U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE | **ANNUAL REPORT** | **2002/14**

ANNUAL REPORT OF THE U.S. ATLANTIC

SALMON ASSESSMENT COMMITTEE

REPORT NO. 14 - 2001 ACTIVITIES

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PREPARED FOR
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1. INTRODUCTION

1.1. EXECUTIVE SUMMARY

The Annual Meeting of the U.S. Atlantic Salmon Assessment Committee was held in Concord, NH at the New Hampshire Fish and Game Department, March 5-7, 2002. At this meeting the Committee developed an annual report that provides stocking data, with fish listed by age/life stage and river of release, and tagging and marking data summarized for all New England programs.

All fisheries (commercial and recreational) for sea-run Atlantic salmon are closed in USA waters (including coastal waters). Documented adult salmon returns to USA rivers totaled 1,083 fish in 2001, 35% more than observed in 2000. Most returns occurred in Maine, with the Penobscot River accounting for 72.6% of the total return. The Connecticut River adult returns accounted for 3.7% of the total and 25% of the adult returns outside Maine. Overall, 25.8% of the adult returns to the USA were 1SW salmon and 74.3% were MSW salmon. Most (79%) returns were of hatchery smolt origin and the balance (21%) originated from either natural reproduction or hatchery fry. A total of 14,947,435 juvenile salmon (fry, parr, and smolts) was stocked. The Connecticut River received the largest percentage (64.1%); most of which was fry. Maine rivers received approximately 19.4% of the total, followed by the Merrimack River with 11.8%. The total release decreased 2% relative to 2000. Mature adults (7,472) were stocked by the Maine and Merrimack programs. Most fish were either spent broodstock or broodstock excess to hatchery capacity. Some excess broodstock were released to support a recreational fishery and to enhance juvenile production through spawning in the Merrimack River watershed. Egg sources included sea-run salmon, captive and domestic broodstock, and reconditioned kelts. A total of 339 sea-run females, 3,555 captive/domestic females, and 124 female kelts contributed to the egg take. The number of females (4,018) contributing was less than in 2000 (4,538); and total egg take (20,081,100) was down from that of 2000 (22,240,700). A variety of marks and/or external tags (e.g., PIT tags, VI tags, elastomer tags, Petersen disc tags, etc.) were applied to juvenile and adult salmon. Releases included about 519,487 marked and tagged salmon in 2001. Of the total, 87.6% were released into Maine rivers, 1.8% were released into the Merrimack River drainage, 10.6% were released into the Connecticut River drainage.

Description of Fisheries

All fisheries (commercial and recreational) 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 excess salmon broodstock occurs in the Merrimack River. In the spring and fall of 2001, 2,869 surplus broodstock were released for the recreational fishery.

Adult Returns

The documented adult salmon return to USA rivers was 1,083 fish in 2001. This represented only 3.7% of the estimated spawner requirement for the USA. Most returns were recorded in Maine, with the Penobscot River accounting for 72.6% of all USA returns. Overall, 25.8% of the adult returns were 1SW salmon and 74.3% were MSW salmon. Most returns (79%) originated from hatchery smolts and the balance (21%) originated from either natural spawning or hatchery fry (collectively considered "natural" origin). The adult return rate of hatchery smolts released in the Penobscot River continued to be less that 0.2%.

Documented returns of 1SW salmon in 2001 (279) increased by 3% from 2000 (270); MSW returns in 2001 (809) increased 52% from those in 2000 (533). Total 2001 returns (1,083) increased by 35% compared to 2000 (803). Changes from 2000 by river were: Connecticut (-52%), Merrimack (+1.2%), Penobscot (+46.9%), Saco (+40.8%), Narraguagus (+39.1%), and St. Croix (+200%).

Stock Enhancement Programs

During 2001, about 14,947,000 juvenile salmon were released into 20 river systems. The number of fish released represented an approximate 2% decrease over the 2000 level. Most fish released (94.5%) were fry. Primary fry release sites were the Connecticut (9.6 million), Merrimack (1.7 million), Saco (0.5 million), and Penobscot rivers (0.4 million). Parr releases occurred primarily as a by-product of smolt production programs. Parr releases including age 0 and 1 parr comprised a minor component of enhancement programs with a total of 258,000 released in 2001. Hatchery smolts are an important component of enhancement programs in the USA and 571,339 were released in 2001. Smolt stocking occurred in the Penobscot (454,000), Merrimack (49,500), Connecticut (1,037), Saco (400), Dennys (49,800), Pawcatuck (8,500), and St. Croix (8,100) rivers. Canada stocked an additional 6,300 age 0 parr in the St. Croix. In addition to juveniles, 7,472 adult salmon were released into USA rivers. Most adults were either spent domestic broodstock or broodstock excess to hatchery capacity.

Tagging and Marking Programs

Tagging and marking programs addressed various research and assessment objectives including identification of release life stage and location, movement studies, and growth/survival studies requiring individual identification of fish. A total of 519,487 salmon released into USA waters in 2001 was marked or tagged in some manner. Tag types included: Floy, Carlin, PIT, radio and acoustical (ping). Fin clips, fin punches, and visual implant elastomer were also used. Parr, smolts and adults were marked. About 10.6% of the marked fish were released into the Connecticut River watershed, 1.8% into the Merrimack River watershed, 66.5% into the Penobscot River, and 21.1% were stocked into other Maine Rivers.

Salmon Habitat Enhancement and Conservation

Salmon habitat enhancement and conservation efforts in New England in 2001 focused on habitat surveys, the development of stream restoration assessment tools, habitat protection projects, and habitat restoration projects including dam removals. These cooperative efforts have involved state and federal fishery resource agencies, watershed councils, non-government organizations, corporate sponsors, volunteers, and numerous public and private interest groups. A unique project in Maine involved an effort to develop regional hydraulic geometry curves. Regional curves relate the dimensions (width, depth, cross sectional area, velocity) of streams at bank-full discharge to drainage area. While the general physical characteristics of good juvenile Atlantic salmon habitat are understood, less information is available on the processes that maintain stable channels in Maine rivers. These geomorphologic processes, including sediment transport and deposition, are critical to maintaining stable and productive fish habitat.

Habitat protection projects in New England have included technical assistance to local conservation groups, funding for acquisition, riparian and stream channel restoration, and state sponsored fish habitat programs that generate revenues to support salmon habitat enhancement and conservation. In the Connecticut River watershed riparian and stream habitat restoration projects were implemented, where a variety of habitat enhancement and channel structure techniques were utilized to address river instability, and restore channel pattern, dimension, and profile of selected river reaches. Also, the McGoldrick Dam (Ashuelot River) was removed, providing migratory fish access to 2.0 km of riverine habitat.

In the State of Maine, numerous riparian restoration and non-point source remediation and road repair projects were completed. In the Downeast Region, watershed councils participated in riparian planting projects, covering four watersheds; Project SHARE assisted corporate landowners with two large-scale riparian planting projects; and watershed councils also aided in eliminating vehicle fords throughout Atlantic salmon rearing habitat.

In the Merrimack River Program several newly proposed dam removal projects will improve habitat and benefit Atlantic salmon. The New Hampshire River Restoration Task Force has identified dams for removal in the state and is working closely with fishery resource agencies. Also, the recent development of a dedicated Fish Habitat Program by the New Hampshire Fish and Game Department will generate several hundred thousand dollars annually which, when matched by grant dollars, is anticipated to fund a variety of projects in the coming years that will include benefits to Atlantic salmon.

1.2. BACKGROUND

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

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

1.3. RELATIONSHIP OF ICES TO NASCO

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

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

Salmon Working Group is reviewed by the Advisory Committee on Fishery Management after which it is presented to the NASCO parties at an annual meeting each June.

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

1.4. CHAIRMAN'S COMMENTS

The U.S. Atlantic Salmon Assessment Committee convened the March 5-7, 2002 meeting at the New Hampshire Fish and Game Department headquarters in Concord, NH. The annual assessment report was reviewed and endorsed by a majority of committee members.

Most salmon rivers in New England again experienced low adult returns, and as a result, all sport fisheries for sea-run Atlantic salmon remain 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 Distinct Population Segment of Atlantic salmon. A recent review of the research and science, particularly the genetic research that supported the listing, by the National Academy of Sciences, which convened a panel composed of a 13 scientists from the U.S., Canada, and Sweden, found that wild Atlantic salmon in the State of Maine are clearly distinct genetically from salmon in Europe, and scientific evidence suggests that salmon in Maine are also genetically different from salmon in Canada. In addition there are also genetic differences among wild salmon in the eight Maine rivers composing the Gulf of Maine Distinct Population Segment. The National Academy of Sciences report, released on January 7, 2002, was preliminary. A final report is expected early in 2003 and will comment on how best to recover the species, and how relevant the genetic findings are with respect to recovery of the species.

The Infectious Salmon Anemia virus continues to threaten the success of salmon restoration and recovery, as well as the viability of the commercial aquaculture industry. The industry has been required to fallow sea pens in Cobscook Bay in an effort to prevent the spread of the disease. Infectious salmon anemia was first detected in the State of Maine in February 2001 in Cobscook Bay and the virus has continued to spread resulting in the enactment of emergency rules that required all fish farmers in the Bay to test fish for the virus. In December 2001, the U.S. Department of Agriculture approved funds ($16.6 million) to assist in the effort to mediate the impacts of the virus. A large percentage of the funds will compensate salmon farmers for the loss of fish and the cost associated with removing and disinfecting cages. A January 2002 order by the Maine Department of Marine Resources and the U.S. Department of Agriculture required the slaughter of all salmon in sea pens in the Bay, an action that has fallowed Cobscook Bay of farmed salmon for the first time in approximately 20 years.

2. STATUS OF PROGRAM

2.1. GENERAL PROGRAM UPDATE

2.1.1. CONNECTICUT RIVER

The CRASC has continued efforts this year with strong emphasis on hatchery releases, hydro-relicensing, and research. Additionally, the CRASC has devoted increased time to environmental education partnerships, fishway construction, dam removal, habitat restoration, and increased government support. These objectives are increasingly important to the success of the program.

2.1.1.a. Adult Returns

A total of 40 sea-run Atlantic salmon adults was observed returning to the Connecticut River watershed including: 24 at the Holyoke fishway on the Connecticut River; six at the Rainbow fishway on the Farmington River; eight at DSI fishway on the Westfield River; and, two at the Leesville fishway on the Salmon River. The run lasted from May 11 to June 19. A total of 36 salmon was retained for broodstock: 28 were held at the RCNSS, and seven were held at the WSS. Of these, there were 20 female and 16 male sea-run salmon. One additional sea run died during capture.

Four salmon were radio tagged and released from the Holyoke fishway (river km 138) and permitted to continue upstream. One salmon passed Turners Falls Dam (river km 198), Vernon Dam (river km 228), and Bellows Falls Dam (river km 280). Tagged salmon were monitored in the Deerfield, Mill and Green Rivers in Massachusetts and the White River in Vermont.

Age and origin information was derived from scales and physical examination of each fish. All but one of the 40 observed salmon were stocked as fry, and one of these were of hatchery origin. Sea-age of fish was comprised of grilse (n=5), 2 sea-winter salmon (n=34), and 3 sea-winter (n=1). Known freshwater ages of wild salmon were age 2(n=38) and age 3(n=1).

The CTDEP benefitted from about 70 volunteer hours during which Connecticut fishways were monitored and maintained. The MAFW received about 100 hours of volunteer assistance from the Westfield River Watershed Association. Their members monitored and maintained the DSI fishway on the Westfield River.

2.1.1.b. Hatchery Operations

Record numbers of salmon were produced in Connecticut River hatcheries this year.

Egg Collection

A grand total of 11,007,543 green eggs was produced at six state and federal hatcheries within the basin. This is almost 3 million fewer eggs than produced in 2000. Egg production was down because of low sea-run returns and reduced domestic egg production.

Sea-Run Broodstock

Sea-run females produced 1.6% (173,410 eggs) of the total eggs from 20 sea-run females (<1% of the total females spawned) held at the WSS and the RCNSS. A sample of the fertilized eggs from all sea-run crosses was again egg-banked at the WSS and WRNFH for disease screening and subsequent production of future domestic broodstock.

Domestic Broodstock

Domestic females produced 89.3% (9,837,815 eggs) of the total eggs from 1,955 domestic females (94.2% of the total females spawned) held at the WRNFH, RRSFH, and KSSH.

Kelts

Kelts produced 9.1% (996,318 eggs) of the total eggs from 101 kelt females (4.9% of the total females spawned) held at the WSS and NANFH.

2.1.1.c. Stocking

Volunteers donated nearly 5,000 hours of time to stock Atlantic salmon fry in the Connecticut River watershed including 350 hours for NHFG, 605 hours for CTDEP, 1,000 hours for VTFW, 2,560 hours for MAFW, and 460 hours for the USFS.

Juvenile Atlantic Salmon Releases. A record total of 9,587,816 Atlantic salmon was stocked into the Connecticut River watershed in 2001. Fish were released into the mainstem and 38 tributary systems. The total consisted of 8,796,879 unfed fry (91.8%), 788,593 fed fry (8.2%), 1,611 parr (<1%), and 1,037 one-year smolts (<1%).

Adult Salmon Releases. The CTDEP released a total of 962 adult, domestic broodstock in the Naugatuck (480) and Shetucket Rivers (482); the VTFW released 200 adults in Lakes Willoughby (100) and Seymour (100); and, the MAFW released 1,082 adult salmon in 15 different lakes and ponds throughout Massachusetts for the benefit of anglers.

2.1.1.d. Juvenile Population Status
Smolt Monitoring

NUSCO, the USFWS/SOFA and SOCNFWR contracted with GCC to conduct a mark-recapture smolt population estimate in 2001. The estimate for smolts emigrating from above Holyoke is 37,000

+/- 10,000 smolts. This was the ninth 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. Problems with the dye used to mark the smolts at the beginning of the run resulted in a valid estimate for only a portion of the run. The estimate and confidence intervals (above) were extrapolated based on timing of smolt captures in the bypass.

Based on expanded electrofishing data from index stations and assumed overwinter mortality, it was estimated that 222,000 smolts were produced in tributaries basin wide, of which 161,000 (73%) were produced above Holyoke in 2001. 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 200 index stations throughout the watershed. Sampling was conducted by CTDEP, MAFW, NHFG, USFS, and VTFW. Data are used to evaluate fry stocking, estimate survival rates, and estimate smolt production. All of the data have not been analyzed yet. Preliminary information indicates that while densities and growth of parr varied widely throughout the watershed as usual, it was generally an average survival and growth year. Most smolts produced are again expected to be two year olds, with some yearlings and three olds. The preliminary data analysis suggests that basin wide smolt production in 2002 will be up about 37% from last year's estimate.

2.1.1.e. Fish Passage

Holyoke Dam - The Holyoke Water Power Company project was purchased by the Holyoke Gas and Electric and FERC has approved transfer of the existing license with the sale.

NU installed a flow deflector (a flip-lip) in the Cabot sluice to reduce bank erosion and maintain use of the bypass during high flow. The flip-lip has not been evaluated as installation was delayed until fall.

Townshend Fish Passage - Construction of a USACOE electric barrier to guide adult Atlantic salmon into the trap at Townshend Dam on the West River was completed in the spring of 2001.

McGoldrick Dam - Removal of the McGoldrick dam on the Ashuelot River in Hinsdale, New Hampshire was completed in July 2001.

