U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE

ANNUAL REPORT 2004/16

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1. INTRODUCTION

1.1. EXECUTIVE SUMMARY

Total Atlantic salmon returns to USA rivers was 1,436 fish. This total represents the sum of documented returns to traps and estimated returns using redd counts on selected Maine rivers. Documented Atlantic salmon returns to USA rivers totaled 1,396 fish in 2003, 43.5% more than observed in 2002. Estimated Atlantic salmon returns to DPS (Distinct Population Segament) rivers, those with endangered populations, ranged from 61 to 86 fish. This estimate represents twice the number of fish that returned to the eight DPS rivers in 2002. However, the estimate is still the second lowest for the 1991-2003 time series. Most Atlantic salmon returned to Maine rivers where the Penobscot River accounted for 80.5% of the total return. Overall, 16% of the adult returns to the USA were 1SW salmon and 84% were MSW salmon. Most (89%) returns were of hatchery smolt origin, whereas, (11%) originated from either natural reproduction or hatchery fry. In total, 13,060,600 juvenile salmon (fry, parr, and smolts) and 4,671 mature adults were stocked in USA rivers. Eggs for hatchery programs were obtained from 461 sea-run and 3,157 captive/domestic females, and 87 female kelts. The number of females (3,705) contributing to egg production was less than in 2002 (3,734), and total egg take (19,564,000) was also less than that in 2002 (20,081,100). About 496,266 salmon carrying a variety of marks and/or tags were stocked in 2003. Production of farmed salmon in the USA, which occurs exclusively in Maine coastal waters, was 6,435 metric tonnes in 2003.

1.2. BACKGROUND

The U.S. became a charter member of the North Atlantic Salmon Conservation Organization (NASCO) in 1984. NASCO is charged with the international management of Atlantic salmon stocks on the high seas. Three Commissioners for the U.S. are appointed by the President 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 New England Atlantic Salmon Committee (NEASC) to create such an advisory committee. NEASC, comprised of State and Federal fishery agency chiefs, 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 International Council for the Exploration of the Sea (ICES), North Atlantic Salmon Working Group, and NASCO, as well as to respond to inquiries from the U.S. Commissioners. In July of 1988, the Research Committee for the U.S. Section to NASCO was restructured and renamed the U.S. Atlantic Salmon Assessment Committee (USASAC). The Committee was charged with the following tasks: 1) to conduct annual U.S. Atlantic salmon stock assessments, 2) to evaluate ongoing U.S. Atlantic salmon research programs and develop proposals for new research, and 3) to serve as scientific advisors to the U.S. Section of NASCO. A key element in the organization of the Committee was the development of an annual USASAC Meeting with the goal of producing an annual US Atlantic salmon program assessment document for the U.S. 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 U.S. Commissioners or other appropriate channels.

1.4. CHAIRMAN’S COMMENTS

The USASAC convened the February 23-26, 2004 meeting at the NOAA-Fisheries, Northeast Fisheries Science Center, Woods Hole, Massachusetts. The annual assessment report and summary/data tables were reviewed and endorsed by committee members. Whereas general program information presented and reviewed at this meeting was similar in content to that which had been compiled in previous years, the structure of this meeting was changed to include greater emphasis on New England wide Atlantic salmon stock assessment. Discussion among USASAC members at the annual meeting in February 2003 and those present at a July 2004 planning meeting, resulted in consensus to continue to streamline data sharing among programs and to address national salmon stock assessment questions. The USASAC has determined that enhanced stock assessment rather than summary program reporting is most desirable, and while minor problems in data sharing across programs are being resolved, data flow from field databases to the USASAC database is now streamlined, resulting in improved data quality and analyses. The USASAC is continuing to achieve its objective of an incremental integration of standardized data management tools (metadata and relational databases) across New England Atlantic salmon programs.

The USASAC again 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. The database is developed and is now being populated with data from the various programs.

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. In its most recent report in early 2004 the NAS identified an urgent need to reverse the decline of salmon populations in Maine if they are to be saved. The NAS called for urgent actions to save the species to include: a renewed focus on efforts to restore the Penobscot River population of salmon; implementation of a dam removal program to enhance Atlantic salmon spawning and rearing habitat; elimination and/or mitigation of water quality impacts, particularly acidification; research directed at hatcheries and scientific guidance for their use; and elimination of interactions between wild and aquaculture produced salmon to prevent adverse genetic and health effects. Indeed, the challenges associated with the recovery and restoration of U.S. Atlantic salmon populations are many. Accordingly, the work and tasks of the USASAC, to conduct annual U.S. Atlantic salmon stock assessments, evaluate ongoing U.S. Atlantic salmon research programs and develop proposals for new research, and to serve as scientific advisors to the US Section of NASCO remains critically important. The USASAC will review current Terms of Reference and identify new areas of research at a July 2004 meeting and at the annual meeting scheduled for the week of February 28, 2005.

2. New England Salmon Stock Assessment

Total return to USA rivers was 1,436; these are the sum of documented returns to traps and returns estimated using redd counts on selected Maine rivers. Documented adult salmon returns to USA rivers totaled 1,396 fish in 2003, 43.5% more than observed in 2002. Seventy-two adult (61 - 86) fish were estimated to return to the rivers with endangered populations; slightly over twice the returns to the eight rivers in 2002. However, this estimate is still the second lowest for the 1991-2003 time-series. Most returns occurred in Maine, with the Penobscot River accounting for 80.5% of the total return. Overall, 16% of the adult returns to the USA were 1SW salmon and 84% were MSW salmon. Most (89%) returns were of hatchery smolt origin and the balance (11%) originated from either natural reproduction or hatchery fry. A total of 13,060,600 juvenile salmon (fry, parr, and smolts) and 4,671 mature adults were stocked. Eggs for U.S. hatchery programs were taken from 461 sea-run females, 3,157 captive/domestic females, and 87 female kelts. The number of females (3,705) contributing was less than in 2002 (3,734); and total egg take (19,564,000) was less than that of 2002 (20,081,000). About 496,266 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 2003. Production of farmed salmon in Maine was 6,435 metric tonnes in 2003.

2.1. 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 recreational fishery for 1,959 surplus broodstock occurred in the Merrimack River.

2.2. Adult Returns

The adult salmon return to U.S. rivers with traps and weirs was 1,396 fish in 2003. Most returns were recorded in Maine, with the Penobscot River accounting for 77% of all U.S. returns. Overall, 16% of the adult returns were 1SW salmon and 84% were MSW salmon. Most returns (89%) originated from hatchery smolts and the balance (11%) originated from either natural spawning or hatchery fry. The adult return rate (1SW plus 2SW) of hatchery smolts released in the Penobscot River in 2001 was 0.27%.

Documented returns of 1SW salmon in 2003 were less than those in 2002; MSW returns in 2003 increased from those in 2002 (526). Total 2003 returns increased by 44% compared to 2002. Changes from 2002 by river were: Connecticut (-2%), Merrimack (+164%), Penobscot (+43%), Saco (-17%), Narraguagus (+163%), and St. Croix (-25%).

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 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. Total estimated return for the DPS (Table 1) was 72 (95% CI = 61-86). The ratio of sea ages from trap catches was used to apportion the estimate and calculate the estimated 2SW spawners.

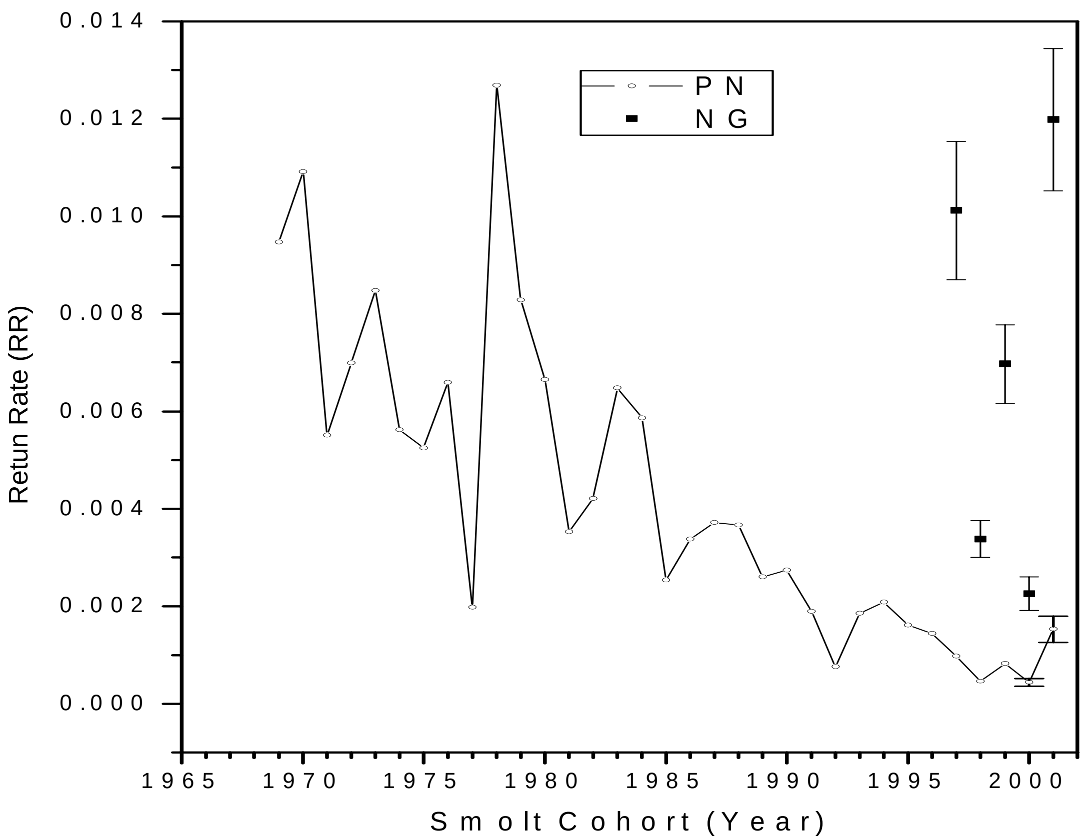
Table 1. Redd based estimates of adult Atlantic salmon in the DPS rivers for 2003, with estimates from 2002, 2001 and 2000.

River	Type	Estimate	90% CL Low	90% CL High
Cove Brook	redd	5	3	8
Ducktrap River	redd	5	3	8
East Machias River	redd	3	2	5
Machias River	redd	22	12	36
Sheepscot River	redd	5	3	8
Dennys River	trap	9	9	9
Narraguagus River	trap	21	21	21
Pleasant River	trap	2	2	2
				86
2002		33	26	41
2001		99	87	115
2000		91	75	111

Returns from traps and weirs were added to the estimated returns based on redds for total U.S. returns of 1,436 (237 1SW and 1,195 MSW). These returns represent 4.8 % of the 2SW conservation for the U.S. with individual river returns ranging from 0.0 to 16.2 % spawner requirements.

In addition to total returns, return rates (RR) provide an index to marine survival over time and between river systems. Historically, most U.S. RR were generated where known numbers of smolts were stocked and weirs or traps allow the recovery of adults where origin was determined by marking programs or scale reading. The longest U.S. time series of return data comes from the Penobscot River in Maine (Figure 1). These rates generally correlate well with other large restoration programs in the Connecticut and Merrimack rivers. Because of this correlation, its numerical dominance, and relatively consistent stocking practices, the Penobscot River population provides the most informative composite index of U.S. marine survival (Figure 1). Additionally, recent marking studies in the Penobscot River have allowed estimates of RR for seven sub-groups providing an error rate around estimated returns in the last two 2SW cohorts. Until recently, RR for wild populations were not estimated consistently. However, smolt assessment work on the Narraguagus River has provided a new index of naturally-reared (wild or fry stocked origin) smolts and subsequent adult returns. RR for this 5-year time series correlate (r^2 = 0.91) closely with Penobscot River RR but are generally 5-10 fold higher as is often observed in other wild populations. Ongoing RR studies in the Dennys and Pleasant rivers will add to the understanding of wild and hatchey RR in other U.S. systems.

Figure 1. Return rate (RR) by smolt cohort of hatchery-reared Atlantic salmon smolts released into the Penobscot River, Maine, USA (PN) and naturally-reared smolts released into the Narraguagus River, Maine, USA (NG).



2.3. Stock Enhancement Programs

During 2003, about 13,060,600 juvenile salmon (91.3% fry) were released into 17 river systems. The number of fish released was greater than that in 2002. Fry were stocked in the Connecticut (7.1 million), Merrimack (1.3 million), Saco (0.5 million), and Penobscot rivers (0.7 million). The 375,000 parr released in 2003 were by-products of smolt production programs and included ages 0 and 1 fish. Smolts were stocked in the Penobscot (547,300), Merrimack (50,600), Connecticut (90,100), Saco (3,200), Dennys (55,200), Pawcatuck (5,200), and St. Croix (3,200) rivers. In addition to juveniles, 4,671 adult salmon were released into U.S. 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.

2.4. 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 502,866 salmon released into U.S. waters in 2003 was marked or tagged. Tags used on parr, smolts and adults included: Floy, Carlin, PIT, radio and acoustical, fin clips, and visual implant elastomer. About 18% of the marked fish were released into the Connecticut River watershed, 1% into the Merrimack River watershed, 63% into the Penobscot River, and 18% into other Maine Rivers.

2.5. Farm Production

Production of farmed salmon in Maine was 6,435 metric tonnes in 2003, a decrease from the 6,804 metric tonnes produced in 2002. Production in each of the last two years has been less than half of the 13,154 tonnes produced in 2001. Production has declined due to ISAv outbreaks and changes in the industry.

2.6. Database Systems

Microsoft Access is being used to manage Atlantic salmon population and habitat data for U.S. rivers. The current USASAC database includes data from reporting agencies. The USASAC has focused on the various databases required for USASAC and ICES reporting requirements. Over the last year data flow from the different program to the USASAC was streamlined, eliminating transcription problems and improving data quality. Databases for juvenile production, smolt emigration, aquaculture production, and in river captures of aquaculture escapes were created and populated with data for the programs. The USASAC now has increased capacity to tackle national stock assessment questions rather than summary program reporting. The next step will be to assure that robust metadata are available, facilitating data sharing and regional analyses.

2.7. Penobscot River Restoration Project

An unprecedented venture to rebalance hydropower production and the ecological importance of a river system took a giant step forward with the announcement of the Penobscot River Restoration project in October 2003. Conservation groups, the Penobscot Indian Nation, Pennsylvania Power and Light Corporation (PPL), the State of Maine (including the Commission) and the U.S. Department of Interior are partners in this landmark project, which endeavors to reconfigure hydropower facilities in the lower Penobscot River thereby opening more than 500 miles of habitat to sea-run fish.

As part of the implementation of the project, the Veazie and Great Works dams will be removed and a fish passage channel will be installed at the Howland Dam. Additionally, upgraded fish passage facilities will be installed at four other hydroelectric projects. Multiple dams on the Penobscot River currently impede the safe upstream and downstream passage of sea-run fish. The

Penobscot Restoration Project is the first project that provides an essential ingredient for the successful restoration of Atlantic salmon as well as other species of native sea-run fish in the river – their ability to reach vast quantities of productive spawning and rearing habitat. To that end, this project will:

- reestablish the river's historic connection to the ocean, dramatically improving access to over 804.5 km of river habitat,
- allow several species including striped bass, Atlantic and shortnose sturgeon, and rainbow smelt to regain their entire historical habitat,
- improve access to hundreds of kms of river and dozens of lakes and ponds that historically provided habitat for American shad, alewife, blueback herring, and American eel,
- significantly improve the ability of adult Atlantic salmon to reach vast quantities of productive spawning and rearing habitat in the Penobscot River,
- allow Atlantic salmon to regain half of their historical habitat in the river with just one dam passage, which will have a new fish lift installed,
- allow nutrients derived from sea-run fish to reach farther up river, and the natural flushing of sediments will reach Penobscot Bay, restoring a natural cycle to the river,
- enhance the supply of food sources for a wide variety of fish and wildlife inhabiting the Gulf of Maine by restoring sea-run fish to the river,
- restore the Penobscot Indian Nation's ability to obtain sustenance, cultural, and identity from the river that bears their name,
- allow PPL, under a reconfigured hydroelectric generating system, the opportunity to maintain 90% of current power production.

Implementing this landmark project will take time. First, a final settlement agreement must be created. A not-for-profit corporation will receive a five-year option period to purchase the Veazie, Great Works, and Howland dams beginning on the date that the Comprehensive Settlement Agreement is signed. Removals and modifications would likely occur between 2006 and 2010 and after all necessary regulatory approvals have been received.

2.8. SPAWNING ESCAPEMENT, BROODSTOCK COLLECTION, AND EGG TAKE

Connecticut River: Four wild sea-run salmon were radio tagged and released upstream of the Holyoke Fishway (river km 138) and then permitted to continue upstream. The movements of these fish are summarized in Section 2.11.1.

Maine Rivers. Natural reproduction was documented by redd counts in seven rivers with natural populations and in tributaries of the Penobscot River. Details can be found in Section 2.11.2. 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 2003 from each category is as follows: sea-run 459; captive 516; domestic 2,641; and kelts 89. The grand total of salmon spawned (3,705) was less than that in 2002 (3,734). The total egg take (19,564,000) was also less than that in 2002 (20,081,119). A more detailed accounting of the egg production is contained within Table 11 in Appendix 7.4.

2.9. SPORT FISHERY

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

2.10. HISTORICAL DATA

2.10.1. EGG PRODUCTION

A summary of egg production for Atlantic salmon restoration and recovery programs in New England for the period 1871-2003 is provided in Table 12 in Appendix 7.4. A summary and grand total of all historical Atlantic salmon egg production for New England salmon rivers is provided in Table 13 in Appendix 7.4. Approximately 62,453 female Atlantic salmon have produced an estimated 422 million eggs for programs throughout the history of salmon enhancement, restoration, and recovery efforts.

2.10.2 STOCKING

Historic stocking information is presented in Tables 14 and 15 in Appendix 7.4. Approximately 208 million juvenile salmon have been released into the rivers of New England during the period, 1967 - 2003. About 79% of the total have been fry. The majority of the juvenile releases have occurred in the Connecticut River (> 102.0 million), the Penobscot River (> 33.0 million), and the Merrimack River (> 33.0 million).

2.10.3. ADULT RETURNS

Historic return information is presented in Tables 16 and 17 in Appendix 7.4. Total returns to New England rivers from 1967 through 2003 now equals 79,700. 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 18.1 through 18.7 in Appendix 7.4. A summary of return rates and age distributions of Atlantic salmon stocked in New England rivers as fry are tabulated in Tables 19 and 20 in Appendix 7.4. 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.

2.11. GENERAL PROGRAM UPDATES

2.11.1. CONNECTICUT RIVER

2.11.1.a. Adult Returns

A total of 43 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed: 28 at the Holyoke fishway on the Connecticut River; one at the Rainbow fishway on the Farmington River; nine at the Leesville fishway on the Salmon River; and five at the Decorative Specialties International (DSI) fishway on the Westfield River. The spring run lasted from May 4 to June 3. One salmon was captured at Leesville fishway in October. A total of 39 salmon was retained for brood stock: 29 were held at the RCNSS, and ten were held at the WSS.

Four salmon were radio-tagged and released above the Holyoke fishway (river km 138) and then permitted to continue upstream. Three of these radio-tagged salmon ultimately passed downstream and were recaptured and retained for brood stock. One was recaptured at the Rainbow fishway in the spring, one was recaptured at the DSI fishway in the spring and one was recaptured at the Holyoke fishlift in the fall. Including these recaptured fish the brood stock was comprised of 34 female and 8 males. The other radio-tagged salmon did not pass Turners Falls and its fate is unknown.

All of the 43 salmon observed were of wild origin. Sea-age of the fry-stocked fish was comprised of, 2 sea-winter salmon (N=42), and 3 sea-winter (N=1). Freshwater ages of wild salmon were ages 1 (N=5), 2 (N=36) and 3 (N=2).

2.11.1.b. Hatchery Operations

The program achieved almost 83% of egg production goals and 70% of fry stocking goals, and 90% of smolt stocking goals in 2003.

A reduction in state revenues forced the Connecticut Department of Environmental Protection to close the Whittemore Salmon Station (WSS) in Barkhamsted, Connecticut. This resulted in the consolidation and transfer of essential program activities to other facilities. The White River National Fish Hatchery (WRNFH)in Bethel, Vermont assumed responsibility for managing the genetic eggbank. The brood stock (168 domestics and 49 kelts) were transferred to the North Attleboro NFH (NANFH), North Attleboro, Massachusetts and the Richard Cronin National Salmon Station (RCNSS), Sunderland, Massachusetts.

Currently, a total of 86,000-1 year old pre-smolts are in production at the Pittsford NFH. The 1 year old pre-smolts were marked with an adipose fin clip and vaccinated in late-October in preparation for spring stocking. They were vaccinated with a multi-valent vaccine for Vibrio and furunculosis.

Egg Collection

A grand total of 12.5 million green eggs was produced at six state and federal hatcheries within the program. This is about 700,000 more eggs than produced in 2002. Kelt egg production decreased but domestic and sea-run egg production increased in 2003.

Sea-Run Brood Stock

Sea-run females produced 2% (245,000 eggs) of the total eggs from 34 sea-run females (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 egg-banked at the WRNFH for disease screening and subsequent production of future domestic brood stock.

Domestic Brood Stock

Domestic females produced 93 % (11.6 million eggs) of the total eggs from 2,152 domestic females (96% of the total females spawned) held at the WRNFH, RRSFH, and KSSH.

Kelts

Kelts produced 5% (659,000 eggs) of the total eggs from 67 kelt females (3% of the total females spawned) held at the WSS and NANFH.

2.11.1.c. Stocking

Volunteers donated 2,519 hours of time to stock Atlantic salmon fry in the Connecticut River watershed including 287 hours for NHFG, 748 hours for CTDEP, 800 hours for VTFW, 564 hours for MAFW, and 120 hours for the USFS.

Juvenile Atlantic Salmon Releases. A total of 7 million Atlantic salmon was stocked into the Connecticut River watershed in 2003. A total of 900,000 fed fry (13%) and 6.1 million unfed fry (87%) were stocked into 38 tributary systems. A total of 90,000 smolts were released into the lower Connecticut River mainstem and the Farmington River.

Surplus Adult Salmon Releases. Domestic brood stock surplus to program needs were made available to the states to create sport fishing opportunities. The CTDEP released a total of 1,384 adult, domestic brood stock in the Naugatuck (666) and Shetucket Rivers (718); the VTFW released 200 adults in Lakes Willoughby (100) and Seymour (100); and, the MAFW released 700 adult salmon in 16 different lakes and ponds throughout Massachusetts with another 1300 planned for release. The White River NFH also provided 618 surplus domestic brood stock to the RIFW.

2.11.1.d. Juvenile Population Status

Smolt Monitoring

Northeast Generation Services and the USFWS/SFRO contracted with Greenfield Community College to conduct a mark-recapture smolt population estimate in 2003. This was the eleventh 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. The smolt estimate was 80,000 (+/- of 42,000 with 95% confidence limits).

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 287,000 smolts were produced in tributaries basin wide, of which 220,000 (77%) were produced above Holyoke in 2003. 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 nearly about 150 index stations throughout the watershed. Sampling was conducted by CTDEP, NHFG, USFS, and VTFW. MAFW was unable to conduct any index station sampling in 2003 due to lack of seasonal help. 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 year with above average growth. Most smolts produced are again expected to be two year olds, with some yearlings and three year olds. The preliminary data analysis suggests that basin wide smolt production in 2004 will be similar to last year’s estimate.

2.11.1.e. Fish Passage

Program cooperators continued to work to improve upstream passage and downstream passage at dams as well as to remove dams.

<u>Holyoke Dam</u> - The City of Holyoke Gas and Electric Department continued to implement new license requirements for upstream and downstream passage.

<u>Bellows Falls and Wilder Projects</u> -Fishways at Bellows Falls and Wilder were not operated in 2003 because no adult salmon passed upstream of the Vernon dam.

<u>Westfield River</u>
<u>DSI-West Springfield Project</u> - Volunteers from the Westfield River Watershed Association again monitored the fishway the DSI.

Westfield Paper Dam - The owner filed an Exemption Application and a Preliminary Permit Application with FERC; FERC is still conducting a jurisdictional review; Upstream and downstream passage will be issues.

Woronoco Project - A smolt bypass plunge pool was constructed but designs were not approved prior to construction. FERC is reviewing the situation.

Deerfield River - USGen New England (USGen) evaluated downstream smolt passage. Study results indicate improvement in passage success at the Number 2 project and moderate success in passage at the Number 3 and Number 4 stations. USGen is proposing to develop a plan to address additional operational or design changes based on what was learned in this and previous studies.

Fifteen Miles Fall Project - The McIndoes bypass was modified and evaluated with hatchery smolts. Study results indicate significant turbine passage and poor bypass effectiveness. USGen proposes to install a smolt sampling device at Moore to collect data on seasonal and diurnal timing and smolt abundance as a precursor to passage facility development at Moore and Comerford.

West Swanzey Dam - The NHDES is soliciting bids to evaluate the removal of this Ashuelot River dam. The dam is in severe disrepair and the NHDES may require impoundment draining.

Fiske Mill Dam - The NHDES, NHFG and USFWS are working with this Ashuelot River dam owner on both license surrender and a removal deal.

Silk Mill Dam - The MAEOEA successfully removed this dam on Yokum Brook in Becket, MA.

Vermont Yankee Nuclear Power Plant-Entergy, the new owner of the Vermont Yankee Nuclear Power Plant has proposed increases to thermal discharge limits. Concerns for salmon include river warming during smolt migration and impacts of the discharge plume on smolt behavior. The proposal is under review by several agencies.

2.11.1.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 characterization (micro satellite analysis). The work was conducted in cooperation with the National Fish Health Research Lab-Leetown. All of the sea-run brood stock was PIT tagged to ensure individual identification at spawning. This information is necessary to develop the mating scheme that is a deliberate effort to mate salmon that are the most distantly related. It is also used to create known families so the fry can be >genetically-marked= for post-stocking evaluation.

The objective is to use a minimum of 50 pairs of sea-run adults for the egg taking operation, but since a total of 43 salmon returned to the river in 2003, kelts and parr were added to the spawning population to raise the total to 50 pairs. The sex ratio of returning salmon was again skewed toward females. Consequently, wild male parr were collected in the Williams River in Vermont (153) and Pine Brook in Connecticut (43) to augment the male population. The spawning population included 28 sea-run and 18 kelt females and 9 sea runs, 5 kelt and 46 mature parr males. Mating utilized a 4 male : 1female breeding matrix in which one unique cross was sent to the Egg Bank (relocated to WRNFH in 2003) and the other three crosses were sent to the WRNFH for production of genetically-marked fry for stocking. The purpose of the Egg Bank is to incubate appropriate quantities of eggs to create future domestic brood stock. The eggs are held (Abanked@) in a quarantined facility while disease screening is completed. Once lots of eggs are shown to be disease-free, they are shipped to rearing hatcheries for future broodstock.

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. Genetically identifiable groups of domestic salmon brood stock have been maintained at the WRNFH since 1998. 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 effort was continued in 2003.

2.11.1.g. General Program Information

The Connecticut River Atlantic Salmon Commission was provided with $250,000 by Congress for migratory fish restoration in the Connecticut River basin. This is the first time that the Commission has ever received direct federal funding. In addition to work on other migratory species, the funding will be used to address budget gaps in salmon production, to continue genetic monitoring an evaluation, to continue index station assessments, and to maintain capabilities in adult transport, handling and spawning.

