson, M. R. (Stocking Strategies for Atlantic Salmon Fry in New England Streams of Varying Productivity, Subject to Availability Constraints, for Maximum Adult Returns; USASAC, Working Paper 93/Annual Assessment Meeting) for a late 1980's to 1992 data set from the same system. The Committee discussed the aspect of whether this work would remain a Term of Reference for next year. The need to have a graduate student focus on this Term of Reference was discussed, funding options were considered, and agreement was reached that means to obtain funds to address this term would require further investigation. Discussion continued on whether Gibson had been reviewing the data to realize a New England wide optimum stocking density or a state specific density. One reason that this Term of Reference continues to be considered is due to a lag in data compilation and analyses since the early 1990's. The future of this

Term of Reference was discussed, and the Committee determined that it would again be addressed at the next annual meeting.

**Variation in Early Development and Growth Among Five New England Atlantic Salmon Populations Reared in a Common Environment** *Abstract by Mariska Obedzinski (mariska@fowrwild.umass.edu), and Benjamin H. Letcher*

Phenotypic variation in early growth and development was tested in a common environment (laboratory) among five New England populations of Atlantic salmon. Study populations included three of the Gulf of Maine DPS populations (East Machias, Narraguagus, Sheepscot rivers), and two populations from the largest salmon rivers in the United States (Penobscot and Connecticut rivers). Eyed eggs from each population were collected from USFWS hatcheries and reared in a common laboratory setting controlling for temperature, light, flow, density, and food availability. Characters measured included hatch time, egg and alevin size, parr size, and growth efficiency. We found that the extent of the stock differences depended on ontogeny. While Penobscot eggs and alevin were smaller and hatched sooner than in other stocks, few differences were detected from the unfed fry stage until fall age 0 parr. In fall, the development of a bimodal size distribution varied among stocks; approximately half of the Connecticut River fish, twenty percent of the Penobscot River fish, and very few fish from the three smaller watersheds were found in the upper mode. Although genetic effects cannot be entirely separated from maternal effects for early trait variation (egg and alevin), it is likely that differences in fall bimodality are genetically-based. It was unclear to what extent natural and artificial (hatchery) selection contributed to variation in fall bimodality, but the stocks with more fish in the upper mode came from much larger watersheds and have been more intensively managed.

Discussion of this topic focused on a number of aspects, and questions and related responses included:

Could environmental variation among rivers including temperature, flow, and gravel size influence variation among stocks in size bimodality? While it is difficult to separate potential effects of natural and artificial (hatchery) selection, it is certainly possible that environmental variation could be a selective factor.

How was temperature variation in the various hatcheries dealt with? There were slight differences in rearing temperatures before the eggs were transported to the Conte laboratory. Once there, temperatures were adjusted to achieve a common developmental stage well before any of the trials.

The biggest differences in size among stocks were observed after the stocks were placed in mixed tanks and therefore, could size competition have influenced variation in growth among stocks? Certainly, competition may have influenced growth, although there were no differences in size when the fish were first placed in the tanks.

Could the variable number of families among stocks have influenced differences observed? This seems possible, but unlikely because there were still 14 families in the low family-number stocks, and while one or two families could have contributed disproportionately to the high number of fish in the upper mode for Connecticut River fish, the high proportion of upper mode fish (~50%) is unlikely to have been produced by randomly sampling small populations.

There was a question about the common ancestry of the Connecticut River and Penobscot River populations and how this could have influenced results. A heritable basis for bimodality in the Penobscot River fish and the extent to which this served as a source of the Connecticut River bimodality is unclear. What is clear is that more fish from the Connecticut River than the Penobscot

River entered the upper mode suggesting a stronger propensity to smolt at age 1 in the Connecticut River than in the Penobscot River.

What was the history of smolt stocking in the Connecticut River and how could this have influenced results? Age1smolts were stocked from 1983 to 1994.

Are there plans to grow these fish through smolting and assess smolt status directly, and are there genetic differences among groups? Yes, gill biopsies of smolts will be analyzed, and genetic variation will be assessed for fish in trials as long as funding is available.

## 3.3. TERM OF REFERENCE NO. 3 - Domestic and International Research Program Updates

**U.S. Atlantic Salmon Assessment Committee Relationship to ICES and NASCO** *Presentation by Mary Colligan (Mary.A.Colligan@noaa.gov), and Steve Gephard*

The NASCO has or is expected to address a number of issues through intercessional meetings and workgroups prior to the scheduled annual meeting in June. Issues include: socioeconomic impacts of the application of the precautionary approach (salmon protection versus community viability); application of the precautionary approach to salmon introductions, transfers, transgenics and aquaculture; and international ocean research.

The International Ocean Research Board was established in 2000 by NASCO to inventory, promote, and fund international cooperation in research pertaining to Atlantic salmon mortality at sea. The Board is developing promotional materials seeking donations/funding from member countries, corporations and private sponsors. The USA has contributed $150,000. The Board has established a scientific advisory group to inventory existing research, identify gaps and develop a call for research proposals. The request for proposals should be available sometime after the NASCO meeting in June. In discussion, it was concluded that the Committee could contribute to this process by identifying potential USA donors, and developing research proposals. It was proposed that this type of input could be developed as a Committee, Term of Reference.

Clearly, the NASCO has evolved from an international committee focusing on stock status to one that is facing a host of increasingly complex and interdisciplinary issues. Other issues on the NASCO agenda for the June meeting include:

- Reconsidering the communication policy established last year by NASCO to limit press releases by NGOs/observers during the annual meeting;
- Revisiting the 1996 discussion on the role of predators/predation on salmon survival;
- Development of a NASCO habitat database;
- Development of a sampling program to evaluate catch by the French in the St. Pierre and Michelon Islands fishery;
- Sampling and determination of harvest levels in the West Greenland fishery (while sampling is planned, the intention is to continue a subsistence-only fishery in West Greenland and establish a harvest quota to be determined after the ICES Work Group meeting); and
- Evaluation of the impacts of acid rain on North American Rivers.

A workshop is scheduled to discuss this issue in Bangor, Maine on March 26. It will be important to consider what is known now and to evaluate the relative importance of this issue to the salmon rivers in the context of the cost of mitigation for the impacts of acid rain on the North American salmon population. It was suggested that the minutes of this meeting be circulated among the USASAC members.

In addition, the U.S. Commissioners to NASCO will be appraised at an April 22 , 2003 meeting of other potential emerging issues including the impacts of climate change and mixed fishery stock assessment. This U.S. Section meeting is open to the public and provides a venue for direct communication with the U.S. Commissioners that include: Mr. Steve Gephard, Connecticut Department of Environmental Protection; Ms. Pat Kurkul, National Oceanic and Atmospheric Administration; and Mr. George Lapointe, Maine Department of Marine Resources.

**National Report : Executive Summary of Assessment Committee Report** *Abstract by Joan Trial (joan.trial@maine.gov)*

It is intended that two issues will be highlighted at the ICES Working Group meeting this year: Conservation Limits and development of a Standardized U.S. Atlantic Salmon Database. The conservation limit issue will focus on reviewing how these have been set for USA rivers and insight provided by population viability analysis (PVA) detailed in a working paper presented at this USASAC annual meeting. The database development process can be illustrated by the Maine database standard, improvements to the USASAC database and reporting process, and the linkage of the new habitat database to the existing database structures on a table-by-table basis. This plan met with acceptance of the USASAC.

**U.S. Forest Service International Programs** *Abstract by Jack Capp (jcapp@fs.fed.us)*

The Committee was briefed on the activities of the USFS International Program. Their mission is to promote sustainable forest management and biodiversity conservation worldwide The International Program is part of the USDA Forest Service which manages over 80 million hedtares of forest and rangeland across the USA. The program promotes the sustainable use and conservation of forest resources by offering technical assistance, training and research cooperation in a variety of areas. In addition to technical assistance the International Programs office can offer administrative expertise including: cooperative program grants to partner organizations including NGO's, universities and other government agencies; conducting equipment needs assessment, purchase and shipping; design and implementation of study tours and training programs; hiring of host country nationals or US citizens for short and long term project management and technical assistance in country; and developing partnerships with other US government agencies and universities.

To date the program has not directed efforts or resources at Atlantic salmon issues, but there is an interest in exploring opportunities. Ideas discussed included exchanges with foreign salmon biologists; working on Atlantic salmon in intact systems in Russia or elsewhere; convening workshops and forums; information exchange with Pacific salmon biologists, and international cooperation on acid precipitation research. Fellowships for foreign students to conduct Atlantic salmon research are a possibility. The Committee expressed interest in further exploration of possible avenues of cooperation and Committee members will follow-up by contacting representatives of the Program.

### 3.4. TERM OF REFERENCE NO. 4 - Atlantic Salmon Population Viability Analysis (PVA)

**Population Viability Analysis** *Abstract by Christopher M. Legault (Chris.Legault@noaa.gov)*

A population viability analysis (PVA) model has been developed for Atlantic salmon in Maine. This model incorporates uncertainty in juvenile and adult survival rates, direct and indirect linkages among populations in different rivers, and a number of potential human removals or stocking in a flexible, modular Fortran program named SalmonPVA. The structure of the model is based on a state-space approach with a detailed life history cycle. Multiple cohorts in multiple rivers progress through their life history based on stage specific survival rates and fecundity with limits imposed by riverine habitat capacity. The model projects the populations forward in time, usually 100 years, numerous times with stochastic variables selected based on a Monte Carlo approach to calculate the probability of extinction. This model is being developed with input from scientists and policy makers from NOAA-Fisheries, U.S. Fish and Wildlife Service, Maine Atlantic Salmon Commission, and the University of Maine. Results from this model will form the basis for delisting criteria in the Recovery Plan for the Maine Distinct Population Segment which was listed as endangered in 1999.

The Salmon PVA model is structured to represent Atlantic salmon life history characteristics in the US. For example, most fish spend four years in the river and two years at sea before returning to the river to spawn. However, there is the possibility to return from sea after one or three years and the model will soon be modified to allow five years in freshwater. Inputs to the model allow for a wide range of simulations. The number of rivers is a dynamic variable limited only by the computer running the program. The linkages among rivers are determined on input and allow for various straying hypotheses as well as linkages among juvenile survival rates due to year effects. The habitat capacity limits will soon be expanded to all juvenile life stages and combined with the approach used for fecundity cause a Beverton and Holt type spawner-recruitment relationship. This will underestimate the probability of extinction when populations are large relative to a Ricker type spawner-recruitment relationship. Unfortunately, the populations are currently so low that this concern is minimized.

A number of human removals from the populations are allowed, but not required, by the model including interception fisheries at sea, river fishing, and broodstock removals of either returning adults or parr. Stocking of any life stage during any year of the simulation is possible. These stocked fish are followed in a separate matrix in the program from the natural fish to allow for different survival rates or removals. The offspring from the hatchery matrix are added to the natural matrix so that hatchery populations disapper if stocking is discontinued. The model allows direct examination of specific simulations as well as summarizes results from the total number of simulations conducted. The probability of extinction is the most important output, but trends in adult returns can also be enlightening, especially when trends are detected. This is because a five percent chance of extinction in one hundred years has different implications if the overall trend for the population is increasing or decreasing over the projected time series.

The Committee was asked to review of the current model and to provide suggestions on how to improve the model. Since the ultimate goal of the model is to produce an accurate management tool, the review and comments of all Committee members and guests at the meeting was requested and they were encouraged to provide comment in the next few weeks. A question posed in discussion was whether aquaculture escapes could be considered in the PVA. There are multiple approaches that could be used to simulate that phenomenon including the results of a catastrophic escape event that could be considered by adding aquaculture fish as a stocking product. In addition, a question was asked regarding what effect bounding by density dependent factors rather than a juvenile production cap would create? Such a change would be difficult to implement and the effect primarily would be a Ricker-type curve of smolt production versus an asymptotic Beverton-Holt curve. Because the descending limb of a density-dependant relationship would likely have a very low decay rate, the effects on a long time series of data are thought to be minimal. It was suggested that the accuracy of future projections might be more realistic if global warming models were used as input. While this may be useful, there are several models of climate change and the selection and incorporation of this information might confound rather than enhance the model. Alternately, a proxy scenario could be simulated in the model by decreasing overall survival (e.g. could decrease survival exponentially at specific stages) to create a sensitivity analysis of suspected climate change effects. It was suggested that the incorporation of noise similar to the North Atlantic Oscillation time series may add more variability and potential errors since it was not measured well over time. In addition, other driving forces may have more overall importance including longer-term cycles or temporally linked factors and should be investigated.

Inquiry was made regarding which survival parameters were most appropriate to use in the model when looking at a 100 year time frame: a broad geographic representation from literature that may incorporate climate change effects or more recent geographically proximate data with short time series. The approach of a broader scale was generally endorsed by the Committee as spatial variation may capture climate related variability. The addition of a more complex freshwater age structure could be a useful addition to the model and was targeted for inclusion in revised versions. In addition, smolt survival caps were suggested as possible inputs. A near term goal of this effort is to have a working model developed for inclusion in the Recovery Plan for the Maine Distinct Population Segment of Atlantic salmon by early summer 2003.

### 3.5. TERM OF REFERENCE 5 - Development of the NASCO Habitat Database

**NASCO Habitat Database** *Presentation by Ed Baum (Atlantic_salmon_unlimited@adelphia.net)*

The current status, future steps and potential limitations of the nascent database were presented. Ideas discussed included placing the database on the Web and identifying responsible parties for program data. It was suggested that a small working group with representatives from each program be established as an efficient and effective way to continue development of the database. The number of data tables required was considered and it was suggested that drop down menus should be optimized with less emphasis on subjective comments. Questions were raised regarding environmental impacts to be identify, the scale of impacts and how best to select and identify impacts, and the need to categorize and/or standardize identified impacts. It was suggested that a working paper be developed and presented to NASCO for consideration. Discussion ensued regarding how this database would be integrated with others previously identified and discussed, and how to avoid redundancy in data entry. It was agreed that a work group would be established to address database development and a Term of Reference would be identified to support this effort.

### 3.6. TERM OF REFERENCE 6 - Overview of Smolt Projects

**Update on Coastal Maine River Atlantic Salmon Smolt Studies: 2002** *Abstract by James P. Hawkes (James.Hawkes@noaa.gov), John F. Kocik, and Greg Mackey*

The goal of this research was to quantify Atlantic salmon smolt production across several Maine rivers, and to develop a better understanding of overwinter survival, population dynamics, and outmigration timing to strengthen stock assessments and population viability analyses. Atlantic salmon populations in Maine rivers are critically low and recent survival estimates from juvenile to adult stages are well below replacement levels. Beginning in 1996, with the deployment of a single-rotary screw fish trap (RST) on the Narraguagus River, NOAA-Fisheries and the Atlantic Salmon Commission (ASC) investigated questions pertaining to smolt production through several smolt trapping operations. Today, the project consists of 11 rotary screw traps on five different rivers along the coast of Maine. In addition to the expansion of the rotary screw trap project, these research platforms have enabled assessment scientists to initiate ultrasonic telemetry studies and assess mass marking of hatchery smolts to gain a better understanding of movement and survival throughout the basins studied. Emigration of Atlantic salmon smolts on five rivers was studied from 10 April to 14 June 2002 with rotary screw fish traps. A variety of sampling designs and goals were set forth on each of the five rivers studied, and setups consisted of: four traps on the Narraguagus River (river km 7.65 and 11.65), three traps on the Penobscot River (river km 45.72, 45.95, 46.93), two traps on the Sheepscot River (km 10.46), one each on the Pleasant (km 0.07) Dennys (km 0.38) rivers. A synopsis of Year 2002 activities related to smolt production assessments and ultrasonic tracking activities follows:

Smolt Production

Narraguagus River. Emigration of Atlantic salmon smolts in the Narraguagus River was monitored from 14 April to 6 June 2002, using four rotary screw fish traps. Two traps were located at river km 7.65 (Crane Camp) and two were located at river km 11.65 (Little Falls). Smolts were fin clipped at Little Falls and recaptured 4 km downstream at Crane Camp to perform a stratified population estimate. These sites are downstream of approximately 82% of juvenile rearing habitat in the basin. In total, 690 smolts were handled, using a Darroch maximum likelihood model were able to derive an estimate of 1,526 +/- 148. All were in excellent condition upon removal from the traps, with a single mortality (1/690) occurring as a result of an obstruction in the trap. Smolts averaged 161.4 $\pm$ 1.19 mm fork length and 43.9 $\pm$ 2.2 g wet weight (n = 179). Fish were close to the 6 year average for both length and weight. Scale, genetic and gill biopsy samples were collected from fish trapped during field operations. Scale samples were collected from a sub-sample of 57 smolts, of which, 91% (52/57) were found to have an age class of 2 and to be of wild origin. Tissue samples (n = 489) were taken from caudal fin clips (~ 3 mm) used in marking operations and preserved in ethanol. Tissue samples will be used as part of a parental-origin study in collaboration with U.S. Geological Survey (USGS) Leetown Science Center. Gill Biopsy samples (n = 47) were collected and used to monitor physiochemical changes or 'readiness' of fish as they prepare for their movement through marine waters. These samples are being analyzed independently by USGS Conte lab and results will be forthcoming shortly. Additional analysis conducted by MariCal Inc., found that Ca+ receptor activity exhibited by wild smolts indicates advanced states of readiness compared to hatchery reared smolts sampled during the same time. Emigrating smolt timing was found to be approximately 50% complete as of 10 May, according to RST % catch at river km 7.65. These results are consistent with cumulative results found between the years of 1996-2002.

Penobscot River. On the Penobscot River there were approximately 548,000 hatchery-reared (at Green Lake National Fish Hatchery—GLNFH) smolts released into the system, of these, one third or 170,000 of these were batch marked with Visual Implant Elastomer Tags (VIE). Colors and location of marks (left/right eye) were dependant on release point, as well as release timing (early/late). A total of 3,165 smolts was captured during trapping operations, of these 974 or 30.8% (974/3,165) were VIE marked smolts. Through preliminary analysis of best survival estimates, approximately 188,000 +/- 52,000 survived movement through the system and all dams downstream. There were 252 mortalities recorded during field operations (208 suspect dam effect, 44 handling effect), with the majority of the smolts in very good condition. Smolts averaged 192.3 $\pm$ .5 mm fork length (n = 3131) and 71.6 +/- 0.6 g wet weight (n = 2,961). Scale, genetic and physiology samples were collected from fish trapped during field operations. Scale samples (n=811) were collected from a sub-sample of smolts and are currently in the process of being aged. Tissue samples (n = 809) were taken from caudal fin clips (~ 3 mm) used in marking operations and preserved in ethanol. Tissue samples will be used as a part of a parental origin study in collaboration with USGS Leetown Science Center. Gill Biopsy and blood plasma samples (n = 68 river, 181 hatchery) were collected by NOAA-Fisheries and USGS crews throughout the smolts' time in the hatchery and in the river to monitor their 'readiness' in preparing for migration out to the ocean . This dataset is extremely unique and valuable in gaining a better understanding of the physiochemical changes a smolt goes through when transitioning from living in fresh water to a marine environment. These samples are being analyzed independently by USGS Conte lab and results will be forthcoming shortly.

Sheepscot River. On the Sheepscot River, two Rotary Screw Traps were fished side by side at the Head Tide Dam study site. In the second year of this study (2002) 95 smolts were trapped, as compared to 54 smolts captured with the one trap design in 2001. No mortality was experienced and all fish were found to be in extremely good health upon handling and release. Smolts captured averaged 188.9 $\pm$ 3.2 mm fork length and a wet weight of 68.7 $\pm$ 3.3 g, which was concurrent with the previous years' data. Scale (n = 95), genetic (n = 95) and physiology samples (gill biopsy) (n = 47) were collected from smolts trapped during field operations. Emigrating smolt timing was normally distributed with 30 April being the date of 50 % emigration, which is found to be consistent with cumulative summary results.

Pleasant River. On the Pleasant River, one Rotary Screw Trap was fished, beneath the Addison Road bridge (river km 0.07). There were a total of six smolts trapped, five of which were sent to Craig Brook National Fish Hatchery (CBNFH) for brood stock collection, with the sixth fish dying en route to the hatchery. Smolts captured averaged 175.8 $\pm$ 27.2 mm fork length and a wet weight of 56.1 $\pm$ 20.4 g, which was found to be the same as data collected in previous years. Scale and genetic samples were collected from all smolts trapped.

Dennys River. The ASC, NOAA-Fisheries, and USFWS began a five year program to stock smolts in the Dennys River, Maine. Smolts were released on two different dates at two locations, one at the uppermost extent of the river, and one in the lower river. The ASC staff installed a five foot diameter rotary-screw smolt trap (RST) at river km 0.80 on the Dennys River to evaluate the smolt stocking by date and location, and to assess the emigration of wild smolts. This trap also provided comparative data to assess the performance of a pair of weir-based smolt trap (WBST) installed at the adult salmon weir located at river km 0.38. The RST was tended daily from 19 April, 2002 through 2 June, 2002, and captured a total of 800 smolts. Of these, 82 were of wild origin, 694 were stocked as smolts, and 24 were stocked as 0 parr the preceding fall. Catch rates between smolts released in the upper extent of the river did not differ from those released in the lower river, suggesting that survival was comparable between the two release sites. A pair of weir-based smolt traps were operated during the same time and captured a total of 326 smolts. Of these, 323 were stocked as smolts, 2 were of wild origin, and one was unknown. The effectiveness of the WBST was highly dependent on flow, while the RST fished effectively across all flows during the season.

Smolt Telemetry Studies in the Narraguagus and Dennys Rivers

Emigration of Atlantic salmon smolts in the Narraguagus and Dennys Rivers was monitored in 2002. This was the second year of work in the Dennys River and the first year of a four-year project in the Narraguagus River. Northeast Center (NEC) deployed arrays of VR-2 (Automated Identification Monitoring Receiver) units in river, estuary, bay, and nearshore environments. Transects were established to evaluate the number of smolts passing ecological transition zones. In the Narraguagus Region an array of 45 units were deployed. In the Dennys Region, 18 units were deployed in the river and Cobscook Bay and these were complemented by 150 units in the Bay of Fundy deployed by Department of Fisheries and Oceans that could also track US fish. In the Narraguagus River, pingers were surgically implanted in 101 wild Atlantic salmon smolts in the course of their natural migration from 29 April to 21 May 2002 (23 d); this number represents 6.76% of the total smolt population. In the Dennys River, NEC released 150 hatchery smolts with pingers from a total of 49,000 released on 9 May 2002. Preliminary analysis of gross detection rates (% of all pingers released to those making outermost array) was 40 % for the Narraguagus and about 18% for the Dennys River. As in previous work, most of the apparent mortality appears to be occurring near transition to seawater in estuaries or shortly thereafter. To assist in interpreting these complex datasets, NEC is developing 3 dimensional modeling capabilities for these data from an independent contractor.

Following these presentations, a discussion of the utility of a cross-program examination of historic and existing smolt programs ensued. There was a consensus that it was worthwhile updating the last smolt analysis with a more narrow focus and a more refined Term of Reference. It was determined that an appropriate Term of Reference for the Committee Meeting in 2004 would be to evaluate run-timing at trapping and monitoring locations and explore estimated dates of ocean entry. A working group was identified to provide results of analyses at the next meeting and to consolidate appropriate data for the Maine program.

**Emerging Ideas on the Recruitment Mechanisms for North American Atlantic Salmon Stocks** *Abstract(s) by Kevin Friedland (friedlandk@forwild.umass.edu), David Reddin, Martin Castonguay, Jay McMenemy, and Ken Drinkwater*

Abstract(s) available in Section 4.1, Current Research Activities.

## 3.7. TERM OF REFERENCE 7 - Genetics/Transgenic Salmon: AQUA Bounty Farms, Inc.

**Transgenic Atlantic Salmon: AQUA Bounty Farms, Inc**. *Presentation by Joseph McGonigle (jbmcgonigle@earthlink.net)*

Aqua Bounty Farms, Inc., a Waltham, Massachusetts based company is developing an Environmental Assessment for a project that would use genes from chinook salmon to expedite the growth of farmed Atlantic salmon. No transgenic animals have been approved for producing food in the USA, however transgenic fish are known to exist in laboratories throughout the world. A transgenic organism is one that contains genes from another species. The company is applying to the US Food and Drug Administration (FDA) to market genetically modified (GM) Atlantic salmon. The FDA, Center for Veterinary Medicine regulates diverse animal biotechnology products, and to date no transgenic animals have been approved for use as human food.

Following the presentation, a question was posed about the public acceptance of transgenic salmon in light of public resistance to GM foods. The company does not believe the 'anti-GM attitudes' will be a "universal phenomenon". There are many GM foods on the US market now and consumption of farmed salmon in the US has increased annually by about 20% in recent years in spite of recent unfavorable news articles about the salmon aquaculture industry. It was stated transgenic salmon could result in routine prices to consumers declining to $2.00/lb, and that the public would respond favorably to these lower prices. When a committee member suggested that the public does not realize that there are many GM foods on the US market and its attitudes might be different if it knew, it was acknowledged that AQUA Bounty Farms, Inc. was investing $20 million in the venture.

Based on the results of growth trials, the company is concerned that currently they could be selecting for only freshwater growth and that the stock may not perform well in seawater cages. However, it is believed that the crossing of the transgenic fish with the St. John commercial stock may mitigate that problem.

The company is also concerned about the development of a meaningful environmental assessment without the ability to put transgenic fish into a real stream. A committee member suggested that an approach could be taken that is similar to a brown trout study in Sweden in which trout were injected with growth hormone and the fish (while not transgenic) exhibited growth similar to transgenic fish. Injected salmon released into a stream could be used as a proxy for released transgenic fish. Skepticism was raised regarding this approach and a similar coho study on the West Coast was identified and considered.

At this point in time the company hatchery is very basic and conducts no photoperiod or temperature manipulation. All conditions are ambient with very basic diet and fish cultural procedures. No information regarding transgenic fish immune response to pathogens was available upon inquiry.

It is the opinion of the company that the aquaculture industry is resisting the transgenic initiative because it is frightened of public perception. Most of the resistance is coming from Europe, and Nutreco, the largest corporation that supplies fish to most of the industry. It is concerned that its operations will be 'tainted' (in the public's perception) by association with transgenic Atlantic salmon. Nutreco and other large corporations are not able to enter the transgenic development process (even if they desired to do so) because AQUA Bounty Farms, Inc. has patented the process. The company is also involved in developing pan-sized rainbow trout (~2 lb.), reaching market size by 3 months rather than 9 months.

A committee member offered the opinion that what the company should develop, to minimize negative ecological interactions, is a very "dumb" fish that could not survive in the wild. This would be analogous to releasing a jersey cow into the wild. There were broad smiles among Committee members and the company agreed that their fish were not yet "jersey cows" but were "moving down that path".

A committee member asked about the status of a Harvard Risk Analysis to be conducted for the project, and was advised that a contract had not been signed and that the company intended to submit a proposal to FDA first so that they would be advised of key questions that may arise. In addition, it is anticipated that the company would have risk assessment protocols developed by summer and there is an interest in having them widely distributed to government agencies and interested parties through the FDA.