2.1.1.f. Genetics

The USGS, through the Conte Anadromous Fish Research Center, again sampled tissue from all sea-run broodstock for genetic monitoring (microsatellite analysis). The work was conducted in cooperation with the National Fish Health Research Lab-Leetown.

All of the sea runs were PIT tagged to ensure individual identification at spawning. The population of spawning sea-run salmon did not meet the minimum requirement for 50 pairs of parents. The sex ratio of returning salmon was again skewed toward females. Consequently, wild male parr were collected in Connecticut and Vermont for spawning with sea runs. Spawning was managed utilizing a 4 male to 1 female breeding protocol and a mating scheme to maximize effective population size. It was also utilized to establish a known family mark for progeny. Similarly, marked families from last year's egg take were batched and stocked in the Williams Rivers (163,858 fry) to assess family survival in that stream and to assess and identify productive tributaries through later sampling of smolts and returning adults.

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

2.1.1.g. General Program Information

The CRASC gave a presentation to Congressional aides in Washington, DC, on March 19, 2001. The CRASC recommended re-authorization of its enabling legislation and additional funding at an estimated cost of $5 million annually for operations and maintenance and $4 million annually for construction and capital improvements. Two re-authorization bills were subsequently introduced in the House and Senate. The Senate passed the original bill. The House Resources Committee passed the bill but amended the authorized funding level, reducing it from $9 million to $5 million. The House Judiciary Committee is still considering the bill.

The Connecticut River Salmon Association in Connecticut and the Deerfield/Millers River Chapter of Trout Unlimited are carrying conservation messages to over 2,000 students in 80 schools in the lower watershed annually. In Vermont, the Salmon Association and the Vermont Institute of Natural Science have teamed up to carry the conservation message to over 300 students in 18 schools in Vermont. This type of educational outreach is beyond the existing capacity of the CRASC but remains an important objective of the restoration program which is being successfully attained through partnerships.

2.1.1.h. Salmon Habitat Enhancement and Conservation

Atlantic Salmon Habitat Restoration. Four riparian and stream habitat restoration projects were implemented in the White River watershed in Vermont. A variety of habitat enhancement and channel structure techniques were utilized to address river instability, and restore channel pattern, dimension and profile of selected river reaches. The USFS, USFWS, VT Agency of Natural Resources, and the White River Partnership worked cooperatively with several non-government organizations to complete these stream conservation projects. Two additional stream habitat restoration projects were implemented by the USFS in two West River tributaries, VT. The projects used large trees, some with attached roots, to create deeper, lower velocity habitat in conjunction with protective cover.

The USFS also completed five miles of stream habitat surveys to classify and assess the quality of salmon habitat in the Green Mountain National Forest. These data document both the quality and quantity of available salmon habitat and are also used to identify habitat deficiencies and limitations that can be addressed through future habitat enhancement or restoration projects.

Migratory Fish Habitat Restoration. CRASC, member agencies, and cooperators are working to restore habitat for Atlantic salmon, including shad and herring. Restoration of habitat is considered to be essential to restoration of diverse species, including Atlantic salmon, and is required for the restoration of the Connecticut River aquatic ecosystem. Biomass, micro-nutrients, and predator-prey interactions will be positively impacted by projects that restore balance to habitat.

The McGoldrick Dam (Hinsdale, NH) was removed, liberating about 2.6 km of river to migratory fish. The Winchester Dam (Winchester, NH) is scheduled for removal in 2002. The Swanzey Dam (Swanzey, NH) is currently being investigated for removal.

2.1.2 MAINE PROGRAM

2.1.2.a. Adult Returns

Adult Atlantic salmon counts were obtained at fishway trapping facilities on the Androscoggin, Aroostook, Narraguagus, Penobscot, Saco, St. Croix, and Union rivers. Additionally, counts were made at weirs on the Dennys and Pleasant rivers. The Maine aquaculture industry reared river specific salmon eggs to maturity and provided 729 pen-reared adults for stocking into the Dennys, Machias, and St. Croix rivers (numbers noted below). In addition, pre- and post-pawn captive reared broodstock from CBNFH were stocked in the Dennys, Machias, East Machias, Narraguagus, and Sheepscot estuaries.

The summer of 2001 was extremely dry, resulting in river discharges the lowest on record throughout July and August. In addition, there were no substantial fall rainstorms extending low flow conditions through spawning. These drought conditions affected access to spawning areas in entire drainages and among sub-drainages. Distributions of redds, located during surveys used to monitor spawning activity and estimate numbers of spawners, reflected the effects of the drought.

Numbers of pen-reared adults released by river and sex. Most stocking occurred during the week of October 9, 2001.				
River	Males	Females	Unknown	Totals
Dennys	25	50	-	75
Machias	39	65	-	104
St. Croix	212	305	7	524
St. Croix Post-Spawn	11	15	-	26
Total	287	435	7	729

Rivers with Native Atlantic salmon

Dennys River. A weir, located at the head of tide in Dennysville, was operated from May 7, 2001 until December 7, 2001 to trap upstream migrating adults, evaluate the size of the wild adult run, and to intercept escaped aquaculture fish. Seventeen wild fish were released upstream. One fish of unknown origin and 65 suspected aquaculture escapees were captured. Of these, 29 were killed, and the remaining 36 were released downstream, as was the one fish of unknown origin. Most of the sacrificed fish were screened for disease and dissected to determine sexual maturity. Of the 16 females, four were mature. One of the seven males was mature. None of the fish carried pathogens included in the disease screening protocol. In addition, seven surplus broodstock captured in the weir were denied access upstream.

Two redd surveys were conducted over time on the Dennys River mainstem in an attempt to capture the spatial and temporal distribution of spawning, particularly by pen-reared adults released in October, with more frequent redd counts on the lower section of the Dennys in Dennysville. In all, 71 redds were distributed throughout the drainage. Numbers increased over time, suggesting that fish moved from their release sites and that spawning continued later than expected. No redds were observed on Lower Cathance Stream. Three to four redds (superimposed) were either constructed by suspected aquaculture escapees or captive reared pre-spawn broodstock in a short section of habitat between the weir and tidewater.

East Machias River. Local permitting issues blocked the scheduled construction of a weir in East Machias River weir during the summer of 2001. Thus, the only way to assess spawning escapement within the East Machias River is to count redds. Three redds, all downstream of Round Lake, were located during two survey trips down the East Machias, which covered most of the available spawning habitat.

Machias River. The Machias and its major tributaries were surveyed for redds. Twenty one redds were located within the drainage. Sixteen of the redds were found in the mainstem and five in the tributaries.

Pleasant River. A weir, located slightly upstream of the Route One bridge, was operated from May 14 to November 14 to trap upstream migrating adults, determine the size of the wild adult run, and to intercept suspected escaped aquaculture fish. Eleven wild, multi-sea-winter fish were released upstream. No suspected aquaculture fish were captured. Redd surveys were conducted on the lower reaches (from Saco Falls to the Route One bridge) of the Pleasant River, producing a minimum count of three redds. Extreme low water conditions that probably blocked adult passage at Saco Falls also prevented surveying the upper reaches.

Narraguagus River. A fishway trap operated at the Cherryfield ice control dam was operated from 1 May through 21 November captured 30 naturally produced sea-run salmon and two adult salmon that were stocked as smolts in the Narraguagus River. We captured no salmon suspected to be aquaculture escapees in the Narraguagus River in 2001. This year's trap catch represents an increase of 11 salmon from the 2000 catch of 21 sea-run salmon. A complete survey of the mainstem and four tributaries located 24 redds on the mainstem, 20 of which were downstream of Beddington Lake (45 km upstream of tidal waters). No redds were observed in the four tributaries surveyed (Baker Brook, Gould Brook, Sinclair Brook, and Shorey Brook). This year's count is slightly larger than observed in 2000 (21 redds), and represents only about 5% of what is needed to ensure full habitat utilization.

Ducktrap River. Extremely low flows in the Ducktrap River most likely precluded access by adult salmon to spawning grounds. No Atlantic salmon redds were observed during three attempts to document spawning in the Ducktrap River (October 30, November 14, November 28).

Sheepscot River. MASC staff surveyed spawning habitat between November 6 and December 4, 2001. A sequence of two surveys was conducted on the West Branch and on the main stem from Somerville Bridge to Head Tide. Another survey was completed on the upper main stem from the Palermo Fish Rearing Station to the Waldo-Lincoln County line. Four redds were found between Whitefield and Alna and fourteen below Head Tide Dam. Captive reared broodstock were observed on redds below Head Tide Dam. No redds were observed on the West Branch.

Total returns to DPS rivers in 2001, based on documented returns and redd-based estimates.

River	Count	Type	Estimate	95% CL Low	95% CL High
Cove Brook	0	redd	0	0	0
Dennys River	17	trap	17	-	-
Ducktrap River	0	redd	0	0	0
East Machias River	5	redd	9	5	14
Machias River	22	redd	23	13	37
Narraguagus River	31	trap	31	-	-
Pleasant River	11	trap	11	-	-
Sheepscot River	4	redd	8	4	12
2001	**DPS Total Estimated Returns**		98	81	122
2000			91	64	130

Other Maine Atlantic Salmon Rivers

Penobscot River. The portion of the Penobscot River in Veazie and Eddington closed to all angling effective July 1, 2000 remained closed in 2001.

MASC operated a fishway trap at the Veazie hydroelectric dam from May 8 through November 5 to capture upstream migrating adult Atlantic salmon. We monitored and collected biological data from the adult salmon run and collected salmon for broodstock use to supply production needs for Penobscot eggs at the Craig Brook and Green Lake National Fish Hatcheries. A total of 786 adult salmon were captured in 2001, which represented an increase of 251 fish from the 2000 catch of 535. One salmon suspected to be an aquaculture escapee was captured at Veazie. Two hundred seventy seven salmon were released to the river to spawn naturally and the remainder (502 salmon) transported to Craig Brook NFH for use as broodstock.

The Great Northern Paper Company operated an Atlantic salmon trap at the fishway of their Weldon dam facility from June 10 to October 31, 2001. This trap, located 60 miles upstream from Bangor, counts spawning escapement that has successfully passed all five main stem dams. The trap was operated daily, with a total catch of 13 grilse and seven MSW salmon. All fish were counted and permitted to swim from the trap without additional handling to minimize stress.

Annual redd count surveys are not usually conducted in the Penobscot watershed upstream of the Veazie dam due to the reliability of population data collected at the Veazie fishway trap, the relatively low spawning escapement, and the physical difficulties in obtaining an accurate estimate on such a large river.

Surveys to locate and count redds were conducted on four tributaries to the Penobscot estuary. This was the first time redd counts had been done by MASC staff on the Kenduskeag Stream in recent years. Historic data, and communications with other biologists that had previously observed redds and/or electrofished areas of the Kenduskeag watershed, indicated that many areas have produced salmon young-of-the-year and parr. Thus, staff personnel were confident that they surveyed areas of the river and tributaries that had the most potential for adult spawning. No salmon redds or evidence of digging activity was found in 2001. There were three attempts to find redds on Souadabscook Stream in 2001. No redds or evidence of digging activity were found. There were three attempts to find redds in Cove Brook in 2001. No salmon digging activity was observed during any sampling period. Extremely low flows in Cove Brook most likely precluded access by adult salmon to spawning grounds during 2001. No redds were found during either of two surveys conducted on Marsh Stream.

St. Croix River. A total of 77 salmon, including 58 aquaculture escapees, was captured at the fishway trap near the head of tide at the Milltown Dam and fish were retained for broodstock.

Androscoggin River. Five Atlantic salmon were captured at the Brunswick Dam fishway in 2001. One of the fish was marked. It had been stocked in the Penobscot as a smolt.

Saco River. Florida Power and Light 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. During 2001, 32 salmon were passed into the Cataract head pond from this facility. The Denil fishway sorting facility on the West Channel in Saco and Biddeford, was also operational from early May to late October and passed another 37 salmon into the head pond for a total of 69 salmon that entered the river. Another passage facility upriver at Skelton Dam opened in late summer and 31 salmon were recaptured and transported further upriver for release into the Ossipee River. MASC staff surveyed portion of the Ossipee River November 19 and 20 and, with the aid of FPL personnel, below Skelton Dam on the main stem of the Saco River. Twenty-one redds were found in the Ossipee and eight below Skelton Dam.

Union River. The Ellsworth Dam, although not equipped with an upstream fishway, has trapping facilities below the dam. Pennsylvania Power and Light, operates the trap from the end of the alewife season through fall to provide passage for Atlantic salmon. The trap, which operated only two days in 2001 due to low flows and high water temperatures, resulted in a catch of two Atlantic salmon, both of which were identified, through scale reading, as aquaculture escapes.

Kennebec River. Two redd surveys were completed of the main stem of the Kennebec River between Waterville and Sidney and four of its tributaries (Bond Brook, Togus Stream, Sevenmile Stream, and Messalonskee Stream) between November and December. No redds were found in 2001.

Passagassawakeag River. The Passagassawakeag River, located in Waldo County, flows into Belfast Bay. Wescott Stream is the only major tributary. In previous years redds have been observed in the lower Passagassawakeag River. This fall, redd surveys were conducted over a three-week period. No redds were observed.

St. George River. The St. George River is located in Waldo and Knox counties. The status of the Atlantic salmon resource in this 56 km river is currently unknown. No redds were observed during the one late season redd survey conducted on the mainstem.

Aroostook River. PDI Canada, Inc. operated a fish trapping and sorting facility at their Tinker Dam Hydro Project on the Aroostook River in New Brunswick under an agreement with ASNM. They reported a total trap catch of 28 salmon (14 MSW and 14 1SW), which were inspected and released above the dam. These fish are included in the returns to the St. John watershed having passed through the N.B. Mactaquac counting facilities.

2.1.2.b. Hatchery Operations

Egg Production

Sea-run, captive, and domestic broodstock produced 5.89 million eggs for the Maine Program in 2001. Of these eggs, 41.6% (2.45 million) came from Penobscot River sea-run fish; 38% (2.23 million) from six captive broodstock stocks; and 20.4% (1.21 million) from Penobscot stock domestic broodstock.

Captive broodstock are collected from their native rivers as parr, and reared to maturity at CBNFH. The exception to this method in 2001 was Pleasant River broodstock. These fish were collected as out-migrating smolts in 2000. The thirteen fish which reached maturity in 2001 produced 45,700 eggs. Fish produced from these captive broodstocks are then returned to their rivers of origin, usually as fry.

Progeny from Penobscot River sea-run broodstock produce fry and smolts primarily for the Penobscot River. Up to 100,000 smolts are targeted for other rivers to assess fish passage or to augment out-of-state stocking efforts.

The domestic origin eggs are used in stocking programs on the Saco and Union Rivers.

Broodstock collection

Collection of native parr from DPS rivers, for broodstock development, continued in 2001. In 2001, Pleasant River smolts were collected and brought to the Craig Brook National Fish Hatchery. A total of 975 parr and smolts were collected from the following rivers: Dennys (159), East Machias (144), Machias (266), Pleasant (15 smolts), Narraguagus (259), and Sheepscot (141). These fish will be reared to maturity in order to provide river specific fry, parr and smolts for programs in these rivers.

Juvenile broodstock were not tagged at capture in 2001. In an attempt to reduce handling stress and tagging-related mortality, tags will be applied at CBNFH when the fish reach an appropriate size to allow intramuscular insertion of PIT tags. These fish were sampled at capture via fin clip to allow for genetic characterization.