The use of salmon egg incubators in school as a tool to teach about salmon, watersheds and conservation continued to expand throughout the basin. The Connecticut River Salmon Association (CRSA) conducted their Fish Friends program at over 50 schools in Connecticut, reaching 1456 students. Trout Unlimited carried a similar message to 37 schools in Massachusetts, reaching 740 students as did the Southern Vermont Natural History Museum and the Vermont Institute of Natural Science in Vermont where 784 students were involved from 28 schools. An additional 4 schools in New Hampshire enrolled in the program. Altogether the educational partnerships reach over 5,176 students in the watershed.

2.11.1.h. Salmon Habitat Enhancement and Conservation

Program cooperators continued their habitat protection efforts in 2003. The USFS continued their habitat restoration project in the White and Green Mountain national Forests.

2.11.2 MAINE PROGRAM

2.11.2.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. Retired captive-reared broodstock from Craig Brook National Fish Hatchery were stocked into estuaries of five of the seven rivers listed as having endangered populations of Atlantic salmon.

The summer of 2003 was not remarkably wet or dry, resulting in “normal” river discharges in July and August. However, there were substantial late fall rainstorms, with flows during and after spawning at or exceeding spring flood stage. These conditions afforded adults access to spawning areas throughout entire drainages. Unfortunately, the high flows made redd counting extremely difficult. Redds located during surveys used to monitor spawning activity and estimate numbers of spawners reflect considerable effort.

Rivers with Native Atlantic Salmon

Dennys River. A total of eleven salmon were captured at a weir located at the head of tide in Dennysville. The weir was operated from 8 May through 28 October 2003. The trapping operation ended early due to unusually high flows, associated with heavy rain events that damaged the weir and made continued operation unsafe and impossible. Four one sea-winter salmon (1SW) and seven multi-sea winter (MSW) salmon were captured. Of the 1SW fish, two originated from smolt stocking in spring 2002, one was an aquaculture suspect, and one, that escaped while being handled, was prorated as a hatchery fish. Of the MSW fish, five originated from smolt stocking in the spring of 2001, one was a wild fish, and one was an aquaculture suspect that was mistakenly released upstream due to miss-reading the fish’s scales. One redd was located on the river.

East Machias River. Redd surveys conducted on the East Machias River covered a much of the available spawning habitat. However, high water and poor visibility made complete surveys impossible, and two high-quality spawning areas were not surveyed. The number of redds was extremely low, with only one redd located in Chase Mill Stream.

Machias River. The major tributaries of the Machias River were surveyed for redds in spite of high water levels and poor visibility. High water this fall precluded redd surveys in the mainstem. Within the tributaries, 21 redds were located, a substantial increase from 2002, when only three redds were counted. Both Old Stream and Crooked River had a significant return of spawners. Eight redds were recorded in Old Stream, twelve were recorded in the Crooked River, and one was recorded in the West Branch. The redds found in Old Stream and the Crooked river may be the result of salmon homing to their natal stream, or of other fish seeking out smaller tributaries for spawning due to high water in the mainstem of the river.

Pleasant River. Two salmon were trapped at a weir operated by the Maine Atlantic Salmon Commission from May 8 to October 28, 2003. Weir operation was truncated when unusually high water flooded the weir, rendering it inoperable and unsafe to tend. One multi-sea winter female was released upstream, and one multi-sea winter male was misidentified as an aquaculture suspect and sacrificed. Further review of this fish’s scales indicated that this fish was of wild origin.

Redd surveys were not attempted due to high water and poor visibility.

Narraguagus River. A fishway trap at the Cherryfield ice control dam was operated from May 1 through November 3. Twenty-one naturally produced sea-run salmon were captured in the Narraguagus River in 2003. This year's trap catch represents an increase of 13 salmon from the 2002 catch of eight salmon, and a decrease of nine salmon from the 2001 catch of 30 sea-run salmon.

Although high water levels and ice formation in the river, combined with bad weather, limited the number of redd surveys and hindered the visibility during surveys, redd counts were conducted on the Narraguagus River mainstem and two of its tributaries. The five redds and six test pits found were located downstream of Beddington Lake outlet (approximately 42 km upstream of tidal waters). No redds or test pits were observed in the two tributaries surveyed (Sinclair Brook and Gould Brook), or upstream of the lake. This year's count is smaller than in 2002 (six redds) and 2001 (24 redds), and represents less than one percent of what is needed to assure full habitat utilization.

Ducktrap River. Low flows throughout the summer in the Ducktrap River likely limited adult salmon access to spawning grounds until late fall, when significant rains provided access for the remainder of the fall. Two redds and two test pits were observed in the Ducktrap River. High water levels, poor visibility, and freezing temperatures, made it impossible to undertake further redd count surveys.

Sheepscot River. Two redds were found between Coopers Mills and Kings Mills in the Sheepscot River. High water and poor weather limited us to one redd survey trip in 2003.

Cove Brook. Low flows throughout the summer in Cove Brook likely limited access for adult salmon to spawning grounds for most of the summer, but by the beginning of October water levels were sufficient for migration. There were two attempts to find redds in Cove Brook in 2003. On November 3 there were no redds, but on December 3 two redds and three test pits were located.

Total Returns to DPS. Scientists estimate the total number of returning salmon to the Gulf of Maine Distinct Population Segment using capture data on all DPS rivers with trapping facilities (Dennys, Pleasant, and Narraguagus Rivers) combined with redd count data from the other five 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 will 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 2003 ranged from 61 to 86. This range represents a 220% increase from 2002 return estimates (Table 2). However, this estimate is still the second lowest for the 1991-2003 time-series.

Table 2. Redd based estimates of adult Atlantic salmon in the DPS rivers for 2003, with estimates from 2002, 2001 and 2000.

River	Type	Estimate	90% CL Low	90% CL High
Cove Brook	redd	5	3	8
Ducktrap River	redd	5	3	8
East Machias River	redd	3	2	5
Machias River	redd	22	12	36
Sheepscot River	redd	5	3	8
Dennys River	trap	9	9	9
Narraguagus River	trap	21	21	21
Pleasant River	trap	2	2	2
Total 2003	Model	72	61	86
2002		33		41
2001		99		115
2000		91		111

Managers need a quantitative measure of recovery of the Gulf of Maine DPS that shows if overall population decline has been halted, and integrates the results of implemented recovery actions with changes in habitat and survival over time. One such measure is replacement rate (RPR). The RPR describes the demographics of each subsequent generation, or cohort, as it ages and replaces the previous one. Current redd-count-based assessments do not allow for cohort analysis that would track a given year-class from spawning through return as 1SW or 2SW fish over two years. But given the predominance of 2SW returns in these populations, a simple calculation of returning adults in year n divided by the number of returning adults in year n-5 is used. An RPR of 1 would indicate a stable population while below 1 is declining and above 1 growing. The current simulation model above provides data for 8 generations of Atlantic salmon starting with returns in 1996 from the 1991 spawning cohort. The replacement rate averaged 0.6 during this time and the mean replacement rate has not exceeded 1 during this time period. However, in 3 of the 8 years (1996, 1998, and 1999) the upper bound of the 90% confidence limits did exceed 1. The replacement rate for 2003 was 0.38 (0.21-0.62) and was the second lowest in the time series.

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 2003.

ASC operated a fishway trap at the Veazie hydroelectric dam from May 12 through November 3 to capture upstream migrating adult Atlantic salmon. We measured and recorded biological data from returning salmon and retained a portion of the run for hatchery broodstock. We captured a total of 1114 adult salmon in 2003, an increase of 334 fish from the 2002 catch and the first time the trap catch exceeded 1000 fish since 1998. We collected scale samples from 616 salmon to estimate the age and origin structure of the run, and obtained non-lethal tissue samples from 772 fish for DNA analysis. Of the 1114 adults returning to the trap in 2003, 202 (18.1%) were one-sea-winter salmon (grilse), 903 (81%) were two-sea-winter salmon, and the remainder were repeat spawners. The proportion of 1SW fish fluctuates annually, and while this year's rate is below the 25.6% average for the previous 16 years, it does fall within the observed range for this time period. Only 5.7% of the 2003 salmon run was determined to be of wild origin, which is similar to the 4.2 % observed for 2002. We captured no salmon suspected to be aquaculture escapees in the Penobscot River, and two salmon that had been previously reared at Green Lake National Fish Hatchery as captive broodstock. Of the 510 fish (MSW salmon and grilse) released upstream of the Veazie Dam after capture in 2003, 143 were multi-sea-winter females. This represents approximately four percent of the spawning escapement required to meet the conservation target set for the Penobscot drainage.

The Great Lakes Hydro America, LLC (GLHA) continued operation of an Atlantic salmon trap at the fishway of the Weldon dam. The dam is located 60 miles upstream from Bangor and is the fifth and final mainstem dam encountered by salmon on their upstream migration. The trap was operated daily from June 19 through October 31. The 2003 trap catch (40 salmon) was less than half of the previous year's catch (99 salmon). The catch included 20 multi-sea-winter salmon and 20 one-sea-winter fish (grilse). All trapped fish were counted and permitted to swim from the trap without additional handling to minimize stress.

Surveys to locate and count redds were conducted on two tributaries to the Penobscot estuary.

<u>Kenduskeag Stream.</u> Four redd count surveys were conducted on the mainstem (October 4, 6, 17, and 18), each covering only portions of the spawning habitat in the Kenduskeag. Most areas were visited once; however, areas of known prior spawning activity were checked twice. Three redds were observed in the mid-reaches of the mainstem. Surveys of spawning activity in the Kenduskeag were emphasized because a number of adult salmon had been seen in the lower river over the summer. However, with little spawning observed, it is presumed many of these fish later returned to the Penobscot River to continue their upstream migration.

<u>Souadabscook Stream.</u> There was one attempt to find redds on Souadabscook Stream in 2003, on November 19. Due to the significant amount of water from fall rains, staff were unable to find evidence of spawning activity.

<u>Marsh Stream.</u> No redd counts were conducted on Marsh Stream.

St. Croix River. Adult salmon are monitored at a fishway trap operated 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 Milltown trap catch was 24 sea-run salmon in 2003. Of these, 15 were the product of juvenile stocking programs in previous years. Three of the 15 salmon died on site before they could be transported to the broodstock holding facility. Necropsy reports on these mortalities indicated severe gill damage, similar in appearance to the salmon mortalities observed at some aquaculture sites in 2003 coincident with an unusually large phytoplankton bloom late in the summer. Aquaculture escapees have been a principal 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 as recently as 2001. Only six aquaculture fish were observed in 2002, following complete depopulation of all Cobscook Bay salmon pens in U.S. waters in 2001 to control the spread of ISA. Partial depopulations of the pens were required again in 2002, and only nine aquaculture escapees were trapped in 2003 (Table 3).

Androscoggin River. Three 2SW hatchery origin Atlantic salmon were captured at the Brunswick Dam fishway in 2003.

Saco River. Florida Power and Light (FPL) currently operates 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 12 salmon were passed into the Cataract headpond via this facility. In the West Channel, between Saco and Biddeford, the Denil fishway-sorting facility was also operational from early May to late October. This facility passed 27 salmon into the headpond. A third passage facility at Skelton Dam was used to capture adult salmon for transport by truck to the Ossipee River. FPL transported and released 24 salmon from this facility.

Union River. The Ellsworth dam, although not equipped with an upstream fishway, has trapping facilities below the dam. The current dam owners, Pennsylvania Power and Light (PPL), provide fish passage by trapping fish below the dam and transporting them in tank trucks to upriver release sites. The trap is owned by the Commission but is operated from mid-May to mid-June by commercial fishermen who are permitted to harvest a portion of the alewives entering the trap. The alewife run in 2003 was considered average in size and PPL successfully transported the target-spawning escapement (104,000 alewives) to upriver spawning areas. No salmon were captured during the alewife harvest in 2003, but one salmon was captured later in the year. Biological data were collected from the fish and it was immediately returned to river. Analysis of those data indicated that the fish was the product of the 1999 parr stocking. No aquaculture escapees were observed in the Union River in 2003.

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

Passagassawakeag River. No redd counts were conducted on the Passagassawakeag River this year as weather conditions hindered our planned surveys.

Aroostook River. Tinker Dam is the gateway to the Aroostook River located five kilometers upstream from the confluence with the St. John River in New Brunswick, Canada. PDI Canada, Inc. operates a fish trapping and sorting facility as part of the Tinker Dam Hydro Project. The Tinker trap catch was only two salmon (one MSW and one 1SW) in 2003. Both fish were released above the dam.

Table 3. Numbers of suspected aquaculture escapes captured at traps on Maine Rivers. Blanks are no data.

YEAR	Dennys	Narraguagus	Penobscot	Pleasant	Union
1997		0	0		
1998		0	0		
1999		8	0		63
2000	28	0	0	0	3
2001	62	1	1	0	2
2002	4	0	4	0	6
2003	2	0	0	0	0

2.11.2.b. Hatchery Operations

Egg Production

Sea-run, captive and domestic broodstock produced 6.6 million green eggs for the Maine program in 2003. Of these eggs, 3 million (45%) came from Penobscot sea-run fish; 2.3 million (35%) from six captive broodstock stocks; and 1.30 million (20%) from Penobscot domestic broodstock.

Progeny produced from captive broodstocks are released into their rivers of origin, primarily as fry.

All three egg sources were used for the Salmon in the Schools program, and domestic eggs were transferred to the Saco River hatchery for rearing and release. Domestic Penobscot strain eggs were also used for a streamside incubation study on the Kennebec River.

Nate Wilke, MS candidate at University of Maine in Orono, worked closely with Craig Brook facility staff during the spawning season in the second year of a study to correlate DNA markers with phenotypic traits such as fecundity and morphology. Each spawned fish was sampled for DNA analyses and photographed. Samples of egg size, fecundity and weight were also taken.

Program personnel continued to refine spawning protocols for spawning the captive broodstocks at CBNFH in 2003 by refining a “life-time contribution” approach for each adult fish, and conducting preliminary trials to look at selected paired matings.

Broodstock Collection

Collection of parr and smolts from the DPS for broodstock development continued in 2003. Captive broodstock are collected from their native rivers as parr (and smolts in the case of the Pleasant River), and reared to maturity at CBNFH. In 2003, a total of 1299 parr and smolts was collected from the following rivers: Dennys (276 parr), East Machias (160 parr), Machias (310 parr), Pleasant (119 parr; 3 smolts), Narraguagus (264 parr), and Sheepscot (167 parr). These fish will be reared to maturity in order to provide river specific fry, parr and smolts for restoration programs in these rivers. The numbers of parr targeted for collection were increased in 2002 and 2003 in preparation for the single year-class and lifetime contribution protocols being developed and phased in to spawning protocols.

Parr collected for broodstock in 1999 (N = 914) and 2000 (N = 1080) were fitted with PIT tags in the body cavity at the time of capture. This proved to be a problem starting with spawning in 2001, when approximately 70% of the females expelled the tags along with the eggs. There were no tags lost while expressing milt, or with fish tagged in the dorsal musculature (Buckley, 2002). This trend, although not quantified, continued during spawning in 2002 and 2003. In an effort to reduce handling stress, tag loss, and tagging-related mortality, juvenile broodstock were not tagged at capture with (PIT) tags beginning in 2002. Tags will be applied at CBNFH when the fish reach an appropriate size to allow intramuscular insertion of the tags.

In September and October of 2003, 1209 DPS broodstock, which were collected in 2002, were PIT tagged at CBNFH and moved from the Receiving Building to the broodstock modules.

A total of 605 sea-run adult salmon were collected from the Penobscot River and brought to CBNFH for broodstock in 2003 (compared to 378 in 2002).

2.11.2.c. Stocking

During 2003, a total of four million juvenile Atlantic salmon were stocked into the rivers of Maine, produced primarily within the state, but also in Canada. Of this number, a total of 1.36 million salmon was stocked into six DPS rivers as river specific fry, as well as 740,000 fry into the Penobscot River. In addition to the fry, age 1 smolts were stocked into the Dennys (55,200) and Pleasant (2,800) rivers.

A complete summary of stocking efforts by lifestage and river can be found in Tables 7 and 14.

In addition to fry reared at CBNFH, 131 schools participated in the stocking effort by raising small numbers of DPS and Penobscot origin eggs (200 eggs per school) and stocking approximately 19,000 fry into designated segments of the parent river. These school activities are jointly organized and monitored by the FWS Salmon in Schools Program, the Atlantic Salmon Federation Fish Friends Program, and the ASC.

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

The number of fry available to the Dennys River has been reduced during the past three years to allow for the production of river specific 1-year-old smolts at Green Lake NFH. In 2003, GLNFH stocked 55,000 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 broodstock populations 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 2003, releases of the excess broodstock to the Sheepscot (70), Dennys (136), East Machias (102), Machias (198), Narraguagus (192) occurred in December.

Approximately 540 Penobscot sea run broodstock were released following spawning (60 were retained for fish health sampling). A summary of adult stocking is found in Table 2.2.1.b.

2.11.2.d. Juvenile Salmon Population Status

Surveys to estimate density or relative abundance of juvenile salmon were conducted on most of the rivers in Maine with wild or stocked populations of Atlantic salmon. On the Narraguagus, median parr densities were 2.1 parr/100m^2 (Table 4). However, there was considerable variability among the sites, with densities ranging from 0.01 parr/100 m^2 to 9.8 parr/100 m^2. In the Dennys River, parr densities ranged from 0.1 parr/100 m^2 to 7.4 parr/100 m^2 (Table x). Basin wide population estimates of Atlantic salmon parr in the Dennys River are being calculated based on a basin-wide parr density of 2.9 parr/unit. However, in 2003, approximately 12% of the parr captured (576) were from a stocking of parr the previous fall. This indicates that production in the river is lower than the overall 2.9 parr/unit. Density of young-of-the-year (YOY) has been extremely low in 2001 (median 0.34 YOY/unit), 2002 (median 1.88 YOY/unit), and 2003 (1.8 YOY/unit) in spite of stocking fry and releasing mature adults in 2000 and 2001. In addition to population estimates, we sampled 30 parr across three sites in the Dennys drainage, collecting gill biopsies for PCB exposure analysis. These samples were shipped to Michigan State University for analysis.

Electrofishing in the other rivers (Table 4) was conducted at standard index sites, or used to survey drainages for the presence or absence of Atlantic salmon. On the Sheepscot River, six sites electrofished were long-term monitoring index sites, whereas 20 sites were established to estimate basin-wide parr populations. ASC and Canadian biologists surveyed multiple sites on the St. Croix River in 2003, encompassing a 33 km section of salmon habitat where redds were observed in 2000 and 2001. Abundant rainfall in 2003 resulted in high river flows that restricted the opportunity for effective electrofishing surveys. The flow is controlled by a dam at Vanceboro, and the operator reduced flow from 900 CFS to 350 CFS to accommodate sampling expeditions on September 17-18. On those dates, the Commission, SCIWC, and ASF biologists conducted one-run surveys at 15 sites along a 26km section of the river (Table x.). Parr were absent at seven of the 15 sites sampled, and densities were less than 1 parr per unit at all but one of the remaining sites.

The data from the juvenile abundance surveys in 2003 are being entered into a standardized database system that will allow more thorough analysis of population trends relative to a variety of factors (i.e. stocking, spawning escapement, habitat conditions).

Table 4 . Summary of juvenile Atlantic salmon population densities (fish/100m^2) in Maine Rivers, 2003.

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									
2003	Dennys	0.0	1.3	8.1	22	0.1	3.2	7.4	24
	East Machias	6.2	9.4	52.8	8	0.0	5.3	17.2	8
	Machias	0.0	1.8	15.8	9	0.0	4.1	11.2	13
	Pleasant	0.0	3.4	65.4	8	0.0	2.2	6.9	8
	Narraguagus	0.0	3.1	14.7	31	0.1	2.1	9.8	32
	Sandy	72.6	72.6	72.6	1	0.0	0.0	0.0	1
	Saco	7.8	21.5	35.2	2	6.0	8.8	11.6	2
	Sheepscot	2.1	24.6	57.8	4	0.3	4.8	14.4	12
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
2003	Cove	0.0	0.0	0.0	3	0.0	0.0	0.0	3
	Ducktrap	0.0	0.0	0.0	2	1*	1*	1*	2
	Eaton	0.0	0.0	0.0	1	1*	1*	1*	1
	Felts	0.0	0.0	0.0	1	0.0	0.0	0.0	1
	Kenduskeag	0.0	0.0	0.0	16	2*	2*	2*	16
	N Br. Marsh	0.0	0.0	0.0	5	0.0	0.0	0.0	5
	Passagassawakeag	0.0	0.0	0.0	3	0.0	0.0	0.0	3
	S Br. Marsh	0.0	0.0	0.0	2	1*	1*	1*	2
	Sedgeunkedunk	0.0	0.0	0.0	1	1*	1*	1*	1
	St. Croix	0.0	0.0	0.3	15	0.0	0.1	3.7	15
	Togus, Bond Brooks	0.0	0.0	0.0	3	0.0	0.0	0.0	3

* indicates total number of salmon caught at the number of sites listed

Basinwide Estimates of Large Parr Abundance. Assessment scientists project the basinwide production of large Atlantic salmon parr (>1+ fish) using a habitat-based stratification method for the Narraguagus River (1991-2003), the Dennys River (2001-2003), and more recently the Sheepscot River (2003). This method uses 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).

Smolt Abundance. NOAA-National Marine Fisheries Service (NOAA) and the Maine Atlantic Salmon Commission (ASC), conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in many of Maine's coastal rivers. Summaries for each river follow.

Narraguagus River. Four RSTs (2 Upstream - River km 11.16, 2 Downstream – River km 7.65) were monitored by NOAA on the Narraguagus River from 22 April to 6 June. 537 naturally-reared smolts were collected, with a population estimate of 1,182 +/- 225, using a Darroch maximum likelihood model. In addition to collecting smolts, ultrasonic telemetry studies where conducted, with 101 smolts (> 150 mm) inserted with ultrasonic pingers at the lower trapping site (River km 7.65).

Pleasant River. One RST (River km 0.07) was monitored by NOAA on the Pleasant River from 22 April to 4 June. 328 smolts were collected, of which 322 were 1-year VIE-marked hatchery smolts.

Dennys River. One RST (River km 0.78) was monitored by ASC on the Dennys River from 14 April to 1 June. 962 smolts (hatchery and wild combined) were collected with a population estimate of 1275 wild smolts derived using a discharged based model. In addition, 150 hatchery smolts tagged with ultrasonic pingers were released and their movements monitored by an array of detection units from freshwater to the entrance to the Bay of Fundy.

Penobscot River. The three RSTs (river km 45.72, 45.95, and 46.93) monitored by NOAA on the Penobscot River from 21 April to 9 June captured 446 smolts. The 2003 population was estimated at 98,900 +/- 17,400 using a Darroch maximum likelihood model. This is the second year for this estimate and abundance was only 51% of the 2002 estimate (195,122 ± 27,721). These estimates raise concerns because they include naturally reared smolts and are less than 40% of the over 500,000 smolts stocked annually. There were 85 mortalities of the 448 fish handled (19%) during smolt operations in 2003, 22 of which were dead at the time of capture (DOA) (Table 5). The number of DOA at traps on the Penobscot River were much higher than those observed on the Narraguagus River (Tables 5). A total of 7.7% of all of the smolts captured were found to have injuries, and some smolts had multiple injuries (Table 6).

Table 5. Comparison of the numbers of dead fish captured in RST traps on the Penobscot and Narraguagus Rivers by likely cause of death.

	Penobscot		**Narraguagus**	
Cause	**# of DOA**	**% of Total Catch**	**# of DOA**	**% of Total Catch**
Hydroelectric Dam	14	3.3%	0	0.0%
Sampling Gear	0	0.0%	0	0.0%
Predation	0	0.0%	0	0.0%
Unknown	8	1.9%	2	0.3%
Total	22	5.2%	2	0.3%

Table 6. Comparison of the numbers of injured fish captured in RST traps on the Penobscot and Narraguagus Rivers by likely cause of injury.

	Penobscot		**Narraguagus**	
Cause	**# of Injuries**	**% of Total Catch**	**# of Injuries**	**% of Total Catch**
Hydroelectric Dam	5	1.2%	0	0.0%
Sampling Gear	0	0.0%	0	0.0%
Predation	0	0.0%	7	1.1%
Unknown	13	3.1%	14	2.3%
Total	18	4.3%	21	3.4%

2.11.2.e. Fish Passage

Effective fishway operation is essential for returning salmon to pass dams and access headwater spawning areas. Fishways on the Penobscot were inspected on a routine basis in 2003 in conjunction with a PIT tag study, which required biologists to visit fishways twice each week to download data and maintain equipment. Fishways were inspected on a routine basis in order to ensure proper operation and confirm operator compliance with appropriate maintenance procedures. Inspections were routinely conducted at four dams in the Piscataquis (Howland, Browns Mill, Moosehead Manufacturing, and Guilford Industries), the Lowell Tannery Dam on the Passadumkeag, and five main stem Penobscot dams (Veazie, Great Works, Milford, West Enfield, and Weldon). Each site was inspected regularly in the course of downloading data from the PIT tag detection arrays. PIT antenna arrays and data were used to troubleshoot fish passage problems at the Great Works dam. The dam owners used our findings to implement minor changes to the structure that enhanced fish passage for the remainder of the summer and autumn. Improper fishway maintenance and operation practices were rare, relatively minor in nature, and were readily corrected by dam operators upon request.

Staff attended numerous meetings and field events associated with the hydro relicensings of the Saccarappa, Mallison Falls, Little Falls, Dundee, Gambo, and Eel Weir projects on the Presumpscot River. All projects are owned and operated by S.D. Warren. On the Saco River, Commission staff attended meetings and site visits involving the relicensing of the Bar Mills Project.

The Commission is working with DMR, IF&W, USFWS, NOAA, Trout Unlimited, the SRWC to address native fish species passage issues at the Coopers Mills Dam. Removal is one of the options being considered.

The USFWS, in consultation with the Commission, is exploring options to obtain federal grants that may be applicable to repairs to the fishway at a dam on the Little Madawaska River. The impoundment created by the dam serves as the primary water source for the Loring property and is considered vital to the long-term development goals of the Loring Development Agency. Transfer of dam ownership from the U.S. Air Force to the LDA was finalized in 2000.

A multi-agency project involving the ASC, NOAA, FWS and the Downeast Salmon Federation to remove a dam at Saco Falls on the Pleasant River is moving forward, and will hopefully be completed in 2004.

2.11.2 f. Genetics Collections and Broodstock Evaluation

Beginning in 1999, all broodstock at CBNFH were PIT tagged and sampled for genetic characterization via fin clips. 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 broodstock prior to spawning also allows program managers to eliminate undesirable genomes from the spawning population.

Fin samples were collected in 2003 from all parr-broodstock transported to CBNFH in 2002 from the following rivers: Dennys (286), East Machias (168), Machias (350), Pleasant (4), Narraguagus (264) and Sheepscot (160). In 2003, genetic samples were collected at the rotary screw traps by taking fin clips from smolts from the following rivers: Dennys (88), Pleasant (6), Narraguagus (577), and Penobscot (262). Samples were also taken from the two adults caught in the RSTs on the Penobscot River.