## 3.8. TERM OF REFERENCE 8 - Program Conservation Limits

**Conservation Spawning Escapement** *Abstract by Chris Legault (Chris.Legault@noaa.gov)*

$$CSE = \frac{240 eggs / unit * juvenile\ habitat\ units}{0.5 females / escapee * 7{,}200 eggs / female}$$

Conservation spawning escapement (CSE) refers to the number of returning adults needed to produce a desired egg density in a river. Assumptions must be made regarding the age structure of returns, proportion of returns that are female, and the average fecundity of an individual female. The amount of habitat available in the river is measured to allow determination of the expected egg density for a given number of spawning females. The CSE formula used in the US is simply where one habitat unit equals 100 $m^2$. The even sex ratio and fecundity assumptions are commonly accepted. The 240 eggs/unit value comes from Elson (1975).

This value has been reviewed in ICES and recommended as a default when river specific information is not available. Juvenile habitat measurements have not been updated since 1995 for the USA. The total CSE for the USA is 29,199 (Table F). Adult returns have been less than 20% of this value every year for the past 30 years.

Table F. Juvenile habitat units (1 unit = 100 $m^2$) and conservation spawning escapement (CSE) by river system in the US.

| River(s) | Habitat Units | CSE |
|---|---|---|
| Connecticut | 145,905 | 9,727 |
| Merrimack | 38,985 | 2,599 |
| Penobscot | 102,570 | 6,838 |
| Other Maine | 145,020 | 9,668 |
| Paucatuck | 5,505 | 367 |
| Total | 437,985 | 29,199 |

**Identifying the Gulf of Maine Distinct Population Segment component to the West Greenland Atlantic Salmon Catch** *Abstract by Tim Sheehan (Tim.Sheehan@noaa.gov), Tim King, and Chris Legault*

*[1] NOAA-Fisheries, Northeast Fisheries Science Center, Woods Hole, MA*
*[2] USGS-Leetown Science Center, Leetown, WV*

Summary:
In preparation for the National Academy of Science review concerning the listing of the Gulf of Maine Distinct Population Segment (DPS) as endangered under the US Endangered Species Act, Russell Brown (NOAA-Fisheries) was asked to calculate an estimated take for these populations within the West Greenland local consumption fishery. The deterministic model he developed relied heavily on numerous data sources and assumptions to predict the estimated DPS take under differing levels of fishing effort. The estimates developed became widely used in public forum and meetings. Here we attempt to thoroughly detail the data sources, steps and assumptions used to develop that model and propose a new probabilistic based method by which NOAA-Fisheries will determine the DPS take in the West Greenland local consumption fishery. We will also outline the potential future benefits of this approach in identifying management schemes to reduce the impact of the fishery on these populations.

BOAR - Backing Out Adult Returns (Brown 2000)

Step 1 - Determine historic proportion of European and North American components to West Greenland Atlantic salmon catch

*Data Sources:*

- ICES CM 2002/ACFM:14 - Table 5.1.3.2 (1991-2001 only)

*Assumptions:*

- Continent of origin trends are stable over time

Step 2 - Determine historic proportion of Canadian and US (both DPS combined and all other US rivers combined) 2SW adult returns

*Data Sources:*

- CAN vs. US estimate - ICES CM 2002/ACFM:14 - Table 4.2.2.2 (1991-1997 only (1998-2001 incomplete dataset))
- Other US estimates - 2001 USASAC estimates of 2SW returns (1991-2001 only)
- DPS estimate - Kocik and Trial Redd Based Adult Estimates model (1991-2001 only) scaled by 90% to estimate the total number of 2SW returns for the DPS rivers combined

*Assumptions:*

- CAN estimate - accurate reflection of total adult returns
- DPS estimate - accurate reflection of total adult returns
- DPS estimate - 90% of DPS returns are 2SW
- Other US estimate - accurate reflection of total adult returns
- North American 2SW contributions (CAN and US) are stable relative to historical abundance measures from 1998-2001 (data not available)
- Relative adult returns/contributions by country (CAN vs US) and drainage (DPS vs other US) are stable over time
- US and CAN fish have the same probability of being in WG
- US and CAN have the same survival rate after leaving WG
- The 1SW, 3SW, 4SW and/or 5SW components are insignificant and equally contribute across all populations

Step 3 - Determine average weight (kg) of Atlantic salmon caught off West Greenland

*Data Sources:*

- ICES CM 2002/ACFM:14 - Table 5.1.4.1

*Assumptions:*

- Average weight is consistent across all populations
- Average weight is consistent through time

Step 4 - Develop scenario for total West Greenland catch by 5 metric ton bins

*Data Sources:*

- None - bin size is arbitrary

*Assumptions:*

- See step 3

Step 5 - Calculate the number of individual salmon captured according to reported catch weight

*Data Sources:*

- None - simple calculation

*Assumptions:*

- See step 3

Step 6 - Calculate the number of DPS origin salmon captured as a proportion of the total reported catch

*Data Sources:*

- None - simple calculation

*Assumptions:*

- No spatial or temporal trends to total catch

Results - Estimated take of DPS Atlantic salmon in the West Greenland commercial/local consumption fishery according to the U- BOAR model (see Figure G, Section 8.4).

**PGA - Probabilistic-Genetic Approach (Sheehan, Legault and King 2003)**

**Scenario 1 - accurate assignments to DPS level**

Step 1 - Genotyping of collected tissue samples obtain during 2002 West Greenland local consumption fishery

Step 2 - Use assignment tests to determine the likelihood of each individual=s genotype being found in the reference DPS dataset

Step 3 - Compile assignment results (with appropriate error measurement) to determine the estimated DPS occurrence in the sample dataset*

Step 4 - Estimate the total DPS take by adjusting the DPS sample estimate in accordance with the total reported West Greenland local consumption catch

**Scenario 2 - accurate assignments to Maine level**

Step 1 - Genotyping of collected tissue samples obtain during 2002 West Greenland local consumption fishery

Step 2 - Use assignment tests to determine the likelihood of each individual=s genotype being found in the reference anadromous Maine dataset

Step 3 - Compile assignment results (with appropriate error measurement) to determine the estimated Maine occurrence in the sample dataset*

Step 4 - Determine the DPS and Maine (all other anadromous Maine populations combined) 2SW adult returns to prorate the assigned Maine samples into these two categories

Step 5 - Estimate the total DPS take by adjusting the DPS sample estimate in accordance with the total reported West Greenland local consumption catch

* When the assignment data is compiled we will apply appropriate statistical techniques to compile the information probabilistically

**Future Directions/possibilities**

! Investigate the possibility to increase the DPS/Maine assignment power through additional loci

! Analyze landings data and DPS take data to investigate the possibility of spatial or temporal trends to DPS catch while using environmental data to help explain and predict these trends

### 3.9. TERM OF REFERENCE 9 - Water Quality and Salmon Health/Physiology

**Endocrine Disruption in Atlantic Salmon Exposed to Pesticides** *Abstract by Terry Haines (haines@maine.edu), Ben Spaulding, Rebecca Van Beneden, Rebecca Holberton, Wendy Morrill*

Abstract available in Section 4.1, Current Research Activities.

**The Role of Acidity from Acid Rain on Atlantic salmon Survival in Maine DPS Rivers** *Abstract by Terry Haines (haines@maine.edu), Ben Spaulding, Steve McCormick*

Abstract available in Section 4.1, Current Research Activities.

**Physiological Smolt Status of Wild Atlantic salmon in Maine, 1998-2002** *Abstract by Steve McCormick (Stephen_McCormick@usgs.gov)*

Abstract available in Section 4.1, Current Research Activities.

The Committee was presented with research results that demonstrate the negative impact of low pH on Atlantic salmon juveniles. These presentations combined with results published in the literature by these and other scientists provide compelling evidence of the detrimental effect of low pH on Atlantic salmon. Measurements of the DPS rivers in Maine have found low pH levels on average and brief periods of very low pH. Given the current declining trend in Altantic salmon returns seen in all US rivers, the Committee recommends examining the possibility of mitigation by raising the pH in one or more rivers, commonly referred to as liming. This would require inviting scientists with experience in liming to the next Committee meeting and the development of a study plan. In addition, the Committee recommends that the Chairman of the Committee write a letter of support for the action items from the March 26 low pH meeting. The text of this letter will be discussed at the Committee meeting scheduled for July 2003. The intent of this letter is to show the strong support of the Committee for adaptive management approaches to mitigation of the low pH seen in many Maine rivers.

Following the presentations, Committee members had numerous questions and pertinent questions and answers are listed as follows:

With respect to Atlantic salmon exposed to pesticides, are you looking at bio-accumulation through feed? No, pesticides are relatively short lived in the environment and are unlikely to bio-accumulate, though it has not been tested.

Were the effects of pesticides on fish behavior and predator avoidance observed. No, but you would need high doses of pesticides or herbicides for their to be noticeable effects on behavior. These levels are not evident in the Downeast rivers of Maine.

With respect to the role of acidity from acid rain on Atlantic salmon survival in Maine rivers, it is noted that ATPase peaked in March and April in the river whereas in the experiment it appeared later? This is most likely associated with artificial lighting and impacts on the diurnal cycle in the laboratory.

The Merrimack River watershed has gradient in pH from headwater streams to the main stem. What is persistence of effects of pH? Fish can recover from damage to cells within days or weeks. Fish affected by pH in the upper reaches of the watershed could feasiblely recover by the time they reached the estuary.

It is evident that there is a significant loss of pre-smolts over winter in Maine rivers. Does low pH have a significant adverse effect on parr in the river? It is less likely that pH would cause mortality in parr. The most significant threat is at the embryonic stage and at smoltification stage.

Are calcium levels being monitored since element can ameliorate the effects of pH? Calcium is being measured and it is low. Calcium levels appear to be similar to those in rivers in Nova Scotia, though the difference is that USA are high in DOC which aluminum readily binds too.

Looking at the distribution of cations, it is apparent that rivers are low in calcium and higher in magnesium? Magnesium can take the place of calcium which can ameliorate the effects of acid, but typically calcium is more abundant then magnesium.

Aquaculture release smolts in sea cages, has ATPase activity in these smolts? No, but the Norwegians have, and have found in increased ATPase activities.

Is there historical data on pH and aluminum levels in the Maine rivers? One thing that is apparent is that calcium levels are dropping which is significant. We have unreliable long term data on pH and aluminum. There are ice core and diatom data that indicates that pH levels were a lot higher 100 years ago than now observed. There is no question that there are water chemistry problems that should cause damage to fish in the river.

What was the difference in ATPase levels between Dennys River, GLNFH fish compared to Narraguagus River wild fish?

The Dennys River, GLNFH smolts had ATPase levels that were in the range considered normal for smolts.

In some years, smolt survival of Narraguagus River fish has been better then that of Penobscot River smolts. Why? It should also be noted that there is variation from year-to-year in the level of ATPase activity in Narraguagus River smolts that would definitely impact survival or mortality.

**Infectious Salmon Anemia Virus (ISAv) Status in the Gulf of Maine** *Presentation by Steve*

*Ellis, USDA (stephen.k.ellos@aphis.usda.gov)*

A comprehensive overview of the status of ISAv in the Gulf of Maine was presented. Topics included the history of ISAv from Norway to its North American detection in USA waters by 2001.

Production of farmed salmon was 6,804 metric tonnes in 2002, a decrease from the 13,154 tonnes produced in 2001. Depopulation of aquaculture operations in Cobscook Bay due to ISAv reduced production. ISA was detected in USA waters 2001, however it is suspected that the virus may have been present at least a year earlier; it had been detected in nearby Canadian waters in 1996. Since the confirmed outbreak in USA waters, the U.S. Department of Agriculture has implemented an aggressive control program involving the following components: Bio-security, Surveillance (including monthly mandatory veterinarian inspections), Testing, Disease Reporting, Quarantine, Depopulation, and Indemnity.

Canadian and USA control programs have many similarities, but significant distinctions also exist. The USA program resulted in the depopulation in 2002 of 1.1 million fish, with subsequent equipment decontamination and site fallowing. Inspections of cod and lumpfish in the pen sites were negative for the pathogen. USA inspectors have recently visited a number of repopulated sites in nearby Canadian waters, and it is evident that the virus continues to persists at some sites. It has been documented in the 2002 year class of salmon in Canadian waters, and genetic material, often a pre-cursor of outbreaks has been detected in sampled fish from USA inspectors believe the Canadian outbreaks are too close to repopulated USA sites and are concerned with violations of Best Management Practices in Canadian waters, including the lack of expeditious response to mitigate impacts at sites known to be contaminated. Monitoring suggests that USA sites near Canadian waters may have been exposed again to the virus, and industry representatives and regulators remain highly vigilant for new occurrences of ISA in USA waters.

## 4. RESEARCH

### 4.1. CURRENT RESEARCH ACTIVITIES

The research abstracts were compiled into a single MicroSoft Word Document this year instead of using Procite software due to the inability to export the data to a MicroSoft Access database as intended. The goal remains to place abstracts into a common database accessible through a Website both for submission as well as key word searching and subsequent use. This would be maintained as a continuing database over the years.

In reviewing the current format of the abstracts, a recommendation was made to categorize the abstracts by the source of information e.g. peer review paper, abstract of current work, poster presentation, etc. It was agreed that this would be incorporated into the database.

Efforts will continue to design and implement a Website enabled database with appropriate fields including the source of the abstract as noted above. The prototype database will be circulated to the Committee for review. The intent is to have this process operational in advance of next year's meeting.

## CONSERVATION OR MANAGEMENT

### Continent of Origin of Atlantic Salmon Collected At West Greenland, 2001

*King, Tim. L.; Reddin, D. G.; Brown, R. W., and Kanneworff, P. email: John.Kocik@noaa.gov*

A total of 545 salmon sampled from Kangamiut (40), Fiskenesset (99), Nuuk (59), and Qaqortoq (377), Greenland were genotyped at 4 microsatellite DNA loci for assignment to continent of origin. A database of 4347 Atlantic salmon genotypes of known origin was used to assign the 545 salmon to continent of origin using the maximum likelihood algorithm. In total, 388 (67.5%) of the salmon sampled from the 2001 fishery were of North American (NA) origin and 187 (32.5%) fish were determined to be of European origin (Table 2). From the samples taken at Kangamiut in NAFO 1C, 39 (97.5%) salmon were determined to be of North American origin and 1 (2.5%) were of European origin (Table 2). From the samples taken at Nuuk and Kiskenesset in NAFO 1D, 144 (90.6%) salmon were determined to be of North American origin and 15 (9.4%) were of European origin. The Qaqortoq in NAFO 1F collection on the other hand yielded an equivalent distribution of salmon of North American (205 or 54.5%) and European (171 or 45.5%) origins. The lack of correspondence in the portion of continental representation between these two collections underscores the need to sample multiple NAFO regions to achieve the most accurate estimate of the contribution of fish from each continent to the mixed fishery. The river age distribution of the samples indicated that for North American salmon 4% were 1, 22.6% were 2, 39.4% were 3, 26.0% were 4, 7.7% were 5, and 0.3% were 6. For European salmon, 19.3% were 1, 48.9% were 2, 26.1% were 3, 4.5% were 4, 1.1% were 5 (Table 3). The sea age 1 group dominated the collection at 96.0%, 2 were 2.1% and repeat spawners were1.9% (Table 3).

### From Game Fish to Tame Fish: Atlantic salmon in North America, 1798 to 1998.

*Kocik, J. F. and Brown, R. W. in Lynch, K. D.; Jones, M. L., and Taylor, W. W., editors. Sustaining North American Salmon: Perspectives Across Regions and Disciplines. Bethesda, Maryland: American Fisheries Society; 2002; pp. 3-31.*
*email: John.Kocik@noaa.gov*

Atlantic salmon *Salmo salar* have an extensive pan-North Atlantic distribution that historically ranged from Portugal northward to the Arctic Circle in Europe across the Atlantic Ocean, from Ungava Bay to Long Island Sound in North America (Scott and Crossman 1973). Within North America, anadromous Atlantic salmon were native to nearly every coastal river north of the Hudson River (Atkins 1874; Kendall 1935; Scott and Crossman 1973). Although this represents a longitudinal range of approximately 2,100 km, the North American coastline length inhabited by the species exceeds 16,000 km (Dunfield 1985).

### Evaluation of reproductive success of captive marine-reared adult Atlantic salmon via trapping emergent fry in the Dennys and St. Croix Rivers.

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In fall 2001, the United States Fish and Wildlife Service, Maine Atlantic Salmon Commission, and NOAA Fisheries stocked adult Atlantic salmon reared in marine net pens by the aquaculture industry into several Maine salmon rivers to spawn naturally. We stocked 76 river-specific adults in the Dennys River and 524 mixed-stock adults in the St. Croix. To evaluate the reproductive success of these fish, we designed and constructed emergent fry traps that were placed over redds that were likely to have been constructed by these adult salmon prior to fry emergence in spring 2002. We deployed six traps in the Dennys River, and 12 traps in the St. Croix. In the Dennys, we captured fry in four of the six traps, but numbers were very low, ranging from one to four fry per redd. In the St. Croix we captured fry in 11 of 12 traps and fry were abundant (> 800 fry/redd) at two of the three areas where traps were deployed. These data combined with redd count data suggest over 250,000 fry were produced in the St. Croix by the captive-reared adults stocked the previous year. These mixed results suggest that reproductive success of these fish may be either: 1) stock specific, 2) river specific, or 3) site specific. We only trapped fry in the lower Dennys River, so do not know if reproductive performance was higher in other areas. In the St. Croix, one site had emergence levels similar to the Dennys, while at others emergent fry were abundant.

**Population modeling of Atlantic salmon in Vermont tributaries of the Connecticut River**

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Our goal is to develop a population model that will be useful in exploring various stocking and restoration strategies for Atlantic salmon in Vermont. Examples of possible scenarios we can explore are: 1) If we increase the survival of 0 to 0+ salmon by 10%, what is the effect on the number of smolts migrating or adults returning? 2) What are the effects of increasing survivorship at other life stages (0+-1+, 1+ to 2+ or smolt, smolt survival in river, or adults returning)? 3) What are the effects of density on each stage and size of individuals on survival? This approach should provide for detection of effect sizes of these different scenarios.

**Cold Water Fisheries Restoration Through Partnership: Yokum Brook, Becket**, MA.

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The Yokum Brook Restoration Project in Becket, Massachusetts offers fisheries managers an opportunity to employ a new approach to restore fish passage and movement. This restoration project involves removal of Silk Mill Dam, breaching of Ballou Dam, creation of a natural fishway@ below Ballou Dam, and instream habitat enhancement. Completion of the project will eliminate barriers to Atlantic salmon migration and resident trout movement and will restore continuity to five miles of pool-step habitats located upstream and between the two dams. Collaboration with the Town of Becket and partnership with local committees, regional and national non-profit groups, and state and federal agencies contributed to the success of the project. Integrating concerns for dam safety and fire protection with opportunities for fisheries restoration and environmental education helped build a strong foundation of partners who have provided funding, technical assistance, and community support. This strong and diverse partnership enabled the project to meet and surmount design challenges at Ballou Dam and permitting uncertainties at Silk Mill Dam. Completion of the project in 2003 will be documented by a professional videographer and children's book illustrator. Removal and breaching of the dams will not just be experienced by the Town and its project partners as it happens - it will be captured on tape and on the printed page for generations of Town and watershed residents as they continue to learn about the importance of their local river to the Atlantic salmon recovery. The partnership approach enables fisheries managers and others to incorporate a broad perspective and participation in restoration projects to ensure their short-and long-term success.

## CULTURE OR LIFE HISTORY

### Ocean thermal conditions in the post-smolt nursery of North American Atlantic salmon

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The effect of climate on the post-smolt survival of North American Atlantic salmon is obscure due to the difficulties associated with characterizing post-smolt ecology. To date, the only relationships observed between the abundance of these stocks and climate have focused on winter conditions, which is contrary to conventional thinking on post-smolt survival, which places greater importance on the spring period. The spring is believed to be critical since that is when the post-smolts migrate to sea and transition to ocean life. The pre-fishery abundance for North American stocks was compared to thermal conditions in potential post-smolt nursery areas during the period 1982-1999. Pre-fishery abundance was modeled as a reconstruction of one-sea winter (1SW) and two-sea winter (2SW) age salmon populations. The cohort abundance was compared to mean temperature and thermal habitat (area of the sea surface of a given temperature range) in five index areas. Stock size was negatively correlated with the mean sea surface temperature (SST) during the month of June. Correlations were comparatively stronger between stock abundance and thermal habitat, further supporting the assertion that June conditions, which is the first month at sea for most stocks in the region, may be pivotal to smolt survival. These correlations suggest that post-smolt survival is negatively impacted by the early arrival of warm ocean conditions in the nursery area. Hypotheses related to post-smolt migration, predation, and the availability of suitable prey are discussed.

### Multi-decadal trends in North American Atlantic salmon stocks and climate trends relevant to juvenile survival

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The changes in abundance of North American Atlantic salmon over the past century can be decomposed into a multi-decadal oscillation and a declining secular trend. Stock size is compared with sea surface temperature (SST) data stratified by time and space to reflect conditions in the marine nurseries of post-smolt Atlantic salmon. A previously described correlation between stock abundance and winter SST conditions was again documented; however, of more relevance to the survival of salmon post-smolts, a correlation was also observed between abundance and spring SST in the Gulf of St. Lawrence. This new correlation suggests a climate linkage to the critical time and area associated with ocean entry of Gulf post-smolts, which are an important component of the stock complex. The relevance of the winter SST correlation was further investigated by considering winter conditions in the freshwater nurseries for pre-migrant parr. The salmon abundance time series was compared to air temperature, precipitation, and rainfall trends averaged over time and space. Though air temperature and rainfall did not appear to be significant environmental variables, precipitation may be a factor in causing elevated over-wintering mortality. The timing of smolt runs with respect to ocean conditions was modeled as a function of putative thermal migration triggers. A mismatch between the predicted initiation of smolt migrations and SST in post-smolt nursery areas is a function of shifting ocean conditions, not conditions in freshwater. Oceanic and atmospheric climate indicators suggest that the North Atlantic Oscillation (NAO) is associated with variation in weather conditions over land, as reflected in the change in precipitation patterns in the freshwater nursery areas, and at sea, as reflected in the position of the Gulf Stream and the distribution of SST in the Northwest Atlantic. These factors provide the broad scale forcing for Atlantic salmon stock production, which appears to be primarily impacted by events during the early marine life of post-smolts and only secondarily, if at all, by events in freshwater. The relationship between marine and freshwater impacts may change with changing climate conditions. Persistent positive phase forcing in the NAO raises the concern that recent declines in Atlantic salmon are, in part, due to global climate change.

**Evaluation of Water Alkalinity Enhancement on Atlantic Salmon Growth and Survival at the Craig Brook National Fish Hatchery**

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The Craig Brook National Fish Hatchery, East Orland, Maine, is a key component of the Atlantic salmon conservation and recovery program. However, the hatchery is located in an area that receives acidic precipitation and where the geologic material is low in acid-neutralizing (buffering) capability. The prime water source, Craig Pond, is very low in dissolved minerals and is below the optimum alkalinity level (20 mg/L as $CaCO_3$) for rearing Atlantic salmon. This project evaluated the efficacy of a system to add limestone (calcium carbonate) to the hatchery water source to

increase alkalinity, and the effects of rearing in higher-alkalinity water on fitness of the fish produced. The system was designed to increase water alkalinity from the average of 7 mg/L normally to approximately 30 mg/L ("medium alkalinity water"), and 50 mg/L ("high alkalinity water"). The limestone dissolution system was effective in raising the alkalinity and pH of the hatchery water to levels believed to be optimal for Atlantic salmon culture. The system was able to maintain reasonably consistent water chemistry with minimal attention. There were few adverse effects of the system to the fish. There was a non-significant trend to higher mortality of embryos in the treated water that may have been caused by wash-out of fine limestone particles from the system to the hatching and rearing containers. Sand filters greatly alleviated this problem. The fish from the treated water were also smaller than control fish in two years of the project, but this effect did not occur in the third year. Reduction in the amount of limestone particles reaching the fish may have eliminated this effect. The limestone treatment provided some physiological benefit to the fish. Residual ATPase activity in fish gills was higher, possibly enabling fish to better osmoregulate. Whole-body sodium was lower, also possibly indicating that fish osmoregulated better in soft water. Plasma cortisol was lower after a stress test, indicating that treated fish were not stressed by transfer to low alkalinity water or handling. The limestone treatment significantly improved survival of the fish in the riverine environment, at least through the first year after stocking. Two years of stocking fry in the Narraguagus River demonstrated improved survival of fish from the treated water both after 5 months as fry, and after a year and 5 months as parr. Fish from the medium and high alkalinity treatments were recovered at significantly greater rates than expected if there had been no effect of the treatment on survival.

## Endocrine Disruption in Atlantic Salmon Exposed to Pesticides

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Atlantic salmon in eight rivers in Maine have been classified as a distinct population segment under the endangered species act. Previous research has shown that smolts in one of these rivers (Narraguagus) have abnormally low gill Na/K-ATPase activity and had lower survival in salt challenge tests than hatchery fish, demonstrating that they were less able to osmoregulate in seawater. Many of the salmon rivers in Maine receive pesticide runoff from nearby blueberry barrens. Nineteen chemicals are registered for use on blueberries, including insecticides, herbicides, and fungicides. Some of these chemicals are known endocrine disruptors. We evaluated the estrogenic activity of these chemicals in a cell-culture assay (E-SCREEN) and found that several ingredients and formulations had activities of 25% to 76% of 17ß-estradiol. We selected three pesticides with relatively high estrogenic activity (Velpar, 2,4-D, Orbit) and exposed 1-year Penobscot strain Atlantic salmon smolts to a nominal concentration of 0.5 ppm active ingredient of each compound for 24 h intervals once per week for 5 weeks. We assessed smoltification and osmoregulatory ability of the control and exposed fish by periodically measuring hematocrit, plasma Cl, plasma estrogen and androgen, and gill Na/K-ATPase activity of fish from fresh water and after 24 h saltwater challenge tests. Notwithstanding published studies demonstrating effects of estrogenic compounds on enzyme activity and osmoregulatory ability of smolts, we found no effect from pesticide exposure on any metric, indicating that pesticide exposure through the water had no effect on smoltification or predicted marine survival of these fish. This study will be repeated in 2003, using different pesticides, different concentrations, and different routes of exposure to confirm the present findings.

**The Role of Acidity From Acid Rain On Atlantic Salmon Parr/Smolt Survival in Maine DPS Rivers.**

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Atlantic salmon in eight Maine rivers have been classified as Distinct Population Segments under the Endangered Species Act, and adult returns to these rivers have reached historic lows. Many of these rivers are located in areas where acid-neutralizing capacity of water is low, and precipitation is acidic as a result of acid rain. River pH frequently reaches values of 5.5 or less, and aluminum concentrations exceed 100 µg/L, conditions which have been shown to have adverse effects on smolt survival in Norwegian and Canadian rivers. To determine if water acidity and aluminum is affecting Atlantic salmon smolt survival in Maine, we collected gill tissue from river-produced smolts in the Narraguagus and Dennys rivers, and from captive populations held at Craig Brook National Fish Hatchery, East Orland, Maine. One set of samples was used to determine gill Na/K-ATPase activity, and one set of samples was used to determine aluminum deposition on gills. For the Dennys River, river-produced smolts had mean gill Na/K-ATPase activity of 1.8 µM ADP/mg protein/h, whereas hatchery fish of approximately the same age had mean activity of 4.5 µM ADP/mg protein/h. For the Narraguagus River, hatchery fish had mean activity of 6.7 µM ADP/mg protein/h. Gill tissue for aluminum determination was embedded in paraffin, sectioned, stained with solochrome azurine, and examined by light microscopy. There was no evidence of aluminum deposition on gills of any fish examined. We obtained samples of gill tissue from Atlantic salmon smolts from several Norwegian rivers, some acidic and some not, for comparison with our samples. Results from these samples are not yet available. Enzyme analysis indicates that river-produced smolts have abnormally low activity levels, but there is no evidence as yet that river acidity is responsible for these results. The cause remains unknown.