A total of 512 sea-run adult salmon was collected and brought to CBNFH for broodstock.

2.1.2.c. Stocking

During 2001, the Maine Program stocked a total of 2.99 million salmon into the rivers of the state and the St. Croix River. Of this number a total of 1.45 million salmon were stocked into six rivers as river specific fry. In addition to fry reared at Craig Brook National Fish Hatchery, several schools contributed to the stocking effort by raising small amounts of river specific fry and stocking them into designated stretches of the parent river. These school activities are jointly organized and monitored by the Craig Brook Salmon in Schools Program, and the Atlantic Salmon Federation Fish Friends Program.

The fry numbers allocated to the Dennys River have been reduced during the past two years to allow from the production of river specific 1 year old smolts at Green Lake NFH. In 2001, GLNFH successfully stocked 49,800 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.a. Appendix 8.4

CBNFH maintains a broodstock population created by the captive rearing of 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 2001, two releases of these excess broodstock occurred. On release was made prior to November spawning, and the second release was made post spawning.

Approximately 426 Penobscot 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. Appendix 8.4

2.1.2.d. Juvenile Salmon Population Status

Surveys to estimate juvenile salmon density or relative abundance were conducted on most of the rivers in Maine with wild or stocked populations of Atlantic salmon. On the Narraguagus, median parr densities were 1.5 parr/100m^2 (see data below). However, there was great variability among the sites, with densities ranging from an absence of parr in two low quality runs, to a high of 12 parr/100 m^2. On the Dennys River parr densities ranged from 0 parr/100 m^2 to 7 parr/100 m^2. Basin wide population estimates are being calculated for both these systems.

Electrofishing in the other rivers (site distribution noted below) was conducted at standard index sites or used to survey drainages for the presence or absence of Atlantic salmon. The data from the juvenile abundance surveys in 2001 are being entered into a standard database that will allow more thorough analysis of population trends relative to a variety of factors (i.e. stocking, spawning escapement, habitat conditions).

Summary table of juvenile Atlantic salmon population densities (fish/100m^2) in Maine Rivers, 2001.

River	Age 0 Parr				Age 1 Parr			
	Minimum	Median	Maximum	Sites	Minimum	Median	Maximum	Sites
Cove		0.00		2		0.00		2
Dennys	0.00	.034	3.33	24	0.00	2.53	7.03	24
Ducktrap		0.00		1		0.00		1
East Machias	0.57	32.90	44.98	4	6.12	8.33	9.38	4
Eaton		0.00		1		0.00		1
Felts		0.00		1		0.00		1
Kenduskeag	0.00	0.00	0.00	10	0.00	0.00	0.00	10
Kennebec		0.00		1		0.36		1
Machias	0.33	60.4	18.06	5	2.18	4.18	17.18	5
N.Br. Marsh	0.00	0.00	0.00	17	0.00	0.00	0.00	17
Narraguagus	0.0	2.4	22.0	33	0.0	1.5	11.7	39
Passagassawakeag		0.00		2		1.48		2
Pleasant	0.00	0.00	0.00	3	0.00	0.00	0.23	3
S. Br. Marsh	0.00	0.00	0.00	6	2.15	3.80	5.45	6
Saco	1.68	31.15	111.37	13	0.00	10.14	24.22	13
Sedgunkedunk		0.00		1		2.47		1
Sheepscot	0.00	2.10	7.91	4	0.97	1.97	4.88	4
Souadabscook		.015		3		1.16		1

Atlantic salmon smolt emigration was monitored in the Narraguagus, Pleasant, Penobscot, and Sheepscot rivers from early April until mid-June 2001 using rotary-screw traps. This season marked our fifth year of population estimates on the Narraguagus River. Smolt abundance was a record low in the Narraguagus time-series with the watershed producing approximately 1,780 smolts. Median capture date was 18 May for the Narraguagus River population. Index sampling in the Pleasant and Sheepscot rivers suggests similarly low abundance with only 24 and 53 fish collected. In the Pleasant River, we again documented 8 emigrating smolts (33% of run) that are of putative hatchery origin despite no documented stocking in the watershed. The second year of the Penobscot River smolt emigration index was very successful and in concert with an elastomer-marking program provides data on marine entry and ecology of this population. A total of 1,190 smolts were sampled in the Penobscot and analysis of scale data suggests 97% of smolts emigrating from this river were age 1 hatchery smolts. Median capture date was 13 May 2001 in this watershed. Seasonal distributions suggest that naturally reared smolts emigrate from the river 6-9 days later than hatchery smolts. Weir-based smolt traps were integrated into adult-capture weirs on the Dennys and Pleasant rivers. Only two smolts were captured in the Dennys River and none in the Pleasant River but valuable information was gained on trap design and data from these efforts have been used to re-engineer traps for a second trial in 2002 on the Dennys River.

River-specific smolts from the Dennys River watershed were stocked for the first time in 2001. ASRCT personnel ultrasonically tagged a portion of this population to determine their lower river and coastal movements. In collaboration with Canadian researchers, we tracked the movements of these fish as they exited the US waters of Cobscook Bay and transited through the Bay of Fundy on their way to the Gulf of Maine. To complete this assessment, US and Canadian researchers coordinated gear types, equipment, and deployments to form an acoustic array that spanned the entrances to the Bay of Fundy from Maine to Nova Scotia. In 2001, we ultrasonically tagged 70 smolts and released them at river kilometer 4 on 9 May. Preliminary analyses indicate that 68 individuals were detected at the adult weir capture facility while 64 fish were detected 1 kilometer downstream. Approximately 40% individuals were detected at the entrance of Cobscook Bay proper, 17 kilometers away from the release site, while 27% were detected outside of Cobscook Bay within the Bay of Fundy. These data are proving essential to developing a complete understanding of these migration and mortality processes and the information gained will be applied when developing future restoration and assessment measures.

2.1.2.e. Fish Passage

Staff participated in developing a fish passage policy with the MDOT. Guidelines will soon be in place to direct construction activities by MDOT to ensure that bridges, culverts, and other road construction actions do not preclude upstream and downstream movements.

Saco River. A new fishway became operational in August 2001 at the Skelton Hydro-electric Project. Although mechanical difficulties were encountered and de-bugging of the lift's operation will continue in 2002, initial tests and monitoring showed use by Atlantic salmon. Florida Power and Light Electric also continues to monitor and make improvements at the Cataract Project, where salmon, American shad, and river herring were passed in 2001.

Androscoggin River. Monitoring and evaluation of fish passage at the Brunswick Hydro-electric Project was performed in 2001. American shad numbers have begun to increase in recent years, and the fish passage continues to allow the passage of small numbers of Atlantic salmon.

Kennebec River. Dam owners and resources agencies and non-government organizations continued to implement provisions of the Lower Kennebec River Comprehensive Hydropower Accord in 2001. This accord resulted in the removal of the Edwards Dam in 1999. Plans are being developed to design and install a fish lift at FPLE's Fort Halifax Project on the Sebasticook River. Re-licensing of the Lockwood Hydro Project, in Waterville Maine, on the mainstem Kennebec River is underway. Interim upstream passage measures to be installed at Lockwood by 2006. With the removal of the Edwards Dam, agencies have documented the occurrence of salmon and other migratory species (shad, river herring, striped bass, sturgeon) downstream of the Lockwood Dam. Planning began in 2001 to secure upstream passage at the Sandy River Hydro Project by 2006. A fish passage agreement has been reached with Madison Paper Industries as part of the re-licensing of the Anson and Abenaki dams on the Kennebec River. The agreement is similar in substance to the Lower Kennebec River Comprehensive Hydropower Settlement Accord, which covers the mainstem Kennebec River dams downstream of Madison. Funds will be provided on an interim basis to move Atlantic salmon upriver, until construction of permanent facilities can occur.

Sheepscot River. The Sheepscot River Watershed Council worked with state and federal agencies, Trout Unlimited, and the Town of Whitefield to address issues concerning fish passage at the Coopers Mills Dam.

St. George River. A USFWS office received funding, in 2001, to assist with the removal of the Sennebec Dam. This 18-foot high, 100 foot long, barrier blocks passage to over half of the watershed for Atlantic salmon, alewives, shad, and river herring. There are no barriers to Atlantic salmon passage upstream of the dam, and its removal will restore fish passage to 17 miles of river.

Penobscot River. Applications to re-license Great Works (mainstem) and Howland (Piscataquis River) Hydroelectric projects are currently before FERC. Studies are being planned by the USGS to track adult salmon as they move upstream beyond the Veazie Dam.

Fishways at mainstem Penobscot dams were inspected on a routine basis in order to ensure proper operation and confirm operator compliance with appropriate maintenance procedures. Fishways on tributaries were generally inspected less frequently, unless problems were identified that required attention. Improper fishway maintenance and operation practices were identified on a few occasions at the upper and lower dams in Dover and the owners were instructed to correct those problems. The Maine Atlantic salmon Commission consulted with Maine Department of Inland Fisheries and Wildlife staff and inspected a new fish ladder installed on the Great Works stream dam to rectify problems with the new installation.

Due to severe drought that Maine experienced in 2001, the fishway on Marsh Stream in Frankfort (at the head of tide) did not always have enough water to provide passage during summer months. This limited all access to the stream from July to the November.

Funding was provided to assist with the removal of the West Winterport dam on the North Branch of Marsh Stream from several agencies and foundations. Removal of the dam will eliminate a large impoundment currently above the dam and will allow access by salmon to many miles of upstream habitat once removed. Because of the decommissioning process, the dam in West Winterport and its fishway was inoperative in 2001.

2.1.2 f. Genetics

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 marked fry and smolt families, which can be tracked through non-lethal fin samples at various lifestages. The need to assess the contribution of hatchery-produced fry to the population of Atlantic salmon in Maine continues to be a high priority of the New England Atlantic salmon program.

Fin samples were collected from juvenile broodstock as follows: Dennys (159), East Machias (141), Machias (266), Narraguagus (250) and Sheepscot (144). Sea-run adults (502) from the Penobscot River were also sampled at the Veazie Dam.

The genetic samples from returning adults, either wild or suspected aquaculture escapes, are routinely collected from trapping facilities

2.1.2.g. General Program Information

SALMOD – Population and Habitat modeling

The MASC cooperated with the U.S. Geological Survey's Mid-continent Ecological Science Center to adapt SALMOD, a simulation model for growth and survival of freshwater life stages of Pacific salmon, to Atlantic salmon. SALMOD is a very data intensive model. Model calibration requires detailed habitat inventory, river discharge, and temperature data, as well as multi-year estimates of numbers of spawners, numbers of redds, and freshwater life stage survival rates. Over the last three decades, the state of Maine has conducted intensive hydraulic habitat, and population surveys, on the Narraguagus River. We reviewed these surveys and additional electronic databases maintained by USGS, MASC, NMFS, and USFWS and determined that adequate data were available to run and calibrate the model. J. Bartholow then modified SALMOD, at MESC, to reflect the multiple years that juvenile Atlantic salmon spend in freshwater and occurrence of repeat adult spawners. A low-resolution estimate of older parr (age I+, II+) production was made for the 1990's. These model runs, with some data synthesized to fill in gaps, were used in a workshop to give MASC, NMFS, and USFWS biologist a basic understanding of the Atlantic salmon version of SALMOD, so that they could determine whether or not to proceed with model application. The results of the project were very encouraging, and an Atlantic salmon version of SALMOD is available from the Maine Atlantic salmon Commission for further testing, calibration, and use.

Calcein Marking Trial

A continual source of discussion within the Maine Salmon Program is the determination of how much the fry stocking program contributes to the number of returning adults. This is aggravated by the fact that natural reproduction occurs in the rivers receiving river specific fry. The program has been attempting to develop a non-lethal field method to determine which fish were stocked as fry.

In 2001, with the assistance of the USFWS Lamar Fish Technology Center, a small number of Sheepscot River sac fry were marked with the fluorochrome chemical calcein. The alevins were subjected to an osmotic induction process of a saline bath followed by a pH adjusted calcein bath. The calcein chemical then is absorbed into the scaleless fish and is adsorbed to the calcium containing structures within. Using a special light array, as small as a standard flashlight, the fish were observed. Fish having received the chemical bath fluoresced green. Approximately one month later, these fish were stocked. Fall electrofishing efforts did find some marked age 0 parr in the river.

Further testing, in 2002 and beyond, will be required before this technique is put into widespread use in Maine.

National Academy of Sciences – National Research Council Program Review

Motivated by the Federal listing of the eight Atlantic salmon populations, comprising the Gulf of Maine Distinct Population Segment, Senators Snowe and Collins sponsored a $5 million funding packaged to be managed by the National Fish and Wildlife Foundation. This appropriations language also provided $500,000 for the National Academy of Sciences to review the data the Services relied upon to propose the listing of the Atlantic salmon DPS.

A sixteen-member panel, from across the United States and Europe, met several times in 2001 to receive scientific input and review program operations and issues. The NAS-NRC issued a January 7, 2002 interim report on the genetic makeup of wild salmon populations in Maine. The report concluded "Maine has wild salmon populations in the eight DPS rivers that are as divergent from Canadian populations and from each other as expected among wild salmon populations elsewhere in the Northern Hemisphere". A final NAS report addressing management actions and non-genetic Atlantic salmon data will be released in December 2002.

2.1.1.h Salmon Habitat Enhancement and Conservation

Maine Program staffs are coordinating efforts in Maine to develop stream restoration assessment tools and to implement natural channel restoration projects. One project, initiated during 2001, includes the development of regional hydraulic geometry curves. Regional curves relate the dimensions (width, depth, cross sectional area, velocity) of streams at bankfull discharge to drainage area. While the general physical characteristics of good juvenile Atlantic salmon habitat are understood, less information is available on the processes that maintain stable channels in Maine rivers. These geomorphologic processes, including sediment transport and deposition, are critical to maintaining stable and productive fish habitat. Without regional curves degraded stream channels are less likely to be restored to mimic natural salmon habitat. At present this information is not available for any Maine rivers.

Habitat protection projects include providing technical assistance to local conservation groups and funding for land acquisition. Habitat maps and GIS coverages are shared with land protection organizations to help focus their activities on high value habitat.

In the Ducktrap River watershed, this funding and technical assistance has enabled the Ducktrap Coalition to protect over 80% of the mainstem of this river. In addition to this mainstem protection

46% of the land along the River's three principal tributaries has been put into permanent conservation.

In late 2001, International Paper transferred ownership of most of the company owned riparian habitat along the Dennys River and it main tributary, Cathance Stream, to MASC. This acquisition will ensure the integrity of the riparian habitat along the Dennys River and will provide significant benefit to all fish and wildlife, especially Atlantic salmon.

The USFWS, along with The Nature Conservancy, the Maine Department of Conservation, and International Paper has provided funding to the Maine Atlantic salmon Commission to develop a permanent conservation easement along most of the mainstem of the Machias River, and several of its important salmon tributaries.

The Maine Program is assisting with watershed assessments in Cove Brook and the West Branch of the Sheepscot River. These projects are trying to gain a greater understanding of the physical and hydrologic processes and biological values that characterize these drainages in order to develop a framework to make more knowledgeable decisions about how to best protect, manage and restore the watersheds.

The Program aided with a channel restoration project on the Kenduskeag watershed. Habitat degradation has been caused by livestock access to an upper section of the stream. This has caused sedimentation and several channel instability. Below the site, the channel is over-widened, braided, and lack shade and overhead cover. Substrate has also become highly embedded. Biologists, working with the Maine Program, have identified this site as a high priority for habitat restoration.