2.11.2.g. General Program Information

Atlantic Salmon Information System

Data management is an increasingly critical and integral part of the Maine Atlantic salmon program. To address this need the U.S. Fish and Wildlife Service, NOAA-Fisheries and Maine Atlantic Salmon Commission developed the Atlantic Salmon Information System (AS-IS). AS-IS promotes the use of standardized codes, U.S. Geological Service hydrological unit codes, and facilitates data sharing between agencies and outside conservation organizations.

The hub of AS-IS is the MaineSalmon database. MaineSalmon is a lookup database for standard coding of species, collection gear types, mark types, injury types, anatomical features, as well as drainage and site information. MaineSalmon uses an innovative linear river model with locations described as distances along a virtual centerline, with a precision of 0.01 km. The centerline originates at an established zero point, typically the confluence with the next higher branch in the watershed hierarchy. Location and site codes for the majority of rivers within the DPS have been assigned using this method. Users are able to query information from individual relational databases and link to existing spatial data using MaineSalmon.

Numerous relational databases address different areas of the program including adult returns, juvenile population estimates, smolt migration, environmental conditions, stocking, redd counts, broodstock management, and egg production. These “spoke” databases, all developed by separate agencies, communicate to each other through the MaineSalmon hub. These databases each have a data steward who is responsible for providing databases for data entry, conducting quality control audits, compiling data annually and redistributing it to interested parties.

The development of AS-IS led to the formation of the Database Working Group (Group), with two representatives from each agency. The Chair is an elected position for a term of one year. The Group is the focal point of database development within the Maine program. The Group provides technical assistance to new database developers to ensure continuity with the rest of AS-IS, regularly reviews MaineSalmon to optimize performance and usability, and encourages the development of sound data backup and documentation systems. The group reports to the Database Administration Group which oversees the AS-IS and its processes to ensure that AS-IS is developing in line with overall program goals.

Recreational Fishing Management

In response to the illegal taking of Atlantic salmon, the Commission, working with the Department of Inland Fisheries & Wildlife (IF&W), had a section of the Narraguagus River below the ice control dam in Cherryfield closed to all fishing, by emergency action, from August 22, 2003 to the end of the open-water fishing season.

The Commission is sensitive to the fact that the listing of Atlantic salmon as an endangered species could affect recreational fishing for other species. To ensure that fishing for species other that Atlantic salmon is minimally impacted, the Commission is working with IF&W to promulgated the following rule: **Narraguagus River**. Closed to all fishing from the ice control dam to the railroad bridge in the town of Cherryfield, except from May 1 to June 10 a portion of river between two sets of red posts (at 100 feet below and 450 feet below the ice control dam) is open to fly-fishing. This rule will protect salmon that migrate to this area while allowing the continuation of the historic recreational fishery for shad.

Penobscot River Restoration Project

An unprecedented venture to rebalance hydropower production and the ecological importance of a river system took a giant step forward with the announcement of the Penobscot River Restoration project in October 2003. Conservation groups, the Penobscot Indian Nation, Pennsylvania Power and Light Corporation (PPL), the State of Maine (including the Commission) and the U.S. Department of Interior are partners in this landmark project, which endeavors to reconfigure hydropower facilities in the lower Penobscot River thereby opening more than 500 miles of habitat to sea-run fish.

As part of the implementation of the project, the Veazie and Great Works dams will be removed and a fish passage channel will be installed at the Howland Dam. Additionally, upgraded fish passage facilities will be installed at four other hydro projects. Multiple dams on the Penobscot River currently impede the safe upstream and downstream passage of sea-run fish. The Penobscot Restoration Project is the first project that provides an essential ingredient for the successful restoration of Atlantic salmon as well as other species of native sea-run fish in the Penobscot – their ability to reach vast quantities of productive spawning and rearing habitat. To that end, this project will:

- reestablish the river's historic connection to the ocean, dramatically improving access to over 500 hundred miles of river habitat,
- allow several species including striped bass, Atlantic and shortnose sturgeon, and rainbow smelt to regain their entire historical habitat,
- improve access to hundreds of miles of river and dozens of lakes and ponds that historically provided habitat for American shad, alewife, blueback herring, and American eel,
- significantly improve adult Atlantic salmon's ability to reach vast quantities of productive spawning and rearing habitat in the Penobscot River,
- allow Atlantic salmon to regain half of their historical habitat in the river with just one dam passage, which will have a new fish lift installed,
- allow nutrients derived from sea-run fish to reach farther up river, and the natural flushing of sediments will reach Penobscot Bay, restoring a natural cycle to the river,
- enhance the supply of food sources for a wide variety of fish and wildlife inhabiting the Gulf of Maine by restoring sea-run fish to the river,
- restore the Penobscot Indian Nation's ability to obtain sustenance, cultural, and identity from the river that bears their name,

allow PPL, under a reconfigured hydroelectric generating system, the opportunity to maintain 90% of current power production.

Implementing this landmark project will take time. First, a final settlement agreement must be created. A not-for-profit corporation will receive a five-year option period to purchase the Veazie, Great Works, and Howland dams beginning on the date that the Comprehensive Settlement Agreement is signed. Removals and modifications would likely occur between 2006 and 2010 and after all necessary regulatory approvals have been received.

Penobscot PIT tag Project

This year was the second for a cooperative research project among the Commission, 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 Integrated Transponder). PIT tag antenna arrays and data loggers were installed at the entrance and exit of fishways at five main stem dams (Veazie, Great Works, Milford, West Enfield, and Mattaceunk) and three Piscataquis drainage dams (Howland, Dover-Foxcroft, and Browns Mills). In 2003, we released 506 salmon to the Penobscot River marked with PIT tags injected into the dorsal musculature. Commission 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 of tagged fish. The project's results so far have exceeded expectations, and have yielded valuable data on the movements and distribution of salmon in the Penobscot River drainage after they pass upstream of the Veazie Dam.

2.11.1.h. Salmon Habitat Enhancement and Conservation

Habitat Connectivity

In 2003, the Maine Fishery Resources Office (MEFRO) of the U.S. Fish and Wildlife Service (USFWS) worked with members of the Atlantic Salmon Commission and the Sheepscot River Watershed Council to begin a study of fish passage, habitat connectivity, and non-point source pollution in Maine's rivers.

Staff biologists began surveys in August of 2003 on Kenduskeag Stream and the West Branch of the Sheepscot River to evaluate the condition and effectiveness of bridge and culvert design in terms of overall river health, and passage of Atlantic salmon and other native fish species. Each site was inventoried for design, condition, and function. The current survey protocol is based on similar projects initiated by the Vermont Agency of Natural Resources and the US Forest Service San Dimas Technology and Development Center. Data collected on habitat conditions of representative reaches upstream, within, and downstream of each road crossing were analyzed to determine the structure's effect on flow, passage, and habitat connectivity. This information will be stored and disseminated to the parties with a vested interest or responsibility in the condition or function of these structures.

MEFRO is currently developing an atlas of surveyed sites on Kenduskeag Stream, and reviewing the survey protocol and data collection techniques used in 2003. This should increase the efficiency of future surveys. It is the goal of the MEFRO to establish a survey protocol that is applicable throughout Maine and New England, and can be used by both staff and volunteers. Staff are currently facilitating this process through contact with various federal, state, and local government agencies, as well as local and national non-profit and non-government environmental organizations.

Kleinschmidt and Associates completed an Instream Flow Incremental Methodology (IFIM) study on the Dennys River 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. The target for optimal salmon habitat throughout the drainage is 80 cfs at the USGS gauge on the Dennys mainstem.

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. In 2003, a 25-foot bridge crossing was replaced with a larger 65-foot bridge designed by Engineering Department at the University of Maine, Orono. This is the initial phase of the project. Jed Wright (USFWS) and John Parrish (Contractor) have completed a geomorphic assessment that will guide the stream channel restoration.

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 mainstem of the Machias River and several of its important tributaries. The project closing occurred in December 2003, resulting in the Commission holding a conservation easement on 18,443 riparian acres along the mainstem and several tributaries. The Commission also developed a Land Management Plan for the riparian habitat along the Dennys River and Cathance Stream purchased from International Paper Company. The plan will help ensure the integrity of the streamside habitat along the Dennys River and will provide significant benefit to all fish and wildlife, particularly Atlantic salmon.

2.11.3. MERRIMACK RIVER

2.11.3.a. Adult Returns

One hundred and forty-nine sea-run Atlantic salmon returned to the Essex Dam Fish Lift in the Merrimack River during 2003. One hundred and forty-seven salmon were captured and transported to the Nashua National Fish Hatchery (NNFH), two salmon escaped to the river, and three salmon died at the hatchery prior to spawning. Of the one hundred and forty-seven captured adult returns, readable scale samples were collected from one hundred and forty-three fish. The 2003 run total represents a 266% increase (149 in 2003, 56 in 2002) in returns compared to the

2002 season. Of the one hundred and forty seven salmon captured, one hundred and seventeen were spring returns (80%) and thirty returned in fall (20%). Gender was determined for one hundred and forty-two fish, with seventy-one identified as females (50%) and an equal number as males. Due to staff shortages, the Essex Dam fish lift operated on a reduced schedule.

Scale analysis of adult returns determined one hundred and thirty-nine fish to be of hatchery smolt origin (97.2%) and four of stocked fry origin (2.8%). Twelve of the one hundred and forty-three fish (8.4%) were determined to be grilse (1SW) and the remaining one hundred and thirty-one (91.6%) were two sea-winter fish (2SW). All of the stocked fry origin adults were two sea-winter fish (W2.2) and one hundred and twenty-seven of the hatchery smolt origin adults were two sea-winter fish (H1.2). Three of the four stocked fry origin fish were females.

The rate of return (adults produced per 10,000 juveniles stocked) for fry-origin adults remains at a low level. The current rate of return for the 1999 fry cohort is 0.028 [5 total return (one grilse in 2002 and four 2SW returns in 2003, n = 5) for the 1,756,013 fry stocked in 1999] a slight decrease in the return rate of 0.031 for 1998. The1999 return rate marks a three year decline in return rates when compared to immediate preceding years (1997=0.020, 1996=0.150, 1995=0.308, 1994=0.192).

The rate of return (adults produced per 1,000 juveniles stocked) for smolt-origin adults increased substantially from rates recorded for the past five years. The rate of return of the 2001 hatchery smolt cohort was 3.19 [158 total return (thirty-one grilse in 2002 and one hundred and twenty-seven 2SW returns in 2003, n = 158) for the 49,500 smolt stocked in 2001], compared with the rate for 0.419 for 2000, 1.755 for 1999, 1.503 for 1998, 1.848 for 1997, and 1.08 for 1996.

2115.3.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 2003 was primarily domestic broodstock (71%), followed by sea-run broodstock (18%), and kelts (11%). Survival of fry for the 2003 year class (sea-run broodstock) decreased significantly this year from past years. Periods of increased mortality occurred during and slightly after initial exogenous feeding was initiated in this lot of fry. Smolts produced for stocking in 2003 were provided by the GLNFH and were of Penobscot River sea-run parentage.

Egg Collection

Sea-Run Broodstock

One hundred forty-seven sea run Atlantic salmon were trapped at the Essex Dam in Lawrence, MA in 2003. Seventy-one sea-run returns were females, of which 60 fish were spawned. Seventy-one fish were males, of which 62 were spawned. The remaining five fish were trapped, but were not sexed or were identified as returning domestic broodstock, and therefore, not suitable as future broodstock. The seventy-one females spawned yielded 518,432 eggs, increasing average fecundity to 8,641eggs/female. The majority of the eggs were transported to the NANFH to be hatched and released as fry. About 16,815 sea-run eggs, approximately 3 %, were retained at the NNFH as future broodstock aliquots, in addition to 27,689 sea-run respawn eggs kept for program development. No pathogens have been suspected or detected in the 2003 sea-run broodstock. In addition, annual fish health testing yielded all negative results for the sea-run broodstock.

Captive/Domestic Broodstock

A total of 485 female broodstock reared at the NNFH provided an estimated 1,914,326 eggs during 2003 domestic spawning operations. For the second year in a row, age-3 non-spawners were retained for an additional rearing year to be spawned as age-4 broodstock. This protocol change has been initiated to diversify year-class structure of the domestic broodstock population at Nashua. Fifty-three (age 4) and 432 (age 3) were spawned. Eggs were transported to the NANFH and WSFH to be held for fry stocking within the Merrimack River basin. In addition, 20 kelts reared at NANFH were spawned and yielded a total of 235,721 eggs.

Captive/Domestic Broodstock - Health Issues

In October, 2003 a fish health case report was submitted to the USFWS, Lamar Fish Health Unit summarizing observations and documentation of fish health and water quality data over a period of two and a half years. The report delineated what was observed by fish culturists to be fish pathogenic activity in the NNFH Atlantic salmon domestic broodstock population. The report led to more intensive sampling efforts for detection of unknown pathogens. At this point in time, tissue samples from NNFH domestic broodstock are being analyzed for viral pathogens. Two tests conducted on samples to date have yielded negative results for viral agents, and subsequent testing will likely target the Herpes virus complex.

Sea Run Broodstock

2.11.3.c. Stocking

Approximately 1.39 million juvenile Atlantic salmon were released in the Merrimack River basin during the period April - June of 2003. The release included approximately 1.33 million unfed fry (NANFH), 929 parr (NNFH), 1,000 age 2 smolts (NNFH), and 49,500 yearling (age 1) 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 age 2 smolts from NNFH received a right ventral fin clip.

All major tributaries upstream from the Nashua River, 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 of predation by striped bass that typically arrive in the estuary and near shore coastal environment in mid to late April. Approximately 500 smolts (200 radio tagged) were released in the Merrimack River (NH) as part of a downstream fish passage study at a hydroelectric site.

2.11.3.d. Juvenile Population Status

Yearling Fry / Parr Assessment

Twenty-four sites in 17 rivers, streams or brooks throughout the basin were sampled in 2003. A stratified sampling scheme has been used to determine the abundance of yearling parr. Parr estimates have been 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 ≥ da ≤ 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, USACOE and volunteers.

The 24 sample sites included a total of approximately 357 units (one unit = 100 m^2) with165.4 units identified as Index Sites and 191.5 units as ancillary sites 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 2003. Units sampled represent about 0.52% of the total available and 0.7% of those stocked with fry.

An extensive time series of estimated parr abundance is available for Index Sites located on the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers. This data and data from ancillary sites will be imported into the recently developed juvenile life state stocking and evaluation database. 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 level of abundance need to be interpreted with caution.While data is being compiled for years 2001 and 2002, preliminary watershed wide parr population estimates for the Merrimack River have been developed for years 1995 - 2001. Point estimates range form a high of 194,044 ± 58,056 (CI 95%) in year 1995 to a low of 51,481 ± 17,026 in year 2001. The estimate for the 2000 year class was 89,444 ± 36,774 and the corresponding total number of fry origin adult returns in 2003 was four 2SW salmon.

2.11.3.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. Wild smolts were captured and trap counts were maintained in 2003 at the site. Flow models have been developed to examine flow fields that could further improve passage efficiency.

Upstream Fish Passage

Public Service Company of New Hampshire (PSNH) is continuing consultation with fishery resource agencies regarding a new operating license for the Merrimack River Project (Amoskeag, Hooksett and Garvins Falls Dams - FERC No 1893), and as a result, these facilities are being examined for operational and structural improvements to benefit a number of fish species. Studies at this project in the spring of 2003 again focused on video monitoring of the Amoskeag Dam fish ladder targeting American shad and eels, and studies in fall were directed at ensuring efficient and effective downstream passage of juvenile clupeids. In addition, an extensive de-watered bypass reach is being considered for additional in stream flows. This development is expected to lead to competing attraction water for fish in the reach and likely require the installation of upstream fish passage on the east side of the dam, opposite the existing powerhouse and ladder entrance on the west side of the river.

Studies were also conducted in spring of 2003 to determine the effectiveness of the Amoskeag Dam bypass at passing smolts using an attraction flow of 285 cfs or 5% of maximum turbine flow. Radio-tagged smolts were released upstream of the project after spill at the project had ceased and the project flashboards were fully installed. A total of 108 radio-tagged smolts was released upstream of the project in seven separate groups between 21and 31 May. Overall pasage results on the 103 smolts that passed the project were: 23 (22%) exited via the bypass, 59 (57%) passed through the turbines, 11 (11%) spilled over the dam and 10 (10%) passed through undetermined routes. Due to the large percentage of smolts that were entrained in turbines, studies will again be conducted in 2004 and will examine increased attraction flow and discharge through the fish bypass gate.

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 can negatively impact migrating smolts. While extensive studies to evaluate smolt passage and survival have been conducted at a number of hydroelectric sites in the watershed, 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.

2.11.3.f. Genetics

In 2002 funding was secured for genetic analyses 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. Samples were recently shipped for laboratory analyses. Paired matings in the fall of 2003 were again 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.

2.11.3.g. General Program Information

Habitat Restoration

In 2003 the multi-agency NH River Restoration Task Force continued to work on identifying dams for removal in the state and pursuing the removal of dams. As reported in 2002, 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 2004. On the Pemigewasset River (Woodstock, NH) another abandoned dam has been targeted for removal with little progress to date. On the Tioga River, a headwater tributary to the Winnipesauke River, the Badger Mill Dam was breached in fall. 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 is now open all year for taking salmon with a catch and release season from October 1 to March 31. In the spring of 2003, 1,459 (age-3 and age-4) domestic broodstock were released for the fishery. In the fall of 2003 another 500 (age-3 and age-4) broodstock were released for a combined total release of 1,959 fish to support the fishery in the mainstem of the Merrimack River and a small reach of the Pemigewasset River.

There is lag time in reporting from angler diaries which results in this summary characterizing the 2002 fishery. There were 2.263 salmon stocked and 1,233 permits sold in 2002 from which an estimated 741 anglers actually fished for salmon. The majority of the anglers were NH residents, 9% were nonresidents. Anglers fished an estimated 12,701 hours during 4,446 fishing trips. They caught an estimated 986 fish, released 808, and kept 178 salmon. Catch per unit effort was 0.08 salmon per hour (anglers fished approximately 12.8 hours before catching a salmon). The average angler spent about $166 in 2002, and estimated total expenditure by anglers in the 2002 season was approximately $123,000.

Education / Outreach

Adopt-A-Salmon Family

The 2003-2004 school year marks the eleventh anniversary of the Adopt-A-Salmon Family program affiliated with the NNFH and CNEFRO. The program continues to thrive and grow primarily due to a very dedicated and experienced corp of volunteers. In November, 2003 students from 24 participating schools, located in three different states, toured the NNFH to learn about the life cycle of Atlantic salmon and the migratory fish restoration efforts on the Merrimack River. In total, 11 volunteers dedicated over 200 hours of service to provide tours to 1,457 students. In a show of appreciation for volunteers, the second annual “Volunteer Appreciation Day” reception was held on January 14, 2004. The well attended reception garnered local press attention which resulted in an article about the program and volunteer opportunities associated with the Merrimack River Anadromous Fish Restoration Program. In addition, an incubator workshop was held in December 2003 for new schools intending to raise Atlantic salmon eggs in the classroom. In February 2004, 12,750 eggs were shipped to 37 schools for incubation in the classroom. These schools will rear the eggs until they develop into fry at which time they will release the fry into selected tributaries of the Merrimack River in spring.

Amoskeag Partnership

The Merrimack River Anadromous Fish Restoration Program continued to be represented in the Amoskeag Fishways Partnership. The partners that include PSNH, Audubon Society of New Hampshire, NHFG, and the USFWS 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 2003 was 22,000 people with 13,010 students and 8,991 adults. Of these visitors, 11,148 attended a program, fish season tour or special event, 7,852 were walk-ins. 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.

2.11.4. PAWCATUCK RIVER

2.11.4.a. Adult Returns

Six female sea-run Atlantic salmon were captured in the fish ladder at Potter Hill in 2003.

2.11.4.b. Hatchery Operations

Egg Collection

<u>Sea-Run Broodstock</u>

In total, 6,200 eggs were collected from two female Atlantic salmon. The eggs were fertilized with pooled milt obtained from RCNSS, which was taken from six Connecticut River returns. All of the eggs will be retained for subsequent release as age 1 smolts.

<u>Captive/Domestic Broodstock</u>

NANFH incubated 400,000 eggs for stocking in the Pawcatuck River in spring 2003, and gave an additional 100,00 eggs to Rhode Island’s salmon program for incubation at the Arcadia Research Hatchery (ARH) for stocking as fed fry in May 2003.

2.11.4.c. Stocking

Volunteers and Rhode Island Division of Fish and Wildlife (RIDFW) personnel stocked fry throughout the Pawcatuck River watershed. In addition, one local school volunteered to stock fry, which were hatched in their classroom.

<u>Juvenile Atlantic Salmon Releases</u>

In total, 312,665 fry were released into the Pawcatuck River watershed in 2003. On May 13, 2003 156,719 fry provided by NANFH were stocked in 29 locations in the Pawcatuck River and its tributaries. On May 15, 2003, 155,946 fry were stocked in 29 locations in the Pawcatuck River and its tributaries. About 80,000 of this second batch were fed fry raised at the ARH. Additionally, 5224 age 1 smolts also raised at ARH were released in March of 2003.

Adult Salmon Releases

Adult broodstock donated by WRNFH in Vermont were released in December 2003. A total of 612 Atlantic salmon were stocked in five locations in Rhode Island. These locations included Stafford Pond, Barber Pond, Carbunkle Pond, Meadowbrook Pond and the Wood River.Adult Salmon Releases

2.11.4.d. Juvenile Population Status

Index Stations Electrofishing Surveys

Parr were collected by electrofishing at 13 sites in the Pawcatuck River in the fall of 2003. 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 habitat units available. Sampling of age 0 parr indicated a range in densities of 0 to 42.0 parr/unit with an average of 8.1 parr/unit. Densities of age 1 parr ranged from 0 to 6.27 parr/unit at the sampled sites, and averaged 2.9 parr/unit. The sizes of the juveniles sampled were similar to those in past years, with a total of 310 age 0 parr averaging 65.9 mm total length, and a total of 181 age 1 parr averaging 146.5 mm in total length.

Smolt Monitoring

No work was conducted on this topic during 2003.

Tagging

No work was conducted on this topic during 2003.

2.11.4.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 theopposite 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. RIDFW is investigating its legal options regarding this issue.

2.11.4.g. General Program Information

Dam Removal/Fishway Construction

Improvements were made to the Potter Hill fishway, which improved personnel safety and ease of fish sampling. A new slide gate was installed in the sluiceway to facilitate anadromous fish monitoring. Also, the new cover was replaced on top of the fishway exit and a new ladder was installed to make access to the fishway safer.

Habitat Restoration

No work was conducted on this topic during 2003.

2.11.5. NEW HAMPSHIRE COASTAL RIVERS

2.11.5.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 early-September to mid-November. The Cocheco River fishway was monitored in the fall for the duration of October.

Six wild adult Atlantic salmon returned to fish ladders in 2003. Four fish returned to the Cocheco River and two returned in the Lamprey River.

2.11.5.b. Hatchery Operations

No adult Atlantic salmon were transported to hatcheries in 2003.

2.11.5.c. Stocking

In April 2003, approximately 270,000 Atlantic salmon fry were scatter-stocked by volunteers into the Lamprey (106,492 fry) and Cocheco (163,050 fry) river systems. Fry were stocked at a density of 36 fry/100 m^2 in the Lamprey River and 60 fry/100 m^2 in the Cocheco River.

Eggs for the 2003 fry stocking were obtained in the fall of 2002 from the USFWS. The eggs were taken at NNFH in fall of 2002. The eggs were reared at NANFH until early-February 2003. Approximately 270,000 eggs were delivered to WSFH on February 10 to complete the rearing.

2.11.5.d. Juvenile Population Status

Electrofishing surveys for juvenile salmon at four index sites and one auxiliary site on the rivers produced population estimates for young-of-the-year (YOY) fry ranging from 0.5 – 22.2 fish/100 m^2. Mean length and weight of YOY at the index sites ranged from 70 - 96 mm and 4 - 9 g while mean length and weight at the auxiliary site for YOY was 85 mm and 6 g. Estimates of parr abundance ranged from 0.1 – 5.3 fish/100 m^2. Mean length and weight of parr at the index sites ranged from 139 - 149 mm and 26 - 37 g. Mean length and weight at the auxiliary site for parr was 153 mm and 30 g.

Population estimates at the two index sites in the Cocheco River contrasted significantly. The population estimate for YOY at the Mad River site was 22.2 fish/100 m^2 as compared to 8.5

fish/100 m^2 at the Cocheco River location. Parr population estimates at the two index sites were 5.3 fish/100 m^2 for the Mad River and 0.6 fish/100 m^2 for the Cocheco. Both population estimates for YOY were above the long term average while both estimates for parr 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 average. This has been the case each year since 1999 when stocking densities were reduced from 60 to 36 fry/100 m^2. At the Lamprey River index site the population estimate for YOY was 0.5 fish/100 m^2 and at the North River index site it was 1.0 fish/100 m^2. At both the Lamprey River and North River index sites the population estimate for parr was 0.1 fish/100 m^2.

2.11.5.e. Fish Passage

No work was conducted in this area in 2003.

2.11.5.f. Genetics

No work was conducted in this area in 2003.

2.11.5.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.

2.11.5.h. Decision to Discontinue Program

The stated objectives of this Atlantic salmon restoration program have not been met during its fifteen-year duration and the decision has been made to discontinue this program.

3. TERMS OF REFERENCE

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

Ocean and Land Based Aquaculture

The State of Maine is the only state in New England with Atlantic salmon hatcheries that produce smolt for commercial oceanic pen culture. Five commercially owned freshwater hatcheries are located in Maine. Two of the hatcheries are actively raising fish, (Bingham and Gardner Lake), and three are currently inactive (Solon, Oquossoc, and Deblois). Aquaculture production in 2003 was 13,243,419 tonnes (Table A). This is a reduction in production from 2002. The Maine Aquaculture Association (MAA) marked 88,411 fish with both an adipose clip and a coded wire tag with agency code 55. These fish were all tagged in January and February 2003. All fish stocked into U.S. pens in 2003 by Heritage Salmon had left ventral fin clips. Numbers of fish stocked were reported to Maine Department of Marine Resources. In addition, MAA has coordinated thermal otolith marking of roughly 200,000 eggs in January 2003. A set of tables was developed for the USASAC database to carry aquaculture production, marks, and escape captures.

Table A. Aquaculture production (metric tonne) of Atlantic salmon in Maine from 1997 to 2003.

		FARMS
		14
		12
		31
		28
		29
		28
		23

3.2. TERM OF REFERENCE NO. 2 - Juvenile Life Stage Stocking and Evaluation Database - New England Rivers

Juvenile Life Stage Stocking and Evaluation Database – New England Rivers *Presentation by John Sweka (John_Sweka@fws.gov)*

A working version of the juvenile Atlantic salmon database was developed prior to the 2004 USASAC meeting. This version was revised during the meeting with the comments of working group members and other committee members. The structure of the database is very similar to current the current electrofishing and juvenile abundance database of the Maine Atlantic Salmon Commission. Tables have been developed to store information about a particular site, stocking densities at a site, specific sampling trips to a site, catches of juvenile salmon for a particular trip to a site, and summary population and density estimates for each trip to a site. Additional tables also contain annual information for smolt trapping. Summary population and density estimates can be entered directly into the database, or they can be calculated within the database if the raw electrofishing catch data is supplied. Built in queries can calculate a Carle-Strub 1978 maximum likelihood estimator for population estimates based upon removal sampling or a simple Petersen estimate for mark-recapture studies. These queries will allow users to enter future raw data a single time and generate population estimates without the need for external software and subsequent entry of resultant estimates.