**Cryopreservation of Atlantic salmon semen using five extender and cryoprotectant combinations**

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The Atlantic salmon (ATS) Restoration Program relies heavily upon fish cultural facilities to produce fry, parr, and smolts for restoration stocking. Despite stocking efforts, sea-run returns of Atlantic salmon continue to be at very low levels. Concurrently, in the Connecticut River program, the returning female to male ratio is skewed approximately 3 to1. To address this issue, the U. S. Fish and Wildlife Service has taken strong interest in the potential of cryopreservation techniques to maximize the conservation of available ATS male genetic material. The objective of this investigation was to refine and optimize cryopreservation procedures for the Atlantic salmon by testing five extender and cryoprotectant combinations. Milt was collected from sea-run

Atlantic salmon at Cronin National Salmon Station and from F1 Connecticut River Atlantic salmon at White River National Fish Hatchery and cryopreserved using the following extender-cryoprotectant combinations: Cloud + 5% DMSO, Cloud without yolk, Gallant et al.+10% DMA, HBSS-S + 5% DMSO, and Stoss and Holtz + 10% DMSO. Eggs fertilized with spermatazoa frozen in the Cloud without yolk had eye-up rates of 26.0%, significantly higher than obtained with Cloud + 5% DMSO (5.0%), Gallant et al.+10% DMA (7.2%), HBSS-S + 5% DMSO (6.7%), and Stoss and Holtz + 10% DMSO (7.8%) but less than obtained with fresh semen (72.0%).

**Effects of Timing of Stocking on Atlantic Salmon Parr Growth, Maturity, Movement and Survival in the West Brook, MA.**

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Due to logistical constraints and availability of fry, there is often wide variability in the timing of stocking among rivers and within a river among years. We assessed the effect of variation in the timing of stocking in a single stream (The West Brook, Whately, MA) on growth, parr maturity, movement and survival by resampling PIT tagged fish from the 2001 stocking year. We stocked development-adjusted (to consistent developmental index) fry during three occasions that were separated by approximately 2.5 weeks. We also planted green eggs in incubator boxes directly in the stream. Once fish were big enough to tag (60 mm FL), they were also identified to time of stocking (Early, Middle, Late, or Incubator) using genetic information from fin clips. Fish were sampled five times from age-0+ September to age-1+ October. Early fish were consistently heaviest and incubator fish were the lightest. A laboratory study indicated that competitive interactions among groups may play a large role in maintaining size differences among groups. Surprisingly, the size differences among groups did not result in variable proportions of mature parr among groups - all groups had similar high rates of male parr maturation. Male parr maturation rates appeared more tightly linked to growth rates, which were not variable among groups, than to absolute sizes. Although survival did not vary among groups once they were tagged, middle-stocked fish were much more abundant than any of the other groups, suggesting that there was variable survival among groups between stocking and tagging in September. Multi-strata mark-recapture models indicated that the probability of movement within the study section also did not vary among groups. Based on a single stream for a single cohort, our results indicate that timing of stocking can have substantial effects on size and abundance, but may not influence incidence of parr maturity.

**Scope of Temperature Variation in the Connecticut River and Implications for Juvenile Atlantic Salmon Survival and Growth.**

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Atlantic salmon populations (*Salmo salar*) are widely distributed and have a flexible life-history. Because their restoration and conservation is a priority worldwide, understanding factors that affect their survival and growth is critical. Temperature is an important consideration as it directly influences survival, size, growth, and, subsequently, smolt age. The Connecticut River is a unique system in which to assess the effect of temperature because it is at the southern edge of the Atlantic salmon's range. Consequently, this 660 km watershed encompasses a wide temperature gradient. In this talk, we (1) identify what types of temperature effects might be important for salmon restoration, (2) review critical temperatures for Atlantic salmon from the literature, (3) report the range of temperatures that exist across the watershed at multiple sites and multiple years, then (4) examine the implications of this range and variation for salmon survival and growth. Water temperatures at index sites within the West (VT), Westfield (MA), and Farmington (CT) River basins were quantified to address these questions about site, basin, and watershed patterns. Understanding these temperature-related effects may help in planning management actions to conserve and restore Atlantic salmon in the Connecticut River and other North Atlantic systems.

**Effects of Summer Flow Regime on Growth of Age-0 Atlantic Salmon.**

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Significant reductions in growth of juvenile salmon associated with low summer flow have been observed, but underlying mechanisms are poorly understood, and predictive power is limited. We conducted a stage-specific analysis of the relationship between summer flow and the growth of age-0 Atlantic salmon in two rearing sites in the Upper Connecticut River basin, New Hampshire, USA. We contrasted effects of variation in foraging habitat availability and temperature on salmon growth during high- and low-flow years and from high- and low-flow sites within years. Salmon growth was lowest under low summer discharge, and was positively correlated with the availability of model-predicted favorable foraging locations during the summer. In contrast, variation in growth was not closely associated with temperature-model predictions. Our case study provides a framework for combining empirical and modeling approaches to quantify the potential impact of hydrologic change on fish growth and directly links variation in stream discharge to juvenile salmon performance across time and space.

**Redd to spawner evaluation of adult Atlantic salmon stocking. 2002**

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Wild Atlantic salmon (*Salmo salar*) runs in US waters have experienced significant declines in abundance including the extirpation of numerous stocks. Today, only eight remnant populations remain in the USA; all are located within the State of Maine (Colligan *et. al.* 1999). These populations have also experienced dramatic declines in abundance and it is estimated that between 86 and 114 total mixed origin fish (wild and hatchery reared) returned to these eight rivers to spawn in 2001. In 2000, these populations were formally listed as endangered under the Endangered Species Act.

Historically, the stocking of various stages of Atlantic salmon has been used to artificially augment natural production within these rivers. In 1992, the stocking program was modified to a river-specific approach (stocking progeny originating from broodstock captured as parr from each specific river), with a focus on fry stocking. since its inception, fry have accounted for between 94-100% of the stocked fish. In 1997, as an alternative to fry stocking, a two-year feasibility study was initiated between private aquaculture companies and Federal and State of Maine management agencies. Atlantic salmon were reared to maturity in salt water and stocked in Maine Rivers in an effort to enhance natural spawning escapement. In 1997, river-specific broodstock from three Atlantic salmon populations were held and spawned in a Federal hatchery. Eyed-eggs were transferred to private aquaculture companies and were reared to the smolt stage in freshwater; smolts were then transferred to marine sea-cages and reared to maturity. This process was repeated in 1998 with river-specific broodstock from four rivers. A comprehensive stocking and assessment plan was also developed to gauge the effectiveness of this adult stocking effort in supplementing these depressed populations.

During October 2000, 1,038 marine-reared, mature adult Atlantic salmon were released into the Dennys, Machias, and St Croix Rivers. Prior to stocking, all adults were weighted, measured, PIT tagged and a genetic sample was taken. during the stocking process the adults were physically handled a minimum of 6 times, which anecdotally resulted in increased stress and physical damage to the fish. In addition, 70 Dennys River origin adults were ultrasonically tagged and 15 ultrasonic receivers were deployed throughout the drainage and actively sought appropriate spawning habitat. Post stocking assessments documented a significant increase in redd production attributable to these stocked adults, but negative results from follow-up fry emergence investigations have since called into question the reproductive success of these fish as well as the viability of gametes.

In 2001, 703 marine-reared, mature adults were released into these same three drainages. These adults were sampled in a similar manner as the year 2000 fish, however stocking logistics were modified to help reduce the number of times each adult was handled. These actions presumably resulted in a lower stress level for the pre-spawning adults as well as less external physical damage. Telemetry investigations were duplicated and we expect these data to provide insights into pre-spawning migratory behavior, spatial and temporal behavioral differences and over-winter residency of the stocked adults. Additionally, laboratory and hatchery-based assessments on the viability of gametes produced by these stocked adults were carried out. Preliminary analyses indicate that the 2001 stocked adults are responsible for a significant increase in the number of redds documented within each recipient river and that their gametes are viable. Preliminary fry trapping results aimed at assessing the fry emergence rate from these redds on two rivers have been contradictory. Population surveys of parr (electro fishing) and out-migrating smolts (trapping) will also be conducted and an adult capture facility will be operated annually. Genetic samples will be obtained during all future population assessment activities and will allow for the partitioning of samples by origin via parentage analysis (wild spawning, fry stocked, or adult stocked).

In summary, a total of 1,741 marine-reared, river-specific, mature Atlantic salmon adults were stocked into three Maine rivers over a two-year period (Table 1). Evaluations of this unique supplementation method are ongoing and will provide valuable information regarding the effectiveness of this technique in supplementing natural reproduction within these depressed populations. Initial results indicate that the stocking of marine-reared mature adults may be a management tool capable of artificially increasing the number of adult spawners and egg deposition until a time when environmental conditions improve and natural spawning escapement increases.

**Electroshocking and PIT Tagging Juvenile Salmon: Are There Interactive Effects on Growth and Survival?**

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Electro-fishing is a commonly used method for sampling fish in freshwater environments. A number of studies have addressed the problem of electro-fishing on growth and survival of salmonids in the field. However, few studies have addressed the effects of repeated electro-fishing on growth of salmonids. To investigate this problem we designed an experiment to test for differences in growth of 0+ salmon parr either by shocking or tagging or a combination of both. Five treatments were used. Treatment 1 was the control; treatment 2 fish were PIT tagged and clipped, but not shocked; treatment 3 fish were fin clipped and shocked at a low voltage (300 v), but not PIT tagged; treatment 4 fish were shocked at a low voltage (300 v), PIT tagged, and fin clipped; treatment 5 fish were shocked at a high voltage (500 V), pit tagged and fin clipped. Fish were measured, weighed, and shocked at approximately two month intervals over a period of 10 months. To address differences in growth, initial mass was plotted against final mass for each sampling interval. Although overall variability in growth was quite variable, ANCOVA tests using initial mass as the covariate final mass as the dependent variable, and treatment and tank as independent grouping variables did not indicate any treatment effects on growth within any of the sampling intervals. Initial mortality was relatively high after the first sample, but only occurred within treatments that included PIT tagging. This initial mortality appeared to be negatively correlated with size. Mortality in subsequent samples was very low and did not appear to be related to a treatment effect. We found no evidence that repeated shocking of individual salmon parr nor PIT tagging significantly influence growth over a series of sampling intervals. We suggest that any potential effects of repeated shocking on growth of individuals is negligible in comparison to the large variability in individual growth rates inherent in this species.

## FISH HEALTH

### Detection of antibodies against Infectious Salmon Anemia Virus in sea run Atlantic Salmon (*Salmo salar*) using an ELISA assay.

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The ELISA assay to detect Infectious Salmon Anemia antibodies in sea-run Atlantic salmon (*Salmo salar*) returning to New England rivers since 1996 is under investigation. The assay has been standardized to plate archived serum samples against two antigens: ISAv and HSK-1 antigens. The ISAv is a viral used to detect specific antibody if it is present in the serum of test fish. The HSK-1 cellular antigen is a preparation that is developed from the cell line in which the virus is cultured. Because the monoclonal antibodies developed from mice against ISAv is produced from suspensions that have previously contained HSK-1 cells, it is important to determine the extent of background reaction that may develop against this negative control.

Test and control sera are screened at 1:20 (serum/buffer) dilutions in triplicate. Both ISAv antigen treated and HSK-1 antigen treated blank wells are run in each assay to develop mean background reactions. The mean background value of the blank wells treated with the ISAv antigen (that did not receive either test sera or control serum) is subtracted from the optical density readings of individual test and positive control sera incubated in ISAv antigen treated wells. Thus, a corrected optical density reading is obtained for each individual test. Similarly, corrected readings are obtained for positive and test control sera incubated in HSK-1 treated wells. Because all test sera are run in triplicate, a corrected mean for the ISAv and HSK-1 readings for a specific serum sample are next obtained. The corrected mean of triplicate replicates for a specific serum sample incubated with the ISAv antigen is statistically compared to its corrected mean when the same serum sample is incubated with the HSK-1 antigen by a paired t-Test. If the readings obtained from the serum incubated against ISAv antigen is statistically greater ($P<0.05$) than the same sample incubated against the HSK-1 antigen and the difference between the means is also greater than 0.24; - the assay indicates that the fish possess antibodies against Infectious Salmon Anemia virus. Testing of all archived materials the Penobscot, Merrimack and Connecticut Rivers (n=60 fish/river/year between 1996 and 2002) is underway. Results will be discussed in greater detail once all of the samples have been analyzed.

## MARKING

### Comparison of mortality between calcein-marked and unmarked Atlantic salmon fry stocked in the Sheepscot River, Maine (2nd year study)

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A major obstacle in evaluating the performance of Atlantic salmon fry stocked throughout river basins in Maine each year has been the lack of a practical technology for mass marking fry with subsequent non-lethal mark detection. Recent advance in the use of calcein to produce an externally-visible mark now potentially offers a solution. However, the calcein-marking technique must be field-tested for possible effects on mortality in stocked fish. In 2001, a combined total of about 50,000 calcein-marked and non-marked Atlantic salmon fry reared at CBNFH were field-evaluated for survival in the fall of 2001 after being stocked in May as non-feeding fry in the West Branch Sheepscot River, Maine. Field recovery of young-of-year (YOY) fish and data analysis showed that marked and non-marked fry were recovered at the expected 1:1 ratio. The current study represents a repeat of the 2001 assessment using similar numbers of calcein-marked and non-marked fry released into the West Branch of the Sheepscot River. Results of field recovery efforts in September 2002 showed that 7 sites yielded sufficient numbers of YOY (n= >5) to perform a replicated G-test analysis. Out of these 7 sites, 3 showed calcein-marked vs. unmarked fish were recovered at the expected 1:1 ratio ($P<0.05$). The other 4 sites yielded ratios in favor of unmarked fish, 2 of which were very skewed toward greater numbers of unmarked fish. Combined data showed a recovery ratio of 3:1 in favor of unmarked YOY which obviously did not fit the expected 1:1 ratio we found in 2001. Possible explanations for unequal capture ratios between unmarked and marked fish in 2002 include: presence of wild YOY, faded calcein marks, or post-stocking mortality. Analysis of variance procedures performed on YOY total length data showed mean total lengths (SE) of marked and unmarked fish were 64.9 (0.9) and 65.6 (0.9) mm, respectively with no significant difference ($P$=0.572) between treatments. A combined total of 99 age 1 and age 2 parr were captured with 16 individuals being positively identified as calcein-marked age 1 fish which had been stocked the previous year. Future evaluations must include some determination of numbers of wild fish captured before the efficacy of calcein marking can be determined when used in this manner.

## POPULATION ESTIMATE OR TRACKING

### Evaluation of Sampling Methodology for Merrimack River Age-1 Atlantic Salmon Parr Abundance Estimation (1994 - 2001)

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Between the years of 1994 and 2001, 1.7 - 2.8 million Atlantic salmon fry were stocked annually in the Merrimack River basin. The post-stocking abundance and survival of the cohort is assessed during annual multiple-pass electrofishing surveys in the fall of the following year when the stocked fry have reached the yearling (age-1) parr stage. Seven index sites have been used for abundance estimation in the Merrimack River basin since 1984. In efforts to increase the precision of basin wide parr abundance estimates, a stratified sampling design was implemented in the mid 1990's. Such a sampling design allows for assessment of where the most variability in abundance estimates comes from and for determination of optimal allocation of sampling effort among strata. The number of total sites sampled in the basin increased to 28 per year and although this increase resulted in more precise estimates of abundance, it also increased the costs associated with fieldwork. The purpose of this study was to use multiple years (1994 - 2001) of abundance data to determine if simpler sampling designs can be used, or effort within the current sampling design reduced, while maintaining a desired level of precision (? 10% CV) on basin wide parr abundance estimates. The median CV for current stratified sampling design was 8.23 (range: 5.00 - 11.09) over the eight year period. When abundance estimates were calculated using only historical index site data, the median CV increased to 13.76 (range: 8.08 - 16.09) indicating that data from the seven index sites alone do not provide desired levels of precision. The average allocation of sampling effort among strata was not significantly different from predicted optimal allocation; however the amount of sampling at all 28 sites was significantly higher than that necessary to maintain a 10% CV. These results suggest that sampling effort should continue to be proportionately allocated in the same manner, but the absolute amount in a given strata may be reduced by an average of 29%. Reduction in the amount of effort may be either in the form of reducing the number of sites sampled or the number of habitat units sampled per site (1 habitat unit = 100 $m^2$ of suitable habitat). Additional statistical analyses are being conducted to determine the feasibility and precision of using a single-pass population estimation technique as opposed to a multiple-pass technique. Results from these analyses will be used to recommend more efficient use of personnel and funds required for sampling effort.

## SMOLTIFICATION AND SMOLT ECOLOGY

### Migratory patterns of Wild and Hatchery-Reared Atlantic Salmon Smolts in the Connecticut River.

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The timing of downstream migration of Atlantic salmon smolts was examined through the use of Passive Integrated Transponders (PIT tags) implanted into fish and then detected as they migrate through detectors at smolt bypass facilities on the Connecticut River. Detectors were installed at Holyoke (2000-02), Turners Falls (2000-02), Vernon (2001-02) and Bellow Falls (2002). In 2000 and 2001 hatchery-reared fish were released in mid-April and early May at two sites: the West River (river km 257) or the Passumpsic (river km 435). Median detection date was May 7 >00 and May 12 >01 for West River releases and May 18 >00 and May 27 >01 for Passumpsic River releases. Although hatchery smolts were released 3 weeks apart, they were detected downstream at similar times, indicating that early release fish were either "staging" near the release site, or had a lower average speed throughout migration. Stream-reared presmolts (>12 cm) from several tributaries were tagged in the fall of 2000 and 2001 and detected during migration the following spring. Median detection date was May 16 >01 and May 8 >02 for Smith Brook (river km 310), May 18 >01 and May 11 '02 for White River (river km 407), May 23 >01 and May 29 >02 for Joe's Brook (river km 471), and May 26 >02 for Moose River (river km 484). Detection rates for both stream- and hatchery-reared fish were greater for southern tributaries than northern ones, possibly indicating lower survival of smolts from northern tributaries. The results indicate that fish from the northern watershed will arrive to the mouth of the river later than fish from southern reaches, and that these northern fish are likely to experience higher overall mortality during downstream migration.

### Detrimental effects of environmental estrogens on Atlantic salmon fry and smolts.

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Sex steroids are known to interfere with normal development of the parr-smolt transformation, and environmental estrogens such as nonylphenol have recently been implicated in reduced returns of Atlantic salmon in the wild. Three studies were conducted to examine the impact of nonyphenol on Atlantic salmon fry and smolts. In the first study juvenile Atlantic salmon were injected with 0.5, 2, 10, 40 and 150 ug/g branched 4-nonylphenol and 2 ug/g estradiol? during the parr-smolt transformation in April and sampled 1 and 2 weeks after first exposure. Estradiol and 150 ug/g nonylphenol resulted in lower salinity tolerance and decreased plasma insulin-like-growth factor I (IGF-I). Plasma growth hormone was elevated at intermediate doses of nonylphenol, but there was no effect of higher doses. There was no effect of estradiol on plasma growth hormone. Plasma cortisol was not affected by nonylphenol or estradiol. Plasma thyroxine showed a strong dose dependent decrease in response to nonylphenol and estradiol. The results from injections indicate that plasma IGF-I is the likely endocrine pathway for the effects of estrogenic compounds on osmoregulation, and that plasma thyroxine is negatively affected by nonylphenol at relatively low doses. In the second study Atlantic salmon pre-smolts were exposed to nonylphenol in fresh water at 10 and 100 ppb, and estradiol at 2 ppb for 3 weeks at 10 C. After 3 weeks fish were sampled in fresh water and others subjected to a 30 ppt seawater challenge for 24 hours. There were no mortalities in fresh water or seawater, and no impact of any treatment on gill Na,K-ATPase or salinity tolerance. In the third study, recently hatched Atlantic salmon sac fry were exposed to nonylphenol in the water at 10 and 100 ppb, and estradiol at 2 ppb for 3 weeks at 10 C. At 100 ppb nonylphenol, 50% of the fry died by the end of the 3-week exposure, and elevated mortality continued for several months after exposure. In nonyphenol at 10 ppb and estradiol at 2 ppb, delayed mortality was observed (8-fold higher than controls) 2 months after treatment. We conclude that under the conditions imposed in this study, water exposures of environmentally relevant concentrations of nonylphenol by itself will not impact salinity tolerance of Atlantic salmon smolts. In contrast, recently hatched fry are very sensitive to environmental estrogens, experiencing mortalities at concentrations that are 2-3 orders of magnitude lower than published LC50's.

**Physiological smolt status of wild Atlantic salmon in Maine, 1998-2002.**

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Compromised smolt development due to poor water quality may be a factor in reduced Atlantic salmon populations in Maine. Changes in smolt physiology, which are prerequisite for survival in seawater, were examined in several Downeast rivers from 1998-2002. Downstream migrating Atlantic salmon (*Salmo salar*) smolts were captured in rotary screw traps or counting weirs. Target samples were 10 fish per week throughout the migratory period. Samples were obtained for the Narraguagus river from 1998-2002, the Pleasant river in 1999, the Dennys river in 2002 and Sheepscot river in 2002. Fish were anesthetized and a small amount of gill tissue was placed in buffer and frozen immediately on dry ice. Gill Na,K-ATPase activity was measured as outlined in McCormick, 1993 (Can. J. Fish. Aquat. Sci. 50: 656-658.). Results from 1998-2001 indicated that smolt development was moderately compromised in the Narraguagus river with substantial variation from year-to-year. In spring 2002 smolt physiology in fish from the Narraguagus and Dennys river were severely compromised for most of the smolt migration, suggesting that adult survival from this year class of smolts is likely to be very low.

**Effects of short-term, sub-lethal acid/aluminum exposure on seawater tolerance and**

**endocrinology of Atlantic salmon smolts**

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The acidification of rivers and streams, and the resulting elevated concentrations of dissolved aluminum (Al) have toxic effects on fish, including the disruption of ionoregulatory ability. Atlantic salmon smolts may be particularly vulnerable to this disturbance, for it is critical that they develop sufficient salinity tolerance to survive downstream migration and seawater entry. We examined whether short-term, sub-lethal acid/Al exposure would affect the salinity tolerance and the underlying endocrine mechanisms of Atlantic salmon smolts. We assigned replicate tanks to either control (pH 6.5-6.9) or treatment (pH 5.3-6.0, 200 :g/l total Al) conditions, and exposed fish for 2 and 5 days. Fish were sampled for physiological parameters both in freshwater, and after a 24 h seawater challenge test. Percent hematocrit and plasma glucose were elevated in treatment groups sampled in freshwater after exposure to acid/Al, indicating a stress response. Gill $Na^+/K^+$ ATPase activity was decreased in several treatment groups relative to controls, and preliminary data demonstrate that acid/Al exposure may decrease gill protein levels of $Na^+/K^+/2Cl^-$ cotransporter. Acid/Al exposure did not affect plasma ions in freshwater, but did result in higher plasma chloride after seawater exposure. Plasma cortisol and thyroxine levels remained unaffected by acid/Al exposure. Gill aluminum content was significantly higher in treated fish than in controls. The results indicate that short-term, sublethal acid/Al exposure compromises the salinity tolerance of Atlantic salmon smolts in part, by negatively impacting gill ion transport mechanisms such as $Na^+/K^+$ ATPase and $Na^+/K^+/2Cl^-$ cotransporter.

**Effect of hexazinone on the parr-smolt transformation of Atlantic salmon**

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Hexazinone is a highly mobile herbicide that is widely used along rivers in Maine where Atlantic salmon have recently been listed as an endangered species. The objective of this study was to determine the effect of sublethal concentrations of hexazinone on salmon parr-smolt transformation. Atlantic salmon were exposed to 0, 2, 20, or 200 ppb hexazinone in fresh water for 18 days at 10°C beginning on April 11, just prior to the peak of smolting. At the end of this time, half of the fish were sampled and the other half were exposed to a sea water challenge (30 ppt) for 24 hours. There were no mortalities in fresh water or after seawater challenge. No significant effect of hexazinone was found on plasma cortisol, potassium, chloride, sodium, and acetylcholinesterase and gill $Na^+K^+$ATPase activities. There was no effect of hexazinone on plasma sodium and chloride after seawater challenge. Plasma glucose and calcium in fresh water were not affected, but prior hexazinone treatment resulted

in higher glucose and calcium after seawater challenge, even at low doses of hexazinone. We conclude that under the conditions imposed in this study, there was no effect of hexazinone on salinity tolerance of Atlantic salmon. Hexazinone does appear to affect some aspects of salmon calcium regulation and intermediary metabolism after seawater exposure. Future studies will examine whether other life history stages of Atlantic salmon are impacted by this and other contaminants.

## STOCK IDENTIFICATION OR GENETICS

### Identification of Stocking Location for Farmington River Smolts: What Can Parentage Assignment Tell Us About Stocking Success?

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Beginning in 1967 the effort to restore Atlantic salmon in the Connecticut River consisted primarily of smolt releases from hatchery-produced smolts from a variety of locations in Maine and Canada. In 1987 fry stocking was initiated to aid the production of stream-reared smolts. As of 1996 restoration consisted of captive breeding and management of the sea-run adult Atlantic salmon returning to the Connecticut River and the practice of outside introductions was ended. In order to maintain the genetic variability of the returning Atlantic salmon a number of elements are in place in the brood stock management program, including maximizing the number of parents and reducing mating between related individuals. These efforts are aided by the use of molecular tools developed in the last decade. One of these tools, microsatellite DNA, is a highly variable nuclear DNA marker. The high variability of microsatellites allows for the identification of individuals and matching of offspring to parents (parentage assignment), essentially serving as a "genetic tag". In 2000, as part of an ongoing effort, approximately 88,000 genetically marked fry were stocked in the Farmington River. Outmigrating smolt and, potentially, returning adults may be matched back to family and in turn, their stocking origin in the Farmington River. In the spring of 2002, approximately 100 outmigrating Atlantic salmon smolt were fin clipped for microsatellite analysis and parentage assignment. The results of these analyses will be presented. These data were not analyzed at the time of writing this abstract.

## 5. HISTORICAL DATA

### 5.1 EGG PRODUCTION

A summary of egg production for Atlantic salmon restoration and recovery programs in New England for the period 1871-2002is provided in Table 5.1.a in Appendix 8.4. A summary and grand total of all historical Atlantic salmon egg production for New England salmon rivers is provided in Table 5.1.b. in Appendix 8.4. Approximately 58,748 female Atlantic salmon have produced an estimated 402 million eggs for programs throughout the history of salmon enhancement, restoration, and recovery efforts.

### 5.2. STOCKING

Historical stocking information is presented in Table 5.2.a and 5.2.b in Appendix 8.4. Approximately 193 million juvenile salmon have been released into the rivers of New England during the period, 1967 - 2002. About 79% of the total have been fry. The majority of the juvenile releases have occurred in the Connecticut River (> 94.6 million), the Penobscot River (> 31.6 million), and the Merrimack River (> 32.2 million).