A long-term agreement has been reached with the farmer to keep cattle out of the stream. The project installed fencing in 2001, and plans in 2002 include reshaping and seeding the eroding gully and restoring riparian habitat. The channel restoration will use natural design techniques, including reference reach information collected in stable reaches.

In cooperation with the MASC, State and Federal partners, many non-governmental organizations undertook riparian plantings and non-point source remediation projects on Maine salmon rivers during 2001. The Sheepscot Valley Conservation Association completed a remediation project on the West Branch by planting 500 trees in the riparian zone.

The Sheepscot River Watershed Council completed eight remediation projects, four NPS sites, removal of an Overboard Discharge, drainage repair in Alna, tree planting in Weeks Mills, and road repair in China.

In the Downeast Region, watershed councils participated in six riparian planting projects, covering four watersheds. Over 140 volunteer hours resulted in planting 900 plants. The Machias River Watershed Council completed habitat restoration projects at Sand Beach and the Whitneyville Boat Landing. Project SHARE assisted corporate landowners with two large-scale riparian planting projects: Cherryfield Foods planted 7,000 trees as windbreaks and 20,000 trees for riparian spray buffer. Jasper Wyman and Son planted 10,000 trees to vegetate the riparian zone. In addition, International Paper restored more than 70 NPS sites that had been contributing sediment to the Machias and Narraguagus Rivers. Sites were generally classified as related to roads or recreational vehicles.

Watershed councils also help eliminate vehicle fords throughout Atlantic salmon rearing habitat and several small tributary streams. The Narraguagus River Watershed Council, with assistance from the Department of Conservation and Project SHARE, constructed a 110-foot bridge for use by all terrain vehicles crossing the Little Narraguagus River. The Council also installed several culverts, a 16-foot-long bridge, water diversion measures, and stabilized general erosion in the first half mile of an ATV trail along the West Branch Narraguagus River.

2.1.3. MERRIMACK RIVER

2.1.3.a. Adult Returns

A total of 83 sea-run Atlantic salmon returned to the Essex Dam Fish Lift in the Merrimack River during 2001. All salmon were captured and transported to NNFH. The 2001 run total is one fish greater than observed in the 2000 season with the majority of fish captured/counted in the spring (77 fish) as opposed to the fall (six fish). It is important to note the observed shift in the proportion of hatchery smolt origin versus fry origin fish in 2001. In 2000, 24 of the 85 fish that returned to the river were from the fry stocking program, whereas five of the 83 fish that returned in 2001 were determined to be from the fry stocking program.

The returns are categorized as follows:

	1SW	2SW	3SW	RS
Fry Stocking Origin Adults	2	3	0	0
Parr Stocking Origin Adults	0	0	0	0
Smolt Stocking Origin Adults	5	73	0	0

The virgin multi-sea-winter component (92% of river returns - 76 fish) was comprised of 51% males (39 fish) and 49% females (37 fish). The rate of return (adults produced per 1,000 juveniles stocked) for fry-origin adults remains at low levels. The current rate of return for the 1997 fry cohort is 0.002 (grilse and 2SW returns, n = 4) compared to 0.015 for the 1996 fry cohort (n = 27). The rate of return (adults produced per 1,000 juveniles stocked) for smolt-origin adults increased for the seventh consecutive cohort. The rate for the 1999 cohort was 1.8 (grilse and 2SW returns, n = 99) the highest in the available time series.

2.1.3.b. Hatchery Operations

The majority of the Atlantic salmon fry produced for release in the watershed was provided by the NANFH (27.0%) and the WSFH (72.5%) with a small proportion of fed fry (0.5% out of total fry) produced by the NNFH. The parentage of fry stocked in 2001 were primarily from domestic broodstock (47%) followed by kelts (36%) and sea-runs (17%). Smolts produced for stocking in 2001 were provided by the GLNFH and were of Penobscot River sea-run parentage.

Egg Collection

Sea-Run Broodstock

Thirty-seven females were captured at the Essex Dam fishlift and transported to the NNFH, where 37 produced 295,800 eggs in 2001. The majority of the eggs were transported to the NANFH to be hatched and released as fry. Some eggs, approximately 2.5%, were retained at the NNFH for broodstock development.

Captive/Domestic Broodstock

A total of 726 female broodstock (primarily age 3) reared at the NNFH provided an estimated 2,585,400 eggs. Eggs were transported to the NANFH to be held for fry stocking within the Merrimack River watershed. Approximately 500,000 of the eggs transported to the NANFH are being incubated for the Pawcatuck River salmon restoration program. In addition to the domestic broodstock, a total of 22 female kelts produced 294,300 eggs at the NANFH. Kelt eggs were fertilized with milt from domestic broodstock from NNFH. In the fall of 2001 both male and female kelts from NNFH were transferred to NANFH as opposed to just females in past years.

2.1.3.c. Stocking

Approximately 1.70 million juvenile Atlantic salmon were released in the Merrimack River watershed during the period, May - June of 2001. The release included approximately 1.70 million unfed fry, 3,000 fed fry, and 49,500 yearling smolts (GLNFH). Although the majority of the smolts were not marked or tagged, it is possible to determine the origin of adult returns by analyzing the pattern or signature on the scales of fish. Scale analyses are therefore used to differentiate between fish stocked as fry or smolts.

All major tributaries upstream from the Nashua River in NH, excluding the Winnipesaukee River, were stocked with fry. Numerous small tributaries to the Merrimack River and its principal tributary, 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. Approximately 1,500 smolts were released in the mainstem of the river in New Hampshire and the Contoocook River (NH) as part of studies to test the effectiveness of downstream fish passage facilities at hydroelectric sites.

2.1.3.d. Juvenile Population Status

Yearling Fry / Parr Assessment

Twenty-eight sites in 20 rivers, streams or brooks throughout the basin were sampled in 2001. A stratified sampling scheme was used to determine the abundance of parr. Parr estimates were determined for the basin, regions and geostrata. Habitat was stratified into four regions, where each region has different characteristics that included climate, geography, geology, hydrology, and land use. Estimates derived for geostrata involved sampling within regions in very large rivers [drainage area (da) > 200,000 ha, in large river (44,289≥da≤200,000 ha], and small rivers and brooks where da < 40,500 ha. Sampling was directed at yearling parr (age 1) and involved electrofishing during late summer and early fall. Data collection involved a cooperative effort and included staff from the NHFG, USFS, USFWS, and volunteers.

The 28 sample sites included a total of approximately 400 units (one unit = 100 m^2) of juvenile habitat. The estimated number of available habitat units in the basin is 68,800 and of the total units available, approximately 55,600 were stocked with fry in 2001. Units sampled represent about 0.6% of the total available and 0.7% of those stocked with fry.

Natural reproduction of Atlantic salmon is not known to occur in the Merrimack River watershed. In recent years (2000 not in 2001), sexually mature broodstock salmon have been released in headwater areas, but due to low numbers released, their contribution to the production of fry is assumed to be minimal. Assessments of the 2000 release in the Baker River produced small numbers of fry believed to be from natural spawning due to their proximity to redds, smaller mean size than hatchery plants upstream, and the fact that no stocking occurred in the study reach.

Results of assessments in 2001 showed below average abundance of yearling parr at seven key index rivers located throughout the watershed. This decrease may be partially attributed to a planned reduction in fry stocking densities (~50%) initiated in 1999 but was also likely influenced by low flow conditions experienced throughout the basin in 2001. A time series of estimated parr abundance is available for seven rivers including the East Branch Pemigewasset, Pemigewasset, Mad, Baker, Smith, South Branch Piscataquog, and Souhegan rivers. In recent years the stocking density of fry has been decreased ~50% in these seven rivers to compare 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. Evaluations of yearling parr abundance at these and other sites in the watershed suggest that past high stocking densities have resulted in density dependent factors that adversely affected the growth and survival of parr. Given the shift in stocking densities, direct comparisons to past years levels of abundance need to be interpreted with caution.

The average number of parr per unit during years of high fry stocking densities ranged from a low of 0 parr/unit to a high of 4.9 parr/unit. However, yearling parr/unit at sample sites in index rivers (original seven) ranged from a low of 0 to a high of 2.1 in 2001. The remaining 21 sites sampled had yearling parr densities ranging from 0.2 to a high of 4.9 (Hubbard Brook). Summary analysis of the expanded index site data (previous eight years) shows 2001 as the lowest mean parr densities for 15 sites sampled annually (some sites were sampled inconsistently over the period). Mean parr density estimates for the 15 sites have ranged from a high of 4.0 (CV = 82) in 1998 to the low of 1.1 (CV = 76) parr/unit observed in 2001.

In 2001, a total of 1.70 million fry was stocked, down from the 2.22 million fry stocked in 2000. The annual fry stocking target is set at 1.76 million fish, when the target is exceeded, secondary or new habitat is utilized to keep densities at desired rates. The majority of fry are released within watershed Region 1, 2 and 4. The headwaters of the watershed are located within Region 1, which is forested with rugged terrain and high peaks. This region represents approximately 32% of the habitat stocked with fry. Region 2 is forested, interspersed with agricultural lands, large lakes and less mountainous terrain and represents 42% of the total juvenile rearing habitat in the watershed. Region 3 is agricultural with broad valleys and moderately rolling hills and represents 2% of the habitat stocked in the watershed. Region 4 contains about 17% of the habitat stocked and is an area interspersed with ponds, wetlands, and sluggish streams with widespread agricultural and developed lands.

2.1.3.e. Fish Passage

Downstream Fish Passage

PSNH continued to conduct downstream fish passage studies at Amoskeag Dam (Manchester, NH) using hatchery reared Atlantic salmon smolts. The study provided information on bypass vs. turbine usage, fate of fish upon passing either location and longer term downstream movements. Overall bypass efficiency was determined to be 71%, with 74% smolt passage at a bypass flow of 100 cfs vs. 64% passage at 125 cfs. A substantial number of smolts became stationary in the tailrace area regardless of passage route, 30% bypass and 36% turbine passed. In addition, the study revealed that only 25% of the study fish reached a lower downstream station regardless of passage route (bypass or turbine) and continued downstream. The data suggests a substantial predation issue in the tailrace of the dam with many tags showing upstream movements.

Comments to PSNH on Amoskeag Dam include operating the bypass at higher flow rates than those tested in 2001 and examining the conditions of the plunge pool for the bypass. Agency staff will be investigating the potential sources of predation in the tailrace area to better define the role of this issue. The Hooksett Dam (Hooksett, NH) operated by PSNH is the next project to be assessed for smolt passage as part of an upcoming relicensing process.

Boott Hydropower, Inc., operators of the Pawtucket Dam (Lowell, MA), conducted downstream passage studies with radio tagged and HI-Z turb'N ballon tagged smolts. Three different bypass flows were tested (2%, 3.5%, and 4.5% of turbine flow). Smolt bypass efficiency averaged 32%, but ranged from 15% (2% turbine flow) to 42% (4% turbine flow). Evaluation of turbine entrained smolts indicated 100% immediate and delayed survival (n=50). Similar to the Amoskeag study, predation was noted as a substantial impact to tagged smolt survival in the tailrace area. As a result, individuals conducting the study were able to physically remove striped bass (n=7) that were documented as predating on study smolts.

Upstream Fish Passage

No significant studies related to upstream fish passage at dams were conducted in 2001, however observations of fish behavior and use occurred at staffed facilities and those with video monitoring installed. Recent observations have broadened knowledge regarding use of facilities by river herring, American eels, American shad, broodstock salmon, and non-migratory fish species. River herring appear to congregate near the plunge pool of the fish bypass at Essex Dam (Lawrence, MA) presumably attracted to the outfall, sub-adult American eels have been observed moving upstream in the Amoskeag Dam (Manchester, NH) fish ladder in moderate numbers in August in 2000 and 2001, and broodstock salmon released in river for sport angling opportunities passively drift down river throughout spring and summer and at times use fish lifts and ladders (MA/NH) in all seasons when operating to move upriver.

2.1.3.f. Genetics

Existing Atlantic salmon spawning protocols have been maintained at federal hatcheries and no additional work has been conducted in this area in 2001. In 2002, plans to genetically characterize program broodstock and implement paired matings will be established. The genetic analyses work will also permit studies to examine the origin of adult returns by tracking family groups on a large scale (e.g. upper vs. lower basin).

2.1.3.g. General Program Information

Domestic Atlantic Salmon Broodstock Releases

A total of 2,869 surplus broodstock from the NNFH was released to provide angling opportunities in the mainstem of the Merrimack River and a small reach of the Pemigewasset River in the spring and fall of 2001. Broodstock released for the fishery consisted of age 3 and age 4 fish. In addition, 1,500 age 2, and 233 age 3 salmon were released in the lower Merrimack River below Lawrence, MA.

Pre-spawner Releases / Natural Reproduction Study

During the Fall of 2000, surplus broodstock were released into the Baker River to determine the potential use of broodstock for the natural production of fry. The Baker River is a major tributary of the Pemigewasset River. The Pemigewasset and Winnipesaukee rivers join to form the Merrimack River. In November 2000, 258 broodstock Atlantic salmon were released into the Baker River. The releases consisted of 98, 3-year-old females, 62, 2-year-old females and 98, 2-year-old males. The released fish were in various states of spawning maturity.

Extensive field surveys were conducted by canoe and by wading. All spawning activity was recorded and the locations of excavations flagged riverside and their positions recorded using GPS. Forty-one sites of spawning activities were recorded prior to ice up. The spawning activities at these sites included scratching, test pits and what was thought to be completed redds. Eight of these completed redds were marked with streamers attached to rebar placed at the head of the redd. Initial plans were to extract egg samples from these completed redds to test for fertilization. Four redds were partially excavated and eggs were extracted from one of the redds but no eggs were found in the remaining three. Extracted eggs were damaged during transfer and whether fertilization occurred was not determined.

In the Spring of 2001 the reach of river targeted for the spawning study was removed from the fry stocking schedule. In fall electrofishing surveys in the vicinity of known redds were conducted. Substrate and water flow conditions were very favorable for parr collection during the sampling dates. Age 0 parr were collected in targeted areas and significantly ($P<0.05$) smaller than hatchery origin age 0 parr sampled in upper sites and catch-per-unit-effort of wild fish was low relative to other index sites.

Education / Outreach

Adopt-A-Salmon Family

Adopt-A-Salmon Family (AASF) concluded its eighth highly successful year in June, 2001. Membership in the program remained at about one hundred schools. Similar to previous years, demand for inclusion in AASF program by additional schools continues. However, a reduction in staff and budget shortfalls at CNEFRO has placed continued support for the AASF program at risk. Admission of additional schools to the program is now contingent upon non-participation by others. AASF continues to draw positive attention to the effort to restore anadromous fish species to New England rivers. While there is an active interest in additional schools participating in the program, schools that inquire about participation in the program and those now enrolled have been advised of the potential for reductions in support by the CNEFRO for the program. The Nashua and North Attleboro National Fish Hatcheries continue to provide eggs to participating schools and conduct tours of hatchery operations and facilities.

Amoskeag Partnership

The migratory fish program continued to be represented in the Amoskeag Partnership. The partners (PSNH, Audubon Society of NH, NHFG, and USFWS) continued to create and implement broad-based educational outreach programs, based at the Amoskeag Fishways Learning and Visitors Center 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. 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 Amoskeag Fishways. The four way collaboration among partners was formed in 1995 to increase visitation to the Amoskeag Fishways by creating new and improved educational programs, expanded year-round hours of operation, and an innovative, hands-on exhibit hall; by strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire; and by broadening the educational focus of the visitor center to encompass more than just the fish passage facility.