Much data was provided by state agencies during the meeting, and this data will be appropriately formatted and imported to the database over the next year. It is the goal of the working group to have all historical data and 2004 data entered by the 2005 USASAC meeting. This database will then allow for examination of trends in juvenile survival both temporally and spatially throughout New England.

3.3. TERM OF REFERENCE NO. 3 - Domestic and International Research Program Updates *Presentation by Pasquale Scida (Pasquale.Scida@noaa.gov)*

NASCO, and/or the U.S. Section to NASCO has or is expected to address a number of issues through intercessional meetings and workgroups prior to the scheduled annual meeting in June 2004. Issues include: developing guidelines for incorporating socio-economic factors in the application of the precautionary approach to Atlantic salmon management; the future of NASCO; and international ocean research.

The International Ocean Research Board (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 has developed promotional materials seeking donations/funding from member countries, corporations and private sponsors, and has established a webiste (www.salmonatsea.com). The Board has established a scientific advisory group to inventory existing research, identify gaps and develop a call for research proposals. The U.S. has contributed $150,000 to this effort, and other parties have contributed funds (smaller amounts) as well. Most of the funds were received late in 2003, and a Request for Proposals (RFP)was not put out in June 2003 as planned. If the Board decides to issue an RFP this year, it would be available sometime after the NASCO meeting in June. In discussion, it was suggested that state Sea Grant offices be contacted to help update the inventory of research being conduct in the U.S.

The early years of NASCO were focused on negotiation of harvest agreements. Unfortunately, the depleted status of Atlantic salmon stocks worldwide has resulted in there being little to no “surplus” above conservation needs for negotiation. Over the past few years, NASCO has focused its attention on application of the Precautionary Approach to the broad range of Atlantic salmon management activities. Some NASCO participants, as well as outside parties, are seeking to identify the most appropriate role for NASCO now in Atlantic salmon conservation and recovery. The U.S. Section to NASCO met in October 2003 to discuss this issue. Norway, and the World Wildlife Fund and Atlantic Salmon Foundation will likely present papers on this subject at the annual NASCO meeting.

In late March 2003, the U.S. is hosting a NASCO Technical Workshop in New Orleans to develop guidelines for incorporating socio-economic factors in the application of the precautionary approach to Atlantic salmon management. Most NASCO member states will be represented. The guidelines developed by this Technical Workshop will likely be adopted by NASCO at the annual meeting in June.

NASCO and ICES are hosting a Symposium on wild/aquaculture Atlantic salmon interactions, which is tentatively planned for September 2005. A representative from NOAA is on the steering committee for this symposium, which will likely be held in Europe.

The meeting of the U.S. Section to NASCO will be held in Gloucester, MA April 26 , 2004. The

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, CTDEP, Ms. Pat Kurkul, National Oceanic and Atmospheric Administration; and Mr. George Lapointe, Maine Department of Marine Resources.

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

Salmon PVA Update. *Presentation by Chris Legault (Chris.Legault@noaa.gov)*

The population viability analysis model for the Maine DPS (SalmonPVA) has been updated to include a number of options as well as measure replacement rates. A user's manual has been produced and is available at http://nefsc.noaa.gov/nefsc/publications/crd/crd0402/index.htm. This user's manual contains a full description of the model, input and output as well as examples of how the model can be used to determine viability or provide information for setting recovery criteria. While the model is currently configured to be used for management purposes, application of the model will likely not occur until a decision is made regarding the inclusion of the Penobscot River in the Maine DPS.

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

Nasco Database Workgroup *Presentation by Ed Baum (Atlantic_salmon_unlimited@adelphia.net)*

Mr. Ed Baum, private contractor with NOAA-Fisheries, reported progress in developing a NASCO sponsored database of all Atlantic salmon rivers, worldwide. The U.S. was assigned as the lead in developing this database. The current effort is focusing on rivers in North America. The database is in Microsoft Access© but data entry does not require detailed knowledge of Access. Data is entered via user-friendly forms that utilize many drop-down boxes with choices. The data entry forms are accessed via the website (www.wildatlanticsalmon.com), using pre-assigned passwords for authorized personnel. There is at least one person per program authorized to enter data. These authorized persons may edit databases but only the database manager can delete records. Each program will be responsible for determining which rivers are entered into the database and how they are entered. For example, the Connecticut River Program decided to enter the Connecticut River as one river and 39 tributaries all as separate salmon rivers. Tributaries that flow into the 39 tributaries are not listed separately but appropriate data are entered as a part of the larger tributary system. The Merrimack River program followed the same basic approach but listed fewer tributaries. The State of Maine will follow the same basic approach in which all streams that enter the sea directly, and historically supported salmon, will be listed and for the more expansive Penobscot River watershed, major tributaries (e.g. East Branch, West Branch, Mattawamkeag, etc.) will be listed separately. Members discussed using Charles Atkins' paper about historic salmon rivers of New England (circa 1880) as a guide for streams to include.

Minimal progress had been achieved in entering data prior to the meeting but during two breakout sessions, some data were entered. The names of all rivers to be included in the database from the southernmost (Housatonic River) to the Maine border were entered. Only basic information was entered for rivers in the 'lost' category for which no restoration work is anticipated. Additional information was entered for rivers with active programs but all rivers still require additional data entry. Ed requested that this initial submission of data be completed prior to May 1. It is not practical to expect all rivers will be completed at this time but it is hoped that each agency will select one river and enter all required data. This will help train these people in using the database, provide valuable feedback and provide a significant amount of data to display at the annual NASCO meeting for demonstration purposes. It is recognized that it will take years to complete this effort.

3.6. TERM OF REFERENCE 6 - Overview of Atlantic Salmon Smolt Emigration in New England

Update on Maine River Atlantic Salmon Smolt Studies

Abstract by: Christine A. Lipsky (Christine.Lipsky@noaa.gov), James P. Hawkes (James.Hawkes@noaa.gov), John F. Kocik, and Greg Mackey

Atlantic salmon smolt studies in Maine began with the deployment of a single rotary screw fish trap (RST) on the Narraguagus River in 1996. These studies were undertaken in order to collect information about smolt production, outmigration timing, and run composition. Today, the project consists of 12 RSTs on six different rivers along Maine's coast. 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 being studied. In 2003, NOAA's National Marine Fisheries Service, in conjunction with the Maine Atlantic Salmon Commission and the St. Croix International Waterway Commission, monitored the emigration of Atlantic salmon smolts on five rivers with rotary screw fish traps. A variety of sampling designs and goals are set forth on each of the rivers studied. The 2003 setup consisted of four traps on the Narraguagus (river km 7.65 and 11.65), three traps on the Penobscot (river km 45.72, 45.95, 46.93), and one each on the Pleasant (km 0.07), Dennys (km 0.78), and St. Croix (km 54.87) Rivers.

NOAA-National Marine Fisheries Service Smolt Trapping Summary (2003)

NOAA-Fisheries and the ASC conducted seasonal field activities enumerating smolt populations using Rotary Screw Traps (RSTs) in many coastal rivers in Maine. Summaries for each river follow.

Narraguagus River—Four RSTs (2 Upstream - River km 11.16, 2 Downstream – River km 7.65) were monitored by NOAA-Fisheries on the Narraguagus River from 22 April to 6 June. 537 naturally-reared smolts were collected, with a population estimate of 1,182 +/- 225, using a Darroch maximum likelihood model. In addition to collecting smolts, ultrasonic telemetry studies where conducted, with 101 smolts (> 150 mm) inserted with ultrasonic pingers at the lower trapping site (River km 7.65).

Pleasant River—One RST (River km 0.07) was monitored by NOAA-Fisheries on the Pleasant River from 22 April to 4 June. 328 smolts were collected, of which 322 were 1-year VIE-marked hatchery smolts.

Dennys River—One RST (River km 0.78) was monitored by ASC on the Dennys River from 14 April to 1 June. 962 smolts (hatchery and wild combined) were collected with a population estimate of 1275 wild smolts derived using a discharged based model. In addition, 150 hatchery smolts tagged with ultrasonic pingers were released and their movements monitored by an array of detection units from freshwater to the entrance to the Bay of Fundy.

Penobscot River—Three RSTs (river km 45.72, 45.95, and 46.93) were monitored by NOAA-Fisheries on the Penobscot River from 21 April to 9 June. 446 smolts were collected with a population estimate of 98,900 +/- 17,400 using a Darroch maximum likelihood model.

Maine River Atlantic Salmon Smolt Studies: 2003

Abstract by: Christine A. Lipsky (Christine.Lipsky@noaa.gov), James P. Hawkes (James.Hawkes@noaa.gov), John F. Kocik, and Greg Mackey

There were 85 mortalities of the 448 fish handled (19%) during smolt operations in 2003, 22 of which were classified as “dead upon arrival” (DOA). Approximately 5.2% of the fish captured in the RST which originated above the Veazie Dam were DOA in 2003 (table 5). This rate of DOA capture is similar to the rate reported for the Penobscot River in 2002 (6.5%). In 2003, eight of the DOA smolts had no apparent injury or disease while 14 had an observable injury. A total of 7.7% of all of the smolts captured were found to have injuries, and some smolts had multiple injuries (Table 6). Injuries are broken down by cause in Table 5. The mortality rates on the Penobscot River are much higher than those observed in the Narraguagus River.

Table 5. Comparison of the numbers of dead fish captured in RST traps on the Penobscot and Narraguagus Rivers by likely cause of death.

	Penobscot		**Narraguagus**	
Cause	**# of DOA**	**% of Total Catch**	**# of DOA**	**% of Total Catch**
Hydroelectric Dam	14	3.3%	0	0.0%
Sampling Gear	0	0.0%	0	0.0%
Predation	0	0.0%	0	0.0%
Unknown	8	1.9%	2	0.3%
Total	22	5.2%	2	0.3%

Table 6. Comparison of the numbers of injured fish captured in RST traps on the Penobscot and Narraguagus Rivers by likely cause of injury.

	Penobscot		Narraguagus	
Cause	**# of Injuries**	**% of Total Catch**	**# of Injuries**	**% of Total Catch**
Hydroelectric Dam	5	1.2%	0	0.0%
Sampling Gear	0	0.0%	0	0.0%
Predation	0	0.0%	7	1.1%
Unknown	13	3.1%	14	2.3%
Total	18	4.3%	21	3.4%

Bycatch of Atlantic Salmon at Sea

Presentation by Chris Legault (Chris.Legault@noaa.gov)and Tim Sheehan

Bycatch of Atlantic salmon in the Norwegian Sea has been estimated to be a large issue by one group of researchers using scientific nets and has been estimated to be a small issue by researchers on board the commercial herring and mackerel boats. This large discrepancy in estimates has led to a study group being formed by ICES and has caused the question to be raised in the northwest Atlantic Ocean. Observer and commercial logbook databases were examined to determine if bycatch is a large problem in US waters or not. Based on the limited data available, there is potential for bycatch to occur, especially in the herring midwater trawl fishery, but the data do not currently demonstrate a problem. Increased observer coverage in the herring midwater trawl fishery in 2004 and 2005 should allow a more direct answer to the question of whether or not bycatch at sea is a large problem in US waters.

Smolt migration, demography and overwinter survival of Atlantic salmon in a restoration stream of the Connecticut River, USA

Abstract by: Stephen D. McCormick (Stephen_McCormick@usgs.gov), Gayle Barbin Zydlewski, Kevin G. Whalen, Alex J. Haro, Darren T. Lerner, Michael F. O'Dea and Amy M. Moeckel

Advances in passive integrated transponder (PIT) tag technology, including the low cost of PIT tags, offer the opportunity to locate and individually identify large numbers of fish without disrupting their natural habitat choice, activity, and behaviors. Because PIT tags are passive, remain viable for a number of years, and have a high retention rate when implanted peritoneally, tagged fish can be both recaptured within rearing habitats andor detected as they emigrate downstream without trapping or handling the fish. Larger PIT tags have allowed larger read ranges (2 m) and permitted us to construct antennas which can monitor the width of an entire stream. With these tags and antenna-systems we have developed a method for passively monitoring movements of individuals in the natural environment with only one initial handling. Estimates of detection efficiency using dummy tags and tagged hatchery smolts indicate that detection efficiency is > 93%. In the autumns of 1998-2003, 302-460 fry-stocked parr (9-17 cm fork length; 1^+- and 2^+-year olds) from Smith Brook, VT (a tributary of the Connecticut River)

were PIT tagged and their downstream movement was continuously monitored. Each fall there was a substantial downstream movement of parr (5-20% of fish tagged that fall). Fish migrating as smolts the following spring were those that had been greater than 11.5 cm fork length in the fall., whereas fish that remained were those less than 12 cm In spring 1998-2003, the smolt migration began in mid-March and ended in mid-May, with 90% occurring between April 20 and May 12. Most of the smolt migration occurred at night. The median date of migration varied by only 6 days over the 6 years, perhaps indicative of the photoperiodic control of smolt migration. There was no apparent relationship of smolt migration to flow. There was a strong relationship between degree days in April and the median date of migration, whereas the relationship between first date of 10 ^{o}C and median date of migration was weaker. There was a strong positive relationship between size at tagging in the fall and probability of smolting, with immature fish larger than 11.5 cm fork length having a probability of smolting nearly 100%. Estimates of winter survival for immature fish > 11.5% varied substantially from year-to-year and were between 28-68%. Estimates of smolt recruitment for all fish (mature and immature fish) also varied from year-to-year and were between 19-42%.

Overview of Atlantic Salmon Smolt Emigration in New England

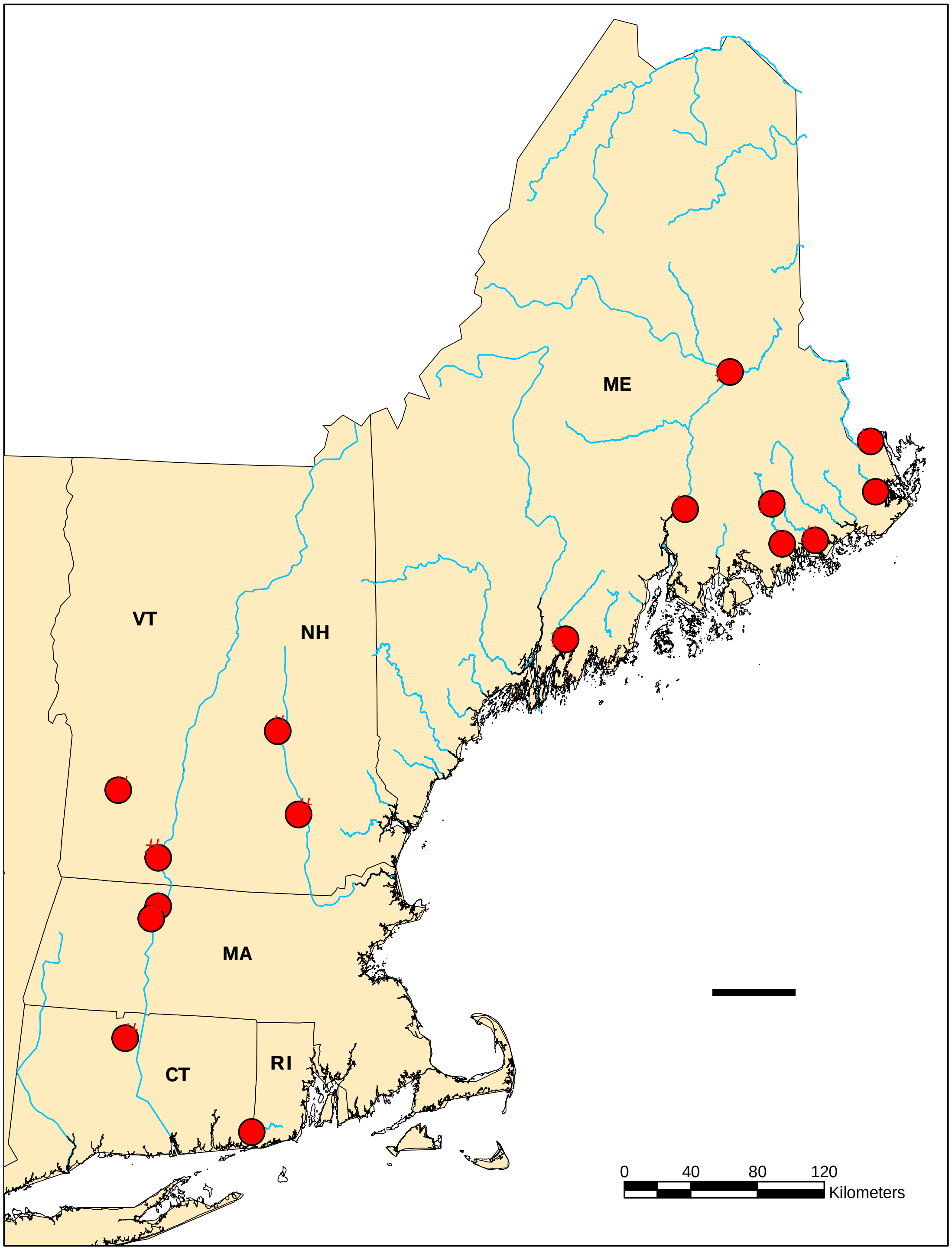
Presentation by: James Hawkes (James.Hawkes@noaa.gov),
Steve Gephard, Ben Letcher, Greg Mackey, Joe McKeon, Jay McMenemy, and Bob Stira

In 1998, the United States Atlantic Salmon Assessment Committee (USASAC) put forth a term of reference that resulted in the development of a working paper: "Preliminary Overview of Atlantic Salmon Smolt Emigration in New England". This working paper was developed with the intention of compiling a dataset to be used to assess smolt migration timing, date of ocean entry, run duration and size distribution throughout the historical and current range of Atlantic salmon. Since inception of that paper the subject had not been revisited and the dataset had not been expanded until now. The goals of revisiting the 1998 working paper are to: 1) assemble a comprehensive database of all Atlantic salmon smolt studies that have been conducted throughout New England since the release of that paper; and 2) revisit the preliminary examination of these data to evaluate geographic trends in Atlantic salmon smolt ecology throughout their southern range in North America. This paper continues to use the same analysis format put forth in 1998 with the addition of sites and rivers. The preliminary investigation compiled a relatively comprehensive database of smolt data from six New England states at five mainstem and four tributary sites. In this version of the working paper six additional sites on four rivers were added. While compiling this dataset, it is understood studies may have been overlooked or not included in this synthesis because authors of this paper were unaware of its existence. As such, this aggregate of data may be incomplete, but represents the largest and most spatially diverse assemblage of Atlantic salmon smolt data from the U.S. to date (Table B and Figure A). Preliminary analysis of these data suggests that such a comprehensive examination may be useful to rehabilitation and restoration programs throughout New England. Comprehensive summaries of these data may provide clues relating to factors that could assist in determining optimal smolt quality, stocking strategies, and ultimately, marine survival success.

Table 1. Smolt emigration data in U.S.A.S.A.C. dataset.

Location	River	Drainage	Years	# Years	Lat	Long	Distance to Head of Tide (km)	Sea Lat	Sea Long
White Rock, RI	Pawcatuck	Pawcatuck	97-98	2	41.41	-71.80	16.00	41.32	-71.86
Rainbow Dam	Farmington	Connecticut	83-03	20	41.91	-72.70	89.00	41.28	-72.34
Whatley MA	West Brook	Connecticut	98-03	6	42.55	-72.57	166.00	41.28	-72.34
Below Deerfield Confluence	Connecticut	Connecticut	85-86	2	42.58	-72.56	168.00	41.28	-72.34
Cabot Station/Turners Falls	Connecticut	Connecticut	93-98, 00-03	10	42.60	-72.54	176.00	41.28	-72.34
West River	Connecticut	Connecticut	92	1	42.91	-72.59	217.00	41.28	-72.34
Garvins Falls	Merrimack	Merrimack	92	1	43.16	-71.49	125.00	42.82	-70.81
Utley Brook	Connecticut	Connecticut	92	1	43.24	-72.84	264.00	41.28	-72.34
Ayer Island Dam	Merrimack	Merrimack	90-91	2	43.60	-71.70	183.00	42.82	-70.81
Head Tide	Sheepscot	Sheepscot	2001-02	2	44.11	-69.62	10.46	44.01	-69.65
Crane Camp	Narraguagus	Narraguagus	96-03	8	44.63	-67.95	7.46	44.54	-67.87
Columbia Falls	Pleasant	Pleasant	99-03	5	44.65	-67.72	0.07	44.60	-67.75
Gin Pole	Penobscot	Penobscot	00-03	4	44.82	-68.70	45.72	44.52	-68.81
Beddington Lake	Narraguagus	Narraguagus	60-68	9	44.83	-68.05	40.00	44.54	-67.87
Dennys River RST	Dennys	Dennys	2001-03	3	44.89	-67.23	0.78	44.91	-67.19
St. Croix RST	St. Croix	St. Croix	2002-03	2	45.17	-67.29	54.87	45.17	-67.16
Weldon Dam, Mattaceunk	Penobscot	Penobscot	88-90, 93-95	6	45.54	-68.37	140.00	44.52	-68.81

Figure A. Map of smolt collection locations.



3.7. TERM OF REFERENCE 7 - Water Quality: Acidic Waters / Mitigating Measures

Proposed Liming Project Update *Presentation by: Dan Kirchies (Dan.Kirchies@noaa.gov)*

The following provides an update as of February 2004 on the proposed liming project for downeast Maine. The intent of the project is to identify whether or not adding a calcium product to the downeast rivers is an effective restoration tool for Atlantic salmon. Data has shown that the health of salmon, specifically smolts are significantly impacted by adverse water chemistry conditions that do occur in many of the downeast rivers during high water events most often associated with storms.

The decision to lime:

In the fall of 2001, the signatories of the Maine Atlantic Salmon Technical Advisory Committee (TAC) requested guidance from the Committee proper to resolve whether or not water quality issues are a concern to the management of Atlantic salmon, specifically water quality issues associated with acidification and endocrine disrupting chemicals. In March 2002, a water quality ad hoc committee to the TAC presented a report to the TAC signatories intended to specifically address their concerns based on the best available information. In summary, the committee believed that there was sufficient evidence that several water quality parameters are affecting the restoration of Atlantic salmon in Maine rivers of which acidification is of the greatest importance (Maine Atlantic Salmon Technical Advisory Committee, unpublished report).

In December, 2002, the Project SHARE Research and Management Committee reorganized and established the goal of trying to address the concerns that acidification may be adversely affecting the restoration of Atlantic salmon in Maine rivers. The first task of the committee was the coordination of a Water Chemistry Forum and Workshop held in March 2003 in Orono, Maine, which presented information on the water chemistry of Maine's downeast coastal rivers and associated threats, and developed a course of action to address any identified problems. The outcome of the workshop was the reaffirmation that pH-related factors may indeed be inhibiting the survival and restoration of salmon. Atlantic salmon and water quality scientists and managers participating in the forum recommended that the implementation of a pilot liming project should be investigated to determine its potential benefit to Atlantic salmon restoration (Project SHARE, unpublished report).

In April, 2003, the Project SHARE Research and Management Committee proceeded to address the recommendations made at the workshop by coordinating and assembling a water chemistry enhancement committee. The committee is made up of scientists, biologists, and cooperative partners from the Maine Atlantic Salmon Commission, NOAA – Fisheries, University of Maine Orono, University of Maine Machias, U.S. Fish and Wildlife Service, Maine Department of Environmental Protection, U.S. Geological Services, Project SHARE, and the Maine Atlantic Salmon Federation. In addition, a list of professionals in the fields of forest ecology, riverine liming, and water chemistry has been compiled to serve as advisors to the committee.

Since the formation of the committee, the decision to lime has been reinforced by the National Academy of Science's (NAS), who were charged by congress to develop a report looking into factors that lead to the decline of Atlantic salmon in Maine and options to help them recover. The NAS made a strong and clear recommendation that liming should at least be experimented with as a tool to aid in salmon recovery.

The Vision of the Committee:

THE VISION: "Enhance water quality to benefit juvenile Atlantic salmon production and seawater tolerance and other community-specific species and monitor ecosystem indicators."

The committees charge:

The charge of the committee has been faced with several daunting tasks which include reviewing the science and the data that supports pursuing a liming project; identifying the most appropriate river in which to conduct the project; identifying the mechanism in which the product will be delivered into the river; identifying the product (ie. Limestone sand) that will be used to achieve the desired objectives; identify water chemistry targets needed to achieve the objectives; initiate intensive water chemistry monitoring and assessments of biological indicators including invertebrates, aquatic plants, mussels, crayfish, fish communities which will be used to track ecological impacts associated with the liming application; identify hydrologic and flow regimes of the target watershed to determine watershed function and major inputs of surface, sub-surface and groundwater within the watershed.

Accomplishments to date:

As of February 18, two very important decisions have been made that will help push this project forward to implementation. These decisions are the river in which to conduct the project, and the method in which the product will be delivered into the river. Though there has been much preliminary discussion as to where the project will be conducted and how it will be conducted, gaps in available data and information has limited the committee up to this point from making conclusive decisions. It should be noted that there are still data and information gaps that we are working on filling that could possibly change these two decisions. But we feel confident that based on the information that we have, that we have made both scientifically and biologically sound decisions on these two key aspects of the project.

On February 17, 2004, an important milestone was reached when a bill was passed by the Maine State Legislature that will allow the Maine Department of Environmental Protection to issue a discharge permit for the proposed liming project. The bill allows for a discharge with the intended purpose of maintaining or enhancing the existing water quality of a river for the purpose of restoring populations of Atlantic salmon.

River Selection:

Over the past eight months, the committee has been reviewing existing water chemistry data and collecting additional data in the Dennys River, Pleasant River, and the Naraguagus River to help in the decision of which river the liming project should be conducted. In addition, the committee has assembled a decision matrix of biological factors to help in the decision making process.

After much discussion, the committee was torn the Pleasant and the Dennys Rivers. Ultimately the committee chose the Dennys over the Pleasant considering that the genetic health and future amounts of available stock for the Pleasant are highly questionable which would compromise the ability to monitor the effectiveness of the project.

Method of Application:

There are numerous methods that have been used around the world to effectively enhance water chemistry for the benefit of fisheries restoration. Methods include Dosers or Silo's, diversion wells, direct limestone applications to either a river or lake, riparian liming, watershed liming, flow through limestone check dams, anaerobic marshes or wetlands, groundwater wells, etc… How to effectively achieve the objective of enhancing water chemistry for the benefit of salmon restoration is largely based on the ability of control. There has been widely expressed concern that once the application takes place, that there is no mechanism to turn it off. The only mechanism that provides us the ability to turn on or turn off the treatment are liming dosers. The doser provides the operator the ability to regulate the level of input, the timing of input as well as the ability to shut the treatment off entirely if desired. Though dosers are the most labor intensive and require the construction of structure on the bank of a river, having the ability to control the dosage is essential for both the experiment as well as alleviating some of the concerns of the public.