## 5.3. ADULT RETURNS

Historical return information is presented in Table 5.3.a and 5.3.b in Appendix 8.4. Total returns to New England rivers from 1967 through 2002 now equals 78,327. The majority of the returns have occurred in Maine rivers (91%) followed by the returns to the Connecticut River (6.0%), and the Merrimack River (3.0%). Adult returns to the Penbscot River represent 71% of the total.

Return rates for Atlantic salmon stocked as fry for southern New England rivers are tabulated in Tables 5.3.c-1 through 5.3.c-7 in Appendix 8.4. A summary of return rates and age distributions of Atlantic salmon stocked in New England rivers as fry are tabulated in Tables 5.3.d and 5.3.e in Appendix 8.4. Summaries of return rates and age distributions of adult salmon that were stocked as fry are not reported for rivers in the State of Maine. Adult salmon return rates and age distribution data for Maine rivers can not be accurately reported until returns from natural reproduction and fry stocking can be distinguished.

# 6. TERMS OF REFERENCE FOR 2003 MEETING

The Committee agreed to address the following Terms of Reference for the 2004 meeting:

1. Program summaries for Year 2003 to include: (a) stocking program for current year with breakdowns by time, location, marks and lifestage; (b) returns for current year by sea-age, marked versus unmarked fish, and wild versus hatchery fish; (c) general summary of program activities including new and emerging issues, and program direction; and (d) update and improve Assessment Committee databases.

2. Fry Stocking Densities and Data Collation for New England Rivers.

3. Domestic and International Research Program Updates.

4. Atlantic Salmon Population Viability Analyses (PVA).

5. Development of the NASCO Habitat Database.

6. Review of Smolt Projects.

7. Water Quality and Salmon Health/Physiology: Acidic Waters and Mitigative Measures.

8. Genetics/Transgenics: Environmental Risks.

9. Additional Terms of Reference will be developed at a Committee meeting to be held in July 2003 at a location in central New England.

## 7. U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE MEMBERS

List of U.S. Atlantic Salmon Assessment Committee Members


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## 8.2. GLOSSARY OF ABBREVIATIONS

| | |
|---|---|
| Adopt-A-Salmon Family | AASF |
| Arcadia Research Hatchery | ARH |
| Central New England Fisheries Resource Office | CNEFRO |
| Connecticut River Atlantic Salmon Association | CRASA |
| Connecticut Department of Environmental Protection | CTDEP |
| Connecticut River Atlantic Salmon Commission | CRASC |
| Craig Brook National Fish Hatchery | CBNFH |
| Decorative Specialities International | DSI |
| Developmental Index | DI |
| Distinct Population Segment | DPS |
| Federal Energy Regulatory Commission | FERC |
| Geographic Information System | GIS |
| Greenfield Community College | GCC |
| Green Lake National Fish Hatchery | GLNFH |
| International Council for the Exploration of the Sea | ICES |
| Kensington State Salmon Hatchery | KSSH |
| Maine Atlantic Salmon Commission | MASC |
| Maine Department of Transportation | MDOT |
| Massachusetts Division of Fisheries and Wildlife | MAFW |
| Massachusetts Division of Marine Fisheries | MAMF |
| Nashua National Fish Hatchery | NNFH |
| National Academy of Sciences | NAS |
| National Marine Fisheries Service | NMFS |
| New England Atlantic Salmon Committee | NEASC |
| New Hampshire Fish and Game Department | NHFG |
| New Hampshire River Restoration Task Force | NHRRTF |
| North Atlantic Salmon Conservation Organization | NASCO |
| North Attleboro National Fish Hatchery | NANFH |
| Northeast Utilities Service Company | NUSCO |
| Passive Integrated Transponder | PIT |
| PG&E National Energy Group | PGE |
| Pittsford National Fish Hatchery | PNFH |
| Public Service of New Hampshire | PSNH |
| Rhode Island Division of Fish and Wildlife | RIFW |
| Richard Cronin National Salmon Station | RCNSS |
| Roger Reed State Fish Hatchery | RRSFH |
| Roxbury Fish Culture Station | RFCS |
| Salmon Swimbladder Sarcoma Virus | SSSV |
| Silvio O. Conte National Fish and Wildlife Refuge | SOCNFWR |
| Southern New Hampshire Hydroelectric Development Corp | SNHHDC |
| Sunderland Office of Fishery Assistance | SOFA |
| University of Massachusetts / Amherst | UMASS |
| U.S. Army Corps of Engineers | USACOE |
| U.S. Atlantic Salmon Assessment Committee | USASAC |

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|---|---|
| U.S. Generating Company | USGen |
| U.S. Geological Survey | USGS |
| U.S. Fish and Wildlife Service | USFWS |
| U.S. Forest Service | USFS |
| Vermont Fish and Wildlife | VTFW |
| Warren State Fishery Hatchery | WSFH |
| White River National Fish Hatchery | WRNFH |
| Whittemore Salmon Station | WSS |

## 8.3. GLOSSARY OF DEFINITIONS

*GENERAL*

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

suitable for the rearing of young salmon to the smolt stage.

| | |
|---|---|
| Objective | The specific level of achievement that management hopes to attain towards the fulfillment of the goal. |
| Restoration | The re-establishment of a population that will optimally utilize habitat for the production of young. |
| Salmon | A general term used here to refer to any life history stage of the Atlantic salmon from the fry stage to the adult stage. |
| Sea-run Broodstock | Atlantic salmon that return to the river, are captured alive, and held in confinement for the purpose of providing eggs for fish culture activities. |
| Strategy | Any action or integrated actions that will assist in achieving an objective and fulfilling the goal. |
| Wild Atlantic Salmon | Salmon that are the product of natural reproduction or the stocking of fry. Stocked fry are included because of the difficulty associated with discriminating between salmon produced through natural reproduction and those produced as a result of the stocking of fry. |

*LIFE HISTORY RELATED*

| | |
|---|---|
| Green Egg | The stage from spawning until faint eyes appear. |
| Eyed Egg | The stage from the appearance of faint eyes until hatching. |
| Fry | |
| Sac Fry | The period from hatching until end of primary dependence on the yolk sac. |
| Feeding Fry | The period from the end of the primary dependence on the yolk sac (initiation of feeding) to June 30 of the same year. |
| Fed Fry | Fry stocked subsequent to being fed an artificial diet. Often used interchangeably with the term “feeding fry” when associated with stocking activities. |
| Unfed Fry | Fry stocked without having been fed an artificial diet or natural diet. Most often associated with stocking activities. |
| Parr | Life history stage immediately following the fry stage until the commencement of migration to the sea as smolts. |
| Age 0 Parr | The period from August 15 to December 31 of the year of hatching. |

| | |
|---|---|
| Age 1 Parr | The period from January 1 to December 31 one year after hatching. |
| Age 2 Parr | The period from January 1 to December 31 two years after hatching. |
| Smolt | An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater. |
| 1 Smolt | The period from January 1 to June 30 of the year of migration. The migration year is one year after hatch. |
| 2 Smolt | The period from January 1 to June 30 of the year of migration. The migration year is two years after hatch. |
| 3 Smolt | The period from January 1 to June 30 of the year of migration. The migration year is three years after hatch. |
| Post Smolt | The period from July 1 to December 31 of the year the salmon became a smolt. |
| 1SW Smolt | A salmon that survives past December 31 since becoming a smolt. |
| Grilse | A one-sea-winter (SW) salmon that returns to the river to spawn. These fish usually weigh less than five pounds. |
| Multi-Sea-Winter Salmon | All adult salmon, excluding grilse that return to the river to spawn. Includes terms such as two-sea-winter salmon, three-sea-winter salmon, and repeat spawners. May also be referred to as large salmon. |
| 2SW Salmon | A salmon that survives past December 31 twice since becoming a smolt. |
| 3SW Salmon | A salmon that survives past December 31 three times since becoming a smolt. |
| 4SW Salmon | A salmon that survives past December 31four times since becoming a smolt. |
| Kelt | A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to homewaters to spawn again. |
| Reconditioned Kelt | A kelt that has been restored to a feeding condition in captivity. |
| Repeat Spawners | Salmon that return numerous times to the river for the |

purpose of reproducing. Previous spawner.

## 8.4. TABLES AND FIGURES SUPPORTING THE DOCUMENT

Figure G. Estimated take of DPS Atlantic salmon in the West Greenland commercial/local consumption fishery according to the U-BOAR model (Update – Backing Out Adult Returns). Straight line represents model results when all years are combined and points represent year-specific model results.

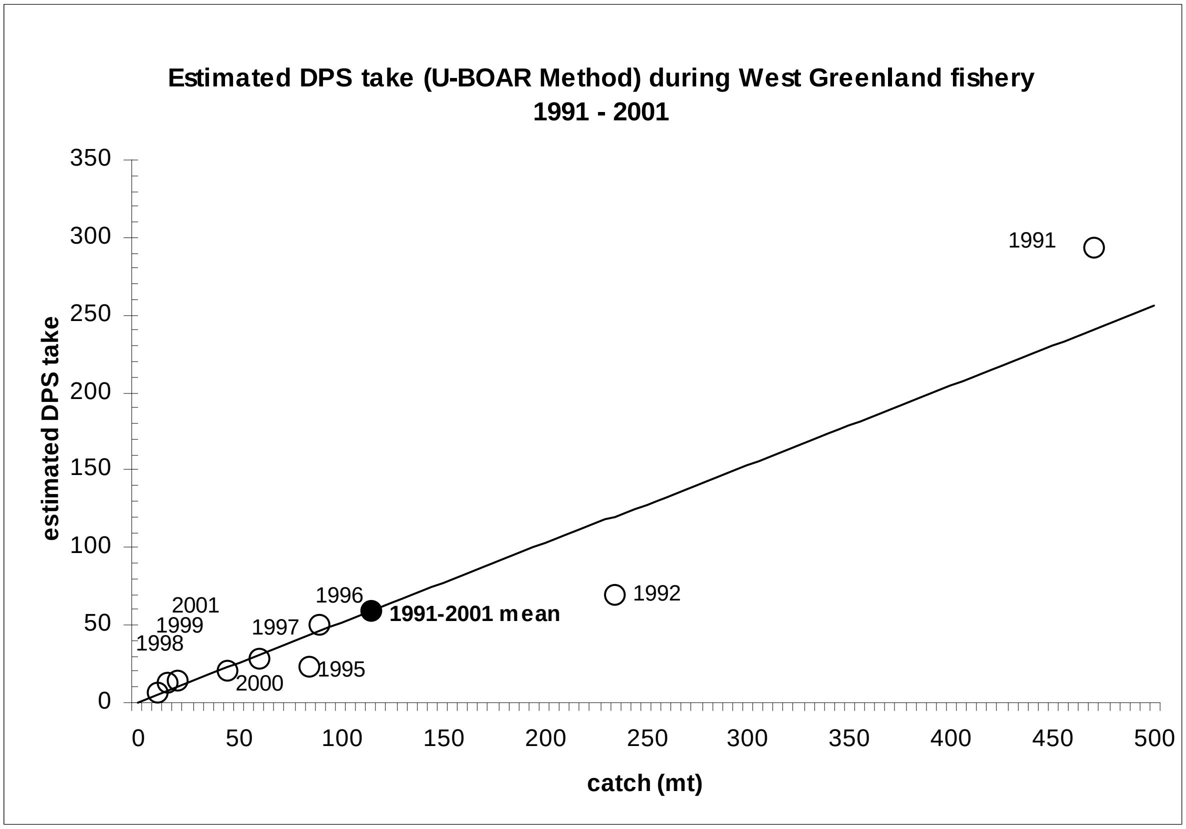


*Table 2.2.1.a Juvenile Atlantic salmon stocking summary for New England in 2002*

## United States

No. of fish stocked by lifestage

| River | Fry | 0+ Parr | 1 Parr | 1+ Parr | 1 Smolt | 2 Smolt | Total |
|---|---|---|---|---|---|---|---|
| Cocheco | 181,000 | 0 | 0 | 0 | 0 | 0 | 181,000 |
| **Total for Cocheco Program** | | | | | | | **181,000** |
| Connecticut | 7,283,000 | 700 | 0 | 0 | 500 | 0 | 7,284,200 |
| **Total for Connecticut Program** | | | | | | | **7,284,200** |
| Lamprey | 103,000 | 0 | 0 | 0 | 60,000 | 0 | 163,000 |
| **Total for Lamprey Program** | | | | | | | **163,000** |
| Androscoggin | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aroostook | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dennys | 84,000 | 33,000 | 1,900 | 0 | 49,000 | 0 | 167,900 |
| Ducktrap | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| East Machias | 236,000 | 0 | 0 | 0 | 0 | 0 | 236,000 |
| Kennebec | 7,000 | 0 | 0 | 0 | 0 | 0 | 7,000 |
| Machias | 327,000 | 0 | 0 | 0 | 0 | 0 | 327,000 |
| Narraguagus | 261,000 | 0 | 0 | 0 | 0 | 0 | 261,000 |
| Penobscot | 746,000 | 396,700 | 1,800 | 0 | 54,700 | 0 | 1,199,200 |
| Pleasant | 0 | 13,500 | 0 | 0 | 0 | 0 | 13,500 |
| Saco | 597,000 | 0 | 0 | 0 | 4,100 | 0 | 601,100 |
| Sheepscot | 172,000 | 0 | 0 | 0 | 0 | 0 | 172,000 |
| St Croix | 1,000 | 0 | 0 | 0 | 4,100 | 0 | 5,100 |
| Union | 5,000 | 0 | 0 | 0 | 0 | 0 | 5,000 |
| Upper StJohn | | | | | | | |
| **Total for Maine Program** | | | | | | | **2,994,800** |
| Merrimack | 1,414,000 | 0 | 0 | 1,900 | 50,000 | 1,200 | 1,467,100 |
| **Total for Merrimack Program** | | | | | | | **1,467,100** |
| Pawcatuck | 403,000 | 0 | 0 | 0 | 0 | 0 | 403,000 |
| **Total for Pawcatuck Program** | | | | | | | **403,000** |

**Total for United States** **12,493,100**

## Canada

No. of fish stocked by lifestage

| River | Fry | 0+ Parr | 1 Parr | 1+ Parr | 1 Smolt | 2 Smolt | Total |
|---|---|---|---|---|---|---|---|
| Aroostook | 122,000 | 0 | 0 | 0 | 0 | 0 | 122,000 |
| St Croix | 0 | 15,400 | 0 | 0 | 0 | 0 | 15,400 |
| **Total for Canada Program** | | | | | | | **137,400** |

**Total for Canada** **137,400**

## Grand Total **12,630,500**

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

*Table 2.2.1.b. Captive and domestic adult Atlantic salmon stocking summary for New England in 2002 by river, season, and year class (= year of egg take or wild collection).*

| | NUMBER RELEASED BY SEASON AND YEAR CLASS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring / early summer | | | | | Autumn | | | | | |
| | **1996** | **1997** | **1998** | **1999** | **2000** | **1996** | **1997** | **1998** | **1999** | **2000** | **Total** |
| ***United States*** | | | | | | | | | | | |
| Sheepscot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 120 | 0 | 0 | 120 |
| Penobscot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 551 | 527 | 1,078 |
| East Machias | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 107 | 0 | 0 | 107 |
| **Maine pgm :** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 227 | 551 | 527 | 1,305 |
| Merrimack | 0 | 0 | 1,053 | 840 | 0 | 0 | 0 | 278 | 100 | 0 | 2,271 |
| **Merrimack pgm :** | 0 | 0 | 1,053 | 840 | 0 | 0 | 0 | 278 | 100 | 0 | 2,271 |
| **Total United States** | 0 | 0 | 1,053 | 840 | 0 | 0 | 0 | 505 | 651 | 527 | 3,576 |

99% of Merrimack fish stocked for recreational angling purposes.

## Table 2.2.2.a. Atlantic salmon marking database for New England; marked fish released in 2002.

| River of release | Mark Agency | Age | Life Stage | Rearing History | Stock Origin | Tag/ Mark | Num Marked | Mark Comment | Aux Mark | Comments | Release Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Connecticut | PGE | 1+ | Smolt | Hatchery | Connecticut | RAD | 98 | | | Deerfield R., Normandeau Study | 5/29/2002 |
| Connecticut | PGE | 1+,2+ | Parr | Wild | Connecticut | PIT | 7 | | | Deerfield R., Normandeau Study | 11/19/2002 |
| Connecticut | PGE | 1+,2+ | Parr | Wild | Connecticut | PIT | 14 | | | Deerfield R., Normandeau Study | 11/20/2002 |
| Connecticut | PGE | 1+,2+ | Parr | Wild | Connecticut | PIT | 10 | | | Deerfield R., Normandeau Study | 11/21/2002 |
| Connecticut | PGE | 1+,2+ | Parr | Wild | Connecticut | PIT | 10 | | | Deerfield R., Normandeau Study | 11/25/2002 |
| Connecticut | PGE | 4 | Adult | Wild | Connecticut | RAD | 1 | | | Connecticut R., Normandeau Study | 6/11/2002 |
| Connecticut | PGE | 4 | Adult | Wild | Connecticut | RAD | 1 | | | Connecticut R., Normandeau Study | 6/19/2002 |
| Connecticut | PGE | 4 | Adult | Wild | Connecticut | RAD | 2 | | | Connecticut R., Normandeau Study | 5/31/2002 |
| Connecticut | USGS | ? | Parr | Wild | Connecticut | PIT | 312 | | | West Brook Study | 1/1/2002 |
| Connecticut | USGS | 0+ | Parr | Wild | Connecticut | PIT | 294 | | | West Brook Study | 1/1/2002 |
| Connecticut | USGS | 1 | Parr | Wild | Connecticut | PIT | 228 | | | West Brook Study | 1/1/2002 |
| Connecticut | USGS | 1+ | Smolt | Hatchery | Connecticut | PIT | 20 | | | Power Canal Turner Falls | 1/1/2002 |
| Connecticut | USGS | 1+ | Smolt | Hatchery | Connecticut | PIT | 200 | | | West R. Study | 1/1/2002 |
| Connecticut | USGS | 1+ | Smolt | Hatchery | Connecticut | PIT | 200 | | | Passumpsic R. Study | 1/1/2002 |

| River of release | Mark Agency | Age | Life Stage | Rearing History | Stock Origin | Tag/ Mark | Num Marked | Mark Comment | Aux Mark | Comments | Release Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Connecticut | USGS | 1+,2+ | Parr | Wild | Connecticut | PIT | 302 | | | Smith Brook Study | 1/1/2002 |
| Connecticut | USGS | 2 | Parr | Wild | Connecticut | PIT | 3 | | | West Brook Study | 1/1/2002 |
| **TOTAL Tags/Marks for** | **Connecticut** | | | | | | **1,702** | | | | |
| Dennys | NOAA | 0+ | Parr | Hatchery | Dennys | RV | 32,898 | | | | 10/2/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 3,383 | left eye red | AD | Meddybemps - Late Release | 5/6/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 3,207 | right eye red | AD | Meddybemps - Early Releas | 4/19/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 8,148 | right eye green | AD | Robinsons (parr/smolt) - Early | 4/19/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 17,598 | left eye orange | AD | Robinsons - Late Release | 5/6/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 2,573 | left eye green | AD | Robinsons (parr/smolt) - Late | 5/6/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | Ping | 150 | | | | 5/9/2002 |
| Dennys | NOAA | 1 | Smolt | Hatchery | Dennys | VIE | 15,952 | right eye orange | AD | Robinsons - Early Release | 4/19/2002 |
| **TOTAL Tags/Marks for** | **Dennys** | | | | | | **83,909** | | | | |
| Merrimack | EssexHydro | 1 | Smolt | Hatchery | Merrimack | FLOY | 500 | lakeng… | | Penacook | 5/1/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 160 | Yellow | | Franklin | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 6 | Blue | | Amoskeag Fishway | 4/15/2002 |

| River of release | Mark Agency | Age | Life Stage | Rearing History | Stock Origin | Tag/ Mark | Num Marked | Mark Comment | Aux Mark | Comments | Release Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 187 | Blue | | Garvins Falls | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 200 | Blue | | Hooksett | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 100 | Purple | | Franklin | 10/1/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 5 | Yellow | | Boscawen | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 2 | Yellow | | NHFG | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 160 | Yellow | | Sewalls Falls | 4/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 30 | Yellow | | Contoocook R. | 5/15/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 26 | Yellow | | Contoocook R. | 6/1/2002 |
| Merrimack | NHFG | 3 | Adult | Domestic | Merrimack | FLOY | 64 | Yellow | | Bristol | 4/15/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 178 | Grey | | Bristol | 10/1/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 100 | Purple | | Franklin | 10/1/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 155 | Yellow | | Boscawen | 4/15/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 80 | Yellow | | Bristol | 4/15/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 220 | Yellow | | Boscawen | 5/15/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 158 | Yellow | | Bristol | 5/15/2002 |

| River of release | Mark Agency | Age | Life Stage | Rearing History | Stock Origin | Tag/ Mark | Num Marked | Mark Comment | Aux Mark | Comments | Release Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 220 | Yellow | | Franklin | 5/15/2002 |
| Merrimack | NHFG | 4 | Adult | Domestic | Merrimack | FLOY | 220 | Yellow | | Sewalls Falls | 5/15/2002 |
| Merrimack | USFWS | 1 | Parr | Domestic | Merrimack | RV | 1,924 | | | Souhegan R. | 4/1/2002 |
| Merrimack | USFWS | 2 | Smolt | Domestic | Merrimack | RV | 1,246 | | | Lawrence | 4/1/2002 |
| **TOTAL Tags/Marks for** | | **Merrimack** | | | | | **5,941** | | | | |
| Narraguagus | NOAA | 2+ | Smolt | Wild | Narraguagus | Ping | 100 | | | | 1/1/2002 |
| **TOTAL Tags/Marks for** | | **Narraguagus** | | | | | **100** | | | | |
| Penobscot | NOAA | 0 | Parr | Hatchery | Penobscot | LV | 33,560 | | | | 9/26/2002 |
| Penobscot | NOAA | 0 | Parr | Hatchery | Penobscot | LV | 32,770 | | | | 9/30/2002 |
| Penobscot | NOAA | 0 | Parr | Hatchery | Penobscot | LV | 34,354 | | | | 10/1/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,698 | left eye red | AD | Piscataquis - Late Release | 5/7/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,716 | right eye red | AD | Mattawamkeag - Late Release | 5/6/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,636 | right eye pink | AD | Smolt ponds | 4/20/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,670 | right eye orange | AD | Penobscot Mainstem - Early | 5/8/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,615 | right eye green | AD | Mattawamkeag - Early Release | 4/15/2002 |

| River of release | Mark Agency | Age | Life Stage | Rearing History | Stock Origin | Tag/ Mark | Num Marked | Mark Comment | Aux Mark | Comments | Release Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 4,100 | left eye yellow | AD | Saco | 5/2/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,581 | left eye orange | AD | Penobscot Mainstem - Early | 4/17/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 24,673 | left eye green | AD | Piscataquis - Early Release | 4/16/2002 |
| Penobscot | NOAA | 1 | Smolt | Hatchery | Penobscot | VIE | 4,100 | left eye yellow | AD | St. Croix | 5/3/2002 |
| Penobscot | USFWS | 2+ | Adult | Domestic | Penobscot | PIT | 68 | | | | 12/11/2002 |
| Penobscot | USFWS | 3+ | Adult | Domestic | Penobscot | PIT | 66 | | | | 12/10/2002 |
| **TOTAL Tags/Marks for** | **Penobscot** | | | | | | **281,607** | | | | |

TAG/MARK CODES: AD = adipose clip; RAD = radio tag; AP = adipose punch; RV = RV Clip; BAL = Balloon tag; VIA = visible implant, alphanumeric; CAL = Calcein immers VIE = visible implant elastomer; FLOY = floy tag; VIEAC = visible implant elastomer and anal clip; PIT = PIT tag; VPP = VIE tag, PIT tag, and ultrasonic pinger; PTC = PIT tag a Carlin tag; VPT = VIE tag and PIT tag; ANL = anal clip/punch.