2.1.3 h. Salmon Habitat Enhancement and Conservation

In 2001 the multi-agency RRTF continued to work on identifying dams for removal in the state and pursuing the removal of six dams already targeted. The New Hampshire Department of Environmental Services, Dam Bureau has been identified as the lead agency for dam removal coordination (RRTF) which included the creation of a Dam Removal Coordinator Position. Several proposed projects in various states of progress will benefit historic and currently targeted Atlantic salmon habitat in the Merrimack River watershed. On the Contoocook River (Henniker, NH) an abandoned mill dam has been identified for removal, preliminary steps regarding town meetings, planning, and related work is underway at this time. On the Pemigewasset River (Woodstock, NH) another abandoned dam has been identified for removal.

The recent development of a dedicated Fish Habitat Program by the New Hampshire Fish and Game Department will generate several hundred thousand dollars annually which when matched by grant dollars is anticipated to fund a variety of projects in the coming years that will include benefits to Atlantic salmon. In addition, the NHFG manages an Atlantic salmon broodstock fishery in the Merrimack River watershed via a permit system. The permit system involves the purchase of an Atlantic salmon stamp by anglers who fish for salmon, and proceeds from the sale of stamps directly support the Atlantic salmon restoration program in NH. Angler outings for salmon typically exceed 6,000 per year, and estimated total expenditures in a season by anglers approaches $150,000. The fishery, supported through the use of adult broodstock that become surplus to the restoration program, provides high visibility for the program and increased public awareness of the effort to restore salmon to the Merrimack and other New England rivers.

2.1.4. PAWCATUCK RIVER

2.1.4.a. Adult Returns

No sea-run Atlantic salmon were captured in the fish ladder at Potter Hill in 2001.

2.1.4.b. Hatchery Operations

An outbreak of disease and a power failure resulted in the loss of 6,222 parr, 30,000 fry of sea-run parentage, 28,000 domestic fry, and seven female kelts. As a result, the UV system at ARH was repaired, a new generator was ordered, and an alarm system will be installed. These measures should help ensure that losses of this magnitude will not occur in the future.

Egg Collection

Sea-Run Broodstock

A total of 7,750 eggs was collected from the one female kelt. The eggs were fertilized with pooled milt obtained from WSS. All of the eggs will be retained for subsequent release as age 1 smolts.

Captive/Domestic Broodstock

The NANFH incubated 500,000 eggs for the Pawcatuck River. At Arcadia, two domestic females produced 2,250 eggs, which were fertilized with domestic milt from the male at Arcadia.

2.1.4.c. Stocking

Juvenile Atlantic Salmon Releases. In February, 8,300 age 1 pre-smolts were released into the mainstem Pawcatuck River. In April, 200 age 1 fin-clipped smolts were released into the Pawcatuck River. NANFH provided 423,000 fry for the stocking effort in May. Stocking of fry throughout the Pawcatuck River watershed was performed by RIFW personnel on two separate occasions. NANFH provided an additional 28,000 domestic fed fry to be held at ARH until their release in Fall 2001. However, they all died in the power outage in July.

Adult Salmon Releases. The USFWS supplied 250 adult domestic salmon from NNFH for stocking in Rhode Island waters for a domestic fishery. These fish were released in May.

2.1.4.d. Juvenile Population Status

Index Station Electrofishing Surveys

Parr were collected by electrofishing at 11 sites in the Pawcatuck River watershed in the fall of 2001. The 11 sites included a total of 51 units (one unit = 100 m^2) of juvenile habitat. Units sampled represent about 1.1% of the 4,792 total units of available habitat. Densities of age 1 parr ranged from 0 to 10 parr/unit at the sampled sites, and averaged 3.2 parr/unit. Sampling of age 0 parr indicated an average abundance in 2001 with a mean density of 6.8 parr/unit. The sizes of the juveniles sampled were similar to those in past years, with age 0 parr averaging 65.3 mm and age 1 parr averaging 144.1 mm.

Smolt Monitoring

No work was conducted on this topic during 2001.

Tagging

Two hundred Atlantic salmon smolts with adipose fin clips were released into the Pawcatuck River watershed. These smolts overwintered in a hatchery pond, and the clips will be used to differentiate fish raised in indoor raceways from those raised in the pond.

2.1.4.e. Fish Passage

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

In addition, broken gates on the opposite side of the dam are creating attraction flow which draws fish away from the fish ladder. The dam has been under private ownership, and the owner is unwilling to make the necessary repairs. The State of Rhode Island is in the process of acquiring the dam. Plans are being made to upgrade the existing fish ladder as well as to install an additional ladder on the other side of the dam.

Plans are also being made to improve the fish ladder at the second dam in Bradford, Rhode Island.

2.1.4.f. Genetics

No work was conducted on this topic during 2001.

2.1.4.g. General Program Information

A cooperative agreement for the restoration of anadromous fishery resources in the Pawcatuck River was signed in the fall of 2001 by the Rhode Island DEM Division of Fish and Wildlife, USFWS, and NMFS. The signing of this agreement is an important step toward the future success of Atlantic salmon in the Pawcatuck River. The pH for the entire watershed is extremely low, with values ranging from 4.45 to 5.8. Future research will look at the chronic effects of this water on osmoregulation, which may give some insight into the low numbers of sea-run returns to the Pawcatuck River.

2.1.4. h. Salmon Habitat Enhancement and Conservation

No work was conducted in this area in 2001.

2.1.5. NEW HAMPSHIRE COASTAL RIVERS

2.1.5.a. Adult Returns

The Lamprey River fish ladder was monitored for returning adult salmon from mid-April until the end of June and from mid-September to mid-November. The Cocheco River fish ladder was monitored for returning adult salmon from mid-April until the end of June. The Cocheco River fish ladder has not been operated during the fall since 1993 due to a continuing dispute between the company operating the hydroelectric facility at the Cocheco Falls dam and NHFG.

No wild adult Atlantic salmon returned to fish ladders in 2001.

2.1.5.b. Hatchery Operations

No adult Atlantic salmon were transported to hatcheries in 2001.

2.1.5.c. Stocking

In April of 2001, approximately 275,000 Atlantic salmon fry were scatter stocked by volunteers into the Lamprey (110,968 fry) and Cocheco (164,500 fry) River watersheds. Fry were stocked at a density of 36 fry/100 m^2 unit in the Lamprey and 60 fry/100 m^2 unit in the Cocheco.

Eggs for the 2001 fry stocking were obtained in the fall of 2000 from USFWS. The eggs were taken from NNFH in November of 2000. The eggs were reared at NANFH until mid-January 2001. Two lots of approximately 290,000 and 650,000 eggs were delivered to WSFH on January 18 and January 31 to complete the rearing.

2.1.5.d. Juvenile Population Status

Electrofishing surveys for juvenile salmon at four index sites and two alternates on the rivers produced population estimates for age 0 parr ranging from 0.3 – 11.0 fish/100 m^2 unit. Mean length and weight of age 0 parr at the sites ranged from 67-92 mm and 2-8 gms. Estimates of age 1 parr abundance at the sites ranged from 0 – 4.2 fish/100 m^2 unit. Age 1 parr ranged in size from 151-176 mm and 29 - 45 gms.

Population estimates at the two index sites and one alternate site in the Cocheco River contrasted significantly. The population estimate for age 0 parr at the Mad River site was 13.2 fish/100 m^2 unit as compared to 1.1 fish/100 m^2 unit at the Cocheco River location. The alternate site on the Isinglass River had a population estimate for age 0 parr of 2.4 fish/100 m^2 unit. Age 1 parr population estimates at the two index sites were 4.2fish/100 m^2 unit for the Mad River and 1.1 fish/100 m^2 unit for the Cocheco. The Isinglass River had an estimate of 0.2 fish/100 m^2 unit. Population estimates for age 1 parr in the Mad River and Cocheco River age 0 and age 1 parr were below the ten year average while the estimate for age 0 parr in the Mad River was slightly above the long term average. Mean length and weight for age 0 parr and age 1 parr at the index sites were at or above long term average.

Population estimates for age 0 parr and age 1 parr at both index sites in the Lamprey River watershed were below the long term mean. This has been the case each year since 1999 when stocking densities were reduced from 60 to 36 fry/100 m^2 unit. At the Lamprey index site the population estimates for age 0 and age 1 parr were 0.4 and 0.1 fish/100 m^2 unit respectively. At the

North River index site the estimate for age 0 parr was 0.6 fish/100 m^2 and the estimate for age 1 parr was 0.2 fish/100 m^2. At the alternate site on the North River no age 1 parr and only three age 0 parr were captured resulting in population estimates of 0 and 0.5 fish/100 m^2 unit. Mean length and weight for age 0 parr at the North River index site was above the long term mean. There were insufficient captures of age 1 parr at the North River index site and age 0 and age 1 parr at the Lamprey River to determine mean length and weights. No long term averages are available for the alternate sites because of intermittent sampling at those locations.

2.1.5.e. Fish Passage

The NHFG has petitioned the FERC to reopen the operating license of SNHHDC hydroelectric facility at Cocheco Falls on the Cocheco River. The petition requested three changes to the license: 1) to provide for summer and fall operation of the NHFG fish ladder at Cocheco Falls with sufficient attraction water, 2) to increase the required operation time of the SNHHDC's downstream fish passage facility into the spring to allow for downstream migration of Atlantic salmon smolts, and 3) modification of the downstream passage facility to increase the passage efficiency. In 2001, FERC staff finalized its environmental assessment which agreed with most, but not all of the department's petition. NHFG is still awaiting a final decision from FERC. In addition, NHFG and USFWS, have been working with other agencies and organizations to work towards fish passage construction or dam removal at Wiswall Dam in Durham on the Lamprey River.

2.1.5.f. Genetics

No work was conducted in this area in 2001.

2.1.5.g. General Program Information

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

2.1.5 h. Salmon Habitat Enhancement and Conservation

No work was conducted in this area in 2001.

2.2. STOCKING

2.2.1. TOTAL RELEASES

During 2001, the participating agencies released approximately 14,949,168 juvenile salmon into 16 river systems (Table 2.2.1.a in Appendix 8.4). Canada stocked an additional 6,300 age 0 parr into the St. Croix from the Canadian side. The number of fish released represented an approximated 2% decrease from the 2000 level.

In addition to juveniles, mature adults were also stocked in some river systems (Table 2.2.1.b in Appendix 8.4). In general, these fish were either spent domestic broodstock or pre-spawned domestic broodstock in excess to hatchery capacity and were of river-specific origin. Sea-run kelt releases are not included in this table. In 2001, 7,722 adult salmon were released into the rivers of New England.

2.2.2. SUMMARY OF TAGGED AND MARKED FISH

A total of 519,487 salmon released into New England waters in 2001 was marked or tagged in some manner. Tag types included: Floy, Carlin, PIT, radio and acoustical (ping). Fin clips, fin punches, and elastomer visual implants were also used. Parr, smolts and adults were marked. About 10.0% of the marked fish was released into the Connecticut River watershed, 1.8% into the Merrimack River watershed, 66.4% into the Penobscot River, 19.3% was stocked into six other rivers in Maine, and 1.8% was stocked into the St. Croix River.

A comprehensive summary of marked and tagged Atlantic salmon released in New England rivers during 2001 is presented in Table 2.2.2.a (Appendix 8.4).

2.3. ADULT RETURNS

2.3.1. TOTAL DOCUMENTED RETURNS

A total of 1,083 adult salmon was documented to have returned to rivers in New England in 2001 (Table 2.3.1. in Appendix 8.4). The majority of the returns was recorded in the rivers of Maine with the Penobscot River accounting for nearly 72.5% of the total New England returns. The Connecticut River adult returns accounted for nearly 3.4% of the New England returns and 32.5% of the adult returns outside of Maine. Overall, 25.8% of the adult returns to New England were 1SW salmon and 74.2% were MSW salmon. Most of these fish (79.2%) originated from hatchery smolts and the balance (20.9%) were of wild origin (natural reproduction and fry plants).

Documented returns of 1SW salmon to New England rivers (279) were up slightly from 2000 (270). MSW returns in 2001 (805) were above those in 2000 (533). Overall, the total returns were 35% higher than those in 2000 (1,083 in 2001 verses 803 in 2000). Changes from 2000 by river are: Connecticut (-52%), Merrimack (+1.2%), Penobscot (+46.9%), Saco (+40.8%), Narraguagus (+39.1%), and St. Croix rivers (+200%).

2.3.2. RETURNS OF TAGGED SALMON

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

2.3.3. SPAWNING ESCAPEMENT, BROODSTOCK COLLECTION, AND EGG TAKE

Connecticut River. A total of 4 wild sea-run adult salmon was permitted to ascend the rivers upstream of fishway traps where broodstock are captured. All were radio tagged as part of a utility company sponsored study on the main stem. The movements of these fish are summarized in Section 2.1.1.

Maine Rivers. Natural reproduction was documented by redd counts in the 16 rivers with natural populations and in some tributaries of the Penobscot River. Details can be found in Section 2.1.2. There is no consistent trend relative to last year, but the redd counts remain well below appropriate levels.

Egg sources for the New England Atlantic salmon culture programs included sea-run salmon, captive salmon (fish collected as wild parr and grown to maturity in hatcheries), domestic broodstock (fish grown to maturity in hatcheries from eggs), and reconditioned sea-run kelts. The total number of females spawned in 2001 from each category is as follows: sea run-339, captive-419, domestic-3,136, kelts-124. The grand total of salmon spawned (4,018) was less than that in 2000 (4,538). The total egg take (20,081,119) was somewhat lower than that in 2000 (22,240,700). A more detailed accounting of the egg production is contained within Table 2.3.3 in Appendix 8.4.

2.3.4. SPORT FISHERY

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

3. TERMS OF REFERENCE

3.1. TERM OF REFERENCE 1 - Program Summaries for Current Year

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

Historical data was validated by the Committee and the information can be found in Tables 3.2.a. and 3.2.b. in Appendix 8.4 and in Section 5 of this report.

3.2. TERM OF REFERENCE 2 - Model: Optimum Fry Stocking for New England Rivers

A Model for Optimum Fry Stocking Levels Throughout New England Abstract by Ben Letcher, Gabe Gries, and Christine Lipsky

Across New England, agencies stock fry at a variety of densities. An analysis based on stocking data and resulting densities aims to determine relations between age 0 and age 1 parr densities and sizes as a function of stocking densities. The future of the term of reference was discussed, and the group decided that the term of reference should remain a part of the meeting. A focus on the questions to be asked so that people will know exactly why data are being submitted will be added. A request for data using the standardized format will be sent out in the next month.

3.3. TERM OF REFERENCE 3 - Domestic and International Research Program Updates

The Committee was briefed on the NASCO Plan of Action for the application of the Precautionary Approach to the protection and restoration of Atlantic salmon habitat. The Committee was advised that objectives of the approach were to maintain and where possible increase the current productive capacity of Atlantic salmon habitat; establish comprehensive salmon habitat protection and restoration plans; and establish inventories of rivers.

The Committee was also briefed on NASCO guidelines and requirements for Containment of Farmed Salmon. Currently there is a need to develop a national plan for containment based on existing draft guidelines; a need to include elements on monitoring, control and enforcement; and a need for a requirement to adopt improved technology for containment as it becomes available.