Water Chemistry Changes:

There has been extensive discussion on what water chemistry parameters we intend to change. There is strong understanding that the waters in Downeast Maine are naturally acidic. However, on a regional scale, studies from across the Northeastern United States and Eastern Canada have identified changes in river and stream water chemistry directly associated with anthropogenic acidic deposition. There is no reason to assume that Maine has not been adversely affected as well. Some preliminary models suggest that while the Clean Air Acts have reduced nitrate and sulfate emissions resulting in a current slight stream water pH recovery, base cation recovery could take over one-hundred years. The relationships between pH, aluminum, dissolved organic carbon, and calcium is highly complex. It is difficult, if not impossible to determine what the water chemistry in our rivers looked like pre-industrialization. Though we cannot determine with precision how different our rivers are now compared to what they use to be, we are confident based on the biological indicators that the water chemistry complex, being pH, Al, Ca, and DOC, is not in balance and is creating an environment that is unhealthy for Atlantic salmon. Water chemistry data from Downeast rivers has shown that in general the baseline water chemistry is relatively healthy and can support salmon populations. But the data also shows that storm events often result in sudden, and in some cases dramatic changes in pH, DOC and Al, creating an environment that is likely having sub-lethal, if not lethal effects on juvenile life stages of salmon, particularly smolts. The intent of this project is not to change the baseline water chemistry of the rivers, but rather, to provide a buffer against the pulses that occur during storm events. Using the liming doser we will have the ability to control the input of product into the river to achieve this objective.

Conclusion:

In summary, the intent of the committee is to implement a pilot liming project on a portion of the

Dennys River in which a liming doser will be used to deliver a calcium product to buffer against pulses of Al and pH that is effecting salmon survival in downeast Maine. Over the next year, there will be extensive pre-assessment work to gather information on key biological indicators, as well as conduct water chemistry monitoring and Atlantic salmon physiology work so that we will be able to evaluate changes that occur as a result of the application. The timing of the project ultimately depends on the time to obtain all the necessary permits, and the time needed to finish the design and assembly of the project. The goal is to try to have something in operation by spring of 2005, though it may be more realistic to not expect a fully operational project until the summer of 2005.

3.8. TERM OF REFERENCE 8 - Genetics / Transgenics: Environmental Risks

Presentation by: Steve Gephard (Steve.Gephard@po.state.ct.us)

The committee discussed the issue of transgenic salmon. Transgenic salmon are salmon that have a gene or genes from other species that have been artificially inserted into their chromosomes. The threats to wild Atlantic salmon from interactions with transgenic Atlantic salmon have been well documented in the past. It is also well established that salmon commonly escape from land-based and marine-based fish cultural facilities. Such escapees commonly appear in rivers in which wild salmon live and spawn. It is likely that these escaped salmon interbreed with wild salmon. If these fish cultural facilities begin using transgenic salmon, interbreeding between transgenic Atlantic salmon and wild Atlantic salmon could introduce transgenes into the wild salmon populations. Such genetic introgression could reduce the fitness of the local population. For example, a transgenic Atlantic salmon with an accelerated growth transgene from Chinook salmon could outgrow non-transgenic Atlantic salmon at similar life stages and therefore outcompete such fish. The transgenic fish could displace a local population in the short term but in the long term, the transgenic salmon could be maladapted to the local ecosystem and suffer abnormally high mortality. This could result in the extirpation of all Atlantic salmon in the stream. The committee agreed that not enough is known about the full impacts of transgenes on recepient fish and the impacts of transgenic fish on wild populations. Since unknown impacts could be irreversible, the use of transgenic fish in non-secure fish cultural facilities violates the Precautionary Approach, endorsed by the North Atlantic Salmon Conservation Organization (NASCO), of which the U.S. is a contracting party.

NASCO has adopted a guideline that states *"(the parties will:)… take all possible actions to ensure that the use of transgenic salmon, in any part of the NASCO Convention Area, is confined to secure, self-contained, land-based facilities;"*. The American Fisheries Society passed Policy Statement No. 21 in 1990 urging caution in the use of transgenic fish, restricting such fish to secure, land-based facility, and careful public review and agency permission prior to stocking transgenic fish in public waters. The States of Washington, Oregon, California, and Maryland have prohibited transgenic fish in their waters. The NPDES regulations for salmon aquaculture in the State of Maine prohibit the use of transgenic salmon in marine aquaculture sites.

The National Marine Fisheries Service and U.S. Fish and Wildlife Service issued a 'Biological Opinion' on the proposed modification of existing Army Corps of Engineers permits authorizing the installation and maintenance of aquaculture fish pens within the State of Maine, as required under the Endangered Species Act. The Biological Opinion prohibits the use of transgenic salmonids at these facilities. Transgenic salmonids are defined as species of the genera *Salmo*, *Oncorhynchus* and *Salvelinus* of the family Salmonidae and bearing, within their DNA, copies of novel genetic constructs introduced through recombinant DNA technology using genetic material derived from a species different from the recipient, and including descendents of individuals so transfected. The prohibition, however, does not apply to vaccines. The requirements for the General Permit for Atlantic Salmon Aquaculture for the State of Maine Pollutant Discharge Elimination System also carries the same prohibition.

In light of these concerns and these actions, the U.S. Atlantic Salmon Assessment Committee recommends that state fisheries management agencies in the Northeast U.S. adopt regulations that prohibit the use of transgenic Atlantic salmon in their waters. The Committee recognizes the need to continue to conduct research on this issue and exceptions to this prohibition for research could be warranted but all such research should be restricted to secure, land-based facilities. Permits from the state agencies should be required for such facilities and these permits should be conditioned upon compliance with biosecurity standards set by the agencies and confirmed with regular on-site inspections.

3.9. TERM OF REFERENCE 9 - Development of Atlantic Salmon Stock Recruitment Curves for Select Rivers

Development of Atlantic Salmon Stock Recruitment Curves for Select Programs

Presentation by: Mike Millard (Mike_Millard@fws.gov) Chris Legault, and Joe McKeon

The working group assembled fry stocking data and adult returns, by cohort, for the Merrimack River (1979-1998) and Connecticut River (1978-1998) programs. Plots of total adult returns versus the number fry stocked for the cohort revealed no clear patterns for either program. Return rates from fry stocking in both the Merrimack and Connecticut rivers appeared to peak in the early to mid 1980's. Adult returns were then converted to egg equivalents, via an assumption of age-specific average fecundity. Number of fry stocked was then plotted against eggs produced by returns from that cohort, wherein the diagonal (slope=1) index line would represent the replacement threshold. While replacement was approached in the early 1980's for both systems, fry stocking was clearly not resulting in replacement values of egg production by the mid 1980's. Parr abundance estimates were also unrelated in any clear way with subsequent adult returners in the Merrimack River. A relationship between more proximal life stages, fry and parr, was evident in the Merrimack River. A plot of the abundance of age 0 parr in the Pemigewasset River versus the fry stocked (1984 -1994) revealed a significant positive slope. We hypothesize that numerous confounding effects exist between the parr stage and the adult returns, including survival during smolt migration, survival of post-smolts, and marine survival of adults, such that quantitative relationships between early life stages and returning adults in impounded river systems are complex, if they exist at all.

3.10. TERM OF REFERENCE 10 - Status of Atlantic Salmon Stocks - New England

The International Sampling Program, Continent of Origin and Biological Characteristics of Atlantic Salmon Collected at West Greenland in 2003

Presentation by: Timothy Sheehan (Tim.Sheehan@noaa.gov), Dave Reddin, Per Kanneworff, Timothy King

A significant Atlantic salmon mixed-stock subsistence fishery consisting of North American and European origin fish exists off the western coast of Greenland. Accurate landings data, continent of origin and biological characteristic data describing the catch is necessary for assessing of the impacts that this mixed stock fishery has on these two stock complexes. Since 1969, a coordinated international sampling program has been undertaken to obtained biological samples from this fishery. The USA has coordinated this effort since 1999. The purpose of this presentation was to summarize 1) the international sampling program, 2) the results from the continent of origin analysis and 3) the biological characteristics of the catch from West Greenland during the subsistence fishery of 2003.

Probabilistic-based Genetic Assignment model (PGA): Sub-continent of origin assignments of the West Greenland Atlantic salmon catch

Presentation by: Timothy Sheehan (Tim.Sheehan@noaa.gov), Christopher Legault, and Adrian Spidle

An Atlantic salmon multi-stock fishery occurs annually off the coast of West Greenland. Reported landings for this fishery peaked in the early 1970’s at just over 2,200 metric tons, but have since declined to an all time low of 7.8 metric tons (estimated) in 2003. Members of ICES and participating nations in NASCO have long been concerned as to the effect that this fishery has had on this common mixed resource. In 1966, a multi-national sampling program was begun to biologically sample the West Greenland Atlantic salmon catch to better understand its national composition. Historically, growth characteristics extracted from scale samples obtained during this fishery have been used to statistically determine the continent of origin of the catch. More recently, genetic analysis has also been employed to determine continent of origin information. Genetic techniques are such that the possibility exists for determining the origin of an Atlantic salmon at a finer scale than continent of origin. We have developed a Probabilistic-based Genetic Assignment model (PGA), which takes into account the uncertainty associated with these finer scale assignments. We applied this model to the genetic data obtained during the 1997 and 2000-2002 West Greenland fisheries and have attempted to assign these individuals to a country and region of origin. Adult return data within a country can then be used to probabilistically partition these estimates to an even finer scale. These types of methods are extremely dependant on the accuracy of the genetic assignments to continent of origin and country/region of origin if finer scale information is desired. However, the uncertainty in assignments for country/region is incorporated in the approach such that the results are distributions of numbers instead of single values.

The Effects of Marine Predation on US Stocks of Atlantic Salmon

Presentation by: Rory Saunders (Rory.Saunders@noaa.gov)

Predation has long been recognized as a potential factor that limits the abundance of Atlantic salmon (*Salmo salar*) populations throughout their range. In freshwater environments, predation has been relatively well studied and in some cases these studies have led to a more quantitative understanding of the salmon's role in aquatic food webs (e.g., Larsson 1985, van den Ende 1993). However in marine environments, this level of understanding has not been achieved. This understanding is lacking because of the varying spatial scales at which populations can be studied in the open ocean, the myriad of potential predators that salmon encounter, and the relatively small role that salmon play in marine food webs (Cairns 2001a). A recent review of the potential causes for declines in salmon abundance (Cairns 2001b) underscores the importance of considering marine predation with five of the leading 12 hypotheses being related to predation. The problems of understanding the role of predation in structuring US salmon stocks are exacerbated by critically low abundance levels. The purpose of this paper is to summarize recent advances in our understanding of predation on US stocks of Atlantic salmon since the last comprehensive summary (Anthony 1996) was written.

Species-specific investigations have revealed substantial predation by northern gannets (*Morus bassanus*) (Montevecchi et al. 2002), double-crested cormorants (*Phalacrocorax auritus*) (Blackwell et al. 1997, Cairns 1998) and striped bass (*Morone saxatilis*) (Blackwell and Juanes 1998, Beland et al. 2001). Direct evidence of predation by marine mammals remains sparse.

Several of the underlying mechanisms for the high early marine predation rates observed by many researchers are becoming clear. Some of these mechanisms include water quality perturbations and decreased abundance of other anadromous fish. As smolts emigrate in acidified rivers, more energy is required to simply maintain homeostatic balance leaving less energy available for normal activities such as predator avoidance (Handeland et al. 1996). In addition, other anadromous stocks (e.g., rainbow smelt) may buffer salmon predation rates in properly functioning communities. However, many of these other stocks have declined as dramatically as Atlantic salmon (Colette and Klein-MacPhee 2002) leading to substantially elevated salmon predation. When combined, many anthropogenic perturbations appear to cause system-wide destabilizations that are perceived as predator-prey dynamics issues.

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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

A Synoptic Survey of pH Related Water Chemistry in Maine Atlantic Salmon Watersheds, 2003

Abstract by: Richard Dill (richard.dill@maine.gov) and Ken Johnson

In 2003, the Maine Atlantic Salmon Commission (ASC), in cooperation with the University of Maine Senator George J. Mitchell Center for Environmental and Watershed Research (GMC), conducted a survey of water chemistry in Maine salmon rivers and their tributaries. The first objective was to create three “snap-shots” in time of seasonal pH related water chemistry in Maine salmon rivers. The second objective was an attempt to document depressed pH levels during spring smolt migration. In recent years gill biopsies from out-migrating smolts in the Narraguagus, Pleasant, and Dennys Rivers have revealed low gill Na^+, K^+ ATPase levels, which may be associated with low pH related water chemistry. Water samples were collected on the same day in spring, summer, and fall from 67 sites across 12 Downeast and central Maine river systems, including all 8 of the DPS listed rivers. Samples were analyzed for closed-system pH (ClpH), air-equilibrated pH (EqpH), acid neutralizing capacity (ANC), apparent color, and conductivity. The spring and fall sample days each coincided with peak flow conditions following significant rain events. The summer sample was collected at normal low flow conditions. In both spring and fall all rivers had depressed pH and ANC values associated with the rain events; watersheds east of the Penobscot River had lower pH’s than the rivers to the west; and tributaries tended to have lower pH’s than their associated main stem. The Ducktrap, although a western river, had water chemistry more like an eastern river. Overall, the lowest pH values were observed in the fall during the abnormally high flow conditions. In particular, the eastern rivers had 17 of 21 mainstem sites and 29 of 32 tributary sites below pH 6.0 in the fall sample. In addition, nine tributary sites were below pH 5.0. Rivers west of the Penobscot had much higher ANC and conductivity values and did not experience extreme low pH events in either spring or fall. In addition to repeating this survey scheme in 2004, we hope to sample 1-2 late winter/early spring snow melt and/or rain events with the expectation of identifying early spring extreme low pH’s which may be directly effecting pre-smolt development. This study and similar future studies will help us understand the variables that contribute to the regional water chemistry differences and how changes in water chemistry affect salmon health.

Identifying the Gulf of Maine Distinct Population Segment component of the West Greenland Atlantic salmon catch

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An Atlantic salmon multi-stock fishery occurs annually off the coast of West Greenland. Reported landings for this fishery peaked in the early 1970’s at just over 2,200 metric tons, but have since declined to an all time low of 9 metric tons in 2002. Members of ICES and participating nations in NASCO have long been concerned as to the effect that this fishery has had on this common mixed resource. In 1966, a multi-national sampling program was begun to biologically sample the West Greenland Atlantic salmon catch to better understand its national composition. Historically, growth characteristics extracted from scale samples obtained during this fishery have been used to statistically determine the continent of origin of the catch. More recently, genetic analysis has also been employed to determine continent of origin information. Genetic techniques are such that the possibility exists for determining the origin of an Atlantic salmon at a finer scale than continent of origin. We have developed a Probabilistic-based Genetic Assignment model (PGA), which takes into account the uncertainty associated with these finer scale assignments. We applied this model to the genetic data obtained during the 2002 West Greenland fishery and have attempted to assign these individuals to a country/region of origin. Adult return data within a country/region can then be used to probabilistically partition these estimates to an even finer scale. These types of methods are extremely dependant of accuracy of the genetic assignments to continent of origin, but also country/region of origin assignments if a finer scale is desired. However, the uncertainty in assignments for country/region is incorporated in the approach such that the results are distributions of numbers instead of single values.

Population viability analysis of Atlantic salmon in Maine, USA.

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Atlantic salmon (Salmo salar) populations in eight rivers of Maine, USA are listed as endangered under the U.S. Endangered Species Act. This listing required the creation of measurable and objective delisting criteria. One component of these criteria is the determination of abundance levels associated with recovered populations. Population viability analysis (PVA) was chosen as the method to estimate these recovery levels because it (a) formalizes the combination of information available on the species; (b) quantifies the uncertainty in the population parameters and evaluates the impact of this uncertainty on the probability of extinction; and (c) allows examination of potential management strategies. A PVA specific to the Atlantic salmon populations in Maine was created based on the life history characteristics of the endangered populations (i.e., multiple ages of return from sea, kelting, river specific habitat limitations, and the use of stocking as a recovery tool). Model projections show that the populations have low probability of survival over the next 100 years if stocking hatchery fish is eliminated and survival rates remain at current low levels. However, only relatively small increases in survival rates are needed to increase the probability of survival to the traditionally accepted level of 95% in 100 years.

Evaluation of adult scales to determine the origin of Atlantic salmon recovered in Maine

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Recently issued discharge permits for the salmon aquaculture industry in Maine require a phased in marking of all Maine farmed salmon. The Maine Aquaculture Association in cooperation with federal and state agencies, industry and NGOs has been examining potential marking technologies that could be used to mark Maine's farmed salmon. Through this process it has become clear that for most marking technologies a two-step marking system will be required that includes first, an external mark for easy, reliable streamside identification of aquaculture origin at a minimum and second, an internal tag that provides additional information as to the origin of the fish. Scales have potential as an external marker due to the ease of detection in the field, low cost to apply and detect mark, and 100% mark retention rate. Preliminary studies using smolt scales to differentiate river and hatchery origin showed over a 95% accuracy of correctly identifying fish. The current study examined adult scales of known origin to determine their value in streamside identification of fish origin. Scales were collected from aquaculture fish at the processing plant, marked restoration fish and historical wild scale collections predating 1982. The scales were digitally imaged and distributed around the country to 30 scale readers of varying experience levels. Readers were asked to classify the freshwater origin as hatchery, river reared or unknown and the marine origin as net pen, ocean or unknown. Based on the responses, fish were classified as industry, restoration or river reared. Readers were asked to classify the origins of two test sets containing 100 fish each. The first test set was completed with no training or reference scales. The readers were given a primer on scale reading and a labeled reference set of scales for use with the second test set. Analysis focused on the accuracy of readers to distinguish the origin and classification of the test scales. The effects of reader experience and the use of the labeled reference set on accuracy also were examined.

STREAMSIDE INCUBATION: A Low Tech, Low Cost Approach to Atlantic Salmon Restoration

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During the winter of 2002 – 2003, staff from the Sidney office of the Maine Atlantic Salmon Commission (MASC) tested the feasibility of streamside incubation as a method for volunteer groups to participate in Atlantic salmon restoration. Two types of flow-through incubators were constructed from discarded refrigerators. Three incubators were designed to hold egg filled Whitlock-Vibert boxes placed within an artificial channel and three were designed to hold eggs

between layers of poultry nesting material. Incubators were deployed prior to receiving eggs at three sites on two tributaries to the Sandy River. In February of 2003, a total of 43,496 eyed Atlantic salmon eggs, at approximately 38% development, were divided equally into each of the six incubators. At approximately 95% development, fry were removed from the incubators and enumerated to obtain hatching success. Success ranged from 85% to 98% with an average of 90% for all six incubators. Total operational cost for the project was $2,351. If the project were to continue for a second year, operational costs are estimated at approximately 30% of the initial investment. Total time spent on this project, not including traveling time, amounted to 1,355 hours. Total time for a second project year is also estimated at approximately 30% of the time spent during the initial year. High hatching success, time expended, and low cost makes this streamside incubator system a feasible approach for volunteers. Additional studies to test capacity and improve incubator efficiency are recommended.

Trends in magnitude and timing of summer and fall/winter streamflows for coastal river basins in Maine during the 20th century *Abstract Prepared By U.S. Geological Survey, Maine District Office, Augusta, ME, in cooperation with the Maine Atlantic Salmon Commission*

The USGS, in cooperation with the Maine Atlantic Salmon Commission have recently published results of a study of trends over the 20th Century in streamflow, river ice, and snowpack for coastal river basins in Maine (Dudley and Hodgkins, 2002). Results indicate that historical trends in streamflow, ice, and snow are all consistent with an earlier onset of hydrologic spring conditions in coastal Maine. Since winter/spring high flows associated with snowmelt runoff are occurring earlier, not only for river basins in coastal Maine but for large areas of northern New England as well (Hodgkins et al., 2003), it is hypothesized that the spring/summer recession to low flows could also be getting earlier, resulting in an observable trend toward earlier late summer/early fall low flows. Since few significant changes in the timing of fall high flows have been observed, earlier spring runoff could cause a longer low-flow period and a decrease in the magnitude of low flows. This ongoing research will document the timing and magnitude of summer low-flows for coastal river basins in Maine, document the timing and magnitude of fall/winter streamflows for coastal river basins in Maine, and quantify the statistical significance of trends in timing and (or) magnitude of these seasonal trends. Lower low flows of longer duration during the fall and early winter combined with observed trends toward decreasing ice cover may threaten the survival of Atlantic salmon and other sensitive biota that reside in Maine rivers over the winter.

Preliminary Investigations of Cryopreservation of Atlantic Salmon *Salmo salar* Milt

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Despite decades of stocking, sea-run returns of Atlantic salmon continue to be at very low levels. In 2002, returns of endangered sea-run Atlantic salmon on the Pleasant, Dennys, and Narraguagus rivers in Maine numbered less than 10 fish. Connecticut and Merrimack River returns numbered less than 60 fish and the returning male to female ratio on the Connecticut River was skewed approximately 2 to 1. As populations across the entire northeastern U.S. continue to decline, genetic material is being lost at an alarming rate. This has led the U.S. Fish and Wildlife Service′s Northeast Fishery Center to take a strong interest in the potential of cryopreservation as a tool to preserve the species dwindling genetic diversity. In 2002, the effect of five extenders on the success of cryopreservation of Atlantic salmon *Salmo salar* semen was tested. Extender-cryoprotectant combinations tested included: (1) Cloud with 5% dimethyl sulfoxide (DMSO) and 13% egg yolk, (2) Cloud with 5% DMSO without egg yolk, (3) Gallant with 10% dimethylacetamide (DMA), (4) modified Hanks? Balanced Salt Solution with 10% DMSO, and (5) Stoss and Holtz with10% DMSO. Fertilization rates, expressed as the percentage of eyed embryos, ranged from 5.0- 26.0%. Semen cryopreserved using Cloud with 5% DMSO without egg yolk yielded significantly higher ($P < 0.01$) fertilization rates (26.0%) than sperm cryopreserved with the other four extenders. In an attempt to improve fertilization rates, a series of on-going experiments were undertaken in November 2003 at the White River National Fish Hatchery to evaluate an array of new extenders, the use of theophylline and saline as post-thaw fertilization activator solutions and the impact of sperm-to-egg ratio.

CULTURE OR LIFE HISTORY

Evaluation of Atlantic salmon kelt broodstock diets

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Reproduction from Atlantic salmon (ATS) kelts represents valuable genetic and numeric contributions to restoration fry stocking. However, survival, maturation and gamete quality of kelts has been inconsistent. The present study examines the nutritional effect of two diets (standard vs USGS) upon kelt reproductive success and growth. Nutritional variability and seasonal availability of raw ingredients found in the standard formulation are viewed as potential problems. Biochemistry of the standard diet was examined by comparing mineral and lipid profiles of eggs from wild sea-run ATS and hatchery rejuvenated kelts collected in 2000. The analyses showed that kelt eggs were deficient in copper and selenium and contained excessive amounts of manganese relative to sea-run eggs. The standard diet, however, was found to contain high levels of copper, zinc, manganese and selenium. A five fold reduction of mineral premix was recommended to correct the mineral imbalance found in the standard diet at study inception in 2001. An alternative USGS diet formulation based upon advances in nutritional research moved to processed meals and lower levels of minerals in readily absorbed chelated form. The new protein sources are advantageous in respect to quality and availability. Merrimack and Connecticut River ATS kelts at North Attleboro NFH received standard and USGS diets from rejuvenation in 2001, 2002 to spawning in 2003. Evaluation of gamete quality as measured by survival to eye-up was determined for each mature female from a diet-river group by fertilization with milt from all males representing that group; viability of each male from a diet- river group was measured against a pooled composite of cohort eggs. Although individual performance varied, no eye-up difference was found between the standard (0.72, SE 0.03) and USGS diets (0.76, SE 0.03). Likewise differences were not detected for spermatocrit or sperm motility levels nor were correlations found for these measures with viability. Data analyses relative to growth, survival, maturation, fecundity, egg and fry size are ongoing. Lipid and mineral analyses have not been conducted on diets, nor have these profiles been analyzed for 2003 kelt eggs.

FISH HEALTH

Survey of non-salmonid marine fishes for detection of Infectious Salmon Anemia Virus and other salmonid pathogens

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In an effort to identify potential reservoirs of salmonid pathogens, nearly 3000 fish, including alewife (Alosa pseudoharengus), American eel (Anguilla rostrata), Atlantic herring (Clupea harengus harengus), Atlantic mackerel (Scomber scombrus), Atlantic cod (Gadus morhua), haddock (Melanogrammus aeglefinus), Atlantic halibut (Hippoglossus hippoglossus), pollock (Pollachius virens), American shad (Alosa sapidissima), and winter flounder (Pseudopleuronectes americanus) were sampled from the natural environment. Pollock, cod and lumpfish (Cyclopterus lumpus) also were sampled from within Infectious Salmon Anemia (ISA)-diseased cages. Assays included cell culture for listed salmonid viruses, the direct fluorescent antibody test for Renibacterium salmoninarum, and RT-PCR for ISA virus. All of the fish collected from the natural environment tested negative by any assay method. Two of 12 pollock taken from inside a cage with ISA-diseased salmon showed weak RT-PCR positive results and were cell culture negative, whereas 90 pollock collected outside a diseased cage tested negative for viruses and R. salmoninarum. One of 24 pools (5 fish/pool) of tissues from cod taken from the wellboat of a harvested clinically diseased cage produced cytopathic effects (CPE) characteristic of ISAV on SHK cells. This finding was confirmed by RT-PCR of cell culture supernatant. Viral pathogens and R. salmoninarum were not detected in 26 lumpfish collected from inside diseased cages. These data suggest a need for attention to biosecurity practices concerning non-salmonids retained in and harvested from salmon cages. These results indicate that pollock and cod can harbor the ISA virus, however was not determined if the virus can replicate within these hosts. The significance of such potential carriers to the epizootiology of ISA needs further investigation both as a source of the virus in the wild and to examine potential impacts on non-salmonid populations.

Infection status of asymptomatic ISAV-infected Atlantic salmon

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An experiment was conducted on Atlantic salmon (Salmo salar) experimentally exposed to Infectious Salmon Anemia virus (ISAV) to learn the short-term fate of asymptomatic survivors under various environmental conditions. Additionally, the ISAV status of the exposed survivors was evaluated over time. Pathogen-free Atlantic salmon were inoculated intraperitoneal with the North American strain of the virus at a titer of 10^6 $TCID_{50}$. One month after inoculation, survivors were individually tagged and divided into two groups. One group remained in seawater for the experimental period; the other group was transitioned over a 4 week period from seawater to freshwater. Assays of blood samples taken at the beginning of the experimental period showed that 97% were RT-PCR positive for ISAV while no virus was isolated by cell culture methods. Twenty-three seawater fish and 28 freshwater fish were followed for the entire study period of one month. At the end of the study, RT-PCR and viral isolations were conducted on blood and kidney tissues. After one month in seawater, 6 (26%) of the original 23 RT-PCR positive fish showed weak RT-PCR bands consistent with ISAV from blood samples but no positive results were obtained from the kidney. In contrast, 17 (63%) of the original 27 RT-PCR positive fish that transitioned to freshwater showed weak RT-PCR bands and 3 of these 17 also had RT-PCR positive results for kidney tissue. No virus was cultured from the blood or the kidney in either group. The results suggest that virus was not cleared from fish transitioned to freshwater as quickly as from those fish retained in seawater. The transitioning from salt to fresh water may have stressed and immuno-compromised the fish, allowing the virus to persist. One fish that died after two weeks transitioning to freshwater tested positive by RT-PCR and virus isolation by cell culture. Since viable virus was present in this fish, it may have been shedding virus into the tank that also could account for the higher number of freshwater fish testing positive by RT-PCR at the end of the experiment.