*If release dates were unknown, they were set to 1/1/2002

*Table 2.3.1 Documented Atlantic salmon returns to New England rivers in 2002.*

| | 1SW | | 2SW | | 3SW | | Repeat | | | 1998-2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchery | Wild | Hatchery | Wild | Hatchery | Wild | Hatchery | Wild | Total | Average |
| **Androscoggin** | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | **2** | **3.8** |
| **Cocheco** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1.0** |
| **Connecticut** | 0 | 2 | 3 | 38 | 0 | 1 | 0 | 0 | **44** | **123.0** |
| **Dennys** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | **5.5** |
| **Lamprey** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **2.0** |
| **Merrimack** | 31 | 1 | 17 | 6 | 0 | 0 | 0 | 0 | **55** | **105.6** |
| **Narraguagus** | 0 | 4 | 0 | 3 | 0 | 0 | 1 | 0 | **8** | **23.4** |
| **Pawcatuck** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **3.0** |
| **Penobscot** | 362 | 14 | 344 | 41 | 1 | 0 | 15 | 2 | **779** | **855.6** |
| **Pleasant** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **4.7** |
| **Saco** | 3 | 3 | 37 | 2 | 0 | 0 | 2 | 0 | **47** | **51.8** |
| **St Croix** | 14 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | **20** | **22.8** |
| **Union** | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | **5** | **5.8** |
| **Total** | **412** | **24** | **414** | **90** | **1** | **1** | **18** | **2** | **962** | **1,208.0** |

*Table 2.3.3. Summary of Atlantic salmon egg production in New England facilities in 2002.*

| Source River | Origin | Females Spawned | Total Egg Production | No. eggs per Female |
|---|---|---|---|---|
| Connecticut | Domestic | 1,974 | 10,826,000 | 5,500 |
| Merrimack | Domestic | 361 | 1,816,000 | 5,000 |
| Penobscot | Domestic | 484 | 1,300,000 | 2,700 |
| Dennys | Captive | 68 | 352,000 | 5,200 |
| East Machias | Captive | 92 | 466,000 | 5,100 |
| Machias | Captive | 111 | 533,000 | 4,800 |
| Narraguagus | Captive | 159 | 704,000 | 4,400 |
| Pleasant | Captive | 19 | 84,000 | 4,400 |
| Sheepscot | Captive | 100 | 455,000 | 4,600 |
| **Total** | **Captive/Domestic** | **3,368** | **16,536,000** | **4,900** |
| Connecticut | Kelt | 83 | 827,000 | 10,000 |
| Merrimack | Kelt | 21 | 232,000 | 11,000 |
| Pawcatuck | Kelt | 3 | 10,000 | 3,300 |
| **Total** | **Kelt** | **107** | **1,069,000** | **10,000** |
| Connecticut | Sea Run | 25 | 181,000 | 7,300 |
| Merrimack | Sea Run | 16 | 232,000 | 14,500 |
| Penobscot | Sea Run | 218 | 2,001,000 | 9,200 |
| **Total** | **Sea Run** | **259** | **2,414,000** | **9,300** |
| **Grand Total for Year 2002** | | **3,734** | **20,019,000** | **5,400** |

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

*Table 5.1.a. Summary of Atlantic salmon egg production in New England facilities.*

| Year | Sea-Run | | | Domestic | | | Captive | | | Kelt | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| **Cocheco** | | | | | | | | | | | | | | | |
| 1993 | 3 | 21,000 | 7,100 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 3 | 21,000 | 7,100 |
| **Total Cocheco** | 3 | 21,000 | 7,000 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 3 | 21,000 | 7,000 |
| **Connecticut** | | | | | | | | | | | | | | | |
| 1977-1991 | 208 | 6,787,000 | 8,400 | 1,063 | 19,840,000 | 5,800 | 0 | 0 | | 109 | 5,034,000 | 9,000 | 1,380 | 31,662,000 | 6,500 |
| 1992 | 236 | 1,891,000 | 8,000 | 650 | 3,925,000 | 6,000 | 0 | 0 | | 96 | 1,013,000 | 10,600 | 982 | 6,829,000 | 7,000 |
| 1993 | 121 | 1,054,000 | 8,700 | 714 | 3,879,000 | 5,400 | 0 | 0 | | 164 | 1,768,000 | 10,800 | 999 | 6,700,000 | 6,700 |
| 1994 | 151 | 1,224,000 | 8,100 | 1,094 | 7,551,000 | 6,900 | 0 | 0 | | 208 | 2,428,000 | 11,700 | 1,453 | 11,202,000 | 7,700 |
| 1995 | 101 | 946,000 | 9,400 | 1,258 | 7,555,000 | 6,000 | 0 | 0 | | 183 | 2,159,000 | 11,800 | 1,542 | 10,660,000 | 6,900 |
| 1996 | 115 | 938,000 | 8,200 | 1,732 | 11,845,000 | 6,800 | 0 | 0 | | 206 | 2,221,000 | 10,800 | 2,053 | 15,004,000 | 7,300 |
| 1997 | 110 | 771,000 | 7,000 | 1,809 | 11,602,000 | 6,400 | 0 | 0 | | 188 | 2,003,000 | 10,700 | 2,107 | 14,376,000 | 6,800 |
| 1998 | 185 | 1,452,000 | 7,900 | 1,140 | 7,030,000 | 6,200 | 0 | 0 | | 156 | 1,494,000 | 9,600 | 1,481 | 9,976,000 | 6,700 |
| 1999 | 83 | 622,000 | 7,500 | 1,862 | 11,173,000 | 6,000 | 0 | 0 | | 193 | 1,813,000 | 9,400 | 2,138 | 13,608,000 | 6,400 |
| 2000 | 49 | 300,000 | 6,100 | 2,471 | 12,200,000 | 4,900 | 0 | 0 | | 142 | 1,350,000 | 9,500 | 2,662 | 13,850,000 | 5,200 |
| 2001 | 20 | 162,000 | 8,100 | 1,955 | 9,870,000 | 5,000 | 0 | 0 | | 102 | 1,003,000 | 9,800 | 2,077 | 11,036,000 | 5,300 |
| 2002 | 25 | 181,000 | 7,300 | 1,974 | 10,826,000 | 5,500 | 0 | 0 | | 83 | 827,000 | 10,000 | 2,082 | 11,835,000 | 5,700 |
| **Total Connecticut** | 1,404 | 16,328,000 | 11,600 | 17,722 | 117,296,000 | 6,600 | 0 | 0 | | 1,830 | 23,113,000 | 12,600 | 20,956 | 156,738,000 | 7,500 |
| **Dennys** | | | | | | | | | | | | | | | |
| 1939-1991 | 12 | 113,000 | 9,400 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 12 | 113,000 | 9,400 |
| 1992 | 5 | 38,000 | 7,600 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 5 | 38,000 | 7,600 |
| 1993 | 3 | 19,000 | 6,400 | 0 | 0 | | 0 | 0 | | 2 | 9,000 | 4,300 | 5 | 28,000 | 5,600 |
| 1994 | 2 | 15,000 | 7,400 | 56 | 110,000 | 2,000 | 0 | 0 | | 6 | 30,000 | 5,100 | 64 | 156,000 | 2,400 |

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.
Note: Totals of eggs/female include only the years for which information on number of females is available.
Note: Connecticut data are preliminary prior to 1990.

| Year | Sea-Run No. females | Sea-Run Egg production | Sea-Run Eggs/ female | Domestic No. females | Domestic Egg production | Domestic Eggs/ female | Captive No. females | Captive Egg production | Captive Eggs/ female | Kelt No. females | Kelt Egg production | Kelt Eggs/ female | TOTAL No. females | TOTAL Egg production | TOTAL Eggs/ female |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 0 | 0 | | 0 | 0 | | 105 | 304,000 | 2,900 | 5 | 34,000 | 6,800 | 110 | 338,000 | 3,100 |
| 1996 | 4 | 29,000 | 7,200 | 0 | 0 | | 86 | 311,000 | 3,600 | 3 | 29,000 | 9,700 | 93 | 369,000 | 4,000 |
| 1997 | 0 | 0 | | 0 | 0 | | 113 | 430,000 | 3,800 | 7 | 64,000 | 9,200 | 120 | 494,000 | 4,100 |
| 1998 | 0 | 0 | | 0 | 0 | | 79 | 338,000 | 4,300 | 10 | 106,000 | 10,600 | 89 | 443,000 | 5,000 |
| 1999 | 0 | 0 | | 0 | 0 | | 48 | 249,000 | 5,200 | 7 | 58,000 | 8,200 | 55 | 306,000 | 5,600 |
| 2000 | 0 | 0 | | 0 | 0 | | 64 | 283,000 | 4,400 | 0 | 0 | | 64 | 283,000 | 4,400 |
| 2001 | 0 | 0 | | 0 | 0 | | 82 | 359,000 | 4,400 | 0 | 0 | | 82 | 359,000 | 4,400 |
| 2002 | 0 | 0 | | 0 | 0 | | 68 | 352,000 | 5,200 | 0 | 0 | | 68 | 352,000 | 5,200 |
| **Total Dennys** | 26 | 214,000 | 8,200 | 56 | 110,000 | 2,000 | 645 | 2,626,000 | 4,071 | 40 | 330,000 | 8,200 | 767 | 3,279,000 | 4,300 |
| **East Machias** | | | | | | | | | | | | | | | |
| 1995 | 0 | 0 | | 0 | 0 | | 65 | 144,000 | 2,200 | 0 | 0 | | 65 | 144,000 | 2,200 |
| 1996 | 0 | 0 | | 0 | 0 | | 96 | 221,000 | 2,300 | 0 | 0 | | 96 | 221,000 | 2,300 |
| 1997 | 0 | 0 | | 0 | 0 | | 111 | 394,000 | 3,500 | 0 | 0 | | 111 | 394,000 | 3,500 |
| 1998 | 0 | 0 | | 0 | 0 | | 103 | 362,000 | 3,500 | 0 | 0 | | 103 | 362,000 | 3,500 |
| 1999 | 0 | 0 | | 0 | 0 | | 57 | 296,000 | 5,200 | 0 | 0 | | 57 | 296,000 | 5,200 |
| 2000 | 0 | 0 | | 0 | 0 | | 68 | 394,000 | 5,800 | 0 | 0 | | 68 | 394,000 | 5,800 |
| 2001 | 0 | 0 | | 0 | 0 | | 67 | 400,000 | 6,000 | 0 | 0 | | 67 | 400,000 | 6,000 |
| 2002 | 0 | 0 | | 0 | 0 | | 92 | 466,000 | 5,100 | 0 | 0 | | 92 | 466,000 | 5,100 |
| **Total East Machias** | 0 | 0 | | 0 | 0 | 0 | 659 | 2,677,000 | 4,062 | 0 | 0 | | 659 | 2,677,000 | 4,100 |
| **Kennebec** | | | | | | | | | | | | | | | |
| 1979-1991 | 5 | 50,000 | 10,000 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 5 | 50,000 | 10,000 |
| **Total Kennebec** | 5 | 50,000 | 10,000 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 5 | 50,000 | 10,000 |
| **Lamprey** | | | | | | | | | | | | | | | |
| 1992 | 1 | 2,000 | 2,400 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 | 2,000 | 2,400 |

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

Note: Totals of eggs/female include only the years for which information on number of females is available.

Note: Connecticut data are preliminary prior to 1990.

| Year | Sea-Run | | | Domestic | | | Captive | | | Kelt | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| 1993 | 2 | 13,000 | 6,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 2 | 13,000 | 6,300 |
| 1994 | 3 | 17,000 | 5,700 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 3 | 17,000 | 5,700 |
| **Total Lamprey** | 6 | 32,000 | 5,300 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 6 | 32,000 | 5,300 |
| **Machias** | | | | | | | | | | | | | | | |
| 1941-1991 | 449 | 3,213,000 | 7,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 449 | 3,213,000 | 7,300 |
| 1993 | 7 | 50,000 | 7,200 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 7 | 50,000 | 7,200 |
| 1994 | 0 | 0 | | 88 | 196,000 | 2,200 | 0 | 0 | | 2 | 12,000 | 5,800 | 90 | 207,000 | 2,300 |
| 1995 | 0 | 0 | | 0 | 0 | | 171 | 484,000 | 2,800 | 4 | 28,000 | 6,900 | 175 | 512,000 | 2,900 |
| 1996 | 0 | 0 | | 0 | 0 | | 141 | 513,000 | 3,600 | 2 | 13,000 | 6,400 | 143 | 526,000 | 3,700 |
| 1997 | 0 | 0 | | 0 | 0 | | 176 | 603,000 | 3,400 | 0 | 0 | | 176 | 603,000 | 3,400 |
| 1998 | 0 | 0 | | 0 | 0 | | 166 | 548,000 | 3,300 | 0 | 0 | | 166 | 548,000 | 3,300 |
| 1999 | 0 | 0 | | 0 | 0 | | 121 | 550,000 | 4,500 | 0 | 0 | | 121 | 550,000 | 4,500 |
| 2000 | 0 | 0 | | 0 | 0 | | 110 | 417,000 | 3,800 | 0 | 0 | | 110 | 417,000 | 3,800 |
| 2001 | 0 | 0 | | 0 | 0 | | 108 | 672,000 | 6,200 | 0 | 0 | | 108 | 672,000 | 6,200 |
| 2002 | 0 | 0 | | 0 | 0 | | 111 | 533,000 | 4,800 | 0 | 0 | | 111 | 533,000 | 4,800 |
| **Total Machias** | 456 | 3,263,000 | 7,200 | 88 | 196,000 | 2,200 | 1,104 | 4,320,000 | 3,913 | 8 | 53,000 | 6,600 | 1,656 | 7,831,000 | 4,700 |
| **Merrimack** | | | | | | | | | | | | | | | |
| 1983-1991 | 583 | 4,238,000 | 7,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 583 | 4,238,000 | 7,300 |
| 1992 | 84 | 538,000 | 6,400 | 536 | 2,433,000 | 4,500 | 0 | 0 | | 0 | 0 | | 620 | 2,971,000 | 4,800 |
| 1993 | 42 | 322,000 | 7,700 | 1,573 | 9,665,000 | 6,100 | 0 | 0 | | 0 | 0 | | 1,615 | 9,986,000 | 6,200 |
| 1994 | 10 | 68,000 | 6,800 | 1,035 | 5,721,000 | 5,500 | 0 | 0 | | 0 | 0 | | 1,045 | 5,788,000 | 5,500 |
| 1995 | 24 | 188,000 | 7,800 | 694 | 4,353,000 | 6,300 | 0 | 0 | | 0 | 0 | | 718 | 4,541,000 | 6,300 |
| 1996 | 31 | 212,000 | 6,900 | 912 | 5,469,000 | 6,000 | 0 | 0 | | 0 | 0 | | 943 | 5,682,000 | 6,000 |
| 1997 | 31 | 284,000 | 9,200 | 754 | 4,642,000 | 6,200 | 0 | 0 | | 0 | 0 | | 785 | 4,926,000 | 6,300 |

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

Note: Totals of eggs/female include only the years for which information on number of females is available.

Note: Connecticut data are preliminary prior to 1990.

| Year | Sea-Run | | | Domestic | | | Captive | | | Kelt | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| 1998 | 63 | 518,000 | 8,200 | 560 | 2,669,000 | 4,800 | 0 | 0 | | 5 | 64,000 | 12,900 | 628 | 3,252,000 | 5,200 |
| 1999 | 88 | 737,000 | 8,400 | 520 | 2,659,000 | 5,100 | 0 | 0 | | 50 | 540,000 | 10,800 | 658 | 3,935,000 | 6,000 |
| 2000 | 38 | 311,000 | 8,200 | 596 | 2,625,000 | 4,400 | 0 | 0 | | 62 | 748,000 | 12,100 | 696 | 3,683,000 | 5,300 |
| 2001 | 37 | 296,000 | 8,000 | 726 | 2,585,000 | 3,600 | 0 | 0 | | 22 | 294,000 | 13,400 | 785 | 3,176,000 | 4,000 |
| 2002 | 16 | 232,000 | 14,500 | 361 | 1,816,000 | 5,000 | 0 | 0 | | 21 | 232,000 | 11,000 | 398 | 2,279,000 | 5,700 |
| **Total Merrimack** | 1,047 | 7,944,000 | 7,600 | 8,267 | 44,637,000 | 5,400 | 0 | 0 | | 160 | 1,878,000 | 11,700 | 9,474 | 54,457,000 | 5,700 |
| **Narraguagus** | | | | | | | | | | | | | | | |
| 1962-1991 | | 1,303,000 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | | 1,303,000 | |
| 1994 | 0 | 0 | | 59 | 146,000 | 2,500 | 0 | 0 | | 0 | 0 | | 59 | 146,000 | 2,500 |
| 1995 | 0 | 0 | | 0 | 0 | | 115 | 394,000 | 3,400 | 0 | 0 | | 115 | 394,000 | 3,400 |
| 1996 | 0 | 0 | | 0 | 0 | | 117 | 434,000 | 3,700 | 0 | 0 | | 117 | 434,000 | 3,700 |
| 1997 | 0 | 0 | | 0 | 0 | | 172 | 517,000 | 3,000 | 0 | 0 | | 172 | 517,000 | 3,000 |
| 1998 | 0 | 0 | | 0 | 0 | | 186 | 490,000 | 2,600 | 0 | 0 | | 186 | 490,000 | 2,600 |
| 1999 | 0 | 0 | | 0 | 0 | | 134 | 542,000 | 4,000 | 0 | 0 | | 134 | 542,000 | 4,000 |
| 2000 | 0 | 0 | | 0 | 0 | | 137 | 432,000 | 3,200 | 0 | 0 | | 137 | 432,000 | 3,200 |
| 2001 | 0 | 0 | | 0 | 0 | | 93 | 404,000 | 4,300 | 0 | 0 | | 93 | 404,000 | 4,300 |
| 2002 | 0 | 0 | | 0 | 0 | | 159 | 704,000 | 4,400 | 0 | 0 | | 159 | 704,000 | 4,400 |
| **Total Narraguagus** | 0 | 1,303,000 | | 59 | 146,000 | 2,500 | 1,113 | 3,917,000 | 3,519 | 0 | 0 | | 1,172 | 5,366,000 | 4,600 |
| **Orland** | | | | | | | | | | | | | | | |
| 1967-1991 | 39 | 270,000 | 7,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 39 | 270,000 | 7,300 |
| **Total Orland** | 39 | 270,000 | 6,900 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 39 | 270,000 | 6,900 |
| **Pawcatuck** | | | | | | | | | | | | | | | |
| 1992 | 4 | 36,000 | 8,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 4 | 36,000 | 8,900 |
| 1993 | 1 | 8,000 | 7,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 | 8,000 | 7,900 |

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

Note: Totals of eggs/female include only the years for which information on number of females is available.

Note: Connecticut data are preliminary prior to 1990.

| Year | Sea-Run | | | Domestic | | | Captive | | | Kelt | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| 1994 | 1 | 7,000 | 7,000 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 | 7,000 | 7,000 |
| 1996 | 1 | 17,000 | 16,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 | 17,000 | 16,900 |
| 1997 | 1 | 8,000 | 8,200 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 | 8,000 | 8,200 |
| 1999 | 6 | 61,000 | 10,200 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 6 | 61,000 | 10,200 |
| 2000 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 5 | 43,000 | 8,600 | 5 | 43,000 | 8,600 |
| 2001 | 0 | 0 | | 2 | 2,000 | 1,100 | 0 | 0 | | 1 | 8,000 | 7,800 | 3 | 10,000 | 3,300 |
| 2002 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 3 | 10,000 | 3,300 | 3 | 10,000 | 3,300 |
| **Total Pawcatuck** | 14 | 137,000 | 9,800 | 2 | 2,000 | 1,000 | 0 | 0 | | 9 | 61,000 | 6,800 | 25 | 200,000 | 8,000 |
| **Penobscot** | | | | | | | | | | | | | | | |
| 1871-1991 | 14,299 | 125,633,000 | 7,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 14,299 | 125,633,000 | 7,900 |
| 1992 | 351 | 2,448,000 | 7,000 | 614 | 1,519,000 | 2,500 | 0 | 0 | | 0 | 0 | | 965 | 3,967,000 | 4,100 |
| 1993 | 255 | 1,882,000 | 7,400 | 886 | 2,292,000 | 2,600 | 0 | 0 | | 0 | 0 | | 1,141 | 4,174,000 | 3,700 |
| 1994 | 215 | 1,670,000 | 7,800 | 645 | 1,655,000 | 2,600 | 0 | 0 | | 0 | 0 | | 860 | 3,325,000 | 3,900 |
| 1995 | 380 | 2,736,000 | 7,200 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 380 | 2,736,000 | 7,200 |
| 1996 | 380 | 2,635,000 | 6,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 380 | 2,635,000 | 6,900 |
| 1997 | 313 | 2,225,000 | 7,100 | 639 | 1,381,000 | 2,200 | 0 | 0 | | 0 | 0 | | 952 | 3,606,000 | 3,800 |
| 1998 | 392 | 2,804,000 | 7,200 | 560 | 1,456,000 | 2,600 | 0 | 0 | | 0 | 0 | | 952 | 4,260,000 | 4,500 |
| 1999 | 286 | 2,418,000 | 8,500 | 371 | 1,300,000 | 3,500 | 0 | 0 | | 0 | 0 | | 657 | 3,719,000 | 5,700 |
| 2000 | 196 | 1,559,000 | 8,000 | 540 | 1,334,000 | 2,500 | 0 | 0 | | 0 | 0 | | 736 | 2,893,000 | 3,900 |
| 2001 | 282 | 2,451,000 | 8,700 | 453 | 1,206,000 | 2,700 | 0 | 0 | | 0 | 0 | | 735 | 3,657,000 | 5,000 |
| 2002 | 218 | 2,001,000 | 9,200 | 484 | 1,300,000 | 2,700 | 0 | 0 | | 0 | 0 | | 702 | 3,301,000 | 4,700 |
| **Total Penobscot** | 17,567 | 150,462,000 | 8,600 | 5,192 | 13,443,000 | 2,600 | 0 | 0 | | 0 | 0 | | 22,759 | 163,906,000 | 7,200 |
| **Pleasant** | | | | | | | | | | | | | | | |
| 2001 | 0 | 0 | | 0 | 0 | | 13 | 46,000 | 3,500 | 0 | 0 | | 13 | 46,000 | 3,500 |

Captive refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.
Note: Totals of eggs/female include only the years for which information on number of females is available.
Note: Connecticut data are preliminary prior to 1990.

| Year | Sea-Run | | | Domestic | | | Captive | | | Kelt | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| 2002 | 0 | 0 | | 0 | 0 | | 19 | 84,000 | 4,400 | 0 | 0 | | 19 | 84,000 | 4,400 |
| **Total Pleasant** | 0 | 0 | | 0 | 0 | 0 | 32 | 130,000 | 4,063 | 0 | 0 | | 32 | 130,000 | 4,100 |
| **Sheepscot** | | | | | | | | | | | | | | | |
| 1995 | 11 | 78,000 | 7,100 | 0 | 0 | | 22 | 44,000 | 2,000 | 0 | 0 | | 33 | 123,000 | 3,700 |
| 1996 | 7 | 47,000 | 6,700 | 0 | 0 | | 36 | 66,000 | 1,800 | 7 | 66,000 | 9,400 | 50 | 179,000 | 3,600 |
| 1997 | 0 | 0 | | 0 | 0 | | 75 | 257,000 | 3,400 | 13 | 118,000 | 9,100 | 88 | 376,000 | 4,300 |
| 1998 | 0 | 0 | | 0 | 0 | | 98 | 343,000 | 3,500 | 17 | 181,000 | 10,700 | 115 | 525,000 | 4,600 |
| 1999 | 0 | 0 | | 0 | 0 | | 49 | 218,000 | 4,500 | 8 | 92,000 | 11,500 | 57 | 310,000 | 5,400 |
| 2000 | 0 | 0 | | 0 | 0 | | 60 | 246,000 | 4,100 | 0 | 0 | | 60 | 246,000 | 4,100 |
| 2001 | 0 | 0 | | 0 | 0 | | 56 | 351,000 | 6,300 | 0 | 0 | | 56 | 351,000 | 6,300 |
| 2002 | 0 | 0 | | 0 | 0 | | 100 | 455,000 | 4,600 | 0 | 0 | | 100 | 455,000 | 4,600 |
| **Total Sheepscot** | 18 | 125,000 | 6,900 | 0 | 0 | 0 | 496 | 1,980,000 | 3,992 | 45 | 457,000 | 10,200 | 559 | 2,565,000 | 4,600 |
| **St Croix** | | | | | | | | | | | | | | | |
| 1993 | 15 | 114,000 | 7,600 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 15 | 114,000 | 7,600 |
| 1994 | 11 | 80,000 | 7,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 11 | 80,000 | 7,300 |
| 1995 | 10 | 77,000 | 7,700 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 10 | 77,000 | 7,700 |
| **Total St Croix** | 36 | 271,000 | 7,500 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 36 | 271,000 | 7,500 |
| **Union** | | | | | | | | | | | | | | | |
| 1974-1991 | 600 | 4,611,000 | 7,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 600 | 4,611,000 | 7,900 |
| **Total Union** | 600 | 4,611,000 | 7,700 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 600 | 4,611,000 | 7,700 |

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

Note: Totals of eggs/female include only the years for which information on number of females is available.

Note: Connecticut data are preliminary prior to 1990.

***Table 5.1.b. Summary of all historical Atlantic salmon egg production in New England facilities.***

| | **Sea-Run** | | | **Domestic** | | | **Captive** | | | **Kelt** | | | **TOTAL** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female | No. females | Egg production | Eggs/ female |
| **Cocheco** | 3 | 21,000 | 7,100 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 3 | 21,000 | 7,100 |
| **Connecticut** | 1,404 | 16,328,000 | 11,600 | 17,722 | 117,296,000 | 6,600 | 0 | 0 | | 1,830 | 23,114,000 | 12,600 | 20,956 | 156,737,000 | 7,500 |
| **Dennys** | 26 | 214,000 | 8,200 | 56 | 110,000 | 2,000 | 645 | 2,624,000 | 4,100 | 40 | 330,000 | 8,300 | 767 | 3,278,000 | 4,300 |
| **East Machias** | 0 | 0 | | 0 | 0 | | 659 | 2,677,000 | 4,100 | 0 | 0 | | 659 | 2,677,000 | 4,100 |
| **Kennebec** | 5 | 50,000 | 10,000 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 5 | 50,000 | 10,000 |
| **Lamprey** | 6 | 32,000 | 5,300 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 6 | 32,000 | 5,300 |
| **Machias** | 456 | 3,263,000 | 7,200 | 88 | 196,000 | 2,200 | 1,104 | 4,318,000 | 3,900 | 8 | 52,000 | 6,500 | 1,656 | 7,829,000 | 4,700 |
| **Merrimack** | 1,047 | 7,942,000 | 7,600 | 8,267 | 44,636,000 | 5,400 | 0 | 0 | | 160 | 1,877,000 | 11,700 | 9,474 | 54,456,000 | 5,700 |
| **Narraguagus** | 0 | 1,303,000 | | 59 | 146,000 | 2,500 | 1,113 | 3,917,000 | 3,500 | 0 | 0 | | 1,172 | 5,366,000 | 4,600 |
| **Orland** | 39 | 270,000 | 6,900 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 39 | 270,000 | 6,900 |
| **Pawcatuck** | 14 | 137,000 | 9,800 | 2 | 2,000 | 1,100 | 0 | 0 | | 9 | 61,000 | 6,800 | 25 | 200,000 | 8,000 |
| **Penobscot** | 17,567 | 150,462,000 | 8,600 | 5,192 | 13,443,000 | 2,600 | 0 | 0 | | 0 | 0 | | 22,759 | 163,905,000 | 7,200 |
| **Pleasant** | 0 | 0 | | 0 | 0 | | 32 | 130,000 | 4,100 | 0 | 0 | | 32 | 130,000 | 4,100 |
| **Sheepscot** | 18 | 125,000 | 7,000 | 0 | 0 | | 496 | 1,981,000 | 4,000 | 45 | 458,000 | 10,200 | 559 | 2,565,000 | 4,600 |
| **St Croix** | 36 | 271,000 | 7,500 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 36 | 271,000 | 7,500 |
| **Union** | 600 | 4,611,000 | 7,700 | 0 | 0 | | 0 | 0 | | 0 | 0 | | 600 | 4,611,000 | 7,700 |
| **Grand Total** | **21,221** | **185,029,000** | **8,700** | **31,386** | **175,829,000** | **5,600** | **4,049** | **15,647,000** | **3,900** | **2,092** | **25,892,000** | **12,400** | **58,748** | **402,398,000** | **6,800** |