The Committee agreed to review and consider further guidance received from NASCO regarding domestic and international research programs at its scheduled July 10, 2002 meeting in Concord, NH.

3.4. TERM OF REFERENCE 4 - Modeling Assumptions: Freshwater Survival

Freshwater Survival Assumptions and Population Viability Analysis Abstract by Chris Legault

Freshwater survival rates for Atlantic salmon by life stage are continuing to be compiled for easy access by researchers. This table has had an additional feature added for the objective combination of survival estimates from multiple studies based on the sum of triangle distributions. As more studies are conducted, it is requested that results are sent to the author to be added to the table. Ranges of survival rates for the different life stages of Atlantic salmon are one of the inputs for a life stage based population viability analysis (PVA). Other inputs for the PVA include stocking histories, habitat limitations, fishing removals, straying rates and initial conditions. These uncertain inputs are combined in a Monte Carlo approach to produce probabilities of persistence into the future by river and DPS. Other outputs include average spawning stock size for a period of years in the simulations and the number of years that the habitat limitation was invoked. Policy decisions that still need to be made included the level of acceptable risk, the time frame, and how many rivers can lose their population for the DPS to be considered as persisting. This model is being developed with input from scientists and policy makers from NOAA Fisheries, Fish and Wildlife Service and the Atlantic Salmon Commission.

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3.5. TERM OF REFERENCE 5 - Dam Removal and Fishway Construction

Dam Removals in the Ashuelot River, New Hampshire Abstract by Kenneth Sprankle

In 1998, the New Hampshire Fish and Game Department (NHFG) initiated an effort to remove three unutilized dams in the Ashuelot River watershed, a tributary to the Connecticut River. The proposed removals are part of a migratory fish restoration plan that is targeting American shad, Atlantic salmon, and blueback herring. In the process of contacting dam owners and informing them of pending fish passage issues and their legal responsibilities, the option of breaching or removal was promoted. The owners of the three targeted dams agreed to support removal with various levels of funding support. McGoldrick Dam was the first to have a Wetlands Permit submitted for instream removal work and prompted a number of questions and procedural concerns. Consequently, a statewide River Restoration Task Force was developed consisting of state, federal, and non-government professionals in areas of permitting, engineering, law, archeology/historical, and biology. A model of what steps are necessary to satisfy requirements and address additional concerns was developed. Funding options were identified and expanded in some cases, such as using Clean Water Act grant dollars and a NHFG Fish Habitat Stamp.

Several key steps identified as critical in keeping the proposals on track include; having a fish management plan, removal plan, needs assessment with alternatives to removal, prepared information on benefits of removal (ecological, recreational, economic), public notification and involvement, historical agency involvement, and cooperating agency staff support (Task Force). McGoldrick Dam was removed in July of 2001, with the second dam (Town of Winchester) planned for removal in July or August 2002. The third dam (Homestead, in Swanzey) has a number of difficult issues that are being address in a step down sequence, one or more of which may prevent removal as the best alternative to fish passage concerns.

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Dam Removals in Maine Abstract by Norm Dube

Several dam removals have occurred in the State of Maine over the last few years and include the removal of the Columbia Falls Dam on the Pleasant River in Downeast Maine (1988), the Bangor Dam on the Penobscot River (1995), the Edwards Dam on the Kennebec River (1998), the Grist Mill Dam on Souadabscook Stream (1998), the Brownville Dam on the Penobscot's Pleasant River (1999), and the East Machias Dam on the East Machias River (2000). Other dams proposed or being considered for removal include the Sennebec Dam, St. George River; Main Street Dam, Sebasticook River; West Winterport Dam, Marsh Stream; Smelt Hill Dam, Presumpscot River; Ft. Halifax Dam, Sebasticook River; Sandy River Dam, Sandy River.

The process for dam removal under State of Maine regulatory statutes depends whether the dam is a hydroelectric generating facility (or storage dam associated with a hydro project) or a non-hydro generating dam. There currently are 125 hydro dams and 625 non-hydro dams registered in the state. A permit for removal of a hydro dam is obtained under the Maine Waterway Development and Conservation Act through the Maine Department of Environmental Protection (organized towns and cities) or the Land Use Regulation Commission (unorganized towns). Approval criteria include adequate provisions for financial capability, technical capability, public safety, traffic movement, mitigation of adverse environmental impacts, assurance that water quality standard are met, and benefits to fish and wildlife resources outweigh the harm. For a non-hydro dam, a permit is needed through the Department of Environmental Protection under the Natural Resource Protection Act of the Land Use Regulation Commission under a development permit. However, in limited circumstances, a Permit-by-Rule may be obtained through a simplified process if it can be shown that dam removal will improve water quality or enhance fish and wildlife habitat. Local permits may also be needed depending if the municipality has instituted shoreland zone ordinances or development/demolition standards.

Dam removal may be beneficial or detrimental to fisheries management. Benefits include the restoration of diadromous species to historic habitat, unimpeded upstream/downstream passage, reduction/elimination of cumulative impacts, restoration of riverine habitat and species diversity, input of marine nutrients into freshwater systems, and increased riverine angling opportunities for anadromous and inland fish species. Detrimental results of dam removal include range expansion of managed fish species (e.g. brown trout, rainbow trout) and undesirable fish species (e.g. carp, gizzard shad, sea lampreys), change in inland fisheries management due to new habitat conditions such as changes in existing population abundance and size of individuals, the additional need for increased consultation amongst fisheries agencies, and increased agency responsibilities and costs of program expansion.

Dam removal can be controversial since, in most instances, there is no living memory of a river without dams. Local residents typically oppose dam removal because of the fear of change, emotional attachment, aesthetics, developed infrastructure around impoundments, recreational opportunities, and fear that property values will decrease.

All dam removals in the State of Maine to date have occurred to facilitate diadromous fish restoration (primarily clupeids). Educational outreach is needed to 1) promote dam removal as a selective process and not an environmental movement to remove all dams, 2) instill public appreciation for rivers and the restoration of ecological values and functions, 3) link dam removal and river restoration to community and riverfront revitalization, 4) and the creation of new recreational opportunities.

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Fish Passage Program in Connecticut Abtstract by Steve Gephard

The effort to remove dams and build fishways is spreadheaded by the Department of Environmental Protections' Inland Fisheries Division. The Division has statutory authority for restoration and management of all diadromous fish species. The Division implements fish passage projects on dams through the regulatory process (FERC, 419 Water Quality Certification, and dam repair permits). However, the majority of fish passage projects are currently accomplished through a voluntary, cooperative approach. Features of this program include:

1. Propose fish passage at privately-owned (or Town-owned) dams at no cost to owner,
2. Propose dam removal first; if that is unacceptable, fall back on fishway construction,
3. Minimize State ownership of fishways; identify a partner that will own & operate the fishway after it is completed,
4. The Division maintains primary control of the project to keep the appropriate focus and guard against other groups 'highjacking' the project to serve their own special interests that may compromise the primary objective of fish passage,
5. Contact dam owners early and privately to learn special concerns and issues and respect their need for privacy,
6. Assemble a team of partners consisting of representatives from federal agencies and other state agencies, the Town, local conservation groups (e.g. land trusts), regional NGOs (e.g. watershed associations), and key individuals—as appropriate,
7. Develop a plan, including a conceptual design and cost estimates,
8. Raise funds from a variety of off-budget sources including grants from state and federal agencies, NGOs, private individuals, and Supplemental Environmental Projects, which are funding alternatives to fines for companies liable for violations of state or federal environmental laws,
9. Each project typically takes three to four years from proposal to completion; the Division always is working on many projects at once and at any given time there may be several projects at all phases: Proposal, Early Planning/Fund Raising, Design/Permitting, and Construction,

10. The Division has constructed about 25 fishways and assisted in the removal of seven dams during the past 10 years; the costs of the fishways ranged from $100 to $200,000 and the dam removals costs ranged ~$50,000 to $200,000.

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3.6. TERM OF REFERENCE 6 -Overview of Smolt Projects

The Assessment Committee continues to be interested in pursuing metadata analysis approaches to investigate regional patterns in smolt emigration dynamics. Such efforts could potentially focus on the timing and duration of smolt migrations and relationships of latitude and river migration distance to migration dynamics. The committee identified the lack of focused objectives and difficulties with assembling data in a standardized format as obstacles to making tangible progress on this term of reference. The committee agreed to assemble a group of investigators involved in smolt research and monitoring from the various Atlantic salmon programs to conduct an informal discussion to identify focused objectives for a targeted analytical effort. A product of this discussion will include a proposed format for data submission from regional smolt research and monitoring projects. NOAA Fisheries has committed staff time dedicated to identifying submission formats and working with cooperating personnel to assemble data for analysis. At the summer 2000 USASAC meeting, this group will deliver a list of 2-3 targeted objectives of a metadata analysis and a proposed format for data submission to address these objectives.

3.7. TERM OF REFERENCE 7 - Habitat Restoration

U.S. Forest Service Salmon Habitat Research Abstract by K. H. Nislow, USDA-USFS NERS Amherst, MA 01003

Research on salmon habitat requirements and habitat restoration is generally constrained by the limited temporal and spatial scales at which most studies are conducted. The US Forest Service Northeastern Research Station, in collaboration with academic and management partners, is conducting and supporting research designed to provide a larger perspective on salmon habitat issues. One major focus of interest is the long-term effect of current and historic land use change on habitat in salmon restoration streams. This issue is being addressed by several research initiatives including 1) modeling the dynamics of loading and retention of large woody debris (LWD), a major determinant of physical habitat structure, to New England streams, 2) testing the effects of LWD additions on Atlantic salmon habitat and performance, along with effects on potential prey, predators, and competitors, 3) documenting and comparing channel unit structure across salmonid streams in the Green and White Mountain National Forests, 4) assessing the potential role of anadromous fishes on nutrient budgets and stream chemistry. Our second major focus is on the development and applications of methodologies designed to assess the spatial scale of habitat use in juvenile Atlantic salmon. Using stable isotope signatures and genetic marks, we have been able to determine the characteristic scale of dispersal in age-0 salmon. In addition, using micromilling techniques to isolate isotopic signatures in the otoliths of returning adults, we have found evidence of significant differences in large-scale habitat use patterns among individuals. Overall, our work indicates that expanding the temporal and spatial framework of Atlantic salmon habitat research is likely to yield new and useful insights into management and conservation.

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Stream Assessment and Restoration Using Applied Fluvial Geomorphology Abstract by Jock Conyngham

Stream and river channels are self-maintaining entities that must accommodate a broad range of energy and material flows to endure. System form, function, and equilibrium can be fundamentally disrupted by a variety of common changes to hydrologic parameters, sediment inputs, valley land use, and channel management. Applied fluvial geomorphology offers a set of quantitative tools for assessing these phenomena with robust treatment of temporal and spatial scale issues. Implications for Atlantic salmon and aquatic macroinvertebrate population trends as well as strategies for assessment, protection, and restoration will be presented using examples from Maine and elsewhere.

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Vermont Department of Environmental Conservation: Geomorphic Assessment and Habitat Restoration Programs Abstract by Mike Kline

The White River and Trout River Habitat Restoration Projects were presented to show how natural channel design techniques can be used to restore channel stability and the fluvial geomorphic processes that form and maintain aquatic habitat features. The role of channel and floodplain geometry and sediment transport/distribution in maintaining riffle and pool quality was stressed. The use of Vermont's new Geomorphic Assessment Protocols in problem solving channel instability and habitat degradation at the watershed and river reach-levels was also presented.

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3.8. TERM OF REFERENCE 8 - Habitat Inventories and Prgram Conservation Limits

Since the 1950's, a variety of stream habitat survey methods have been used by federal and state fishery resource agencies cooperating in the protection, management and restoration of Atlantic salmon and riverine habitat. In general, habitat surveys were conducted to identify and quantify habitat in salmon rivers and tributaries. This allowed salmon biologists to: a) define and describe habitat variables; b) apply statistical measures of precision and accuracy to results and to describe variations; c) establish convenient, logical stratification of habitat data; and d) establish standard methods for conducting surveys to determine salmon spawning and rearing (nursery) habitat.

This in turn provided salmon biologists and fisheries managers with an evaluation of habitat, reliable estimates of available habitat units, and an understanding of the potential and limitations for use in the production of Atlantic salmon. The following table summarizes the habitat surveys conducted by fishery resource agencies in New England.

Table of Habitat Survey Methods conducted within States, by agencies, for approximate years.

State	Agency	Method Used	Approximate Year(s)
Maine	MASC and FWS MASC and FWS MASC and FWS	Visual Estimate Transect Method Hankin & Reeves	1950's through 1960's 1970's through 1990 1991 to present
Vermont	VTFW VTFW VTFW FS FS	Transect-type Method Transect Method Modified Transect Method Transect Method Hankin & Reeves	1986 1987 through 1994 1992 through 1996 1987 through 1989 1990 to present
New Hampshire	NHFG and FWS NHFG, FWS, FS FS NHFG	Total Stream Survey Transect Method Hankin & Reeves Hankin & Reeves	1975 through 1986 1987 through 1990 1991 to present mid-1990's to present
Massachusetts	Coop Unit, MAFW	Transect Method	1980's through 1990's
Connecticut	CTDEP	Reach Level: Modified Transect Method	1980's
Rhode Island	RIFW	Transects and Maptech Technique	1980's

After reviewing the Atlantic salmon habitat survey methods employed by state agencies throughout New England, the Committee agreed that the various collection methods used for these on ground surveys all provided data that allow reasonable calculations of habitat area by habitat type. Each program estimated the proportion of salmon habitat surveyed to date and identified survey gaps.

Percent of habitat surveyed by program to date, and identified survey gaps.

Program/State	Estimated % Habitat Surveyed	Identified "Gaps"
Connecticut	95	NH and VT headwaters
Merrimack	95	
Pawcatuck	99	
NH Coastal	95	
ME- DPS	99	
ME - Other Rivers	70	Largest Rivers

The Committee agreed that a habitat workgroup involving members from each program should be established. This workgroup would ensure that any revisions or additions to habitat survey data would be used to refine estimates of Conservation Limits or Thresholds for programs, and would also review the assumptions that defined the portions of river systems included in establishing current Conservation Limits.

4. RESEARCH

4.1. CURRENT RESEARCH ACTIVITIES

The following includes Atlantic salmon research abstracts that were submitted to the Committee in 2001. The Email address at the end of the abstract is that of the primary author.

CONSERVATION OR MANAGEMENT

Atkinson, E., Mackey, G., Horton, G. E., and Simmons, W. **An Investigation of Drift of Atlantic salmon Fry, *Salmo salar* Immediately After Stocking.** 2002. Atlantic salmon restoration efforts in Maine employ fry stocking as one of the primary population enhancement strategies. However, the initial fate of stocked fry is unknown. Fry quickly disappear upon release, but the distance they drift is unknown. The behavior of fry after stocking could affect their survival and the quality of habitat they ultimately inhabit. We released 10,000 unfed fry in late morning into the Dennys River, Maine, May 1999. We trapped these fry using fry drift traps at three downstream transects spaced at 50-meter intervals from May 19 to June 14. Eighty-one percent of fry remained in the first 50 meters, with the remainder distributed throughout the next 100 meters and beyond. No fry were captured during daylight, with 755 caught after nightfall. Fry movement stopped after seven days. Taken together these data suggest that fry are not swept along with the current when stocked, but find refuge and then move volitionally during low light periods. Management implications of this study are to stock fry at rates that prevent over saturation, but take advantage of fry drift to distribute fry effectively. Further study should focus on effects of current velocity on drift, and difference between fry emerging from gravel and stocked fry.