MARKING

Successful marking of Atlantic salmon fed dietary calcein

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Fish stock assessment and hatchery product evaluations rely on one of several marking techniques to calculate population size of a targeted group of fish. Calcein (2,4-bis[N,N?-di(carbomethyl)- amino-methyl]fluorescein) has recently received an investigative new animal drug (INAD) status for immersion marking of fish < 2 gram. Calcein chemically binds with calcium phosphate found in bony fish tissue resulting in non-lethally detectable fluorescent marks when viewed at proper light wavelengths. There are times, especially with endangered species, in which marking of larger fish or an alternate means of mass marking fish would be desirable. Atlantic salmon (Salmo salar) fingerlings (65-70 fish/tank) weighing 0.8 grams/fish were placed in nine tanks and fed one of three diets. Fish were fed semi-purified diets containing calcein at 0, 75, and 125 mg calcein/kg fish. Diet was offered feed at 2% body weight per day for 5 days via automatic feeders. Atlantic salmon were examined seven days post marking with SE-MARK™ calcein detector (Western Chemical, Inc.; Ferndale, WA) equipped with a 3 X lens insert. Average mark detection was 0, 93 and 98% in fish fed 0, 75 and 125 mg calcein/kg fish, respectively. Within the treatment groups (75 and 125 mg/kg) fluorescence intensity was variable. This was consistent with the observation that fish did not uniformly consume the diet. In previous studies with brook trout, all fish aggressively fed and 100% marking was observed. In the brook trout study, when offered experimental diets twice (30-45 days apart), a 2-band pattern was produced on scales which remained readily discernable one year later. To improve dietary marking of Atlantic salmon, two approaches are possible: 1) diet modification to increase feed acceptance or 2) offer the feed to the fish for more than five days. We conclude that calcein marking of Atlantic salmon administered by feed is a viable technique.

Comparison of mortality between calcein-marked and unmarked Atlantic salmon fry stocked in Woods Race tributary at the Northeast Fishery Center

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A study designed to evaluate survival and growth of calcein-marked vs. non-marked Atlantic salmon fry was conducted in a natural stream channel known as Woods Race tributary at the Northeast Fishery Center in 2003. Fry used in the study were of Connecticut River domestic parentage. Once larvae reached a Developmental Index of about 89, one-half (n=900) were marked with calcein via osmotic induction while an equal number were handled similarly with the exception of calcein exposure. Equal numbers of calcein-marked and non-marked larvae were stocked in each of three sections of Woods Race tributary which were separated from each other by concrete control structures outfitted with perforated aluminum screens. Recovery and evaluation of fry (N=198) at 4 months post-stocking showed that an unknown number of fish had escaped the study area and probably emigrated from their assigned stream section due to high water events. In addition, many fish displayed degraded calcein marks with some only identifiable using fluorescence microscopy. Escapement and degraded marks precluded meaningful comparisons between survival and growth of marked vs. non-marked fish. Possible reasons for degraded marks will be investigated in 2004.

Evaluation of Unique Scale Marking of Atlantic Salmon Parr with Calcein

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We evaluated the use of the chemical calcein to create unique banding patterns on the scales of Atlantic salmon parr. Fish were hatched in early February 2003. Five treatments were established with five replicate tanks of 60 fish per treatment. Treatments corresponded to the timing of mark application: June 4 (designated 100), August 12 (010), September 5 (001), June 4 and September 5 (101), and a control group (000). Mortality and growth were assessed from the initial marking through September 23, 2003 when 25 fish per tank were sacrificed and scale samples taken for mark evaluation. Scale samples were evaluated by two independent readers. Scale samples were observed under a microscope equipped with a 490 nm UV light source to illuminate potential calcein marks. Each scale sample was assigned to one of the five treatments and the percentage of correct assignments noted. There was no effect of calcein marking on growth or mortality. Assignments by the two readers were in agreement in 92% of the samples. There was a significant difference in the percentage of correct assignments among treatments. Marked fish of treatments 100 and 101 were misidentified more often (64% and 88% correct, respectively) than marked fish from the other treatments (> 97% correct in all cases). The most likely reason for this difference is that some of the fish may not have developed scales by the time of first marking. Nevertheless, this study showed that calcein can be used to create a unique banding pattern on salmon scales which can be used to differentiate large groups of chemically marked fish. We plan to repeat this study 2004, using similar methodology, but we will delay the first marking period to ensure that all fish have developed scales by the time of calcein immersion. It is expected that refinement of the timing of calcein immersion will result in a high percentage (> 97%) of correct identifications in all treatment groups. This marking technique will prove useful for field investigations.

POPULATION ESTIMATE OR TRACKING

Alternative Methods for Enumerating Juvenile Atlantic Salmon (*Salmo salar*) in Maine Rivers during Summer Months

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Atlantic salmon (*Salmo salar*) is listed by the United States Fish and Wildlife Service and National Marine Fisheries Service as endangered in eight Maine rivers. Electrofishing, the primary technique used to assess juvenile Atlantic salmon populations, can cause mortality (take). The less invasive enumeration techniques of snorkeling, overhead, and streamside viewing were evaluated at eighteen sites within the Narraguagus, Machias, and Sheepscot river drainages. Each site was classified based on stream width (wide >15 meters, medium 8-15 meters, narrow 0-8 meters) and dominant substrate (bedrock/boulder 4096-256 mm, cobble 256-64 mm, gravel/sand 62 -<2 mm). Salmon counts from the alternative techniques were compared to the electrofishing estimates collected during the same time period by the Maine Atlantic Salmon Commission. At the time alternative counts were made, population estimates for the sites were not known. Overhead and streamside viewing techniques, which are used to observe salmonids living in freshwater throughout the United States, proved to be inefficient techniques for counting juvenile Atlantic salmon in Maine rivers. Overhead viewing at nine sites detected a mean of 12% of fish counted by the first run of multiple pass electrofishing estimates and 6.5% of the final estimate. Streamside viewing results were similar. Snorkelers counted greater than 50% of the fish estimated by electrofishing at only one site. At five of the eighteen sites, snorkel counts approximated 50% of the 1-run electrofishing counts. The five sites were distributed among the river drainages, width categories, and substrate categories. The relative accuracy of snorkel counts increased with decreasing substrate size. For future juvenile Atlantic salmon enumeration using snorkeling, best results may be achieved in early summer months when water levels are adequate for underwater viewing in narrow reaches with small dominant substrate.

Upper Kennebec River Atlantic Salmon Nursery Habitat Biological Survey *Abstract prepared by Kleinschmidt Associates, Pittsfield, Maine, in cooperation with the Maine Atlantic Salmon Commission.*

The goal of this research was to conduct a preliminary assessment of methods for estimating Atlantic salmon parr abundance in large river rearing habitat. Kleinschmidt Associates, in cooperation with the Maine Atlantic Salmon Commission and Fred Kircheis, conducted a biological survey of potential Atlantic salmon nursery habitat in the Kennebec River between Caratunk and North Anson, Maine during early October 2003. Quantitative fish sampling protocols were based on boat electrofishing methods adapted from those recently developed for use in a large un-wadable Maine rivers (MBI, 2003) that have proved efficient at capturing other juvenile salmonids with similar habitat requirements that currently occupy this habitat. These methods were combined with the multiple pass depletion electrofishing methods currently employed by MASC and NOAA Fisheries on wadable salmon rivers elsewhere in Maine, but using juvenile landlocked salmon and rainbow trout as surrogates for salmon. The methodology efficiently collected juvenile salmonids ranging in age from 0+ through 2+, and provided additional community data on other cohort species that frequently are guilded with salmon. Preliminary findings are that a three-pass run is generally sufficient to collect juvenile salmonids. The study also provided insights into large river microhabitat selection by juvenile salmonids, and found qualitatively that landscape-level distribution trends consistent with those in smaller rivers showing that 0+ and parr abundance for a given habitat type varies in accordance with proximity to suitable habitat for early lifestages.

Habitat Variability at Different Stream Flows *Abstract By Mitch Simpson*

The Atlantic Salmon Commission uses ground surveys to map salmon habitat within river systems that allow reasonable calculations of area by habitat type. These data are used with electrofishing survey data to estimate basin wide population abundance of juvenile Atlantic salmon within that river system. However, the flows at the time of the habitat survey for a given section may misrepresent the available habitat. Flow is a determining factor for area, depending on the site, changes in flow can significantly increase or decrease wetted width and/or depth. Thus, habitat units calculated during these initial surveys might not be representative of actual habitat present at a "base" flow. We are measuring length and wetted width for all electrofishing sites within the Narraguagus River at three different flows to determine if total habitat units ($100m^2$) varies among three flows. We determined the "base flow" (August median) on the Narraguagus River to be approximately 60 cubic feet per second (cfs). Based on electrofishing survey data, we selected a high flow of approximately 100cfs and a low flow of approximately 30 cfs to re-measure the sites. Due to flow conditions and crew availability, not enough data has been collected for each site to determine if the changes in habitat units are significant. Based on preliminary data tributary sites seemed most affected by varying flows. Habitat units measured at the higher and lower flows at these sites varied from approximately 10 to 45 percent from the base flow measurements. Mainstem sites varied from approximately 5 to 16 percent. Additional site measurements will be collected in 2004 as conditions permit.

Atlantic salmon hatchery smolt emigration dynamics determined through ultrasonic telemetry: Dennys River Maine, USA

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Maine's remnant Atlantic salmon populations are protected under the U.S. Endangered Species Act and stocking is a critical management tool to artificially maintain these populations and conserve their genetic diversity. In 2001, a 5-year smolt-stocking program was started on the Dennys River. We initiated an ultrasonic telemetry investigation on these hatchery-bred fish to better understand their emigration pathways, timing and dynamics and to estimate mortality rates by ecological zones. A total of 70 and 150 ultrasonically tagged smolts were released in 2001 and 2002, respectively. Acoustic receivers were deployed throughout the lower river, Cobscook Bay and the Bay of Fundy. Smolts passed through the freshwater zone quickly, experiencing low mortality. However, once fish entered the near shore environment, mortality markedly increased and large variations were observed in the timing of emigration. Low numbers of smolts were detected entering the Gulf of Maine. Interannual differences occurred in both emigration timing and mortality, and environmental data (temperature, flow and tide) were analyzed to interpret these results. Improved understanding of smolt emigration dynamics and bottlenecks will be useful in developing adaptive strategies to foster the recovery of the remnant salmon populations in Maine.

Changes in the proportion of naturally reared Atlantic salmon smolts to hatchery smolts emigrating from the Penobscot River, ME, during 2000-2003

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Beginning in 2000, NOAA-Fisheries has operated rotary screw traps in the lower Penobscot River to capture/recapture emigrating Atlantic salmon (Salmo salar) smolts. One objective of this program is to determine the relative proportion of stocked smolts to naturally reared smolts, and to assess the annual variability in this ratio.

During 2000-2003, smolts were captured in the rotary traps between April and June. Fin scores were assigned to each fish based on the degree of erosion, with a fin score of 0 indicating no erosion, and a score of 3 indicating almost complete erosion of the fins, commonly seen in hatchery-reared fish. Fish with a fin score of 0 or 1 that had no tags or marks were sampled for scales, which were subsequently analyzed to determine age and life history. The proportion of stocked smolts to naturally reared smolts has remained relatively stable over the past four years. The 2003 smolt season produced a slightly higher percentage of naturally reared smolts than in previous years.

UPDATE ON COASTAL MAINE RIVER ATLANTIC SALMON SMOLT STUDIES: 2003

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The goal of our research is to quantify and compare Atlantic salmon smolt production across several Maine rivers. These comparisons are undertaken to (1) develop a better understanding of overwinter parr to smolt survival, population dynamics, and outmigration timing; and (2) 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 with the deployment of a single rotary screw trap on the Narraguagus River in 1996, NOAA-Fisheries and the Atlantic Salmon Commission have been investigating production, survival and migration of Atlantic salmon smolts in coastal Maine rivers. Today, the salmon smolt research program operates 11 rotary screw traps on five rivers: four traps deployed in the Narraguagus, three traps in the Penobscot, one trap each on the

Sheepscot, Pleasant and Dennys Rivers. These platforms support the field operations for the smolt production research, as well for mass marking and ultrasonic telemetry studies aimed at elucidating hatchery smolt movement patterns and survival rates. Findings of each of these field programs are summarized and briefly discussed.

SMOLTIFICATION AND SMOLT ECOLOGY

Physiological smolt status of wild Atlantic salmon in Maine and its relation to declining populations.

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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 for subsequent measure of gill Na,K-ATPase activity. 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. Elevated acid and aluminum and/or the presence of endocrine disrupting chemicals may be responsible for this compromised smolt development.

Short-term, sub-lethal acid/aluminum effects on seawater tolerance of Atlantic salmon smolts

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The acidification of rivers and streams, and resulting elevated aluminum (Al) concentrations have toxic effects on fish, including the disruption of ionoregulatory ability. Atlantic salmon smolts are particularly vulnerable to this disturbance, for they must develop sufficient seawater tolerance

to survive downstream migration and seawater entry. We examined whether short-term, sub-lethal acid/Al exposure would affect seawater tolerance and underlying endocrine mechanisms of smolts. We assigned replicate tanks to either control (pH 6.5-6.9) or acid/Al treatment (pH 5.3-6.0, 200 µg/l total Al) conditions, and exposed fish for 2 and 5 days. Fish were sampled in freshwater, and after a 24h seawater challenge. Hematocrit and glucose were elevated after acid/Al exposure indicating a stress response. Gill Na^+, K^+ ATPase activity decreased after both 2 and 5 days of acid/Al in freshwater, and after 2 days in seawater. It was also demonstrated using Western immunoblotting that acid/Al may decrease gill protein of $Na^+/K^+/2Cl^-$ cotransporter. Acid/Al didn't effect plasma ions in freshwater, but did result in higher chloride after seawater exposure. Cortisol and thyroxine remained unaffected by acid/Al. Short-term, sub-lethal acid/Al exposure compromises seawater tolerance of smolts 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 (*Salmo salar*) have recently been listed as an endangered species. The objective of this study was to determine the effect of sublethal, environmentally relevant concentrations of hexazinone on smolting. 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 seawater 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.

Smolt migration, demography and overwinter survival of Atlantic salmon in a restoration stream of the Connecticut River, USA

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Advances in passive integrated transponder (PIT) tag technology, including the low cost of PIT tags, offer the opportunity to locate and individually identify large numbers of fish without disrupting their natural habitat choice, activity, and behaviors. Because PIT tags are passive, remain viable for a number of years, and have a high retention rate when implanted peritoneally, tagged fish can be both recaptured within rearing habitats and detected as they emigrate downstream without trapping or handling the fish. Larger PIT tags have allowed larger read ranges (2 m) and permitted us to construct antennas which can monitor the width of an entire stream. With these tags and antenna-systems we have developed a method for passively monitoring movements of individuals in the natural environment with only one initial handling. Estimates of detection efficiency using dummy tags and tagged hatchery smolts indicate that detection efficiency is > 93%. In the autumns of 1998-2003, 302-460 fry-stocked parr (9-17 cm fork length; 1^+- and 2^+-year olds) from Smith Brook, VT (a tributary of the Connecticut River) were PIT tagged and their downstream movement was continuously monitored. Each fall there was a substantial downstream movement of parr (5-20% of fish tagged that fall). Fish migrating as smolts the following spring were those that had been greater than 11.5 cm fork length in the fall. In spring 1998-2003, the smolt migration began in mid-March and ended in mid-May, with 90% occurring between April 20 and May 12. Most of the smolt migration occurred at night. The median date of migration varied by only 6 days over the 6 years, perhaps indicative of the photoperiodic control of smolt migration. There was no apparent relationship of smolt migration to flow. There was a strong relationship between degree days in April and the median date of migration, whereas the relationship between first date of 10 ^{o}C and median date of migration was weaker. There was a strong positive relationship between size at tagging in the fall and probability of smolting, with immature fish larger than 11.5 cm fork length having a probability of smolting nearly 100%. Estimates of winter survival for immature fish > 11.5% varied substantially from year-to-year and were between 28-68%. Estimates of smolt recruitment for all fish (mature and immature fish) also varied from year-to-year and were between 19-42%.

The Relationship Between Smolt Size and Finishing Growth and Post-smolt Growth in Atlantic Salmon in the Gulf of St. Lawrence

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Size at ocean entry and growth rate of post-smolts are believed to be two important factors controlling post-smolt mortality and recruitment of Atlantic salmon (Salmo salar). Studies have addressed both factors, individually and concurrently, revealing mixed results, and generally suggesting both factors contribute to the pattern of mortality. However, what has often been overlooked is whether smolt size and freshwater growth experience influence post-smolt growth. Circuli spacing in the freshwater and marine growth zones of scale samples was measured for 587 post-smolts captured in the Gulf of St. Lawrence during 1982-1984. These samples are of special utility because unlike analyses done on returnees, it may contain individuals that would

have likely been mortalities. Post-smolt growth showed no significant relationship to either smolt size or freshwater finishing growth. Individuals with rapid early marine growth sustain that growth through the balance of the summer growth season. These data suggest a decoupling between freshwater size and growth experience and the growth of post-smolts in the marine environment.

STOCK IDENTIFICATION OR GENETICS

Genetic parentage analysis of Sheepscot River Atlantic salmon: survival and distribution of stocked individuals

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Survival and dispersal of stocked juvenile Atlantic salmon is a vital component to the restoration and recovery efforts for the Distinct Population Segment (DPS) rivers in Maine. Recovery and restoration efforts focus on the stocking of fry and smolts into the DPS rivers. Stocked fry are recaptured as parr and a portion are sent to Craig Brook National Fish Hatchery to serve as broodstock upon maturation. Smolts are rarely recaptured due to the subsequent emigration to the ocean. Therefore, in-river assessment of survival, habitat usage, and stocking practices are best conducted using the stocked fry. In 2001, calcein-marked Atlantic salmon fry of known parentage were stocked into the Sheepscot River, Maine. Offspring of 21 families, grouped into 6 stocking batches, were stocked into three locations in the Sheepscot River: Trout Brook, Choate Brook, and four locations in the West Branch of the Sheepscot. Approximately half of the stocked juveniles were marked with calcein to compare the effects of the mark on survival of marked and non-marked individuals. A disproportionate number of non-marked individuals were recovered compared to the number of marked individuals (potentially due to a number of factors). To determine if the non-marked individuals were actually the stocked individuals, we used genetic parentage analysis based on genotypes from eleven microsatellite loci to identify origin. For the individuals we were unable to assign parentage, we examined the relatedness among the offspring to determine the number of potential family groups represented and evaluated the potential of contribution of natural reproduction. Due to the ability to determine parentage, we were able to evaluate the effects of stocking location and family group on survival to provide a better understanding of factors that contribute to restoration and recovery efforts.

Genetic standardization and Atlantic salmon in Maine: Management of an endangered species and aquaculture industry

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Management of Atlantic salmon (*Salmo salar*) in the state of Maine presents a complicated example of management of biological and genetic resources and data by multiple public and private interests. Eight populations of Atlantic salmon in Maine are listed as endangered Distinct Population Segments (DPS) under the Endangered Species Act. As part of the restoration and recovery effort, captive broodstock for hatchery supplementation purposes are used in the eight DPS and neighboring and currently non-listed rivers. However, the use of Atlantic salmon in the aquaculture industry continues off the coast of Maine. Due to the complex nature of the hatchery supplementation process, it is important to be able to identify the origin of individual salmon returning to the DPS rivers as adults, and also as individuals are brought into the hatchery for captive broodstock purposes. Six of the DPS rivers have captive broodstock that hare held at Craig Brook National Fish Hatchery. Following spawning of captive adults, fry and smolts are stocked out into rivers specific to the origin of the broodstock. The following year, parr are sampled from each of the six rivers and are brought into the hatchery to serve as broodstock once they mature. The goals of the stocking program are to expose at least one life stage to natural selection to minimize artificial hatchery selection, that the recaptured parr are representative of the families stocked out as fry, and to incorporate any natural reproduction that may be occurring within the rivers. The concern is that accidental escapement of aquaculture-origin Atlantic salmon could stray into the rivers, spawn, and their offspring be incorporated into the DPS broodstock. To help identify these potential strays and their offspring, and to identify whether other juveniles sampled are of natural or hatchery stocking origin, genetic identification of individuals has been incorporated into Atlantic salmon management. The importance of genetic standardization of microsatellite-based genotypes is critical to this complex management process as multiple laboratories are responsible for generating information for both the aquaculture industry in order to identify potential escapees, and also for the governmental agencies responsible for broodstock management.

5. TERMS OF REFERENCE FOR 2005 MEETING

The Committee agreed to address the following Terms of Reference for the 2005 meeting:

1. Program summaries for Year 2004 activities 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 and redd based estimates; (c) aquaculture production data; (d) general summary of program activities including new and emerging issues, and program direction; and (e) 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. New and Emerging Issues.

5. Status of the NASCO Habitat Database.

6. Regional Atlantic salmon Stock Assessment.

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

8. Greenland Catch: Continent of Origin and Region of Origin Analyses.

9. Review of Quantitative Studies of Downstream Migration and Passage.

10. Additional Terms of Reference will be developed at a Committee meeting to be held in July 2004 at a location in central New England.

6. U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE MEMBERS

List of U.S. Atlantic Salmon Assessment Committee Members

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7. APPENDICES

7.1 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
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

7.2 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.
Captive Broodstock	Captive broodstock refers to adults produced from wild parr that were captured and reared to maturity in the hatchery.
Sea-run Broodstock	Atlantic salmon that return to the river, are captured alive, and held in confinement for the purpose of providing eggs for fish culture activities.
Strategy	Any action or integrated actions that will assist in achieving an objective and fulfilling the goal.
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.

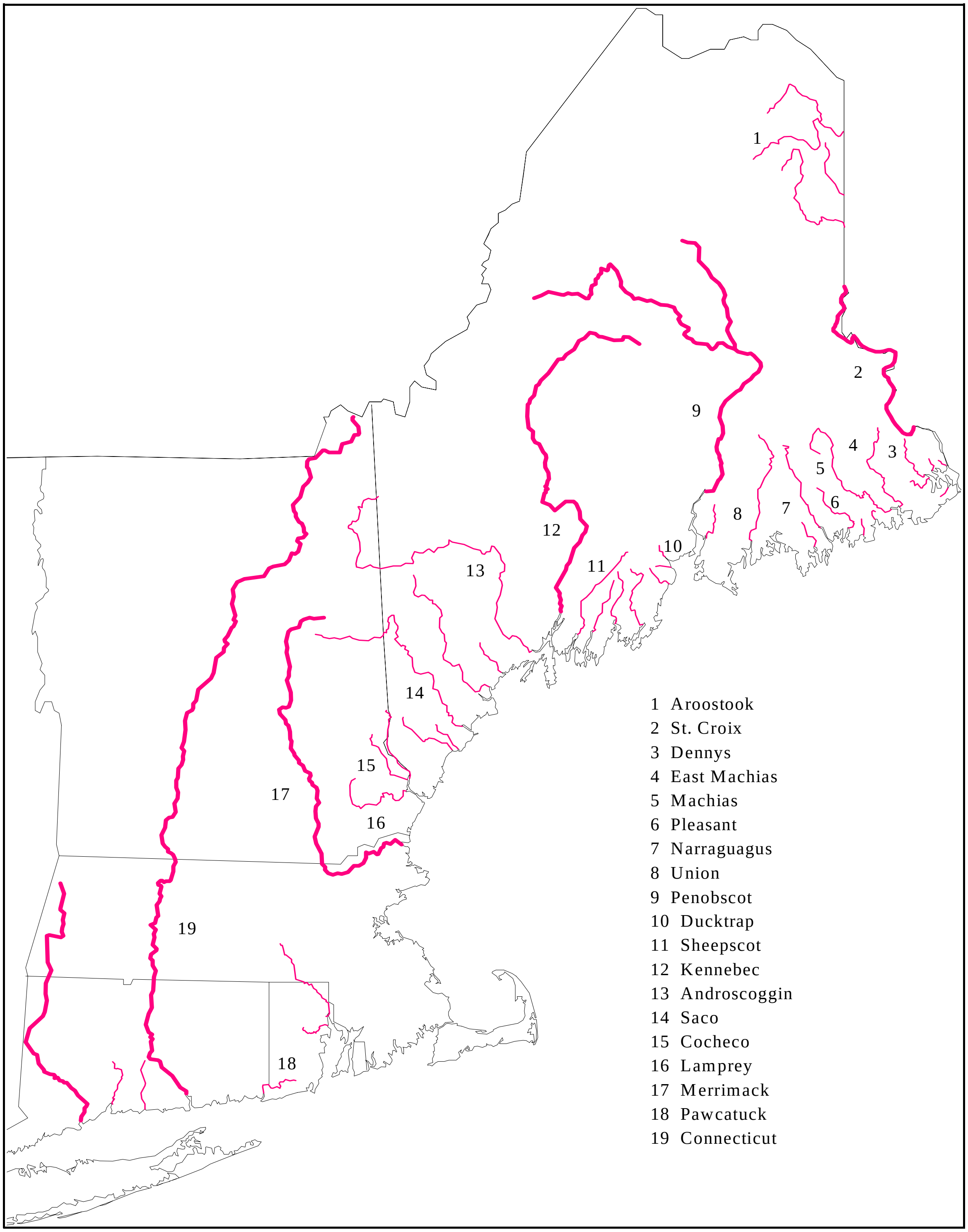
Parr	Life history stage immediately following the fry stage until the commencement of migration to the sea as smolts.
Age 0 Parr	The period from August 15 to December 31 of the year of hatching.
Age 1 Parr	The period from January 1 to December 31 one year after hatching.
Age 2 Parr	The period from January 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.

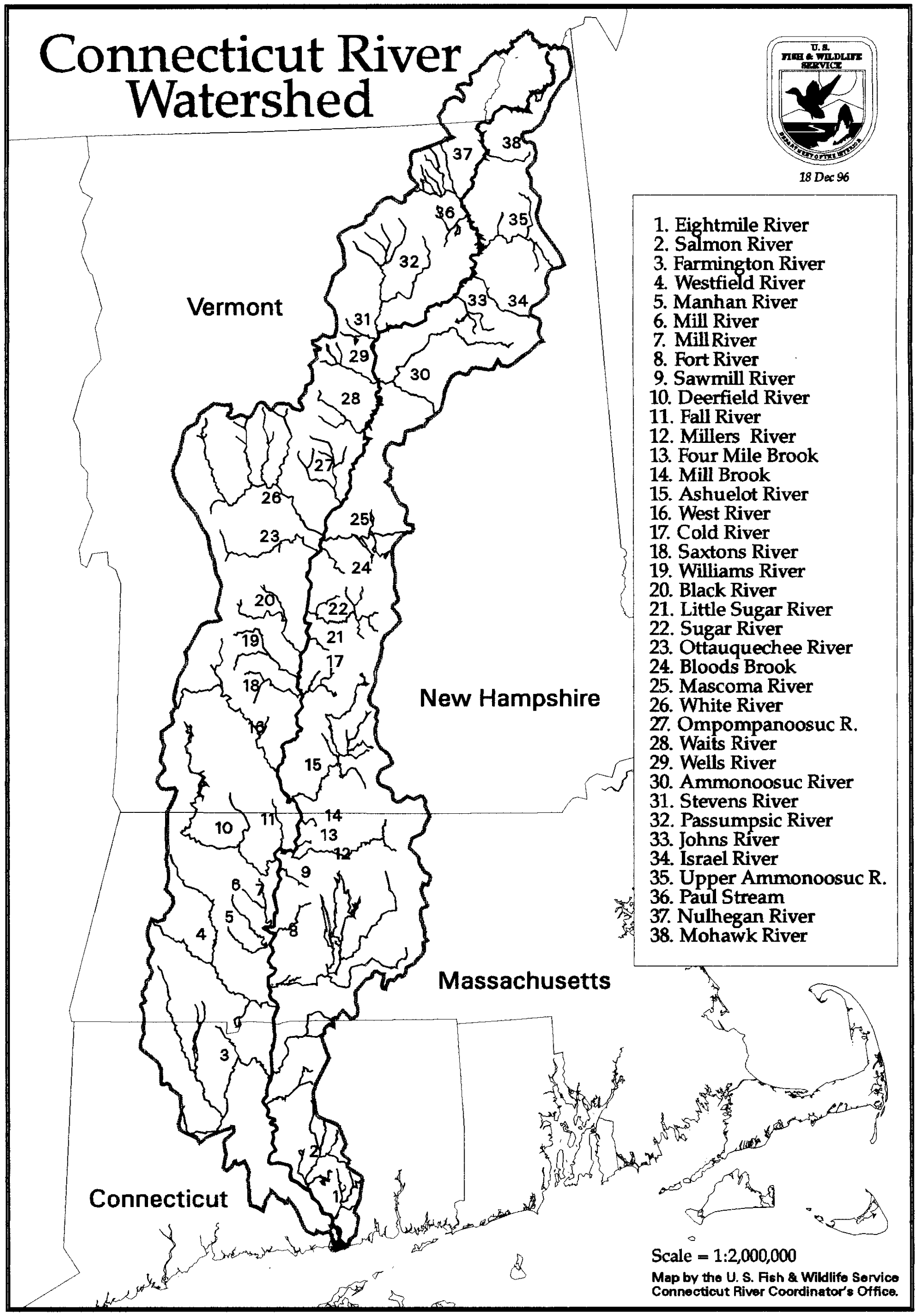
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31four times since becoming a smolt.
Kelt	A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns 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.