*Table 5.2.a. Atlantic salmon stocking summary for New England, by river.*

| | Number of fish stocked by life stage | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fry | 0+ Parr | 1 Parr | 1+ Parr | 1 Smolt | 2 Smolt | Total |
| **Androscoggin** | | | | | | | |
| 2001 | 3,000 | 0 | 0 | 0 | 0 | 0 | 3,000 |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals:Androscoggin** | **3,000** | **0** | **0** | **0** | **0** | **0** | **3,000** |
| **Aroostook** | | | | | | | |
| 1978-1991 | 624,000 | 317,100 | 20,400 | 1,800 | 32,600 | 29,800 | 1,025,700 |
| 1992 | 0 | 0 | 16,400 | 0 | 0 | 0 | 16,400 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 4,000 | 0 | 0 | 0 | 0 | 0 | 4,000 |
| 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 578,000 | 0 | 0 | 0 | 0 | 0 | 578,000 |
| 1998 | 142,000 | 0 | 0 | 0 | 0 | 0 | 142,000 |
| 1999 | 163,000 | 0 | 0 | 0 | 0 | 0 | 163,000 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 182,000 | 300 | 0 | 0 | 0 | 0 | 182,300 |
| 2002 | 122,000 | 0 | 0 | 0 | 0 | 0 | 122,000 |
| **Totals:Aroostook** | **1,815,000** | **317,400** | **36,800** | **1,800** | **32,600** | **29,800** | **2,233,400** |
| **Cocheco** | | | | | | | |
| 1988-1991 | 278,000 | 50,000 | 9,500 | 0 | 0 | 0 | 337,500 |
| 1992 | 128,000 | 0 | 0 | 0 | 0 | 0 | 128,000 |
| 1993 | 127,000 | 0 | 0 | 1,000 | 0 | 0 | 128,000 |
| 1994 | 149,000 | 0 | 0 | 0 | 5,300 | 0 | 154,300 |
| 1995 | 114,000 | 0 | 0 | 0 | 0 | 0 | 114,000 |
| 1996 | 126,000 | 0 | 0 | 0 | 0 | 0 | 126,000 |
| 1997 | 128,000 | 0 | 0 | 0 | 0 | 0 | 128,000 |
| 1998 | 96,000 | 0 | 0 | 0 | 0 | 0 | 96,000 |
| 1999 | 157,000 | 0 | 0 | 0 | 0 | 0 | 157,000 |
| 2000 | 146,000 | 0 | 0 | 0 | 0 | 0 | 146,000 |
| 2001 | 165,000 | 0 | 0 | 0 | 0 | 0 | 165,000 |
| 2002 | 181,000 | 0 | 0 | 0 | 0 | 0 | 181,400 |
| **Totals:Cocheco** | **1,795,000** | **50,000** | **9,500** | **1,000** | **5,300** | **0** | **1,861,200** |
| **Connecticut** | | | | | | | |
| 1967-1991 | 9,315,000 | 2,206,900 | 1,524,900 | 218,700 | 2,658,100 | 963,200 | 16,886,800 |
| 1992 | 2,009,000 | 313,900 | 11,500 | 0 | 313,300 | 0 | 2,647,700 |
| 1993 | 4,147,000 | 237,100 | 28,700 | 0 | 382,800 | 0 | 4,795,600 |
| 1994 | 5,979,000 | 37,000 | 2,300 | 12,900 | 375,100 | 0 | 6,406,300 |
| 1995 | 6,818,000 | 4,500 | 0 | 0 | 1,300 | 0 | 6,823,800 |
| 1996 | 6,675,000 | 12,400 | 0 | 3,600 | 11,500 | 0 | 6,702,500 |
| 1997 | 8,526,000 | 8,800 | 0 | 0 | 1,400 | 0 | 8,536,200 |
| 1998 | 9,119,000 | 3,000 | 0 | 7,700 | 1,700 | 0 | 9,131,400 |
| 1999 | 6,428,000 | 1,000 | 0 | 0 | 22,600 | 0 | 6,451,600 |
| 2000 | 9,328,000 | 600 | 0 | 0 | 700 | 48,200 | 9,377,500 |
| 2001 | 9,591,000 | 1,600 | 0 | 0 | 700 | 0 | 9,593,700 |
| 2002 | 7,283,000 | 700 | 0 | 0 | 500 | 0 | 7,284,500 |

| | *Number of fish stocked by life stage* | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Fry** | **0+ Parr** | **1 Parr** | **1+ Parr** | **1 Smolt** | **2 Smolt** | **Total** |
| **Totals:Connecticut** | **85,218,000** | **2,827,500** | **1,567,400** | **242,900** | **3,769,700** | **1,011,400** | **94,637,600** |
| **Dennys** | | | | | | | |
| 1975-1991 | 131,000 | 8,300 | 3,400 | 0 | 143,100 | 28,300 | 314,100 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 33,000 | 0 | 0 | 0 | 0 | 0 | 33,000 |
| 1994 | 20,000 | 0 | 0 | 0 | 0 | 0 | 20,000 |
| 1995 | 84,000 | 0 | 0 | 0 | 0 | 0 | 84,000 |
| 1996 | 142,000 | 0 | 0 | 0 | 0 | 900 | 142,900 |
| 1997 | 192,000 | 0 | 0 | 0 | 0 | 0 | 192,000 |
| 1998 | 233,000 | 10,400 | 0 | 0 | 9,600 | 0 | 253,000 |
| 1999 | 172,000 | 3,000 | 0 | 0 | 0 | 0 | 175,000 |
| 2000 | 96,000 | 30,500 | 0 | 0 | 0 | 0 | 126,500 |
| 2001 | 59,000 | 16,500 | 1,400 | 0 | 49,800 | 0 | 126,700 |
| 2002 | 84,000 | 33,000 | 1,900 | 0 | 49,000 | 0 | 167,900 |
| **Totals:Dennys** | **1,246,000** | **101,700** | **6,700** | **0** | **251,500** | **29,200** | **1,635,100** |
| **Ducktrap** | | | | | | | |
| 1986-1991 | 68,000 | 0 | 0 | 0 | 0 | 0 | 68,000 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals:Ducktrap** | **68,000** | **0** | **0** | **0** | **0** | **0** | **68,000** |
| **East Machias** | | | | | | | |
| 1973-1991 | 140,000 | 6,500 | 42,600 | 0 | 97,600 | 30,400 | 317,100 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 115,000 | 0 | 0 | 0 | 0 | 0 | 115,000 |
| 1997 | 113,000 | 0 | 0 | 0 | 0 | 0 | 113,000 |
| 1998 | 190,000 | 0 | 0 | 0 | 10,800 | 0 | 200,800 |
| 1999 | 210,000 | 1,000 | 0 | 0 | 0 | 0 | 211,000 |
| 2000 | 197,000 | 0 | 0 | 0 | 0 | 0 | 197,000 |
| 2001 | 242,000 | 0 | 0 | 0 | 0 | 0 | 242,000 |
| 2002 | 236,000 | 0 | 0 | 0 | 0 | 0 | 236,000 |
| **Totals:East Machias** | **1,443,000** | **7,500** | **42,600** | **0** | **108,400** | **30,400** | **1,631,900** |
| **Kennebec** | | | | | | | |
| 2001 | 3,000 | 0 | 0 | 0 | 0 | 0 | 3,000 |
| 2002 | 7,000 | 0 | 0 | 0 | 0 | 0 | 6,600 |

| | Number of fish stocked by life stage | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fry | 0+ Parr | 1 Parr | 1+ Parr | 1 Smolt | 2 Smolt | Total |
| **Totals:Kennebec** | **10,000** | **0** | **0** | **0** | **0** | **0** | **9,600** |
| **Lamprey** | | | | | | | |
| 1978-1991 | 306,000 | 155,200 | 11,400 | 0 | 118,300 | 32,800 | 623,700 |
| 1992 | 127,000 | 12,700 | 0 | 0 | 0 | 0 | 139,700 |
| 1993 | 68,000 | 56,500 | 28,800 | 1,100 | 15,000 | 0 | 169,400 |
| 1994 | 98,000 | 56,300 | 7,800 | 0 | 0 | 0 | 162,100 |
| 1995 | 91,000 | 57,100 | 0 | 0 | 4,800 | 0 | 152,900 |
| 1996 | 115,000 | 37,000 | 8,400 | 1,000 | 0 | 0 | 161,400 |
| 1997 | 141,000 | 52,900 | 0 | 0 | 0 | 0 | 193,900 |
| 1998 | 95,000 | 0 | 0 | 0 | 3,300 | 0 | 98,300 |
| 1999 | 127,000 | 0 | 0 | 0 | 0 | 0 | 127,000 |
| 2000 | 104,000 | 0 | 0 | 0 | 0 | 0 | 104,000 |
| 2001 | 111,000 | 0 | 0 | 300 | 0 | 0 | 111,300 |
| 2002 | 103,000 | 0 | 0 | 0 | 60,000 | 0 | 163,500 |
| **Totals:Lamprey** | **1,486,000** | **427,700** | **56,400** | **2,400** | **201,400** | **32,800** | **2,207,200** |
| **Machias** | | | | | | | |
| 1970-1991 | 175,000 | 86,900 | 117,800 | 0 | 180,500 | 42,200 | 602,400 |
| 1992 | 14,000 | 0 | 0 | 0 | 0 | 0 | 14,000 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 50,000 | 0 | 0 | 0 | 0 | 0 | 50,000 |
| 1995 | 150,000 | 0 | 0 | 0 | 0 | 0 | 150,000 |
| 1996 | 233,000 | 0 | 0 | 0 | 0 | 1,900 | 234,900 |
| 1997 | 236,000 | 0 | 0 | 0 | 0 | 0 | 236,000 |
| 1998 | 300,000 | 5,900 | 0 | 0 | 10,800 | 0 | 316,700 |
| 1999 | 169,000 | 1,000 | 0 | 0 | 0 | 0 | 170,000 |
| 2000 | 209,000 | 0 | 0 | 0 | 0 | 0 | 209,000 |
| 2001 | 267,000 | 0 | 0 | 0 | 0 | 0 | 267,000 |
| 2002 | 327,000 | 0 | 0 | 0 | 0 | 0 | 327,000 |
| **Totals:Machias** | **2,130,000** | **93,800** | **117,800** | **0** | **191,300** | **44,100** | **2,577,000** |
| **Merrimack** | | | | | | | |
| 1976-1991 | 8,021,000 | 222,500 | 398,700 | 157,300 | 695,400 | 630,500 | 10,125,400 |
| 1992 | 1,118,000 | 0 | 100 | 0 | 96,400 | 0 | 1,214,500 |
| 1993 | 1,157,000 | 0 | 0 | 0 | 59,000 | 0 | 1,216,000 |
| 1994 | 2,816,000 | 0 | 0 | 0 | 85,000 | 0 | 2,901,000 |
| 1995 | 2,827,000 | 0 | 12,700 | 0 | 70,800 | 0 | 2,910,500 |
| 1996 | 1,795,000 | 0 | 0 | 4,900 | 50,000 | 0 | 1,849,900 |
| 1997 | 1,977,000 | 5,000 | 4,700 | 5,300 | 52,500 | 5,400 | 2,049,900 |
| 1998 | 2,589,000 | 0 | 0 | 6,800 | 51,900 | 0 | 2,647,700 |
| 1999 | 1,756,000 | 0 | 0 | 4,400 | 56,400 | 0 | 1,816,800 |
| 2000 | 2,217,000 | 0 | 0 | 0 | 52,500 | 0 | 2,269,500 |
| 2001 | 1,708,000 | 0 | 0 | 0 | 49,500 | 0 | 1,757,100 |
| 2002 | 1,414,000 | 0 | 0 | 1,900 | 50,000 | 1,200 | 1,466,800 |
| **Totals:Merrimack** | **29,395,000** | **227,500** | **416,200** | **180,600** | **1,369,400** | **637,100** | **32,225,100** |
| **Narraguagus** | | | | | | | |
| 1970-1991 | 74,000 | 30,300 | 12,600 | 0 | 106,100 | 84,000 | 307,000 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| *Number of fish stocked by life stage* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Fry** | **0+ Parr** | **1 Parr** | **1+ Parr** | **1 Smolt** | **2 Smolt** | **Total** |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 105,000 | 0 | 0 | 0 | 0 | 0 | 105,000 |
| 1996 | 196,000 | 0 | 0 | 0 | 0 | 0 | 196,000 |
| 1997 | 207,000 | 0 | 2,000 | 0 | 700 | 0 | 209,700 |
| 1998 | 274,000 | 14,400 | 0 | 0 | 0 | 0 | 288,400 |
| 1999 | 155,000 | 18,200 | 0 | 0 | 1,000 | 0 | 174,200 |
| 2000 | 252,000 | 0 | 0 | 0 | 0 | 0 | 252,000 |
| 2001 | 353,000 | 0 | 0 | 0 | 0 | 0 | 353,000 |
| 2002 | 261,000 | 0 | 0 | 0 | 0 | 0 | 261,000 |
| **Totals:Narraguagus** | **1,877,000** | **62,900** | **14,600** | **0** | **107,800** | **84,000** | **2,146,300** |
| **Pawcatuck** | | | | | | | |
| 1979-1991 | 163,000 | 935,600 | 228,000 | 0 | 23,200 | 500 | 1,350,300 |
| 1992 | 0 | 70,800 | 2,500 | 0 | 5,000 | 0 | 78,300 |
| 1993 | 383,000 | 14,500 | 4,000 | 0 | 2,300 | 0 | 403,800 |
| 1994 | 557,000 | 0 | 0 | 0 | 0 | 0 | 557,000 |
| 1995 | 367,000 | 52,200 | 0 | 0 | 0 | 0 | 419,200 |
| 1996 | 289,000 | 136,100 | 0 | 0 | 5,000 | 0 | 430,100 |
| 1997 | 100,000 | 0 | 14,000 | 0 | 11,500 | 0 | 125,500 |
| 1998 | 910,000 | 0 | 6,100 | 8,600 | 5,700 | 0 | 930,400 |
| 1999 | 591,000 | 0 | 0 | 0 | 3,900 | 0 | 594,900 |
| 2000 | 326,000 | 0 | 0 | 0 | 0 | 0 | 326,000 |
| 2001 | 423,000 | 0 | 0 | 0 | 8,500 | 0 | 431,500 |
| 2002 | 403,000 | 0 | 0 | 0 | 0 | 0 | 403,200 |
| **Totals:Pawcatuck** | **4,512,000** | **1,209,200** | **254,600** | **8,600** | **65,100** | **500** | **6,050,200** |
| **Penobscot** | | | | | | | |
| 1970-1991 | 2,733,000 | 752,200 | 1,217,800 | 9,100 | 5,134,500 | 2,500,100 | 12,293,200 |
| 1992 | 925,000 | 278,200 | 106,600 | 0 | 816,600 | 8,100 | 2,134,500 |
| 1993 | 1,320,000 | 202,300 | 9,600 | 0 | 580,400 | 0 | 2,112,300 |
| 1994 | 949,000 | 0 | 2,400 | 0 | 567,600 | 0 | 1,519,000 |
| 1995 | 502,000 | 325,000 | 5,600 | 0 | 568,400 | 0 | 1,401,000 |
| 1996 | 1,242,000 | 226,000 | 17,500 | 0 | 552,200 | 0 | 2,037,700 |
| 1997 | 1,469,000 | 310,900 | 4,200 | 0 | 580,200 | 0 | 2,364,300 |
| 1998 | 930,000 | 337,400 | 13,400 | 0 | 571,800 | 0 | 1,852,600 |
| 1999 | 1,498,000 | 229,600 | 1,500 | 0 | 567,300 | 0 | 2,296,400 |
| 2000 | 513,000 | 288,800 | 700 | 0 | 563,200 | 0 | 1,365,700 |
| 2001 | 364,000 | 235,800 | 2,100 | 0 | 454,000 | 0 | 1,055,900 |
| 2002 | 746,000 | 396,700 | 1,800 | 0 | 54,700 | 0 | 1,199,200 |
| **Totals:Penobscot** | **13,191,000** | **3,582,900** | **1,383,200** | **9,100** | **11,010,900** | **2,508,200** | **31,631,800** |
| **Pleasant** | | | | | | | |
| 1975-1991 | 187,000 | 2,500 | 1,800 | 0 | 54,700 | 18,100 | 264,100 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | *Number of fish stocked by life stage* | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Fry** | **0+ Parr** | **1 Parr** | **1+ Parr** | **1 Smolt** | **2 Smolt** | **Total** |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 0 | 13,500 | 0 | 0 | 0 | 0 | 13,500 |
| **Totals:Pleasant** | **187,000** | **16,000** | **1,800** | **0** | **54,700** | **18,100** | **277,600** |
| **Saco** | | | | | | | |
| 1975-1991 | 158,000 | 115,000 | 200,800 | 0 | 143,600 | 9,500 | 626,900 |
| 1992 | 154,000 | 50,200 | 400 | 0 | 19,800 | 0 | 224,400 |
| 1993 | 167,000 | 0 | 0 | 0 | 20,100 | 0 | 187,100 |
| 1994 | 190,000 | 0 | 0 | 0 | 20,000 | 0 | 210,000 |
| 1995 | 376,000 | 0 | 0 | 0 | 19,700 | 0 | 395,700 |
| 1996 | 0 | 45,000 | 0 | 0 | 20,000 | 0 | 65,000 |
| 1997 | 97,000 | 63,300 | 0 | 0 | 20,200 | 0 | 180,500 |
| 1998 | 429,000 | 50,000 | 0 | 0 | 21,300 | 0 | 500,300 |
| 1999 | 688,000 | 47,000 | 0 | 0 | 20,100 | 0 | 755,100 |
| 2000 | 599,000 | 48,200 | 0 | 0 | 22,600 | 0 | 669,800 |
| 2001 | 479,000 | 0 | 0 | 0 | 400 | 0 | 479,400 |
| 2002 | 597,000 | 0 | 0 | 0 | 4,100 | 0 | 601,100 |
| **Totals:Saco** | **3,934,000** | **418,700** | **201,200** | **0** | **331,900** | **9,500** | **4,895,300** |
| **Sheepscot** | | | | | | | |
| 1971-1991 | 159,000 | 70,800 | 20,600 | 0 | 92,200 | 7,100 | 349,700 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 102,000 | 0 | 0 | 0 | 0 | 0 | 102,000 |
| 1997 | 64,000 | 0 | 0 | 0 | 0 | 0 | 64,000 |
| 1998 | 256,000 | 9,300 | 0 | 0 | 0 | 0 | 265,300 |
| 1999 | 302,000 | 4,700 | 0 | 0 | 0 | 0 | 306,700 |
| 2000 | 211,000 | 0 | 0 | 0 | 0 | 0 | 211,000 |
| 2001 | 171,000 | 0 | 0 | 0 | 0 | 0 | 171,000 |
| 2002 | 172,000 | 0 | 0 | 0 | 0 | 0 | 172,000 |
| **Totals:Sheepscot** | **1,437,000** | **84,800** | **20,600** | **0** | **92,200** | **7,100** | **1,641,700** |
| **St Croix** | | | | | | | |
| 1981-1991 | 1,087,000 | 107,300 | 143,200 | 0 | 580,600 | 20,100 | 1,938,200 |
| 1992 | 85,000 | 56,500 | 14,900 | 0 | 50,300 | 0 | 206,700 |
| 1993 | 0 | 101,000 | 0 | 0 | 40,100 | 0 | 141,100 |
| 1994 | 87,000 | 38,600 | 0 | 0 | 60,600 | 0 | 186,200 |
| 1995 | 1,000 | 0 | 0 | 0 | 0 | 0 | 1,000 |
| 1996 | 0 | 52,100 | 0 | 0 | 15,600 | 0 | 67,700 |
| 1997 | 1,000 | 400 | 0 | 0 | 0 | 0 | 1,400 |
| 1998 | 2,000 | 31,700 | 0 | 200 | 0 | 0 | 33,900 |
| 1999 | 1,000 | 22,500 | | | 21,300 | | |
| 2000 | 1,000 | 19,000 | 0 | 0 | 20,000 | 0 | 40,000 |
| 2001 | 1,000 | 6,300 | 0 | 0 | 8,100 | 0 | 15,400 |
| 2002 | 1,000 | 15,400 | 0 | 0 | 4,100 | 0 | 20,500 |
| **Totals:St Croix** | **1,267,000** | **450,800** | **158,100** | **200** | **800,700** | **20,100** | **2,652,100** |
| **Union** | | | | | | | |

| *Number of fish stocked by life stage* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Fry** | **0+ Parr** | **1 Parr** | **1+ Parr** | **1 Smolt** | **2 Smolt** | **Total** |
| 1971-1991 | 21,000 | 0 | 0 | 0 | 379,700 | 251,000 | 651,700 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 60,000 | 111,700 | 0 | 0 | 0 | 0 | 171,700 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 54,800 | 0 | 0 | 0 | 0 | 54,800 |
| 1996 | 0 | 53,500 | 0 | 0 | 0 | 0 | 53,500 |
| 1997 | 12,000 | 69,300 | 0 | 0 | 0 | 0 | 81,300 |
| 1998 | 165,000 | 0 | 0 | 0 | 0 | 0 | 165,000 |
| 1999 | 165,000 | 82,100 | 0 | 0 | 0 | 0 | 247,100 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 2,000 | 0 | 0 | 0 | 0 | 0 | 2,000 |
| 2002 | 5,000 | 0 | 0 | 0 | 0 | 0 | 5,000 |
| **Totals:Union** | **430,000** | **371,400** | **0** | **0** | **379,700** | **251,000** | **1,432,100** |
| **Upper StJohn** | | | | | | | |
| 1979-1991 | 838,000 | 1,001,800 | 14,700 | 0 | 5,100 | 27,700 | 1,887,300 |
| 1992 | 400,000 | 136,100 | 0 | 0 | 0 | 0 | 536,100 |
| 1993 | 361,000 | 102,800 | 0 | 0 | 0 | 0 | 463,800 |
| 1994 | 566,000 | 216,000 | 0 | 0 | 0 | 0 | 782,000 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | | | | | | | |
| **Totals:Upper StJohn** | **2,165,000** | **1,456,700** | **14,700** | **0** | **5,100** | **27,700** | **3,669,200** |

*Table 5.2.b. Overall summary of Atlantic salmon stocking for New England, by river.*

*Totals reflect the entirety of the historical time series for each river.*

| | Fry | 0+ Parr | 1 Parr | 1+ Parr | 1 Smolt | 2 Smolt | Total |
|---|---|---|---|---|---|---|---|
| **Androscoggin** | 3,000 | 0 | 0 | 0 | 0 | 0 | **3,000** |
| **Aroostook** | 1,693,000 | 317,400 | 36,800 | 1,800 | 32,600 | 29,800 | **2,111,400** |
| **Cocheco** | 1,795,000 | 50,000 | 9,500 | 1,000 | 5,300 | 0 | **1,861,200** |
| **Connecticut** | 85,219,000 | 2,827,500 | 1,567,400 | 242,900 | 3,769,700 | 1,011,400 | **94,637,600** |
| **Dennys** | 1,246,000 | 101,700 | 6,700 | 0 | 251,500 | 29,200 | **1,635,100** |
| **Ducktrap** | 68,000 | 0 | 0 | 0 | 0 | 0 | **68,000** |
| **East Machias** | 1,443,000 | 7,500 | 42,600 | 0 | 108,400 | 30,400 | **1,631,900** |
| **Kennebec** | 10,000 | 0 | 0 | 0 | 0 | 0 | **9,600** |
| **Lamprey** | 1,486,000 | 427,700 | 56,400 | 2,400 | 201,400 | 32,800 | **2,207,200** |
| **Machias** | 2,130,000 | 93,800 | 117,800 | 0 | 191,300 | 44,100 | **2,577,000** |
| **Merrimack** | 29,394,000 | 227,500 | 416,200 | 180,600 | 1,369,400 | 637,100 | **32,225,100** |
| **Narraguagus** | 1,877,000 | 62,900 | 14,600 | 0 | 107,800 | 84,000 | **2,146,300** |
| **Pawcatuck** | 4,512,000 | 1,209,200 | 254,600 | 8,600 | 65,100 | 500 | **6,050,200** |
| **Penobscot** | 13,191,000 | 3,582,900 | 1,383,200 | 9,100 | 11,010,900 | 2,508,200 | **31,631,800** |
| **Pleasant** | 187,000 | 16,000 | 1,800 | 0 | 54,700 | 18,100 | **277,600** |
| **Saco** | 3,934,000 | 418,700 | 201,200 | 0 | 331,900 | 9,500 | **4,895,300** |
| **Sheepscot** | 1,437,000 | 84,800 | 20,600 | 0 | 92,200 | 7,100 | **1,641,700** |
| **St Croix** | 1,267,000 | 410,100 | 158,100 | 200 | 800,700 | 20,100 | **2,611,400** |
| **Union** | 430,000 | 371,400 | 0 | 0 | 379,700 | 251,000 | **1,432,100** |
| **Upper StJohn** | 2,165,000 | 1,456,700 | 14,700 | 0 | 5,100 | 27,700 | **3,669,200** |
| **TOTALS** | **153,488,000** | **11,665,800** | **4,302,200** | **446,600** | **18,777,700** | **4,741,100** | **193,322,800** |

Summaries for each river vary by length of time series.