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Dudley, R. W., Trial, J., and Wright, J. **Geomorphology And Trends In Hydrologic Conditions Of Coastal Maine Rivers.** 2002. The Maine Atlantic Salmon Commission, U.S. Geological Survey, and U.S. Fish and Wildlife Service are collaborating on a study of geomorphology of unregulated salmon streams in Maine in an effort to assemble a knowledge-base with which to assess degraded river reaches and design restoration projects. The average characteristics describing the geometry of a river channel within a hydrologically homogenous region are sufficiently consistent that the degree of deviation from normal stream geometry can be interpreted as the magnitude of the effect of disturbance. For this reason, regional models or curves that relate normal stream channel geometry to drainage area size and reference discharge can be a valuable tool used in quantifying disturbance at river reaches and designing projects to restore them. Preliminary curves for Maine based on the 1.5-year recurrence interval flow compare similarly to regional-curves based on bankfull flows for Vermont. The MASC is also working with the USGS examining trends in hydrologic conditions for coastal Maine rivers to aid in evaluation of climatological impacts on salmon. The trend analyses include looking at changes in monthly and annual flows, the timing of seasonal flows, and changes in snowpack and duration of river ice in the coastal river basins over time. Preliminary findings indicate a statistically significant trend in the timing of spring runoff for earlier dates over the past 86 years. Both the geomorphology and hydrologic trend studies are currently ongoing.

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Scott, M. **Occurrence of Smallmouth Bass** ***(Micropterus dolomieu)*** **In the Pleasant River Watershed.** 2002. Smallmouth bass is an exotic species to Maine and were introduced shortly after the Civil War. Since that time the species has become one of the most popular and valuable warmwater sport fisheries in Maine. However, the intentional introduction of exotics is biological pollution of the worst kind. Understanding the implications of such illegal introductions is never fully understood by the perpetrators. During the mid 1970's an illegal introduction of smallmouth bass was made into Pleasant River Lake, the largest headwater lake in the drainage. The species has now spread down the Pleasant River to Columbia Falls, based on Atlantic Salmon Commission data for 1995. This new predator is now in direct competition upon and with young Atlantic salmon life stages. Smallmouth bass were never found to exist in the Pleasant River watershed based on fishery and angler surveys dating back to the 1950's. Drainage basins to the east and west have had smallmouth bass for many decades. This introduction to Pleasant River Lake came after a letter of request for the stocking and the denial given back in 1975. The first fishery survey of Pleasant River Lake, Southwest Pond and other waters did not report collecting Smallmouth Bass. The water quality of the lake is marginal for coldwater species but there does exist a large and healthy smelt population. Extensive water quality data from the early 1970's conclude that the lake has very low productivity and there's a very small basin of cold water for salmonids. These studies collected Chlorophyll a, total phosphorus, secci disk, total alkalinity and dissolved oxygen data. With this recent introduction, the recovery of wild Atlantic salmon for the Pleasant River is now even more questionable and puts the recovery program into greater jeopardy with this predator expanding its range into the critical habitat of Atlantic salmon.

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Sheehan, T. F., Mackey, G., Kocik, J. F., Finaly, D., and Sochasky, L. **Stocking Marine-Reared Adult Atlantic Salmon In Eastern Maine: A Progress Report For Year 2.** 2002. As part of a two year feasibility study initiated between private aquaculture companies and federal and state management agencies, Atlantic salmon (*Salmo salar*) were reared to maturity in salt water and stocked in Maine Rivers to supplement depressed natural spawning escapement. In 2000, 1,038 marine-reared, mature adult Atlantic salmon were released into the Dennys, Machias, and St Croix Rivers. Post stocking assessments documented a significant increase in redd production attributable to these stocked adults, but the viability of the reproductive success of these fish is unknown. In 2001, 729 marine-reared, mature adults were released into these same drainages. Additional laboratory and hatchery-based assessments, which are focused on the viability of gametes produced by these stocked adults, have been incorporate into the evaluation phase of this project. Preliminary analyses indicate that the 2001 stocked adults are also responsible for a significant increase in the number of redds documented within each recipient river and that the reproductive products of these adults are viable. Assessment activities are underway to estimate fry emergence rates from these redds. In addition, population surveys of parr and smolts will be conducted and returning adults will be monitored. These population data will be partitioned by origin via parentage analysis (wild spawning, fry stocked, or adult stocked). Initial results indicate that the stocking of marine-reared mature adults may be a management tool capable of artificially increasing number of adult spawners and egg deposition until a time when environmental conditions improve and natural spawning escapement rebounds.

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Whiting, M. **Baseflow And Stormwater Chemistry Of The Maine Salmon Rivers During The 2001 Field Season.** 2002. The baseflow water chemistry of the Maine salmon rivers is pretty good overall. The pH is fairly moderate (pH 6-7) with positive alkalinity (ANC 37-1300 ueq/L). During the 2001 field season, water quality monitoring was extended to storm runoff events. Even thought 2001 was a historic drought year, strong runoff events were observed in the spring and fall. In the Sheepscot River, many summer baseflow sample sites are very warm (above the 22.5 degrees C threshold at which Atlantic salmon are stressed to the point that they loose weight and body condition). Many sites (often the same ones that show too much summer thermal gain) also have high bacterial counts. The *E coli* counts throughout much of the central part of the river exceed the EPA recommended threshold for swimming and other water contact sports (126 colonies per 100 ml). The bacteria are evidently primarily from dairy farms. Stormwater samples from this spring show that the Sheepscot has moderate turbity (2.4-4.9 NTU) and suspended solids (10-47 mg/L). Cove Brook has the highest pH and alkalinity of the official salmon rivers (pH range7.2-8.2 and ANC range 712-2350ueq/L). These high values are unusual for Maine and suggests that there is a significant source of carbonates in this watershed. Only about 0.05% of Maine's surface waters have a pH greater than 8 (Maine Volunteer Lake Monitoring Program website, Water Resources Inst. (now the George Mitchell Center)). During strong storms or snowmelt events, Cove Brook experiences high turbidity (range 1-40 NTU) and high suspended solids (2.9-100 mg/L). The high turbidity is apparently caused by some bank failures. The downeast rivers have the best overall water quality. These rivers have the lowest pH and ANC, but the main stems of the rivers have not been observed to experience low pH (pH less than 5.5) and high exchangeable aluminum events. High E coli counts appear to be limited to the lower (mostly in-town) sections of the rivers. The herbicide Velpar (hexazinone) occurs in trace amounts (1-3 ppb) in the Narraguagus River, Pleasant River, and Mopang Stream. The herbicide is from expansive blueberry farming in these watersheds. We plan to continue to monitor both baseflow and stormwater events in the salmon rivers. We plan to focus more effort on the water quality of tributaries and expand our bacterial monitoring.

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CULTURE OR LIFE HISTORY

Atkinson, E., Trial, J., Evers, M., Mackey, G., and Beland, K. F. **A Measure of Substrate Embeddedness and Its Relationship to Juvenile Atlantic Salmon (*Salmo salar*) Densities in the Narraguagus River.** 2002. We estimated cobble embeddedness to evaluate the habitat quality for juvenile salmonids. Atlantic salmon (*Salmo salar*) parr use interstitial spaces for shelter from fast moving currents and to find thermal refuge, particularly during winter months. During the summer of 1993, we estimated cobble embeddedness and the interstitial space index (ISI) at 28 sites along the Narraguagus River and its tributaries. We found no significant difference between cobble embeddedness and ISI between riffles (means 22% and 3.10m/m^2) and runs (means 27% and 1.97m/m^2). Both ISI and embeddedness were correlated to substrate size.

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Friedland, K. D. **Post-Smolt Growth Patterns For Atlantic Salmon Released In The Saint John River, Canada.** 2002. The marine survival and sea-age at maturity of the hatchery component of the Saint John River stock of Atlantic salmon were analyzed in regard to the retrospective differences in post-smolt growth as evidenced by circuli spacing patterns in the scales of returning adults. The stock is natal to the Saint John River located in southern New Brunswick, Canada. The run is typified by two sea-age groups, 1SW (seawinter) and 2SW salmon, and approximately 60% of the smolt cohort matures after one winter at sea. Return rates for 1SW and 2SW salmon were highly correlated over the study period of smolt migration years 1974-1992. Using image-processing techniques, we extracted inter-circuli distances from the scales of 2,942 fish in nearly equal numbers for 1SW and 2SW returns. Return rate was related to the size of smolts and negatively correlated, in some respects, with post-smolt growth. Post-smolt growth was systematically greater for the 1SW age component of the stock, though the inter-annual variability in maturation rates could not be related to specific patterns of post-smolt growth variation. The results suggest that combination of smolt size and post-smolt growth play a significant role in deciding the age-at-maturity and survival patterns for Atlantic salmon stocks.

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Friedland, K. D. **The Relationship Between Smolt Size And Finishing Growth And Post-Smolt Growth In Atlantic Salmon In The Gulf Of St. Lawrence.** 2002. The size of smolts and how long they remain at vulnerable sizes as post-smolt are believed to be two of the major factors controlling post-smolt mortality and salmonid recruitment. Studies have addressed both factors, both in isolation and concurrently, revealing mixed results, and thus 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. Post-smolt growth showed no significant relationship to either smolt size or freshwater finishing growth. These data suggest a decoupling between freshwater size and growth experience and the growth of post-smolts in the marine environment.

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Haines, T., Spaulding, B., Watten, B., and McCormick, S. D. **Evaluation of Alkalinity Enhancement of Craig Brook National Fish Hatchery Water on Atlantic Salmon Fitness and Survival.** 2002. The purpose of this study was the evaluation of alkalinity enhancement of Craig Brook National Fish Hatchery water on Atlantic salmon production. The present hatchery water supply, Craig Pond in East Orland Maine, is generally of high quality except that alkalinity (acid neutralizing capacity, ANC) is relatively low. This low ANC may allow pH values to fluctuate greatly in response to acidic inputs from rainstorms and snowmelts. In addition, the low pH values can increase the solubility of harmful ions such as aluminum. An experimental limestone dissolution system was constructed to increase the alkalinity of the water supply. Atlantic salmon from the Narraguagus River were subjected to three different water quality conditions: control (unaltered Craig Pond water), medium alkalinity (20ppm higher than control) and high alkalinity (40ppm higher than control). Fish were reared from fertilization of the egg until stocking (as fry) under each water quality condition. A variety of experiments were conducted to determine the effect of water alkalinity on fry. Gill tissue was analyzed for ATPase activity; growth was measured by video taping the fry over set intervals and doing computer measurements from screen captures; gill arches were removed and examined by scanning electron microscopy (SEM); blood plasma and whole body samples were analyzed for Na and K. In the second and third years of the study the adults used for spawning were genotyped so that offspring could be identified in the future. In 2000 and 2001 fry from each treatment were stocked in equal numbers at each of three locations in the Narraguagus River. Survival of fry was determined by electrofishing these sites in the fall and collecting fin clips from 30 fry at each site. From these experiments we have initially concluded the following: There does not seem to be an impact of alkalinity on Na,K-ATPase. Overall growth/length does not seem to be affected in either a positive or negative manner. Scanning electron microscopy of gill tissue did not show abnormal morphological effects. Survival in the wild for fry stocked in 2000 was greatest for fish from the medium alkalinity treatment and lower and roughly equal for fish from control and high alkalinity treatments. However, the medium alkalinity fish recovered were largely from one family group. Survival of fry stocked in 2001 will be determined when results from genotyping of samples is received.

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Horton, G. E. and Letcher, B. H. **Individual-Based Approach Towards Understanding Atlantic Salmon Smolt Production In Shorey Brook, Maine.** 2002. Thirty-seven, 20 m long sections representing 33, 100 m^2 units of wetted area in Shorey Brook, a tributary to the Narraguagus River, Maine, were sampled six times between April and November, 2001. Additionally, 15 units were sampled above and below these sections in order to detect study fish. Sampling methods were either electrofishing (April/May, June, September, October, November) or night seining (August). A total of 579 individuals were sampled at least once. Of these, 288 were PIT tagged and tissue sampled for later genetic analysis during these sampling periods. The remaining 291 had been previously tagged. Several hundred fish were captured that were too small to tag. Age-1+ fish predominated in the population of tagged fish until late fall when age-0+ fish became large enough to tag (>60 mm fork length). Approximately 2,400 fry were stocked in Shorey Brook (representing about 50/unit) in early May. Additionally, 130 brook trout were PIT tagged which should yield growth and survival information for the potential, primary competitor of Atlantic salmon in Shorey Brook. The smolt trap operated on Shorey Brook from early April through the end of May resulted in a total capture of 63 Atlantic salmon smolts. Almost 1/2 of these had been previously captured as evidenced by having a PIT tag present. The remaining 32 were PIT tagged and, along with the previously tagged fish, released to continue their downstream migration. Ages of emigrating smolts were age-3+ (85%) and age-2+ (15%). As evidenced by daily snorkeling observations upstream of the weir, trap design improvements led to minimal delays as compared to the 2000 smolt trapping season. Upon recapture of residents within the 37 study sections, individuals were resampled to determine growth rate, precocity, movement, habitat selection, and population survival. Although survival rate analysis remains incomplete, overwinter and oversummer survival rates will eventually be computed. Also, family-specific performance will be analyzed using genetic samples collected from juveniles that will allow assignment of individuals to either of six families stocked as fry in May, 2000 or 2001. Mean growth rates between sampling periods tended to be highest for young fish (age-1+) and were higher for all age groups between April and June and lowest late summer and overwinter. Age-2 and age-3 fish that had never been previously mature were consistently heavier than those that had been previously mature. For age-1+ fish prior to the expression of milt, the reverse was true. Data on rainfall amount, pH, temperature and conductivity have been recorded continuously since March. Summarization of these data is incomplete.

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Lacroix, G. L. **Salar MAP: Opportunities for Canada - U.S. Cooperation.** 2002. Salmon stocks from inner Bay of Fundy rivers have crashed in the past decade and, in 2001, they were declared "endangered" under the new Canadian Species at Risk Act. Abnormally low survival of salmon during the oceanic phase has been targeted for the decline. In response, Salar MAP, the Atlantic salmon Acoustic-tracking Project, launched a major marine research effort in the Bay of Fundy in 2001. They demonstrated the feasibility to track salmon post-smolts through coastal areas and developed the capability to capture live post-smolts during their marine migration. A large-scale acoustic telemetry project was conducted to track and compare the migration and distribution of tagged post-smolts from inner and outer Bay of Fundy rivers as they moved through the Bay of Fundy and into the Gulf of Maine. The aim was to find where they go after leaving the rivers and determine areas of potential loss. Simultaneously, a research cruise aboard the Canada Coast Guard fishing trawler, Alfred Needler, used new methods to capture live post-smolts on their way through and out of the Bay of Fundy. These were examined to determine origin and assess health and condition before release. Salar MAP is spearheaded by the Department of Fisheries and Oceans and the Atlantic Salmon Federation, and it involves the participation of many supporting partners. The goal is to ultimately determine the location and timing of salmon disappearance at sea for the endangered stocks and to try and uncover the causes. The focus of Salar MAP activities in the Bay of Fundy and the proposed project expansion to the Gulf of Maine present opportunities for Canada - U.S. cooperation.