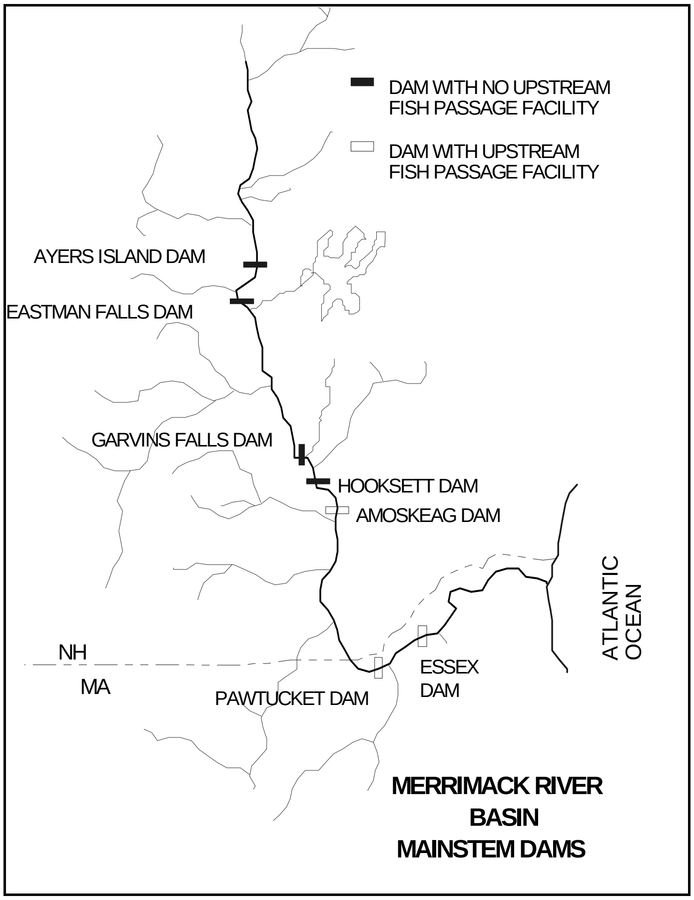
7.3 LOCATION MAPS

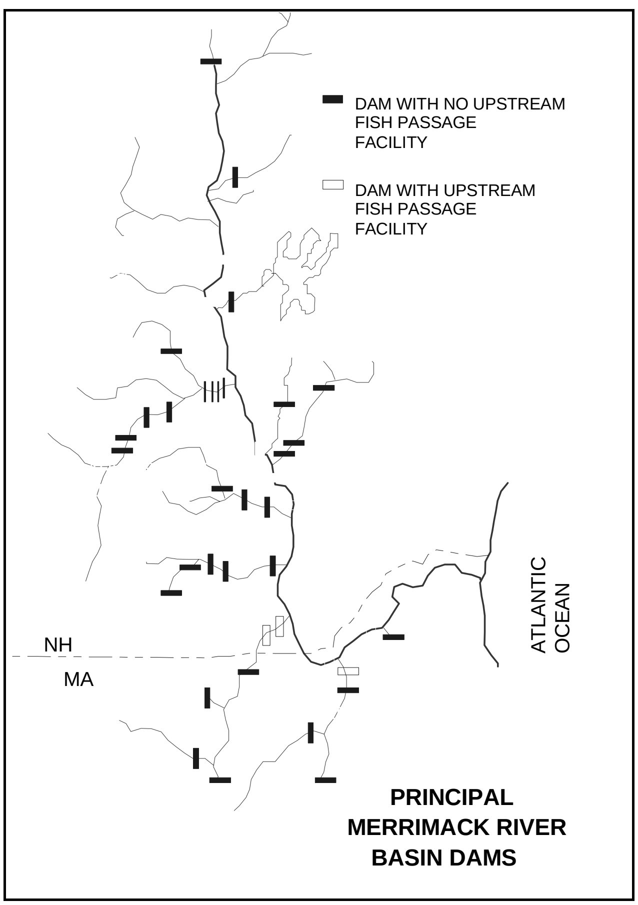
7.4 TABLES AND FIGURES SUPPORTING THE DOCUMENT

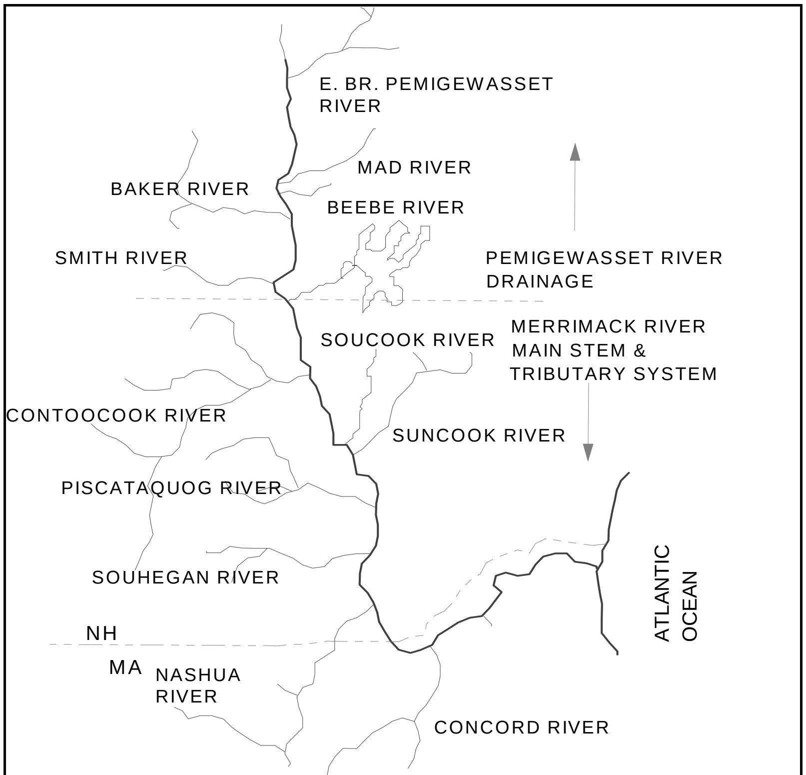
IMPORTANT ATLANTIC SALMON RIVERS OF NEW ENGLAND




Connecticut River
Watershed
U.S. FISH & WILDLIFE SERVICE
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.


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
PAWTUCKET DAM
ESSEX DAM
MERRIMACK RIVER BASIN MAINSTEM DAMS


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



PRINCIPAL MERRIMACK RIVER TRIBUTARIES

Table 7. Juvenile Atlantic salmon stocking summary for New England in 2003.

United States

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
Connecticut	7,038,000	0	0	2,400	87,700	7,128,100
Total for Connecticut Program						**7,128,100**
Androscoggin	1,000	0	0	0	0	1,000
Dennys	133,000	30,400	600	55,200	0	219,200
East Machias	314,000	0	0	0	0	314,000
Kennebec	42,000	0	0	0	0	42,000
Machias	341,000	0	300	0	0	341,300
Narraguagus	491,000	0	0	0	0	491,000
Penobscot	741,000	320,700	2,100	547,300	0	1,611,100
Pleasant	82,000	0	0	2,800	0	84,800
Saco	501,000	20,000	0	3,200	0	524,200
Sheepscot	323,000	0	0	0	0	323,000
St Croix	1,000	0	0	3,200	0	4,200
Union	3,000	0	0	0	0	3,000
Total for Maine Program						**3,958,800**
Merrimack	1,335,000	0	900	49,600	1,000	1,386,500
Total for Merrimack Program						**1,386,500**
Cocheco	163,000	0	0	0	0	163,000
Lamprey	106,000	0	0	0	0	106,000
Total for New Hampshire Coastal Program						**269,000**
Pawcatuck	313,000	0	0	5,200	0	318,200
Total for Pawcatuck Program						**318,200**
Total for United States						**13,060,600**

Canada

No. of fish stocked by lifestage

River	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
Aroostook	138,000	0	0	0	0	138,000
St Croix	0	16,800	0	0	0	16,800
Total for Canada Program						**154,800**
Total for Canada						**154,800**

Grand Total **13,215,400**

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

Table 8. Captive and domestic adult Atlantic salmon stocking summary for New England in 2003 by river, season, and year class (= year of egg take or wild collection).

	NUMBER RELEASED BY SEASON AND YEAR CLASS										
	Spring / early summer					**Autumn**					
	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001	**Total**
United States											
Dennys	0	0	0	0	0	0	78	53	0	0	131
East Machias	0	0	0	0	0	0	0	102	0	0	102
Machias	0	180	0	0	0	0	0	196	0	0	376
Narraguagus	0	177	0	0	0	0	0	192	0	0	369
Penobscot	0	0	0	0	0	0	0	766	898	0	1,664
Sheepscot	0	0	0	0	0	0	0	70	0	0	70
Total for Maine program :	0	357	0	0	0	0	78	1,379	898	0	2,712
Merrimack	0	0	782	677	0	0	0	100	400	0	1,959
Total for Merrimack program :	0	0	782	677	0	0	0	100	400	0	1,959
Total United States	0	357	782	677	0	0	78	1,479	1,298	0	4,671

Table 9. Atlantic salmon marking database for New England; marked fish released in 2003.

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
Connecticut	PGE	4	Adult	Sea Run	Connecticut	RAD	4		PIT	Normandeau Study	5/2003
Connecticut	USFWS	2	Smolt	Hatchery	Connecticut	AD	87,737			Smolt release from Pittsford NFH	4/2003
Connecticut	USGS	0,1	Parr	Wild	Connecticut	PIT	2,000			West Brook Study	1/2003
Connecticut	USGS	0,1	Parr	Wild	Connecticut	PIT	410	Anal fin Paint	PAINT	Smith Brook Study	1/2003
TOTAL Tags/Marks for		**Connecticut**					90,151				
Dennys	NOAA/USFWS	0	Parr	Hatchery	Dennys	LV	30,400				10/2003
Dennys	NOAA/USFWS	1	Parr	Hatchery	Dennys	VIE	600	RightEye yellow elastomer	AD	NOAA smolt migration/marine growth	4/2003
Dennys	NOAA/USFWS	1	Smolt	Hatchery	Dennys	VIE	3,500	LeftEye blue elastomer	AD	NOAA smolt migration/marine growth	5/2003
Dennys	NOAA/USFWS	1	Smolt	Hatchery	Dennys	VIE	23,200	LeftEye yellow elastomer, 200 fish also tagged with ultrasonic pingers	AD	NOAA smolt migration/marine growth	5/2003
Dennys	NOAA/USFWS	1	Smolt	Hatchery	Dennys	VIE	3,500	RightEye blue elastomer	AD	NOAA smolt migration/marine growth	4/2003
Dennys	NOAA/USFWS	1	Smolt	Hatchery	Dennys	VIE	25,000	RightEye yellow elastomer, 200 fish also tagged with ultrasonic pingers	AD	NOAA smolt migration/marine growth	4/2003
Dennys	USFWS	4	Adult	Captive	Dennys	PIT	53			surplus broodstock release	12/2003

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
Dennys	USFWS	5	Adult	Captive	Dennys	PIT	78			surplus broodstock release	12/2003
TOTAL Tags/Marks for	**Dennys**						86,331				
East Machias	USFWS	4	Adult	Captive	East Machias	PIT	102			surplus broodstock release	10/2003
TOTAL Tags/Marks for	**East Machias**						102				
Machias	USFWS	4	Adult	Captive	Machias	PIT	196			surplus broodstock release	12/2003
Machias	USFWS	5	Adult	Captive	Machias	PIT	180			surplus broodstock release	4/2003
TOTAL Tags/Marks for	**Machias**						376				
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	200	Blue Tag		Dorsal, Angling	5/2003
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	200	Grey Tag		Dorsal, Angling	10/2003
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	200	Purple Tag		Dorsal, Angling	10/2003
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	220	Yellow Tag		Dorsal, Angling	5/2003
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	257	Yellow Tag		Dorsal, Angling	6/2003
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	50	Grey Tag		Dorsal, Angling	10/2003

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	50	Purple Tag		Dorsal, Angling	10/2003
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	432	Yellow Tag		Dorsal, Angling	5/2003
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	150	Yellow Tag		Dorsal, Angling	6/2003
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	200	Yellow Tag		Dorsal, Restoration	4/2003
Merrimack	PSNH	1	Smolt	Sea Run	Penobscot	RAD	200			Garvins Fallls, Merrimack River, Study	5/2003
Merrimack	USFWS	1	Parr	Domestic	Merrimack	RV	600			Pemigewasset River, Restoration	6/2003
Merrimack	USFWS	1	Parr	Domestic	Merrimack	RV	329			Souhegan River, Restoration	6/2003
Merrimack	USFWS	2	Smolt	Domestic	Merrimack	RV	1,000			Lawrence, MA, Restoration	4/2003
TOTAL Tags/Marks for		**Merrimack**					4,088				
Narraguagus	NOAA	2	Smolt	Wild	Narraguagus	PING	101			NOAA migration study	5/2003
Narraguagus	USFWS	4	Adult	Captive	Narraguagus	PIT	192			surplus broodstock release	12/2003
Narraguagus	USFWS	5	Adult	Captive	Narraguagus	PIT	144			surplus broodstock release	4/2003
TOTAL Tags/Marks for		**Narraguagus**					437				

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
Penobscot	ASC/USGS		Adult	Sea Run	Penobscot	PIT	447	TIRIS 23 mm tag		USGS/ASC adult movement study	7/2003
Penobscot	NOAA/USFWS	0	Parr	Hatchery	Penobscot	RV	106,000				9/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	400	LC mark blue	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	2,600	LC mark blue	AD	NOAA smolt migration/marine growth	5/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	500	LC mark blue	AD	NOAA smolt migration/marine growth	6/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	800	UC mark blue	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	1,600	UC mark blue	AD	NOAA smolt migration/marine growth	5/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	DYE	1,600	UC mark blue	AD	NOAA smolt migration/marine growth	6/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,600	LeftEye Green elastomer	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,600	LeftEye orange elastomer	AD	NOAA smolt migration/marine	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,400	LeftEye Pink elastomer	AD	NOAA smolt migration/marine growth	5/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,600	LeftEye red elastomer	AD	NOAA smolt migration/marine growth	5/2003

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,600	RightEye Green elastomer	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,600	RightEye orange elastomer	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,400	RightEye pink elastomer	AD	NOAA smolt migration/marine growth	4/2003
Penobscot	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	24,700	RightEye red elastomer	AD	NOAA smolt migration/marine growth	5/2003
Penobscot	USFWS	3	Adult	Domestic	Penobscot	AP	898	double punch		domestic broodstock release	11/2003
Penobscot	USFWS	4	Adult	Domestic	Penobscot	AP	766	double punch		domestic broodstock release	11/2003
TOTAL Tags/Marks for	**Penobscot**						312,111				
Pleasant	NOAA/USFWS	1	Smolt	Hatchery	Pleasant	VIE	2,800	RightEye purple elastomer	AD	NOAA smolt migration study	5/2003
TOTAL Tags/Marks for	**Pleasant**						2,800				
Saco	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	3,200	LeftEye Brown elastomer	AD	NOAA smolt migration study	5/2003
TOTAL Tags/Marks for	**Saco**						3,200				
Sheepscot	USFWS	4	Adult	Captive	Sheepscot	PIT	70			surplus broodstock release	12/2003
TOTAL Tags/Marks for	**Sheepscot**						70				
St Croix	NOAA/USFWS	1	Smolt	Hatchery	Penobscot	VIE	3,200	LeftEye Brown elastomer	AD	NOAA smolt migration study	5/2003

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments	Release Date
TOTAL Tags/Marks for	**St Croix**						3,200				

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; DYE = MetaJet Dye; PIT = PIT tag; VPP = VIE tag, PIT tag, and ultrasonic ping PTC = PIT tag and Carlin tag; VPT = VIE tag and PIT tag; ANL = anal clip/punch.

*If release dates were unknown, they were set to 1/2003

Table 10. Documented Atlantic salmon returns to New England rivers in 2003

	1SW		2SW		3SW		Repeat			1999-2003
	Hatchery	**Wild**	**Hatchery**	**Wild**	**Hatchery**	**Wild**	**Hatchery**	**Wild**	**Total**	**Average**
Androscoggin	0	0	3	0	0	0	0	0	**3**	4
Cocheco	0	1	0	3	0	0	0	0	**4**	2
Connecticut	0	0	0	42	0	1	0	0	**43**	72
Dennys	3	0	5	1	0	0	0	0	**9**	8
Lamprey	0	2	0	0	0	0	0	0	**2**	2
Merrimack	12	0	129	4	0	0	0	0	**145**	110
Narraguagus	0	0	0	21	0	0	0	0	**21**	23
Penobscot	196	6	848	56	2	0	3	1	**1112**	836
Pleasant	0	1	0	1	0	0	0	0	**2**	4
Saco	2	2	23	12	0	0	0	0	**39**	54
Union	1	0	0	0	0	0	0	0	**1**	3
Total	**214**	**12**	**1,008**	**140**	**2**	**1**	**3**	**1**	**1,381**	**1,118**

Note: 6 adult salmon returned to the Pawcatuck River in 2003, however ages were not available at the time of this publication.

Table 11. Summary of Atlantic salmon green egg production in Hatcheries for New England rivers in 2003.

Source River	Origin	Females Spawned	Total Egg Production
Connecticut	Domestic	2152	11,600,000
Merrimack	Domestic	489	1,914,000
Dennys	Captive	79	438,000
East Machias	Captive	93	456,000
Machias	Captive	121	763,000
Narraguagus	Captive	120	624,000
Pleasant	Captive	11	92,000
Sheepscot	Captive	92	433,000
Total	**Captive/Domestic**	**3,157**	**16,320,000**
Connecticut	Kelt	67	660,000
Merrimack	Kelt	20	236,000
Total	**Kelt**	**87**	**896,000**
Connecticut	Sea Run	34	245,000
Merrimack	Sea Run	60	499,000
Pawcatuck	Sea Run	2	6,000
Penobscot	Sea Run	362	3,194,000
St Croix	Sea Run	3	21,000
Total	**Sea Run**	**461**	**3,965,000**
Grand Total for Year	**2003**	**3,705**	**21,181,000**

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

Table 12. 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	7,100	0	0	0	0	0		0	0		3	21,000	7,100
Connecticut															
1977-1993	565	9,732,000	8,400	2,427	27,644,000	5,800	0	0		369	7,815,000	9,900	3,361	45,190,000	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
2003	34	245,000	7,200	2,152	11,600,000	5,400	0	0		67	660,000	9,800	2,253	12,505,000	5,600
Total Connecticut	1,438	16,573,000	7,700	19,874	128,896,000	5,900	0	0		1,897	23,773,000	10,300	23,209	169,242,000	6,400
Dennys															
1939-1993	20	170,000	7,800	0	0		0	0		2	9,000	4,300	22	179,000	7,500
1994	2	15,000	7,400	0	0		56	110,000	2,000	6	30,000	5,100	64	156,000	2,400
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

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
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
2003	0	0		0	0		79	438,000	5,500	0	0		79	438,000	5,500
Total Dennys	26	214,000	7,500	0	0	0	780	3,174,000	4,130	40	330,000	7,700	846	3,717,000	4,700
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
2003	0	0		0	0		93	456,000	4,900	0	0		93	456,000	4,900
Total East Machias	0	0		0	0	0	752	3,133,000	4,278	0	0		752	3,133,000	4,300
Kennebec															
1979-1993	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															
1992-1993	3	15,000	4,400	0	0		0	0		0	0		3	15,000	4,400

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
1994	3	17,000	5,700	0	0		0	0		0	0		3	17,000	5,700
Total Lamprey	6	32,000	5,000	0	0	0	0	0		0	0		6	32,000	5,000
Machias															
1941-1993	456	3,263,000	7,300	0	0		0	0		0	0		456	3,263,000	7,300
1994	0	0		0	0		88	196,000	2,200	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
2003	0	0		0	0		121	763,000	6,300	0	0		121	763,000	6,300
Total Machias	456	3,263,000	7,300	0	0	0	1,313	5,279,000	4,090	8	53,000	6,400	1,777	8,594,000	4,400
Merrimack															
1983-1993	709	5,097,000	7,200	2,109	12,097,000	5,300	0	0		0	0		2,818	17,195,000	7,000
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
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

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

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

Note: Connecticut data are preliminary prior to 1990.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
Year	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
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
2003	60	499,000	8,300	489	1,914,000	3,900	0	0		20	236,000	11,800	569	2,649,000	4,700
Total Merrimack	1,107	8,442,000	8,500	8,756	46,550,000	5,100	0	0		180	2,114,000	12,000	10,043	57,106,000	5,600
Narraguagus															
1962-1993		1,303,000		0	0		0	0		0	0			1,303,000	
1994	0	0		0	0		59	146,000	2,500	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
2003	0	0		0	0		120	624,000	5,200	0	0		120	624,000	5,200
Total Narraguagus	0	1,303,000		0	0	0	1,292	4,687,000	3,630	0	0		1,292	5,990,000	3,600
Orland															
1967-1993	39	270,000	7,300	0	0		0	0		0	0		39	270,000	7,300
Total Orland	39	270,000	7,300	0	0	0	0	0		0	0		39	270,000	7,300
Pawcatuck															
1992-1993	5	44,000	8,400	0	0		0	0		0	0		5	44,000	8,400
1994	1	7,000	7,000	0	0		0	0		0	0		1	7,000	7,000

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run No. females	Sea-Run Egg production	Sea-Run Eggs/ female	Domestic No. females	Domestic Egg production	Domestic Eggs/ female	Captive No. females	Captive Egg production	Captive Eggs/ female	Kelt No. females	Kelt Egg production	Kelt Eggs/ female	TOTAL No. females	TOTAL Egg production	TOTAL Eggs/ female
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
2003	2	6,000	3,100	0	0		0	0		0	0		2	6,000	3,100
Total Pawcatuck	16	143,000	9,000	2	2,000	1,100	0	0		9	61,000	6,600	27	206,000	7,700
Penobscot															
1871-1993	14,905	129,963,000	7,900	1,500	3,811,000	2,500	0	0		0	0		16,405	133,774,000	7,800
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
2003	362	3,194,000	8,800	0	0		0	0		0	0		362	3,194,000	8,800
Total Penobscot	17,929	153,656,000	7,900	5,192	13,443,000	2,700	0	0		0	0		23,121	167,100,000	5,700
Pleasant															
2001	0	0		0	0		13	46,000	3,500	0	0		13	46,000	3,500
2002	0	0		0	0		19	84,000	4,400	0	0		19	84,000	4,400

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

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

Note: Connecticut data are preliminary prior to 1990.

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
2003	0	0		0	0		11	92,000	8,300	0	0		11	92,000	8,300
Total Pleasant	0	0		0	0	0	43	222,000	5,400	0	0		43	222,000	5,400
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	162,000	9,500	115	505,000	4,400
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
2003	0	0		0	0		92	433,000	4,700	0	0		92	433,000	4,700
Total Sheepscot	18	125,000	6,900	0	0	0	588	2,413,000	3,878	45	438,000	9,900	651	2,978,000	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
2003	3	21,000	6,900	0	0		0	0		0	0		3	21,000	6,900
Total St Croix	39	292,000	7,400	0	0	0	0	0		0	0		39	292,000	7,400
Union															
1974-1993	600	4,611,000	7,900	0	0		0	0		0	0		600	4,611,000	7,900
2003	0	0		0	0		0	0		0	0		0	0	
Total Union	600	4,611,000	7,900	0	0	0	0	0		0	0		600	4,611,000	7,900

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

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

Note: Connecticut data are preliminary prior to 1990.

Table 13. Summary of all historical Atlantic salmon egg production in hatcheries for New England rivers.

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco	3	21,000	7,100	0	0		0	0		0	0		3	21,000	7,100
Connecticut	1,438	16,573,000	11,500	19,874	128,896,000	6,500	0	0		1,897	23,773,000	12,500	23,209	169,242,000	7,300
Dennys	26	214,000	8,200	0	0		780	3,172,000	4,100	40	330,000	8,300	846	3,716,000	4,400
East Machias	0	0		0	0		752	3,133,000	4,200	0	0		752	3,133,000	4,200
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	0	0		1,313	5,277,000	4,000	8	52,000	6,500	1,777	8,592,000	4,800
Merrimack	1,107	8,441,000	7,600	8,756	46,551,000	5,300	0	0		180	2,113,000	11,700	10,043	57,104,000	5,700
Narraguagus	0	1,303,000		0	0		1,292	4,687,000	3,600	0	0		1,292	5,990,000	4,600
Orland	39	270,000	6,900	0	0		0	0		0	0		39	270,000	6,900
Pawcatuck	16	143,000	8,900	2	2,000	1,100	0	0		9	61,000	6,800	27	206,000	7,600
Penobscot	17,929	153,656,000	8,600	5,192	13,443,000	2,600	0	0		0	0		23,121	167,099,000	7,200
Pleasant	0	0		0	0		43	222,000	5,200	0	0		43	222,000	5,200
Sheepscot	18	125,000	7,000	0	0		588	2,414,000	4,100	45	438,000	9,700	651	2,977,000	4,600
St Croix	39	291,000	7,500	0	0		0	0		0	0		39	291,000	7,500
Union	600	4,611,000	7,700	0	0		0	0		0	0		600	4,611,000	7,700
Grand Total	**21,682**	**188,993,000**	**8,700**	**33,824**	**188,892,000**	**5,600**	**4,768**	**18,905,000**	**4,000**	**2,179**	**26,767,000**	**12,300**	**62,453**	**423,556,000**	**6,800**

Table 14. Atlantic salmon stocking summary for New England, by river.