## *Table 5.3.a. Documented Atlantic salmon returns to New England rivers.*

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

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| **Androscoggin** | | | | | | | | | |
| 1983-1991 | 17 | 410 | 5 | 1 | 2 | 43 | 0 | 1 | **479** |
| 1992 | 2 | 9 | 0 | 0 | 1 | 3 | 0 | 0 | **15** |
| 1993 | 1 | 33 | 0 | 0 | 1 | 9 | 0 | 0 | **44** |
| 1994 | 2 | 16 | 0 | 1 | 0 | 6 | 0 | 0 | **25** |
| 1995 | 2 | 12 | 0 | 0 | 0 | 2 | 0 | 0 | **16** |
| 1996 | 2 | 19 | 1 | 0 | 1 | 16 | 0 | 0 | **39** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1998 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | **4** |
| 1999 | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | **5** |
| 2000 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | **3** |
| 2001 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | **5** |
| 2002 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| **Total for Androscoggin** | 27 | 513 | 6 | 2 | 6 | 83 | 0 | 1 | **638** |
| **Cocheco** | | | | | | | | | |
| 1990-1991 | | | | | | | | | |
| 1992 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1993 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | **5** |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1995 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1996 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | **2** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1999 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | **3** |
| 2000 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | **2** |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total for Cocheco** | 0 | 0 | 1 | 1 | 5 | 7 | 0 | 0 | **14** |
| **Connecticut** | | | | | | | | | |
| 1969-1991 | 30 | 2,447 | 27 | 0 | 3 | 207 | 6 | 0 | **2,720** |
| 1992 | 3 | 353 | 1 | 0 | 5 | 127 | 1 | 0 | **490** |
| 1993 | 0 | 136 | 0 | 0 | 0 | 61 | 1 | 0 | **198** |
| 1994 | 1 | 263 | 0 | 1 | 0 | 61 | 0 | 0 | **326** |
| 1995 | 1 | 158 | 0 | 0 | 0 | 29 | 0 | 0 | **188** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| 1996 | 0 | 143 | 0 | 0 | 5 | 111 | 0 | 1 | **260** |
| 1997 | 0 | 0 | 0 | 1 | 6 | 191 | 1 | 0 | **199** |
| 1998 | 0 | 0 | 0 | 0 | 10 | 288 | 0 | 2 | **300** |
| 1999 | 0 | 0 | 0 | 0 | 11 | 142 | 0 | 1 | **154** |
| 2000 | 0 | 0 | 0 | 0 | 1 | 76 | 0 | 0 | **77** |
| 2001 | 1 | 0 | 0 | 0 | 4 | 34 | 1 | 0 | **40** |
| 2002 | 0 | 3 | 0 | 0 | 2 | 38 | 1 | 0 | **44** |
| **Total for Connecticut** | 36 | 3,503 | 28 | 2 | 47 | 1365 | 11 | 4 | **4,996** |
| **Dennys** | | | | | | | | | |
| 1967-1991 | 13 | 289 | 0 | 1 | 18 | 706 | 3 | 10 | **1,040** |
| 1992 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | **5** |
| 1993 | 7 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | **13** |
| 1994 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | **6** |
| 1995 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | **5** |
| 1996 | 0 | 0 | 0 | 0 | 3 | 7 | 0 | 0 | **10** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1998 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1999 | | | | | | | | | |
| 2000 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 2001 | 2 | 4 | 0 | 0 | 2 | 9 | 0 | 0 | **17** |
| 2002 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| **Total for Dennys** | 26 | 299 | 0 | 1 | 24 | 738 | 3 | 10 | **1,101** |
| **Ducktrap** | | | | | | | | | |
| 1985-1991 | 0 | 0 | 0 | 0 | 3 | 30 | 0 | 0 | **33** |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1994 | | | | | | | | | |
| 1995 | | | | | | | | | |
| 1996 | | | | | | | | | |
| 1997 | | | | | | | | | |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 2001 | | | | | | | | | |
| 2002 | | | | | | | | | |
| **Total for Ducktrap** | 0 | 0 | 0 | 0 | 3 | 30 | 0 | 0 | **33** |
| **East Machias** | | | | | | | | | |
| 1967-1991 | 21 | 244 | 1 | 2 | 12 | 329 | 1 | 10 | **620** |
| 1992 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | **6** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1994 | | | | | | | | | |
| 1995 | | | | | | | | | |
| 1996 | | | | | | | | | |
| 1997 | | | | | | | | | |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 2001 | | | | | | | | | |
| 2002 | | | | | | | | | |
| **Total for East Machias** | 21 | 250 | 1 | 2 | 12 | 329 | 1 | 10 | **626** |
| **Kennebec** | | | | | | | | | |
| 1975-1991 | 12 | 187 | 5 | 1 | 0 | 9 | 0 | 0 | **214** |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1993 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 1994 | | | | | | | | | |
| 1995 | | | | | | | | | |
| 1996 | | | | | | | | | |
| 1997 | | | | | | | | | |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 2001 | | | | | | | | | |
| 2002 | | | | | | | | | |
| **Total for Kennebec** | 12 | 189 | 5 | 1 | 0 | 9 | 0 | 0 | **216** |
| **Lamprey** | | | | | | | | | |
| 1979-1991 | 10 | 17 | 1 | 0 | 0 | 0 | 0 | 0 | **28** |
| 1992 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | **2** |
| 1993 | 0 | 0 | 0 | 0 | 1 | 7 | 0 | 0 | **8** |
| 1994 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | **3** |
| 1995 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1996 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1999 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | **6** |
| 2000 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | **4** |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total for Lamprey** | 10 | 17 | 1 | 0 | 9 | 16 | 0 | 0 | **53** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| **Machias** | | | | | | | | | |
| 1967-1991 | 32 | 324 | 9 | 2 | 32 | 1,580 | 41 | 131 | **2,151** |
| 1992 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | **3** |
| 1993 | 0 | 2 | 0 | 0 | 1 | 12 | 0 | 0 | **15** |
| 1994 | | | | | | | | | |
| 1995 | | | | | | | | | |
| 1996 | | | | | | | | | |
| 1997 | | | | | | | | | |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 2001 | | | | | | | | | |
| 2002 | | | | | | | | | |
| **Total for Machias** | 32 | 329 | 9 | 2 | 33 | 1592 | 41 | 131 | **2,169** |
| **Merrimack** | | | | | | | | | |
| 1978-1991 | 120 | 558 | 14 | 0 | 60 | 661 | 23 | 0 | **1,436** |
| 1992 | 17 | 66 | 2 | 0 | 14 | 100 | 0 | 0 | **199** |
| 1993 | 0 | 27 | 1 | 1 | 2 | 30 | 0 | 0 | **61** |
| 1994 | 0 | 2 | 0 | 0 | 1 | 18 | 0 | 0 | **21** |
| 1995 | 2 | 18 | 0 | 0 | 0 | 14 | 0 | 0 | **34** |
| 1996 | 11 | 44 | 0 | 3 | 3 | 13 | 0 | 2 | **76** |
| 1997 | 9 | 43 | 0 | 4 | 9 | 5 | 0 | 1 | **71** |
| 1998 | 11 | 45 | 1 | 0 | 19 | 47 | 0 | 0 | **123** |
| 1999 | 46 | 65 | 1 | 0 | 9 | 64 | 0 | 0 | **185** |
| 2000 | 26 | 32 | 0 | 0 | 1 | 23 | 0 | 0 | **82** |
| 2001 | 5 | 73 | 0 | 0 | 2 | 3 | 0 | 0 | **83** |
| 2002 | 31 | 17 | 0 | 0 | 1 | 6 | 0 | 0 | **55** |
| **Total for Merrimack** | 278 | 990 | 19 | 8 | 121 | 984 | 23 | 3 | **2,426** |
| **Narraguagus** | | | | | | | | | |
| 1967-1991 | 85 | 596 | 19 | 46 | 28 | 2,014 | 68 | 124 | **2,980** |
| 1992 | 5 | 13 | 0 | 1 | 10 | 23 | 0 | 4 | **56** |
| 1993 | 0 | 14 | 0 | 4 | 6 | 61 | 0 | 2 | **87** |
| 1994 | 0 | 1 | 0 | 0 | 4 | 42 | 0 | 4 | **51** |
| 1995 | 0 | 0 | 0 | 0 | 0 | 51 | 0 | 5 | **56** |
| 1996 | 1 | 6 | 0 | 0 | 9 | 43 | 0 | 5 | **64** |
| 1997 | 0 | 2 | 0 | 0 | 1 | 30 | 0 | 4 | **37** |
| 1998 | 0 | 0 | 0 | 1 | 1 | 18 | 0 | 2 | **22** |
| 1999 | 0 | 2 | 0 | 0 | 6 | 23 | 0 | 1 | **32** |
| 2000 | 0 | 1 | 0 | 0 | 13 | 8 | 0 | 1 | **23** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| 2001 | 0 | 2 | 0 | 0 | 5 | 22 | 2 | 1 | **32** |
| 2002 | 0 | 0 | 0 | 1 | 4 | 3 | 0 | 0 | **8** |
| **Total for Narraguagus** | 91 | 637 | 19 | 53 | 87 | 2338 | 70 | 153 | **3,448** |
| **Pawcatuck** | | | | | | | | | |
| 1981-1991 | 1 | 127 | 1 | 0 | 0 | 0 | 0 | 0 | **129** |
| 1992 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | **6** |
| 1993 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | **3** |
| 1994 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 1995 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 1996 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | **3** |
| 1998 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | **3** |
| 1999 | 1 | 6 | 0 | 0 | 0 | 4 | 0 | 0 | **11** |
| 2000 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total for Pawcatuck** | 2 | 148 | 1 | 0 | 1 | 10 | 0 | 0 | **162** |
| **Penobscot** | | | | | | | | | |
| 1967-1991 | 6,419 | 32,241 | 192 | 443 | 318 | 1,905 | 21 | 49 | **41,588** |
| 1992 | 932 | 1,174 | 0 | 5 | 27 | 236 | 1 | 4 | **2,379** |
| 1993 | 349 | 1,279 | 7 | 13 | 22 | 92 | 1 | 6 | **1,769** |
| 1994 | 265 | 630 | 2 | 5 | 48 | 93 | 0 | 6 | **1,049** |
| 1995 | 158 | 1,077 | 7 | 9 | 6 | 84 | 0 | 1 | **1,342** |
| 1996 | 482 | 1,187 | 6 | 14 | 13 | 335 | 3 | 5 | **2,045** |
| 1997 | 241 | 914 | 4 | 13 | 6 | 174 | 2 | 1 | **1,355** |
| 1998 | 240 | 796 | 0 | 10 | 29 | 130 | 1 | 4 | **1,210** |
| 1999 | 225 | 568 | 0 | 9 | 46 | 110 | 0 | 10 | **968** |
| 2000 | 166 | 265 | 0 | 15 | 17 | 70 | 0 | 2 | **535** |
| 2001 | 191 | 469 | 0 | 2 | 24 | 98 | 2 | 0 | **786** |
| 2002 | 362 | 344 | 1 | 15 | 14 | 41 | 0 | 2 | **779** |
| **Total for Penobscot** | 10,030 | 40,944 | 219 | 553 | 570 | 3368 | 31 | 90 | **55,805** |
| **Pleasant** | | | | | | | | | |
| 1967-1991 | 5 | 12 | 0 | 0 | 10 | 213 | 2 | 2 | **244** |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1994 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | **2** |
| 1995 | | | | | | | | | |
| 1996 | | | | | | | | | |
| 1997 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | **3** |
| 2001 | 0 | 0 | 0 | 0 | 1 | 9 | 1 | 0 | **11** |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total for Pleasant** | 5 | 12 | 0 | 0 | 13 | 226 | 3 | 2 | **261** |
| **Saco** | | | | | | | | | |
| 1977-1991 | 13 | 253 | 2 | 1 | 0 | 2 | 0 | 0 | **271** |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1993 | 4 | 54 | 0 | 1 | 0 | 0 | 0 | 0 | **59** |
| 1994 | 6 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | **23** |
| 1995 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | **34** |
| 1996 | 11 | 39 | 1 | 3 | 0 | 0 | 0 | 0 | **54** |
| 1997 | 5 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | **28** |
| 1998 | 9 | 7 | 0 | 0 | 4 | 7 | 1 | 0 | **28** |
| 1999 | 10 | 11 | 0 | 0 | 12 | 31 | 2 | 0 | **66** |
| 2000 | 31 | 14 | 0 | 0 | 0 | 4 | 0 | 0 | **49** |
| 2001 | 15 | 49 | 0 | 0 | 0 | 5 | 0 | 0 | **69** |
| 2002 | 3 | 37 | 0 | 2 | 3 | 2 | 0 | 0 | **47** |
| **Total for Saco** | 107 | 538 | 3 | 7 | 19 | 51 | 3 | 0 | **728** |
| **Sheepscot** | | | | | | | | | |
| 1967-1991 | 5 | 20 | 0 | 0 | 26 | 314 | 9 | 0 | **374** |
| 1992 | 1 | 2 | 0 | 0 | 1 | 2 | 1 | 0 | **7** |
| 1993 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | **9** |
| 1994 | 0 | 5 | 0 | 0 | 3 | 12 | 0 | 0 | **20** |
| 1995 | 0 | 2 | 0 | 0 | 0 | 22 | 0 | 0 | **24** |
| 1996 | 0 | 0 | 0 | 0 | | 8 | 0 | 0 | **8** |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1998 | | | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 2001 | | | | | | | | | |
| 2002 | | | | | | | | | |
| **Total for Sheepscot** | 6 | 38 | 0 | 0 | 30 | 358 | 10 | 0 | **442** |
| **St Croix** | | | | | | | | | |
| 1981-1991 | 576 | 894 | 38 | 11 | 375 | 576 | 39 | 15 | **2,524** |
| 1992 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| 1993 | 5 | 76 | 0 | 0 | 4 | 18 | 0 | 2 | **105** |
| 1994 | 23 | 17 | 0 | 1 | 24 | 19 | 0 | 0 | **84** |

| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| 1995 | 7 | 15 | 0 | 0 | 8 | 16 | 0 | 0 | **46** |
| 1996 | 13 | 77 | 0 | 0 | 10 | 32 | 0 | 0 | **132** |
| 1997 | 26 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **28** |
| 1998 | 20 | 3 | 0 | 0 | 12 | 6 | 0 | 0 | **41** |
| 1999 | 1 | 2 | 0 | 0 | 7 | 3 | 0 | 0 | **13** |
| 2000 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | **20** |
| 2001 | 13 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | **20** |
| 2002 | 14 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | **20** |
| **Total for St Croix** | 709 | 1,109 | 38 | 12 | 440 | 670 | 39 | 17 | **3,034** |
| **Union** | | | | | | | | | |
| 1973-1991 | 290 | 1,730 | 9 | 24 | 1 | 11 | 0 | 0 | **2,065** |
| 1992 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | **4** |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1994 | | | | | | | | | |
| 1995 | | | | | | | | | |
| 1996 | 6 | 62 | 0 | 0 | 0 | 1 | 0 | 0 | **69** |
| 1997 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | **8** |
| 1998 | 2 | 7 | 0 | 4 | 0 | 0 | 0 | 0 | **13** |
| 1999 | 3 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | **9** |
| 2000 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **2** |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 2002 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | **5** |
| **Total for Union** | 302 | 1,820 | 9 | 28 | 1 | 15 | 0 | 0 | **2,175** |

## *Table 5.3.b. Summary of documented Atlantic salmon returns to New England rivers.*

Totals reflect the entirety of the available historical time series for each river. Earliest year of data for Penobscot, Narragua Machias, East Machias, Dennys, and Sheepscot rivers is 1967.

| | Grand Total by River | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | HATCHERY ORIGIN | | | | WILD ORIGIN | | | | |
| | 1SW | 2SW | 3SW | REPEAT | 1SW | 2SW | 3SW | REPEAT | Total |
| **Androscoggin** | 27 | 513 | 6 | 2 | 6 | 83 | 0 | 1 | **638** |
| **Cocheco** | 0 | 0 | 1 | 1 | 5 | 7 | 0 | 0 | **14** |
| **Connecticut** | 36 | 3,503 | 28 | 2 | 47 | 1,365 | 11 | 4 | **4,996** |
| **Dennys** | 26 | 299 | 0 | 1 | 24 | 738 | 3 | 10 | **1,101** |
| **Ducktrap** | 0 | 0 | 0 | 0 | 3 | 30 | 0 | 0 | **33** |
| **East Machias** | 21 | 250 | 1 | 2 | 12 | 329 | 1 | 10 | **626** |
| **Kennebec** | 12 | 189 | 5 | 1 | 0 | 9 | 0 | 0 | **216** |
| **Lamprey** | 10 | 17 | 1 | 0 | 9 | 16 | 0 | 0 | **53** |
| **Machias** | 32 | 329 | 9 | 2 | 33 | 1,592 | 41 | 131 | **2,169** |
| **Merrimack** | 278 | 990 | 19 | 8 | 121 | 984 | 23 | 3 | **2,426** |
| **Narraguagus** | 91 | 637 | 19 | 53 | 87 | 2,338 | 70 | 153 | **3,448** |
| **Pawcatuck** | 2 | 148 | 1 | 0 | 1 | 10 | 0 | 0 | **162** |
| **Penobscot** | 10,030 | 40,944 | 219 | 553 | 570 | 3,368 | 31 | 90 | **55,805** |
| **Pleasant** | 5 | 12 | 0 | 0 | 13 | 226 | 3 | 2 | **261** |
| **Saco** | 107 | 538 | 3 | 7 | 19 | 51 | 3 | 0 | **728** |
| **Sheepscot** | 6 | 38 | 0 | 0 | 30 | 358 | 10 | 0 | **442** |
| **St Croix** | 709 | 1,109 | 38 | 12 | 440 | 670 | 39 | 17 | **3,034** |
| **Union** | 302 | 1,820 | 9 | 28 | 1 | 15 | 0 | 0 | **2,175** |

*Table 5.3.c.1: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .*

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | Age (years) dist'n (%) 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1974** | 16 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1975** | 32 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1976** | 27 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1977** | 50 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1978** | 50 | 7 | 1.400 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1979** | 25 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1980** | 89 | 18 | 2.022 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1981** | 151 | 19 | 1.261 | 0% | 0% | 0% | 11% | 89% | 0% | 0% | 0% | 0% | 0% | 0% | 11% | 89% | 0% | 0% |
| **1982** | 128 | 31 | 2.429 | 0% | 0% | 0% | 0% | 90% | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 90% | 10% | 0% |
| **1983** | 70 | 1 | 0.143 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1984** | 455 | 1 | 0.022 | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% |
| **1985** | 286 | 35 | 1.224 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1986** | 97 | 27 | 2.791 | 0% | 0% | 0% | 4% | 96% | 0% | 0% | 0% | 0% | 0% | 0% | 4% | 96% | 0% | 0% |
| **1987** | 981 | 44 | 0.449 | 0% | 16% | 0% | 0% | 68% | 2% | 0% | 14% | 0% | 0% | 0% | 16% | 68% | 16% | 0% |
| **1988** | 928 | 92 | 0.992 | 0% | 0% | 0% | 0% | 97% | 1% | 0% | 2% | 0% | 0% | 0% | 0% | 97% | 3% | 0% |
| **1989** | 747 | 47 | 0.629 | 0% | 6% | 0% | 6% | 85% | 0% | 0% | 2% | 0% | 0% | 0% | 13% | 85% | 2% | 0% |
| **1990** | 765 | 53 | 0.693 | 0% | 13% | 0% | 0% | 87% | 0% | 0% | 0% | 0% | 0% | 0% | 13% | 87% | 0% | 0% |
| **1991** | 982 | 25 | 0.255 | 0% | 20% | 0% | 0% | 64% | 0% | 0% | 16% | 0% | 0% | 0% | 20% | 64% | 16% | 0% |
| **1992** | 929 | 84 | 0.904 | 0% | 1% | 0% | 0% | 85% | 1% | 0% | 13% | 0% | 0% | 0% | 1% | 85% | 14% | 0% |
| **1993** | 2,607 | 94 | 0.361 | 0% | 0% | 0% | 2% | 87% | 0% | 0% | 11% | 0% | 0% | 0% | 2% | 87% | 11% | 0% |
| **1994** | 3,925 | 197 | 0.502 | 0% | 0% | 0% | 1% | 93% | 0% | 0% | 6% | 0% | 0% | 0% | 1% | 93% | 6% | 0% |
| **1995** | 4,507 | 83 | 0.184 | 0% | 2% | 0% | 6% | 89% | 0% | 0% | 2% | 0% | 0% | 0% | 8% | 89% | 2% | 0% |
| **1996** | 4,780 | 55 | 0.115 | 0% | 4% | 0% | 5% | 89% | 2% | 0% | 0% | 0% | 0% | 0% | 9% | 89% | 2% | 0% |
| **1997** | 5,885 | 24 | 0.041 | 0% | 0% | 0% | 4% | 88% | 4% | 0% | 4% | | | 0% | 4% | 88% | 8% | |
| **1998** | 661 | 31 | 0.469 | 0% | 0% | 0% | 6% | 94% | | 0% | | | | 0% | 6% | 94% | | |
| **1999** | 4,565 | 2 | 0.004 | 0% | 0% | | 100% | | | | | | | 0% | 100% | | | |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*__Table 5.3.c.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .__*

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **33,736** | **970** | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.650** | **0%** | **6%** | **0%** | **6%** | **64%** | **5%** | **0%** | **3%** | **0%** | **0%** | **0%** | **12%** | **64%** | **8%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*Table 5.3.c.3: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .*

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1974** | 16 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1975** | 32 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1976** | 27 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1977** | 50 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1978** | 50 | 7 | 1.400 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1979** | 54 | 3 | 0.561 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1980** | 286 | 18 | 0.630 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1981** | 168 | 19 | 1.129 | 0% | 0% | 0% | 11% | 89% | 0% | 0% | 0% | 0% | 0% | 0% | 11% | 89% | 0% | 0% |
| **1982** | 294 | 46 | 1.565 | 0% | 0% | 0% | 0% | 89% | 11% | 0% | 0% | 0% | 0% | 0% | 0% | 89% | 11% | 0% |
| **1983** | 226 | 2 | 0.088 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1984** | 584 | 3 | 0.051 | 0% | 0% | 0% | 0% | 33% | 33% | 0% | 33% | 0% | 0% | 0% | 0% | 33% | 67% | 0% |
| **1985** | 422 | 47 | 1.113 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1986** | 176 | 28 | 1.592 | 0% | 0% | 0% | 4% | 96% | 0% | 0% | 0% | 0% | 0% | 0% | 4% | 96% | 0% | 0% |
| **1987** | 1,169 | 51 | 0.436 | 0% | 18% | 0% | 0% | 67% | 2% | 0% | 14% | 0% | 0% | 0% | 18% | 67% | 16% | 0% |
| **1988** | 1,310 | 108 | 0.825 | 0% | 0% | 0% | 0% | 97% | 1% | 0% | 2% | 0% | 0% | 0% | 0% | 97% | 3% | 0% |
| **1989** | 1,243 | 67 | 0.539 | 0% | 22% | 0% | 7% | 69% | 0% | 0% | 1% | 0% | 0% | 0% | 30% | 69% | 1% | 0% |
| **1990** | 1,346 | 68 | 0.505 | 0% | 19% | 0% | 0% | 79% | 0% | 0% | 1% | 0% | 0% | 0% | 19% | 79% | 1% | 0% |
| **1991** | 1,724 | 35 | 0.203 | 0% | 17% | 0% | 0% | 63% | 0% | 0% | 20% | 0% | 0% | 0% | 17% | 63% | 20% | 0% |
| **1992** | 2,009 | 118 | 0.587 | 0% | 5% | 0% | 0% | 82% | 1% | 0% | 12% | 0% | 0% | 0% | 5% | 82% | 13% | 0% |
| **1993** | 4,147 | 185 | 0.446 | 0% | 4% | 0% | 3% | 87% | 0% | 0% | 6% | 0% | 0% | 0% | 6% | 87% | 6% | 0% |
| **1994** | 5,978 | 294 | 0.492 | 0% | 5% | 0% | 2% | 88% | 0% | 0% | 5% | 0% | 0% | 0% | 7% | 88% | 5% | 0% |
| **1995** | 6,817 | 143 | 0.210 | 1% | 13% | 0% | 7% | 78% | 0% | 0% | 2% | 0% | 0% | 1% | 20% | 78% | 2% | 0% |
| **1996** | 6,677 | 101 | 0.151 | 0% | 16% | 0% | 11% | 71% | 1% | 0% | 1% | 0% | 0% | 0% | 27% | 71% | 2% | 0% |
| **1997** | 8,526 | 37 | 0.043 | 0% | 3% | 0% | 3% | 89% | 3% | 0% | 3% | | | 0% | 5% | 89% | 5% | |
| **1998** | 3,133 | 41 | 0.131 | 0% | 0% | 0% | 10% | 90% | | 0% | | | | 0% | 10% | 90% | | |
| **1999** | 6,278 | 2 | 0.003 | 0% | 0% | | 100% | | | | | | | 0% | 100% | | | |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*Table 5.3.c.4: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .*

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **52,739** | **1,423** | | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.489** | **0%** | **12%** | **0%** | **6%** | **63%** | **2%** | **0%** | **4%** | **0%** | **0%** | **0%** | **18%** | **63%** | **6%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

***Table 5.3.c.5: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .***

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1979** | 29 | 3 | 1.034 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1980** | 197 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1981** | 18 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1982** | 166 | 15 | 0.902 | 0% | 0% | 0% | 0% | 87% | 13% | 0% | 0% | 0% | 0% | 0% | 0% | 87% | 13% | 0% |
| **1983** | 157 | 1 | 0.064 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1984** | 128 | 2 | 0.156 | 0% | 0% | 0% | 0% | 50% | 0% | 0% | 50% | 0% | 0% | 0% | 0% | 50% | 50% | 0% |
| **1985** | 136 | 12 | 0.881 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1986** | 79 | 1 | 0.126 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1987** | 68 | 5 | 0.740 | 0% | 0% | 0% | 0% | 80% | 0% | 0% | 20% | 0% | 0% | 0% | 0% | 80% | 20% | 0% |
| **1988** | 333 | 13 | 0.391 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1989** | 279 | 19 | 0.680 | 0% | 63% | 0% | 11% | 26% | 0% | 0% | 0% | 0% | 0% | 0% | 74% | 26% | 0% | 0% |
| **1990** | 270 | 11 | 0.407 | 0% | 45% | 0% | 0% | 45% | 0% | 0% | 9% | 0% | 0% | 0% | 45% | 45% | 9% | 0% |
| **1991** | 265 | 2 | 0.076 | 0% | 50% | 0% | 0% | 0% | 0% | 0% | 50% | 0% | 0% | 0% | 50% | 0% | 50% | 0% |
| **1992** | 553 | 15 | 0.271 | 0% | 20% | 0% | 0% | 67% | 0% | 0% | 13% | 0% | 0% | 0% | 20% | 67% | 13% | 0% |
| **1993** | 772 | 52 | 0.673 | 0% | 13% | 0% | 6% | 77% | 0% | 0% | 4% | 0% | 0% | 0% | 19% | 77% | 4% | 0% |
| **1994** | 1,097 | 49 | 0.447 | 0% | 31% | 0% | 4% | 63% | 0% | 0% | 2% | 0% | 0% | 0% | 35% | 63% | 2% | 0% |
| **1995** | 1,146 | 42 | 0.367 | 2% | 38% | 0% | 5% | 52% | 0% | 0% | 2% | 0% | 0% | 2% | 43% | 52% | 2% | 0% |
| **1996** | 912 | 19 | 0.208 | 0% | 58% | 0% | 11% | 26% | 0% | 0% | 5% | 0% | 0% | 0% | 68% | 26% | 5% | 0% |
| **1997** | 1,480 | 4 | 0.027 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | | | 0% | 0% | 100% | 0% | |
| **1998** | 1,191 | 2 | 0.017 | 0% | 0% | 0% | 0% | 100% | | 0% | | | | 0% | 0% | 100% | | |
| **1999** | 986 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Total** | **10,261** | **267** | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.356** | **0%** | **25%** | **0%** | **2%** | **51%** | **1%** | **0%** | **8%** | **0%** | **0%** | **0%** | **26%** | **51%** | **8%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*Table 5.3.c.6: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .*

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1975** | 36 | | | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1976** | 63 | | | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1977** | 72 | | | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1978** | 106 | 18 | 1.697 | 0% | 0% | 0% | 0% | 11% | 33% | 22% | 28% | 6% | 0% | 0% | 0% | 33% | 61% | 6% |
| **1979** | 77 | 43 | 5.592 | 0% | 0% | 0% | 0% | 84% | 5% | 2% | 9% | 0% | 0% | 0% | 0% | 86% | 14% | 0% |
| **1980** | 126 | 43 | 3.426 | 0% | 0% | 0% | 0% | 19% | 5% | 21% | 51% | 5% | 0% | 0% | 0% | 40% | 56% | 5% |
| **1981** | 57 | 81 | 14.211 | 0% | 0% | 0% | 10% | 78% | 0% | 5% | 7% | 0% | 0% | 0% | 10% | 83% | 7% | 0% |
| **1982** | 50 | 48 | 9.600 | 0% | 0% | 2% | 2% | 77% | 8% | 0% | 10% | 0% | 0% | 0% | 2% | 79% | 19% | 0% |
| **1983** | 8 | 23 | 27.479 | 0% | 4% | 4% | 17% | 65% | 4% | 0% | 4% | 0% | 0% | 0% | 22% | 70% | 9% | 0% |
| **1984** | 526 | 47 | 0.894 | 0% | 13% | 0% | 4% | 77% | 2% | 0% | 4% | 0% | 0% | 0% | 17% | 77% | 6% | 0% |
| **1985** | 148 | 59 | 3.977 | 0% | 2% | 0% | 7% | 69% | 2% | 0% | 20% | 0% | 0% | 0% | 8% | 69% | 22% | 0% |
| **1986** | 525 | 110 | 2.097 | 0% | 11% | 0% | 0% | 78% | 1% | 0% | 8% | 0% | 2% | 0% | 11% | 78% | 9% | 2% |
| **1987** | 1,078 | 278 | 2.578 | 0% | 2% | 0% | 8% | 86% | 0% | 0% | 4% | 0% | 0% | 0% | 10% | 86% | 4% | 0% |
| **1988** | 1,718 | 95 | 0.553 | 1% | 5% | 0% | 0% | 91% | 0% | 0% | 3% | 0% | 0% | 1% | 5% | 91% | 3% | 0% |
| **1989** | 1,034 | 43 | 0.416 | 0% | 7% | 0% | 30% | 63% | 0% | 0% | 0% | 0% | 0% | 0% | 37% | 63% | 0% | 0% |
| **1990** | 975 | 21 | 0.215 | 5% | 0% | 0% | 10% | 81% | 0% | 0% | 5% | 0% | 0% | 5% | 10% | 81% | 5% | 0% |
| **1991** | 1,458 | 17 | 0.117 | 0% | 6% | 0% | 6% | 76% | 12% | 0% | 0% | 0% | 0% | 0% | 12% | 76% | 12% | 0% |
| **1992** | 1,118 | 14 | 0.125 | 0% | 0% | 0% | 0% | 93% | 7% | 0% | 0% | 0% | 0% | 0% | 0% | 93% | 7% | 0% |
| **1993** | 1,157 | 11 | 0.095 | 0% | 0% | 0% | 27% | 45% | 0% | 9% | 18% | 0% | 0% | 0% | 27% | 55% | 18% | 0% |
| **1994** | 2,816 | 54 | 0.192 | 0% | 0% | 0% | 15% | 83% | 0% | 0% | 2% | 0% | 0% | 0% | 15% | 83% | 2% | 0% |
| **1995** | 2,827 | 87 | 0.308 | 0% | 0% | 0% | 22% | 72% | 0% | 6% | 0% | 0% | 0% | 0% | 22% | 78% | 0% | 0% |
| **1996** | 1,795 | 27 | 0.150 | 0% | 0% | 0% | 15% | 85% | 0% | 0% | 0% | 0% | 0% | 0% | 15% | 85% | 0% | 0% |
| **1997** | 2,000 | 4 | 0.020 | 0% | 0% | 0% | 25% | 75% | 0% | 0% | 0% | | | 0% | 25% | 75% | 0% | |
| **1998** | 2,589 | 8 | 0.031 | 0% | 0% | 0% | 25% | 75% | | 0% | | | | 0% | 25% | 75% | | |
| **1999** | 1,756 | 1 | 0.006 | 0% | 0% | | 100% | | | | | | | 0% | 100% | | | |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