	Number of fish stocked by life stage					
	Fry	**0 Parr**	**1 Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin						
2001	3,000	0	0	0	0	3,000
2002	0	0	0	0	0	0
2003	1,000	0	0	0	0	1,000
Totals:Androscoggin	**4,000**	**0**	**0**	**0**	**0**	**4,000**
Aroostook						
1978-1993	624,000	317,100	38,600	32,600	29,800	1,042,100
1994	0	0	0	0	0	0
1995	4,000	0	0	0	0	4,000
1996	0	0	0	0	0	0
1997	578,000	0	0	0	0	578,000
1998	142,000	0	0	0	0	142,000
1999	163,000	0	0	0	0	163,000
2000	0	0	0	0	0	0
2001	182,000	300	0	0	0	182,300
2002	122,000	0	0	0	0	122,000
2003	138,000	0	0	0	0	138,000
Totals:Aroostook	**1,953,000**	**317,400**	**38,600**	**32,600**	**29,800**	**2,371,400**
Cocheco						
1988-1993	533,000	50,000	10,500	0	0	593,500
1994	149,000	0	0	5,300	0	154,300
1995	114,000	0	0	0	0	114,000
1996	126,000	0	0	0	0	126,000
1997	128,000	0	0	0	0	128,000
1998	96,000	0	0	0	0	96,000
1999	157,000	0	0	0	0	157,000
2000	146,000	0	0	0	0	146,000
2001	165,000	0	0	0	0	165,000
2002	181,000	0	0	0	0	181,000
2003	163,000	0	0	0	0	163,000
Totals:Cocheco	**1,958,000**	**50,000**	**10,500**	**5,300**	**0**	**2,023,800**
Connecticut						
1967-1993	15,937,000	2,757,900	1,783,800	3,354,200	963,200	24,796,100
1994	5,978,000	37,000	15,200	375,100	0	6,405,300
1995	6,817,000	4,500	0	1,300	0	6,822,800
1996	6,677,000	12,400	3,600	11,500	0	6,704,500
1997	8,526,000	8,800	0	1,400	0	8,536,200
1998	9,119,000	3,000	7,700	1,700	0	9,131,400
1999	6,428,000	1,000	0	22,600	0	6,451,600
2000	9,325,000	600	0	700	48,200	9,374,500
2001	9,591,000	1,600	0	700	0	9,593,300
2002	7,283,000	700	0	500	0	7,284,200
2003	7,038,000	0	0	2,400	87,700	7,128,100
Totals:Connecticut	**92,719,000**	**2,827,500**	**1,810,300**	**3,772,100**	**1,099,100**	**102,228,000**
Dennys						

	Number of fish stocked by life stage					
	Fry	**0 Parr**	**1 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1975-1993	164,000	8,300	3,400	143,100	28,300	347,100
1994	20,000	0	0	0	0	20,000
1995	84,000	0	0	0	0	84,000
1996	142,000	0	0	0	900	142,900
1997	213,000	0	0	0	0	213,000
1998	233,000	10,400	0	9,600	0	253,000
1999	172,000	3,000	0	0	0	175,000
2000	96,000	30,500	0	0	0	126,500
2001	59,000	16,500	1,400	49,800	0	126,700
2002	84,000	33,000	1,900	49,000	0	167,900
2003	133,000	30,400	600	55,200	0	219,200
Totals:Dennys	**1,400,000**	**132,100**	**7,300**	**306,700**	**29,200**	**1,875,300**
Ducktrap						
1986-1993	68,000	0	0	0	0	68,000
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**68,000**
East Machias						
1973-1993	140,000	6,500	42,600	97,600	30,400	317,100
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	115,000	0	0	0	0	115,000
1997	113,000	0	0	0	0	113,000
1998	190,000	0	0	10,800	0	200,800
1999	210,000	1,000	0	0	0	211,000
2000	197,000	0	0	0	0	197,000
2001	242,000	0	0	0	0	242,000
2002	236,000	0	0	0	0	236,000
2003	314,000	0	0	0	0	314,000
Totals:East Machias	**1,757,000**	**7,500**	**42,600**	**108,400**	**30,400**	**1,945,900**
Kennebec						
2001	3,000	0	0	0	0	3,000
2002	7,000	0	0	0	0	7,000
2003	42,000	0	0	0	0	42,000
Totals:Kennebec	**52,000**	**0**	**0**	**0**	**0**	**52,000**
Lamprey						
1978-1993	501,000	224,400	41,300	133,300	32,800	932,800
1994	98,000	56,300	7,800	0	0	162,100
1995	91,000	57,100	0	4,800	0	152,900
1996	115,000	37,000	9,400	0	0	161,400

	Number of fish stocked by life stage					
	Fry	**0 Parr**	**1 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1997	141,000	52,900	0	0	0	193,900
1998	95,000	0	0	3,300	0	98,300
1999	127,000	0	0	0	0	127,000
2000	104,000	0	0	0	0	104,000
2001	111,000	0	300	0	0	111,300
2002	103,000	0	0	60,000	0	163,000
2003	106,000	0	0	0	0	106,000
Totals:Lamprey	**1,592,000**	**427,700**	**58,800**	**201,400**	**32,800**	**2,312,700**
Machias						
1970-1993	189,000	86,900	117,800	180,500	42,200	616,400
1994	50,000	0	0	0	0	50,000
1995	150,000	0	0	0	0	150,000
1996	233,000	0	0	0	1,900	234,900
1997	236,000	0	0	0	0	236,000
1998	300,000	5,900	0	10,800	0	316,700
1999	169,000	1,000	0	0	0	170,000
2000	209,000	0	0	0	0	209,000
2001	267,000	0	0	0	0	267,000
2002	327,000	0	0	0	0	327,000
2003	341,000	0	300	0	0	341,300
Totals:Machias	**2,471,000**	**93,800**	**118,100**	**191,300**	**44,100**	**2,918,300**
Merrimack						
1975-1993	10,296,000	222,500	556,100	850,800	630,500	12,555,900
1994	2,816,000	0	0	85,000	0	2,901,000
1995	2,827,000	0	12,700	70,800	0	2,910,500
1996	1,795,000	0	4,900	50,000	0	1,849,900
1997	2,000,000	5,000	10,000	52,500	5,400	2,072,900
1998	2,589,000	0	6,800	51,900	0	2,647,700
1999	1,756,000	0	4,400	56,400	0	1,816,800
2000	2,217,000	0	0	52,500	0	2,269,500
2001	1,708,000	0	0	49,500	0	1,757,500
2002	1,414,000	0	1,900	50,000	1,200	1,467,100
2003	1,335,000	0	900	49,600	1,000	1,386,500
Totals:Merrimack	**30,753,000**	**227,500**	**597,700**	**1,419,000**	**638,100**	**33,635,300**
Narraguagus						
1970-1993	74,000	30,300	12,600	106,100	84,000	307,000
1994	0	0	0	0	0	0
1995	105,000	0	0	0	0	105,000
1996	196,000	0	0	0	0	196,000
1997	209,000	0	2,000	700	0	211,700
1998	274,000	14,400	0	0	0	288,400
1999	155,000	18,200	0	1,000	0	174,200
2000	252,000	0	0	0	0	252,000
2001	353,000	0	0	0	0	353,000
2002	261,000	0	0	0	0	261,000
2003	491,000	0	0	0	0	491,000
Totals:Narraguagus	**2,370,000**	**62,900**	**14,600**	**107,800**	**84,000**	**2,639,300**
Pawcatuck						

	Number of fish stocked by life stage					
	Fry	**0 Parr**	**1 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1979-1993	546,000	1,020,900	234,500	30,500	500	1,832,400
1994	557,000	0	0	0	0	557,000
1995	367,000	52,200	0	0	0	419,200
1996	289,000	136,100	0	5,000	0	430,100
1997	100,000	0	14,000	11,500	0	125,500
1998	910,000	0	14,700	5,700	0	930,400
1999	591,000	0	0	3,900	0	594,900
2000	326,000	0	0	0	0	326,000
2001	423,000	0	0	8,500	0	431,500
2002	403,000	0	0	0	0	403,000
2003	313,000	0	0	5,200	0	318,200
Totals:Pawcatuck	**4,825,000**	**1,209,200**	**263,200**	**70,300**	**500**	**6,368,200**
Penobscot						
1970-1993	4,978,000	1,232,700	1,343,100	6,531,500	2,508,200	16,593,500
1994	949,000	0	2,400	567,600	0	1,519,000
1995	502,000	325,000	5,600	568,400	0	1,401,000
1996	1,242,000	226,000	17,500	552,200	0	2,037,700
1997	1,472,000	310,900	4,200	580,200	0	2,367,300
1998	930,000	337,400	13,400	571,800	0	1,852,600
1999	1,498,000	229,600	1,500	567,300	0	2,296,400
2000	513,000	288,800	700	563,200	0	1,365,700
2001	364,000	235,800	2,100	454,000	0	1,055,900
2002	746,000	396,700	1,800	547,000	0	1,691,500
2003	741,000	320,700	2,100	547,300	0	1,611,100
Totals:Penobscot	**13,935,000**	**3,903,600**	**1,394,400**	**12,050,500**	**2,508,200**	**33,791,700**
Pleasant						
1975-1993	187,000	2,500	1,800	54,700	18,100	264,100
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	13,500	0	0	0	13,500
2003	82,000	0	0	2,800	0	84,800
Totals:Pleasant	**269,000**	**16,000**	**1,800**	**57,500**	**18,100**	**362,400**
Saco						
1975-1993	479,000	165,200	201,200	183,500	9,500	1,038,400
1994	190,000	0	0	20,000	0	210,000
1995	376,000	0	0	19,700	0	395,700
1996	0	45,000	0	20,000	0	65,000
1997	97,000	63,300	0	20,200	0	180,500
1998	429,000	50,000	0	21,300	0	500,300
1999	688,000	47,000	0	20,100	0	755,100
2000	599,000	48,200	0	22,600	0	669,800
2001	479,000	0	0	400	0	479,400

	Number of fish stocked by life stage					
	Fry	**0 Parr**	**1 Parr**	**1 Smolt**	**2 Smolt**	**Total**
2002	597,000	0	0	4,100	0	601,100
2003	501,000	20,000	0	3,200	0	524,200
Totals:Saco	**4,435,000**	**438,700**	**201,200**	**335,100**	**9,500**	**5,419,500**
Sheepscot						
1971-1993	159,000	70,800	20,600	92,200	7,100	349,700
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	102,000	0	0	0	0	102,000
1997	64,000	0	0	0	0	64,000
1998	256,000	9,300	0	0	0	265,300
1999	302,000	4,700	0	0	0	306,700
2000	211,000	0	0	0	0	211,000
2001	171,000	0	0	0	0	171,000
2002	172,000	0	0	0	0	172,000
2003	323,000	0	0	0	0	323,000
Totals:Sheepscot	**1,760,000**	**84,800**	**20,600**	**92,200**	**7,100**	**1,964,700**
St Croix						
1981-1993	1,172,000	264,800	158,100	671,000	20,100	2,286,000
1994	87,000	38,600	0	60,600	0	186,200
1995	1,000	0	0	0	0	1,000
1996	0	52,100	0	15,600	0	67,700
1997	1,000	400	0	0	0	1,400
1998	2,000	31,700	200	0	0	33,900
1999	1,000	22,500	0	21,300	0	44,800
2000	1,000	19,000	0	20,000	0	40,000
2001	1,000	6,300	0	8,100	0	15,400
2002	1,000	15,400	0	4,100	0	20,500
2003	1,000	16,800	0	3,200	0	21,000
Totals:St Croix	**1,268,000**	**467,600**	**158,300**	**803,900**	**20,100**	**2,717,900**
Union						
1971-1993	81,000	111,700	0	379,700	251,000	823,400
1994	0	0	0	0	0	0
1995	0	54,800	0	0	0	54,800
1996	0	53,500	0	0	0	53,500
1997	12,000	69,300	0	0	0	81,300
1998	165,000	0	0	0	0	165,000
1999	165,000	82,100	0	0	0	247,100
2000	0	0	0	0	0	0
2001	2,000	0	0	0	0	2,000
2002	5,000	0	0	0	0	5,000
2003	3,000	0	0	0	0	3,000
Totals:Union	**433,000**	**371,400**	**0**	**379,700**	**251,000**	**1,435,100**
Upper StJohn						
1979-1993	1,599,000	1,240,700	14,700	5,100	27,700	2,887,200
1994	566,000	216,000	0	0	0	782,000
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0

	Number of fish stocked by life stage					
	Fry	0 Parr	1 Parr	1 Smolt	2 Smolt	Total
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
Totals:Upper StJohn	**2,165,000**	**1,456,700**	**14,700**	**5,100**	**27,700**	**3,669,200**

Table 15. 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 Smolt	2 Smolt	Total
Androscoggin	4,000	0	0	0	0	**4,000**
Aroostook	1,953,000	317,400	38,600	32,600	29,800	**2,371,400**
Cocheco	1,958,000	50,000	10,500	5,300	0	**2,024,200**
Connecticut	92,717,000	2,827,500	1,810,300	3,772,100	1,099,200	**102,226,500**
Dennys	1,400,000	132,100	7,300	306,700	29,200	**1,875,300**
Ducktrap	68,000	0	0	0	0	**68,000**
East Machias	1,757,000	7,500	42,600	108,400	30,400	**1,945,900**
Kennebec	52,000	0	0	0	0	**51,600**
Lamprey	1,593,000	427,700	58,800	201,400	32,800	**2,313,700**
Machias	2,471,000	93,800	118,100	191,300	44,100	**2,918,300**
Merrimack	30,752,000	227,500	597,700	1,419,000	638,100	**33,634,400**
Narraguagus	2,370,000	62,900	14,600	107,800	84,000	**2,639,300**
Pawcatuck	4,825,000	1,209,200	263,200	70,300	500	**6,368,100**
Penobscot	13,935,000	3,903,600	1,394,400	12,050,500	2,508,200	**33,791,700**
Pleasant	269,000	16,000	1,800	57,500	18,100	**362,400**
Saco	4,435,000	438,700	201,200	335,100	9,500	**5,419,500**
Sheepscot	1,760,000	84,800	20,600	92,200	7,100	**1,964,700**
St Croix	1,268,000	467,600	158,300	803,900	20,100	**2,718,100**
Union	433,000	371,400	0	379,700	251,000	**1,434,800**
Upper StJohn	2,165,000	1,456,700	14,700	5,100	27,700	**3,669,200**
TOTALS	**166,185,000**	**12,094,400**	**4,752,700**	**19,938,900**	**4,829,800**	**207,801,200**

Summaries for each river vary by length of time series.

Table 16. Documented Atlantic salmon returns to New England rivers.

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

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin									
1983-1993	20	452	5	1	4	55	0	1	**538**
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**
2003	0	3	0	0	0	0	0	0	**3**
Total for Androscoggin	27	516	6	2	6	83	0	1	**641**
Cocheco									
1990-1993	0	0	1	1	1	3	0	0	**6**
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**
2003	0	0	0	0	1	3	0	0	**4**
Total for Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut									
1969-1993	33	2,936	28	0	8	395	8	0	**3,408**
1994	1	263	0	1	0	61	0	0	**326**
1995	1	158	0	0	0	29	0	0	**188**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
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**
2003	0	0	0	0	0	42	1	0	**43**
Total for Connecticut	36	3,503	28	2	47	1407	12	4	**5,039**
Dennys									
1967-1993	21	294	0	1	18	711	3	10	**1,058**
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**
2003	3	5	0	0	0	1	0	0	**9**
Total for Dennys	29	304	0	1	24	739	3	10	**1,110**
Ducktrap									
1985-1993	0	0	0	0	3	30	0	0	**33**
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001									
2002									
2003									
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-1993	21	250	1	2	12	329	1	10	**626**
1994									
1995									
1996									
1997									
1998									
1999									

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2000									
2001									
2002									
2003									
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-1993	12	189	5	1	0	9	0	0	**216**
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001									
2002									
2003									
Total for Kennebec	12	189	5	1	0	9	0	0	**216**
Lamprey									
1979-1993	10	17	1	0	1	9	0	0	**38**
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**
2003	0	0	0	0	2	0	0	0	**2**
Total for Lamprey	10	17	1	0	11	16	0	0	**55**
Machias									
1967-1993	32	329	9	2	33	1,592	41	131	**2,169**
1994									
1995									
1996									
1997									
1998									
1999									

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2000									
2001									
2002									
2003									
Total for Machias	32	329	9	2	33	1592	41	131	**2,169**
Merrimack									
1978-1993	137	651	17	1	76	791	23	0	**1,696**
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**
2003	12	129	0	0	0	4	0	0	**145**
Total for Merrimack	290	1,119	19	8	121	988	23	3	**2,571**
Narraguagus									
1967-1993	90	623	19	51	44	2,098	68	130	**3,123**
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**
2001	0	2	0	0	5	22	2	1	**32**
2002	0	0	0	1	4	3	0	0	**8**
2003	0	0	0	0	0	21	0	0	**21**
Total for Narraguagus	91	637	19	53	87	2359	70	153	**3,469**
Pawcatuck									
1981-1993	1	135	1	0	0	1	0	0	**138**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
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									
1967-1993	7,700	34,694	199	461	367	2,233	23	59	**45,736**
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**
2003	196	848	2	3	6	56	0	1	**1,112**
Total for Penobscot	10,226	41,792	221	556	576	3424	31	91	**56,917**
Pleasant									
1967-1993	5	12	0	0	10	213	2	2	**244**
1994	0	0	0	0	1	1	0	0	**2**
1995									
1996									
1997	0	0	0	0	0	1	0	0	**1**
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**
2003	0	0	0	0	1	1	0	0	**2**
Total for Pleasant	5	12	0	0	14	227	3	2	**263**
Saco									
1977-1993	17	307	2	2	0	2	0	0	**330**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2001	15	49	0	0	0	5	0	0	**69**
2002	3	37	0	2	3	2	0	0	**47**
2003	2	23	0	0	2	12	0	0	**39**
Total for Saco	109	561	3	7	21	63	3	0	**767**
Sheepscot									
1967-1993	6	31	0	0	27	316	10	0	**390**
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	
1997	0	0	0	0	0	0	0	0	**0**
1998									
1999									
2000									
2001									
2002									
2003									
Total for Sheepscot	6	38	0	0	30	358	10	0	**434**
St Croix									
1981-1993	582	970	38	11	379	594	39	17	**2,630**
1994	23	17	0	1	24	19	0	0	**84**
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**
2003	6	9	0	0	0	0	0	0	**15**
Total for St Croix	715	1,118	38	12	440	670	39	17	**3,049**
Union									
1973-1993	290	1,734	9	24	1	11	0	0	**2,069**
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**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
2001	0	0	0	0	0	0	0	0	**0**
2002	0	5	0	0	0	0	0	0	**5**
2003	1	0	0	0	0	0	0	0	**1**
Total for Union	303	1,820	9	28	1	15	0	0	**2,176**

Table 17. Summary of documented Atlantic salmon returns to New England rivers.

Totals reflect the entirety of the available historical time series for each river. Earliest year of data for Penobscot, 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	516	6	2	6	83	0	1	**641**
Cocheco	0	0	1	1	6	10	0	0	**18**
Connecticut	36	3,503	28	2	47	1,407	12	4	**5,039**
Dennys	29	304	0	1	24	739	3	10	**1,110**
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	11	16	0	0	**55**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	290	1,119	19	8	121	988	23	3	**2,571**
Narraguagus	91	637	19	53	87	2,359	70	153	**3,469**
Pawcatuck	2	148	1	0	1	10	0	0	**162**
Penobscot	10,226	41,792	221	556	576	3,424	31	91	**56,917**
Pleasant	5	12	0	0	14	227	3	2	**263**
Saco	109	561	3	7	21	63	3	0	**767**
Sheepscot	6	38	0	0	30	358	10	0	**434**
St Croix	715	1,118	38	12	440	670	39	17	**3,049**
Union	303	1,820	9	28	1	15	0	0	**2,176**

Table 18.1: 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)	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	24	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

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.1: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (above Holyoke) River .

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	0	0	4	88	8	0
1998	6,614	32	0.048	0	0	0	6	91	0	0	3			0	6	91	3	
1999	4,565	29	0.064	0	0	3	7	90		0				0	7	93		
2000	6,928	0	0.000	0	0		0							0	0			
2001	6,989	0	0.000	0										0				
Total	**53,607**	**998**																
Mean			**0.590**	**0**	**6**	**0**	**2**	**65**	**5**	**0**	**3**	**0**	**0**	**0**	**8**	**65**	**8**	**0**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.2: 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)	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	100
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	11
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	100
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	4
1987	1,169	51	0.436	0	18	0	0	67	2	0	14	0	0	0	18	67	16	18
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	30
1990	1,346	68	0.505	0	19	0	0	79	0	0	1	0	0	0	19	79	1	19
1991	2,208	35	0.159	0	17	0	0	63	0	0	20	0	0	0	17	63	20	17
1992	2,009	118	0.587	0	5	0	0	82	1	0	12	0	0	0	5	82	13	5
1993	4,147	185	0.446	0	4	0	3	87	0	0	6	0	0	0	6	87	6	6
1994	5,938	294	0.495	0	5	0	2	88	0	0	5	0	0	0	7	88	5	7

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

1995	6,780	143	0.211	1	13	0	7	78	0	0	2	0	0	1	20	78	2	20
1996	6,645	101	0.152	0	16	0	11	71	1	0	1	0	0	0	27	71	2	27
1997	8,498	37	0.044	0	3	0	3	89	3	0	3	0	0	0	5	89	5	5
1998	9,085	43	0.047	0	0	0	9	86	0	0	5			0	9	86	5	
1999	6,395	39	0.061	0	0	0	5	92		0				0	5	95		
2000	9,292	4	0.004	0	100		0							0	100			
2001	9,557	0	0.000	0										0				
Total	**78,007**	**1,466**																
Mean			**0.451**	**0**	**16**	**0**	**2**	**64**	**2**	**0**	**4**	**0**	**0**	**0**	**18**	**64**	**6**	**15**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1979	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	371	2	0.054	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	0	0	100	0	0
1998	1,191	2	0.017	0	0	0	0	100	0	0	0			0	0	100	0	
1999	986	1	0.010	0	0	0	0	100		0				0	0	100		

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

2000	1,247	0	0.000	0	0		0							0	0			
2001	1,252	0	0.000	0										0				
Total	**12,867**	**268**																
Mean			**0.324**	**0**	**24**	**0**	**2**	**56**	**1**	**0**	**8**	**0**	**0**	**0**	**25**	**56**	**8**	**0**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.4: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1975	36	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	63	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	72	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	106	18	1.698	0	0	0	0	11	33	22	28	6	0	0	0	33	61	6
1979	77	43	5.584	0	0	0	0	84	5	2	9	0	0	0	0	86	14	0
1980	126	43	3.413	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	3.986	0	2	0	7	69	2	0	20	0	0	0	8	69	22	0
1986	525	110	2.095	0	11	0	0	78	1	0	8	0	2	0	11	78	9	2
1987	1,078	278	2.579	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

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.4: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .

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	0	0	25	75	0	0
1998	2,589	8	0.031	0	0	0	25	75	0	0	0			0	25	75	0	
1999	1,756	5	0.028	0	0	0	20	80		0				0	20	80		
2000	2,217	0	0.000	0	0		0							0	0			
2001	1,708	0	0.000	0										0				
Total	**28,040**	**1,136**																
Mean			**2.733**	**0**	**2**	**0**	**9**	**63**	**3**	**3**	**7**	**0**	**0**	**0**	**11**	**65**	**11**	**1**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.5: Return rates for Atlantic salmon that were stocked as fry in the Pawcatuck River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.2**	**2**	**3**	**4**	**5**	**6**
1993	383	3	0.078	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
1994	557	2	0.036	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	
1998	910	0	0.000	0	0	0	0	0		0				0	0	0		
1999	591	0	0.000	0	0		0							0	0			
2000	326	0	0.000	0										0				
2001	423			0														
Total	**3,946**	**10**																
Mean			**0.031**	**0**	**0**	**0**	**3**	**47**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**47**	**0**	**0**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 18.6: Return rates for Atlantic salmon that were stocked as fry in the Salmon River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	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	49	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	0	0	33	67	0	0
1998	257	1	0.039	0	0	0	0	100	0	0	0			0	0	100	0	
1999	132	6	0.454	0	0	0	0	100		0				0	0	100		
2000	278	3	0.108	0	100		0							0	100			
2001	250	0	0.000	0										0				
Total	**2,461**	**44**																
Mean			**0.195**	**0**	**23**	**0**	**2**	**57**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**57**	**0**	**0**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

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

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.2**	**2**	**3**	**4**	**5**	**6**
1988	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	806	8	0.099	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	0	0	100	0	0
1998	1,022	8	0.078	0	0	0	25	63	0	0	13			0	25	63	13	
1999	712	3	0.042	0	0	0	0	100		0				0	0	100		
2000	839	1	0.012	0	100		0							0	100			
2001	1,066	0	0.000	0										0				
Total	**9,069**	**156**																
Mean			**0.178**	**0**	**10**	**0**	**4**	**81**	**0**	**0**	**5**	**0**	**0**	**0**	**14**	**81**	**5**	**0**

Mean return rate computation includes incomplete return rates for 1998 - 2001 year class fish.

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

Table 19. Summary return rates in southern New England for Atlantic salmon that were stocked as fry.

Year Stocked	Number of adult returns per 10,000 fry stocked						
	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	1.698		1.400	1.400			
1979	5.584		0.561	0.000		1.034	
1980	3.413		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	3.986		1.113	1.224		0.881	
1986	2.095		1.592	2.791		0.126	
1987	2.579		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		0.159	0.255	0.000	0.054	0.099
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	0.036	0.495	0.502	0.166	0.447	0.652
1995	0.308	0.136	0.211	0.184	0.041	0.367	0.192
1996	0.150	0.000	0.152	0.115	0.607	0.208	0.170
1997	0.020	0.000	0.044	0.041	0.134	0.027	0.066
1998	0.031	0.000	0.047	0.048	0.039	0.017	0.078
1999	0.028	0.000	0.061	0.064	0.454	0.010	0.042
2000	0.000	0.000	0.004	0.000	0.108	0.000	0.012
2001	0.000		0.000	0.000	0.000	0.000	0.000
Mean	**2.733**	**0.031**	**0.451**	**0.590**	**0.195**	**0.324**	**0.178**
StndDev	**5.954**	**0.051**	**0.501**	**0.781**	**0.226**	**0.339**	**0.207**

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 1998 (5 year olds), 1999 (4 y olds), 2000 (3 year olds), and 2001(2 year olds).

Table 20. 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	2.8	0.1	2.3	89.0	0.9	0.0	0.0	0.0	0.0	0.0	5.1	89.1	5.8	0.0
Connecticut (basin)	0.1	7.9	0.1	3.1	83.5	0.8	0.0	0.0	0.0	0.0	0.1	11.1	83.6	5.3	0.0
Farmington	0.4	27.6	0.0	4.1	63.1	0.7	0.0	0.0	0.0	0.0	0.4	31.7	63.1	4.9	0.0
Salmon	0.0	27.3	0.0	11.4	61.4	0.0	0.0	0.0	0.0	0.0	0.0	38.6	61.4	0.0	0.0
Westfield	0.0	1.3	0.0	4.5	89.7	0.0	0.0	0.0	0.0	0.0	0.0	5.8	89.7	4.5	0.0
Merrimack	0.2	3.1	0.2	8.5	76.3	1.8	0.0	0.1	0.3	0.2	0.2	11.5	78.6	9.2	0.4
Overall Mean:	**0.1**	**11.7**	**0.1**	**5.6**	**77.2**	**0.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**17.3**	**77.6**	**5.0**	**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.