***Table 5.3.c.7: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .***

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **24,115** | **1,132** | | | | | | | | | | | | | | | | |
| **Mean** | | | **3.354** | **0%** | **2%** | **0%** | **13%** | **62%** | **3%** | **3%** | **8%** | **0%** | **0%** | **0%** | **15%** | **65%** | **11%** | **1%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

***Table 5.3.c.8: Return rates for Atlantic salmon that were stocked as fry in the Pawcatuck River .***

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1993** | 383 | 3 | 0.078 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1994** | 351 | 2 | 0.057 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1995** | 367 | 5 | 0.136 | 0% | 0% | 0% | 20% | 80% | 0% | 0% | 0% | 0% | 0% | 0% | 20% | 80% | 0% | 0% |
| **1996** | 289 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1997** | 100 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1998** | 910 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1999** | 591 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Total** | **2,991** | **10** | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.039** | **0%** | **0%** | **0%** | **3%** | **40%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **3%** | **40%** | **0%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

***Table 5.3.c.9: Return rates for Atlantic salmon that were stocked as fry in the Salmon River .***

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1987** | 121 | 2 | 0.165 | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% |
| **1988** | 43 | 3 | 0.693 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1989** | 111 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1990** | 38 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1991** | 25 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1992** | 124 | 4 | 0.322 | 0% | 50% | 0% | 0% | 50% | 0% | 0% | 0% | 0% | 0% | 0% | 50% | 50% | 0% | 0% |
| **1993** | 105 | 2 | 0.190 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1994** | 241 | 4 | 0.166 | 0% | 25% | 0% | 0% | 75% | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 75% | 0% | 0% |
| **1995** | 242 | 1 | 0.041 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1996** | 247 | 15 | 0.607 | 0% | 20% | 0% | 33% | 47% | 0% | 0% | 0% | 0% | 0% | 0% | 53% | 47% | 0% | 0% |
| **1997** | 223 | 3 | 0.134 | 0% | 33% | 0% | 0% | 67% | 0% | 0% | 0% | | | 0% | 33% | 67% | 0% | |
| **1998** | 257 | 1 | 0.039 | 0% | 0% | 0% | 0% | 100% | | 0% | | | | 0% | 0% | 100% | | |
| **1999** | 15 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Total** | **1,794** | **35** | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.181** | **0%** | **18%** | **0%** | **3%** | **49%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **20%** | **49%** | **0%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*Table 5.3.c.10: Return rates for Atlantic salmon that were stocked as fry in the Westfield River .*

| Year | Total Fry (1000s) | Total Returns | Returns (per 10,000 fry) | Age class (smolt age.sea age) distribution (%) | | | | | | | | | | Age (years) dist'n (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 4.2 | 2 | 3 | 4 | 5 | 6 |
| **1988** | 6 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **1989** | 106 | 1 | 0.095 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1990** | 274 | 4 | 0.146 | 0% | 25% | 0% | 0% | 75% | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 75% | 0% | 0% |
| **1991** | 454 | 8 | 0.176 | 0% | 0% | 0% | 0% | 75% | 0% | 0% | 25% | 0% | 0% | 0% | 0% | 75% | 25% | 0% |
| **1992** | 402 | 15 | 0.373 | 0% | 0% | 0% | 0% | 93% | 0% | 0% | 7% | 0% | 0% | 0% | 0% | 93% | 7% | 0% |
| **1993** | 662 | 37 | 0.559 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| **1994** | 674 | 44 | 0.652 | 0% | 0% | 0% | 2% | 91% | 0% | 0% | 7% | 0% | 0% | 0% | 2% | 91% | 7% | 0% |
| **1995** | 885 | 17 | 0.192 | 0% | 0% | 0% | 18% | 82% | 0% | 0% | 0% | 0% | 0% | 0% | 18% | 82% | 0% | 0% |
| **1996** | 706 | 12 | 0.170 | 0% | 0% | 0% | 8% | 92% | 0% | 0% | 0% | 0% | 0% | 0% | 8% | 92% | 0% | 0% |
| **1997** | 909 | 6 | 0.066 | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | | | 0% | 0% | 100% | 0% | |
| **1998** | 1,022 | 7 | 0.068 | 0% | 0% | 0% | 29% | 71% | | 0% | | | | 0% | 29% | 71% | | |
| **1999** | 712 | 0 | 0.000 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Total** | **6,811** | **151** | | | | | | | | | | | | | | | | |
| **Mean** | | | **0.208** | **0%** | **2%** | **0%** | **5%** | **73%** | **0%** | **0%** | **3%** | **0%** | **0%** | **0%** | **7%** | **73%** | **3%** | **0%** |

Mean return rate computation includes incomplete return rates for 1998- and 1999-year class fish.



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

*Table 5.3.d. Summary return rates in southern New England for Atlantic salmon that were stocked as fry.*

| Year Stocked | Number adult returns per 10,000 fry stocked | | | | | | |
|---|---|---|---|---|---|---|---|
| | Merrimack | Pawcatuck | CT Basin | Connecticut (above Holyoke) | Salmon | Farmington | Westfield |
| 1974 | | | 0.000 | 0.000 | | | |
| 1975 | 0.000 | | 0.000 | 0.000 | | | |
| 1976 | 0.000 | | 0.000 | 0.000 | | | |
| 1977 | 0.000 | | 0.000 | 0.000 | | | |
| 1978 | 1.697 | | 1.400 | 1.400 | | | |
| 1979 | 5.592 | | 0.561 | 0.000 | | 1.034 | |
| 1980 | 3.426 | | 0.630 | 2.022 | | 0.000 | |
| 1981 | 14.211 | | 1.129 | 1.261 | | 0.000 | |
| 1982 | 9.600 | | 1.565 | 2.429 | | 0.902 | |
| 1983 | 27.479 | | 0.088 | 0.143 | | 0.064 | |
| 1984 | 0.894 | | 0.051 | 0.022 | | 0.156 | |
| 1985 | 3.977 | | 1.113 | 1.224 | | 0.881 | |
| 1986 | 2.097 | | 1.592 | 2.791 | | 0.126 | |
| 1987 | 2.578 | | 0.436 | 0.449 | 0.165 | 0.740 | |
| 1988 | 0.553 | | 0.825 | 0.992 | 0.693 | 0.391 | 0.000 |
| 1989 | 0.416 | | 0.539 | 0.629 | 0.000 | 0.680 | 0.095 |
| 1990 | 0.215 | | 0.505 | 0.693 | 0.000 | 0.407 | 0.146 |
| 1991 | 0.117 | | 0.203 | 0.255 | 0.000 | 0.076 | 0.176 |
| 1992 | 0.125 | | 0.587 | 0.904 | 0.322 | 0.271 | 0.373 |
| 1993 | 0.095 | 0.078 | 0.446 | 0.361 | 0.190 | 0.673 | 0.559 |
| 1994 | 0.192 | 0.057 | 0.492 | 0.502 | 0.166 | 0.447 | 0.652 |
| 1995 | 0.308 | 0.136 | 0.210 | 0.184 | 0.041 | 0.367 | 0.192 |
| 1996 | 0.150 | 0.000 | 0.151 | 0.115 | 0.607 | 0.208 | 0.170 |
| 1997 | 0.020 | 0.000 | 0.043 | 0.041 | 0.134 | 0.027 | 0.066 |
| 1998 | 0.031 | 0.000 | 0.131 | 0.469 | 0.039 | 0.017 | 0.068 |
| 1999 | 0.006 | 0.000 | 0.003 | 0.004 | 0.000 | 0.000 | 0.000 |
| **Mean** | **2.951** | **0.039** | **0.489** | **0.650** | **0.181** | **0.356** | **0.208** |
| **StndDev** | **6.143** | **0.054** | **0.502** | **0.787** | **0.230** | **0.338** | **0.212** |

Note: Maine rivers not included in this table until adult returns from natural reproduction and fry stocking can be distinguished

Note: Summary mean and standard deviation computations includes incomplete return rates from 1997 (5 year olds), 1998 (4 y olds), and 1999 (3 year olds).

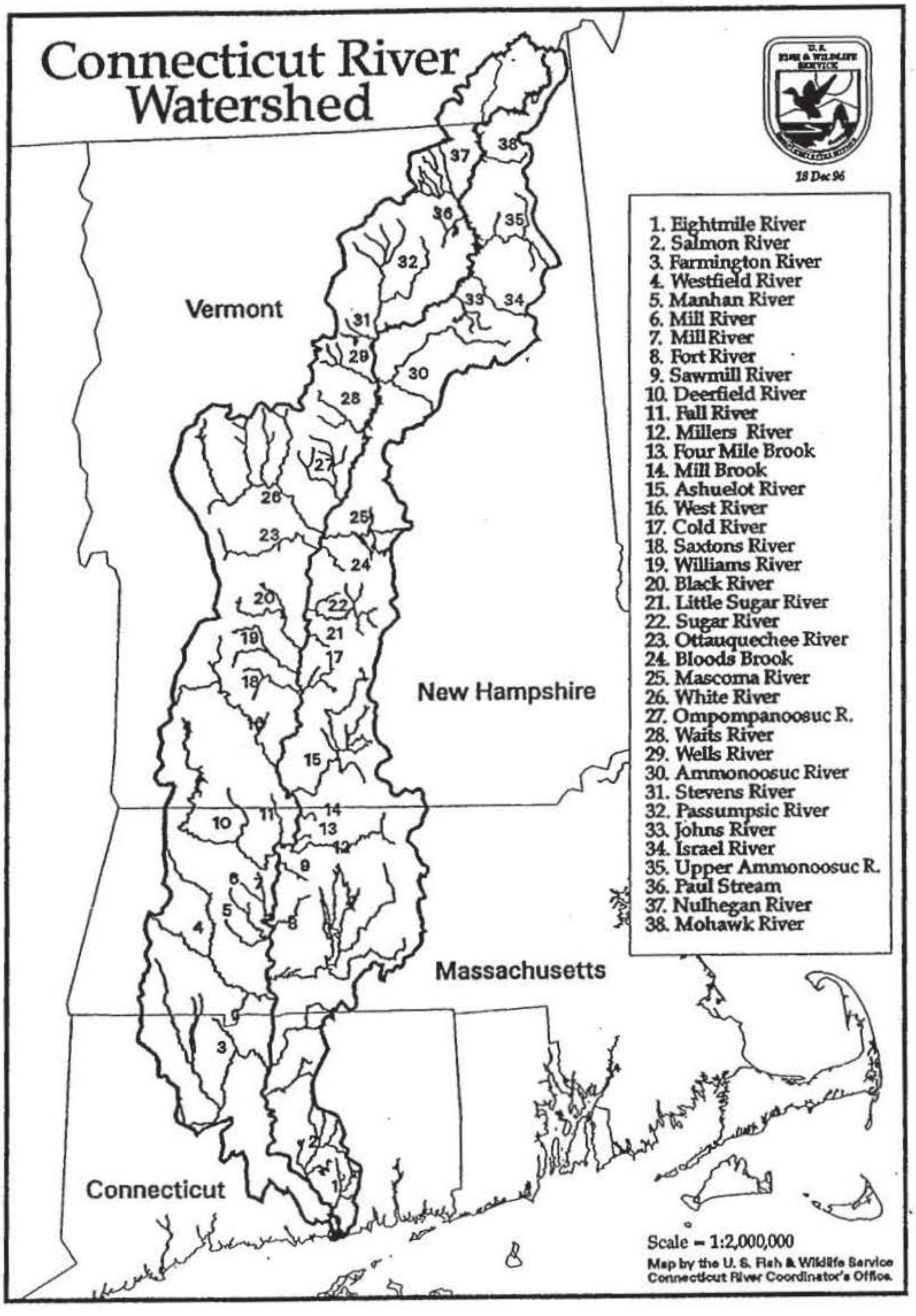
*Table 5.3.e. Summary of age distributions of adult Atlantic salmon that were stocked in southern New England as fry.*

| | Mean age class (smolt age.sea age) distribution (%) | | | | | | | | | | Mean age (years) (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1.1** | **1.2** | **1.3** | **2.1** | **2.2** | **2.3** | **3.1** | **3.2** | **3.3** | **4.2** | **2** | **3** | **4** | **5** | **6** |
| **Connecticut (above Holyoke)** | 0.0% | 2.9% | 0.0% | 2.4% | 88.9% | 0.9% | 0.0% | 4.9% | 0.0% | 0.0% | 0.0% | 5.3% | 88.9% | 5.9% | 0.0% |
| **CT Basin** | 0.1% | 7.9% | 0.0% | 3.2% | 83.5% | 0.8% | 0.0% | 4.6% | 0.0% | 0.0% | 0.1% | 11.1% | 83.5% | 5.3% | 0.0% |
| **Farmington** | 0.4% | 27.7% | 0.0% | 4.1% | 62.9% | 0.7% | 0.0% | 4.1% | 0.0% | 0.0% | 0.4% | 31.8% | 62.9% | 4.9% | 0.0% |
| **Salmon** | 0.0% | 25.7% | 0.0% | 14.3% | 60.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 40.0% | 60.0% | 0.0% | 0.0% |
| **Westfield** | 0.0% | 0.7% | 0.0% | 4.6% | 90.7% | 0.0% | 0.0% | 4.0% | 0.0% | 0.0% | 0.0% | 5.3% | 90.7% | 4.0% | 0.0% |
| **Merrimack** | 0.2% | 3.1% | 0.2% | 8.5% | 76.2% | 1.9% | 2.1% | 7.4% | 0.3% | 0.2% | 0.2% | 11.6% | 78.5% | 9.3% | 0.4% |
| **Overall Mean:** | **0.1%** | **11.3%** | **0.0%** | **6.2%** | **77.0%** | **0.7%** | **0.4%** | **4.2%** | **0.0%** | **0.0%** | **0.1%** | **17.5%** | **77.4%** | **4.9%** | **0.1%** |

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

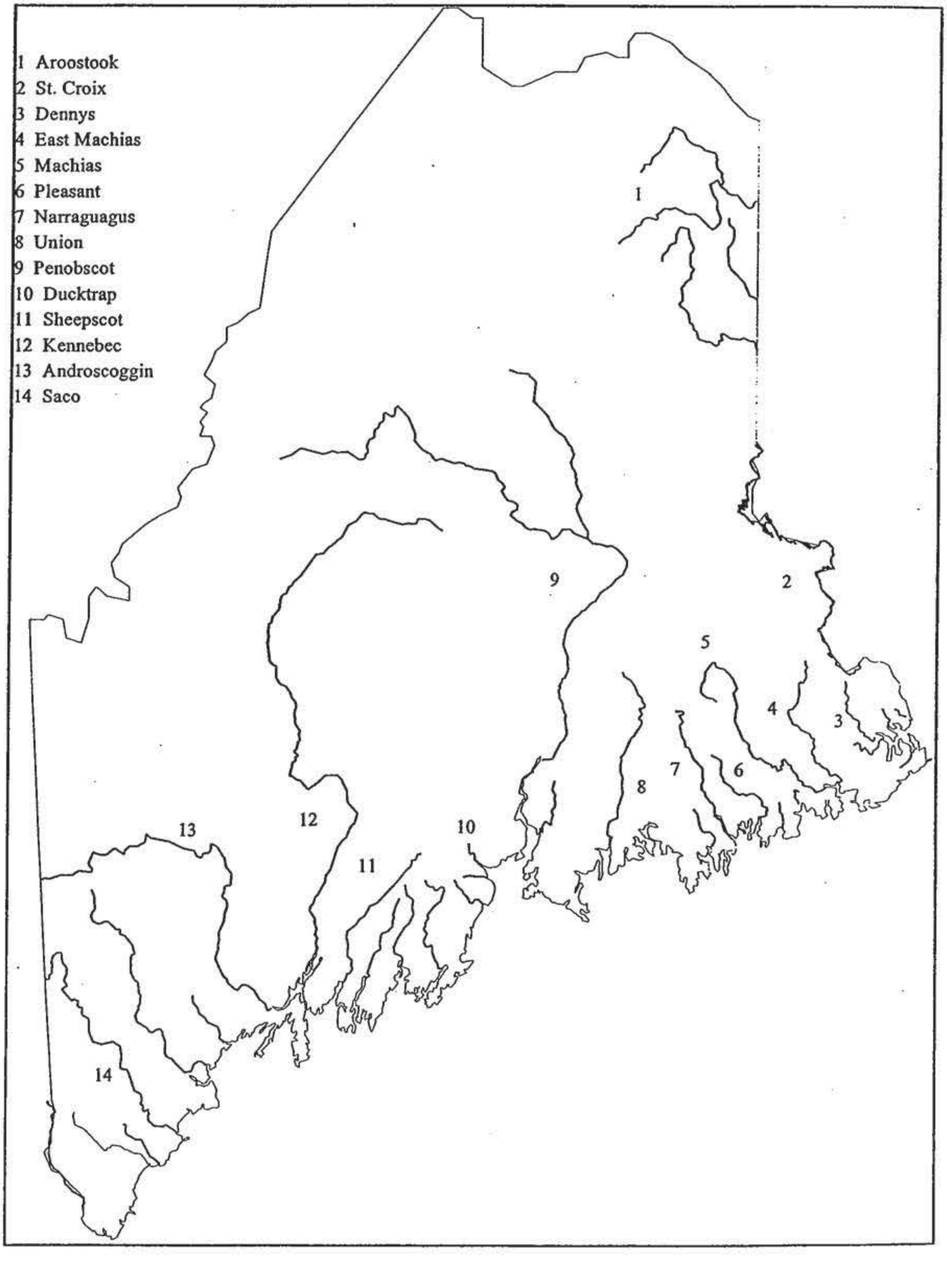
Note: Maine rivers not reported until adult returns from natural reproduction and fry stocking can be distinguished.

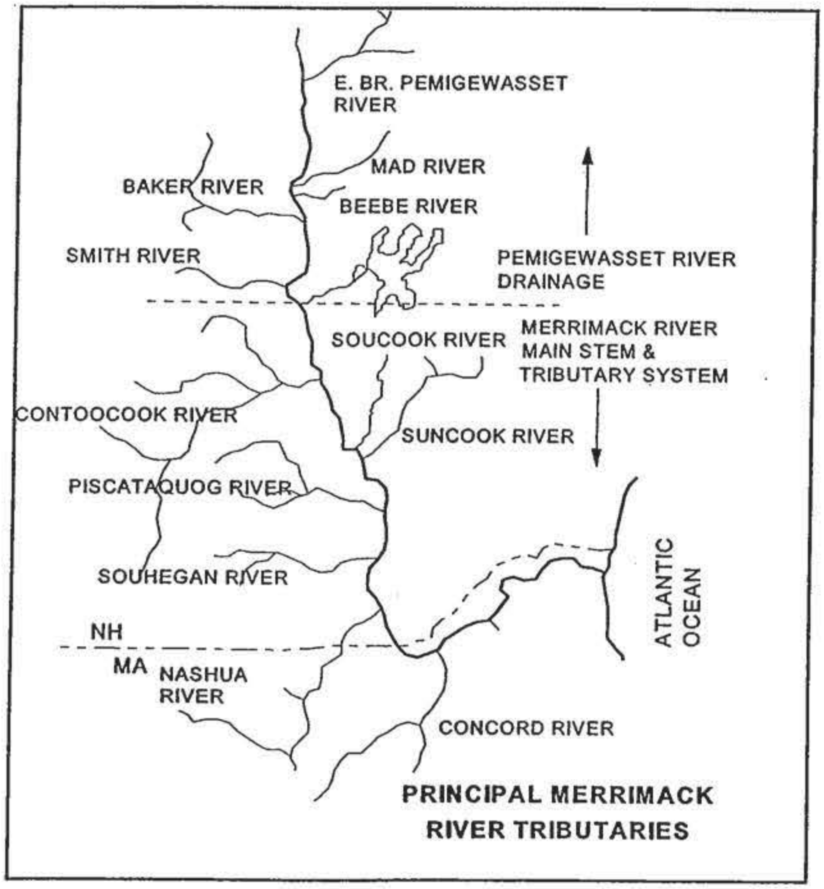
# Important Atlantic Salmon Rivers of New England

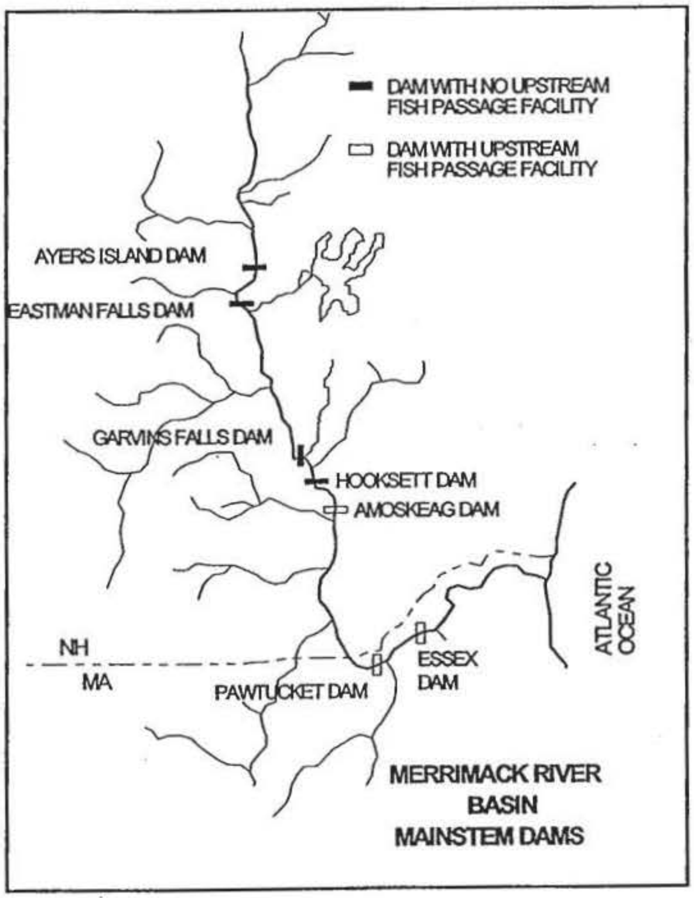


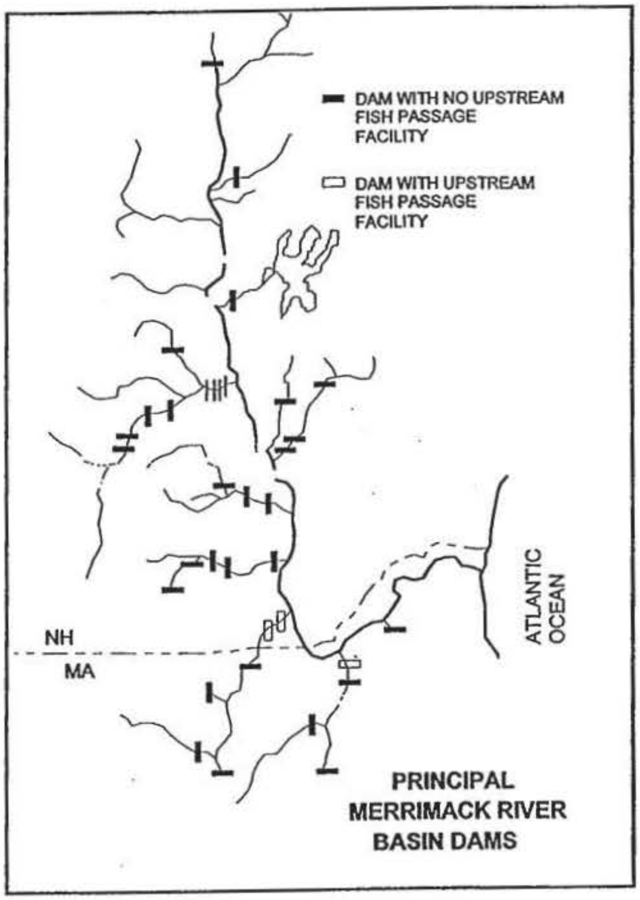
Connecticut River
Watershed
18 Dec 96
Vermont
New Hampshire
Massachusetts
Connecticut
1. Eightmile River
2. Salmon River
3. Farmington River
4. Westfield River
5. Manhan River
6. Mill River
7. Mill River
8. Fort River
9. Sawmill River
10. Deerfield River
11. Fall River
12. Millers River
13. Four Mile Brook
14. Mill Brook
15. Ashuelot River
16. West River
17. Cold River
18. Saxtons River
19. Williams River
20. Black River
21. Little Sugar River
22. Sugar River
23. Ottauquechee River
24. Bloods Brook
25. Mascoma River
26. White River
27. Ompompanoosuc R.
28. Waits River
29. Wells River
30. Ammonoosuc River
31. Stevens River
32. Passumpsic River
33. Johns River
34. Israel River
35. Upper Ammonoosuc R.
36. Paul Stream
37. Nulhegan River
38. Mohawk River
Scale = 1:2,000,000
Map by the U. S. Fish & Wildlife Service
Connecticut River Coordinator's Office

# Important Atlantic Salmon Rivers of Maine




E. BR. PEMIGEWASSET RIVER
MAD RIVER
BAKER RIVER
BEEBE RIVER
SMITH RIVER
PEMIGEWASSET RIVER DRAINAGE
SOUCOOK RIVER
MERRIMACK RIVER MAIN STEM & TRIBUTARY SYSTEM
CONTOOCOOK RIVER
SUNCOOK RIVER
PISCATAQUOG RIVER
SOUHEGAN RIVER
ATLANTIC OCEAN
NH
MA
NASHUA RIVER
CONCORD RIVER
PRINCIPAL MERRIMACK RIVER TRIBUTARIES


DAM WITH NO UPSTREAM FISH PASSAGE FACILITY
DAM WITH UPSTREAM FISH PASSAGE FACILITY
AYERS ISLAND DAM
EASTMAN FALLS DAM
GARVINS FALLS DAM
HOOKSETT DAM
AMOSKEAG DAM
ATLANTIC OCEAN
NH
MA
ESSEX DAM
PAWTUCKET DAM
MERRIMACK RIVER BASIN MAINSTEM DAMS


DAM WITH NO UPSTREAM FISH PASSAGE FACILITY
DAM WITH UPSTREAM FISH PASSAGE FACILITY
NH
MA
ATLANTIC OCEAN
PRINCIPAL MERRIMACK RIVER BASIN DAMS