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Mackey, G. and Sheehan, T. F. **Gamete Viability of Adult Pen-Reared Restoration Atlantic Salmon.** 2002. As a means to supplement populations in several Downeast salmon rivers, the National Marine Fisheries Service, Maine Atlantic Salmon Commission, and U. S. Fish and Wildlife Service stocked river-specific Atlantic salmon adults in 2000 and 2001 that were reared in net pens by the aquaculture industry. Attempts to evaluate the reproductive success of these adults suggest that these fish achieved relatively low reproductive success. However, the methods we used to evaluate this were either indirect or provided results with relatively low interpretive power. We wished to test the hypothesis that poor gamete quality may be limiting reproduction by these fish. We moved 26 pen-reared adults to the Center for Cooperative Aquaculture Research, Franklin, Maine, in October 2001, spawned them as they matured, and incubated the eggs in a standard Heath tray stacks. These fish were from the same cohort that was stocked into the rivers. We attempted to do at least 2x2 spawnings to account for individuals that may perform poorly, but we did not always achieve this. The fish matured slowly, and many had not matured by December 12 when we ceased spawning. Of those that did mature, we spawned eight females and two males. Fertilization was greater than 95% in all spawnings, except one female achieved 85% fertilization with both males. Preliminary results suggest that survival to eyed-egg stage was 86%. These results suggest that gametes are not the limiting factor in reproduction by these fish. However, the low rate of sexual maturation could explain poor reproductive performance if this occurs in the rivers. In addition, we did not expose the eggs in this study to environmental stressors that may be encountered in a river. We also did not consider milt volume, which appeared low, although we did document motility.

Olsen , J. R. and Parrish, D. L. **Seasonal, Annual And Life History Effects On Individual Growth Of Atlantic Salmon Parr.** 2002. The growth of Atlantic salmon (*Salmo salar*) in fresh water affects parr survival, smolt age, and maturation rates that in turn influence smolt production and ultimately, adult return rates. In this study we quantified Atlantic salmon growth during 1999 and 2000 in Vermont tributaries of the Connecticut River. We individually marked $\geq$ age 1 parr in four stream sites that ranged in salmon density and growth rates to determine: (i) how salmon partition growth seasonally (i.e., early summer, summer, fall and winter/spring), (ii) how dry and wet summers affect parr growth and (iii) how parr maturation alters growth and consumption. We used bioenergetics modeling that incorporated differences in temperature, diets, and fish size to predict consumption rates across sites, seasons, and life history strategies. Stomach samples of salmon were collected to determine prey consumption and stomach mass and to relate prey consumed to growth rates. Growth partitioning by Atlantic salmon parr varied substantially across seasons, sites, and years. Salmon in fast growth sites did not grow faster than those in slow growth sites during all seasons; i.e., during fall 1999 and 2000, and summer 2000. However, during summer 1999 and early summer 2000 growth was greater in fast growth sites. Salmon density had no effect on growth rates at fast growth rate sites but was negatively related to salmon growth at slow growth sites. Despite cold water temperatures, salmon grew in all sites in spring, yet fast spring growth rates did not continue into the early summer in the slow growth sites. Salmon growth rates were greater during the wet summer than the drought summer in two sites, but were similar in the other two sites. Salmon consumed 31% larger, and 93% fewer prey during the drought than the wet summer. The amount (i.e., grams) of predicted food consumed was equivalent in dry and wet summers, but the energy of food consumed (i.e., Joules) decreased during 2000, suggesting that salmon consumed lower energy in 2000. Using a bioenergetics model, we modeled the effects of temperature at small time scales (i.e., hours) to relate the predictions of the model to the energetic consequences of behavior patterns of salmon parr during summer. During summer mature and immature parr growth rates were similar, but in fall growth rates were 146% greater for immature parr. Stomach content mass of mature and immature parr was similar in July, but stomach content mass for immature was greater than that of mature parr in September and October. The findings of this study suggest that growth is highly dependent on seasonal and annual effects and different life history strategies. Increased understanding of freshwater growth can lead to better management that will result in enhancement or restoration of Atlantic salmon populations.

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Pearlstein, J., Letcher, B. H., and Brown, R. W. **Estimating Predation Using a Switchable Radio Tag.** 2002. Predation can be an important source of mortality for migrating smolts, but its contribution to overall mortality is difficult to quantify. The objective of this study is to develop and implement a novel radio tag that will provide a direct estimate of the proportion of mortality of outmigrating Atlantic salmon (*Salmo salar*) smolts due to predation. A change in the transmitting signal will indicate predation. Investigating predation via radio telemetry may avoid some of the drawbacks associated with other techniques, such as stomach content analysis. This method overestimates predation and underestimates other sources of mortality. The radio tag will indicate one source of mortality only, predation, thus providing a more accurate direct estimate of predation. Additionally, the radio tag will provide the time and relative location of predation. The radio tag will be inserted gastrically into wild smolts and released into the tailraces of Cabot Station and Holyoke Dam. Data collected from this study can be used to identify potential areas where predation is unusually high, such as near dams.

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Ravita, J. and Gephard, S. **The Use Of Hormone Implants To Synchronize, Advance, And Improve The Maturation Of Sea-Run And Kelt Atlantic Salmon Broodstock.** 2002. Captive Atlantic salmon broodstock often "ripen" at different rates, resulting in a prolonged spawning season. Non-random, genetically-based mating schemes can be thwarted by non-synchronous ripening of spawners. The aquaculture industry has used commercially available hormones to synchronize ripening of Atlantic salmon broodstock but government-based restoration programs in the U.S. have not. In October 2001, the Connecticut River Atlantic Salmon Restoration Program implanted 150 *ug* of salmon gondotropin releasing hormone (SGnRH) into 20 female and 9 male sea-run salmon at the Whittemore Salmon Station (Barkhamsted, CT) and the Richard Cronin National Salmon Station (Sunderland, MA) in order to synchronize their ripening. Also implanted were 36 female and 7 male reconditioned kelt salmon broodstock at the Whittemore Salmon Station and the North Attleboro National Fish Hatchery (North Attleboro, MA). This was done to accelerate their spawning and to study the impacts on the quality and production of milt by male kelts. This paper reports the costs and methodology of implantation, the impact on the timing of ripening of spawners, and the impact on the quality of the gametes.

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Sheehan, T. F., Kocik , J. F., and Atkinson, E. **Phenotypic Differences Expressed During The Marine Phase For Three Remnant Populations Of Atlantic Salmon.** 2002. During 19982000, stock-specific marine growth rates were monitored for three endangered Atlantic salmon (*Salmo salar*) populations from eastern Maine. Atlantic salmon from the Dennys, East Machias, and Machias Rivers were spawned at a Federal hatchery and their offspring were reared to the smolt stage at commercial facilities. Approximately 2,000 smolts from each stock were tagged with an elastomer injection, and then transferred to two marine sites (approximately 1,000 per site) for grow-out to the adult stage. At each site, smolts from each stock were placed together into a single sea-cage for 29 months and reared under similar environmental and growing conditions. Biological sampling (length and weight measurements) was conducted bimonthly. Standardized photographs were taken from a random sample of individuals from one site at the conclusion of the study, and Truss Analysis (multivariate morphometrics) was conducted on these photographs. Significant differences in growth rates were detected at each site. Significant differences in body morphometrics were also detected among the three stocks indicating a genetic basis for these phenotypic differences. Several hypotheses are offered as to the ecological meaning of these differences.

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Sigourney, D. B., Letcher, B. H., and Cunjak, R. A. **Estimating Growth And Survival Of Stream Salmonids In Catamaran Brook Using An Individual Based Approach.** 2002. Catamaran Brook is a second order stream that flows into the Little Southwest Miramichi River. This study was conducted in the lower reach of Catamaran Brook approximately 500 meters from the mouth of the brook. The study area is divided into twenty-two 10 m long sections that were sampled four times over the course of the season. Average width of the brook is 10 m, so each section is approximately 100 m^2 in area. In addition, after each sample 70 meters above and below the study site were sampled to search for individuals that may have migrated out of the study area. Both juvenile salmon and brook trout > 60 mm in length were individually marked by inserting a PIT tag into there peritoneal cavity. Genetic samples and scale samples were also taken from each tagged fish. A total of 686 salmon and 88 brook trout were tagged over the course of the 2001 season. Age-1+ salmon were the most prevalent in the population of fish > 60 mm until the fall samples when Age-0+ salmon > 60 mm in length began to recruit into the population. Using software for analyzing mark-recapture data, different models can be built from the data collected in this study. A set of competing models for testing hypotheses about survival differences over time and between cohorts will be derived and model selection criteria will be used to pick the best model or group of models that explain survival in this system. Information on length and weight of each individual is used both to calculate growth rate and condition factor over time and as individual covariates in the mark-recapture models. Ultimately, this study will be compared to similar studies in both Maine and Massachusetts as part of a cross-system comparison in an attempt to elucidate some of the mechanisms that drive growth and survival of salmonids in different systems.

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FISH HEALTH

Cipriano, R. C., Novak, B. M., Flint, D. E., and Cutting, D. C. **Reappraisal Of The Federal Fish Health Recommendation For Disinfecting Eggs Of Atlantic Salmon (*Salmo salar*) In Iodophor.** 2002. The U.S. Fish and Wildlife Service federal protocol for dual disinfection of fish eggs in 50-mg/L of iodine for 30 minutes followed by a secondary disinfection in 100-mg/L iodine for 10 minutes was investigated during six spawning cycles of Atlantic salmon (*Salmo salar*) held at the Richard Cronin National Salmon Station (Sunderland, MA). This population of salmon had undergone an epizootic of furunculosis and the surviving fish maintained a persistent infection of *A. salmonicida* throughout the course of study. Eggs from twenty individual paired-matings of salmon were annually obtained during the first two weeks of November in each spawning cycle from 1995 through 2000, except for 1999 when fertilized eggs from 35 pairs of salmon were examined. *Aeromonas salmonicida* was isolated from 19 of 135 total groups of fertilized eggs that were investigated throughout the duration of this study. In these cases, all isolations of the pathogen were made only in fertilized eggs before any disinfection in iodophor had occurred. In contrast to the results produced in the field, *in vitro* assays actually showed that *A. salmonicida* was not completely killed when initial concentrations of the bacterium ranged between 1.0×10^7 to 1.2×10^8 cfu of bacteria per mL. However, even when bacterial concentrations exceeded 1.0×10^7 cfu/mL no *A. salmonicida* remained viable if treated first with 50-mg/L iodine for 30 minutes and then with 100- mg/L iodine for 10 minutes, as prescribed in federal policy. These results suggest that it is critical to conduct the secondary disinfection in order to avoid inadvertent contamination. Results of the current analysis also provided further evidence that A. *salmonicida* is not transmitted vertically via intra-ovum infection.

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MacLean, S. A. **Wild Fish Disease Screening.** 2002. Infectious Salmon Anemia broke out in more than 50% of the Atlantic salmon netpen sites in Cobscook Bay in 2000. Industry began voluntary removal of fish from diseased cages and emergency measures were instituted by the State of Maine to prevent further spread of the disease and particularly to prevent spread to areas outside Cobscook Bay. In an effort to identify potential carriers of salmonid pathogens, various species of wild non-salmonid marine fishes were collected and assayed for several salmonid viruses and *Renibacterium salmoninarum*, an agent of bacterial kidney disease. Fish tested were taken from the vicinity of salmon culture netpen sites, as well as from locations hundreds of miles away from salmonculture activities. Since testing began in 2000, over 1400 fish including alewife (N= 589), American eel (N= 207), Atlantic herring (N= 207), Atlantic mackerel (N= 204), pollock (N= 102), and winter flounder (N=90), have been assayed by cell culture for viruses, direct fluorescent antibody test for BKD, and/or RTPCR and indirect fluorescent antibody test for infectious salmon anemia virus. BKD was not detected in any of the fish sampled. Viruses were not isolated in cell culture nor detected by IFAT from any fish sampled. Weak RTPCR-positive results were obtained from two pollock taken from an ISA-diseased salmon netpen; whereas, pollock collected outside a diseased pen were not positive by RTPCR. Because the corresponding cell cultures were negative, the significance of the RTPCR-positive results is unclear. The most immediate use of this information is in industry attention to biosecurity practices concerning non-salmonids retained in and harvested from salmon netpens. These data also indicate that non-salmonids can harbor the virus and be asymptomatic of disease. Fishes for examination were collected through the cooperation of several individuals from National Marine FisheriesService, Sea Grant, the salmon industry, and the Atlantic Salmon Commission. The assessment of salmonid disease agents in wild fishes will continue in the next fiscal year.

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MARKING

Dubreuil, T. L and Letcher, B. H. **Utilization of a Small Stream FDX Pit-Tag Detection System to Monitor Variation In Seasonal Atlantic Salmon Movement In West Brook, MA USA.** 2002. PIT tags have proven to be a very powerful research and management tool. This is due to the low cost, small size (12mm length by 2.1mm diameter cylinder), high retention rate (99 %) and durability (tag life virtually indefinite) of the tags. Since 1997, 7236 Atlantic salmon (>60mm 2g) have been tagged within the 1 Km West Brook, MA study site. Data have been attained for growth, survival, morphology and genetic variation. The need to assess migration timing and separate emigration from mortality, led to the development a small steam PIT tag detection system for the 12mm Destron Fearing FDX (full duplex) tag. The system allows for passive monitoring both upstream and downstream of tagged Atlantic salmon. The PIT tag detection system was installed in April 2001 prior to the smolt migration and logged 84 tagged smolts over the course of four weeks. The majority of fish moved between 1800 hr and 0400 hr at night. The antennas also recorded seasonal variation in movement of resident fish. Very few fish moved during winter, but there was a pulse of fish (all age classes) during two weeks in autumn. Additional data will include insights into cues for movement (i.e. flow, temperature, photoperiod and life history) and new mark-recapture models under development will allow incorporation of movement data into survival estimates, separating mortality from emigration.

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FitzGerald, J. L., Sheehan, T. F., and Kocik, J. F. **Visibility And Detection Of Visual Implant Elastomer Tags In Adult Atlantic Salmon (*Salmon Salar*) Reared For Two Years In Sea Cages.** 2002. We evaluated detectability of visual implant elastomer (VIE) tags through visual inspection of individual Atlantic salmon (Salmo salar L.) reared from smolts to adults at commercial netpen facilities. A total of 9,000 individuals were marked (adipose eye and/or lower jaw) with a uniquely colored VIE tag. During the period of March 1998 December 2000 a total of 3,220 fish were visually assessed for VIE tag retention. For doublemarked individuals, at least one tag (eye or jaw) could be visually detected on all individuals inspected during the first 15 months post tagging. Despite significant differences in weight gain between rearing sites, tag detection rates remained consistently high for the first 17 months after tagging but began to decline sharply after this point, particularly for the jaw tags. Use of a UV light significantly increased detection of both eye and jaw tags. There were statistically significant differences in length and weight among stocks and between rearing facilities as well as variation in tag detection. We concluded that the use of VIE tags in fisheries research and management can be a valuable tool, but that these tags are optimal for use in Atlantic salmon when mark recovery will occur within 18 months.

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Mohler, J., Millard, M., and Perkins, D. **Field Evaluation of Calcein Marks on Atlantic Salmon Fry Stocked Into the West Branch Sheepscot River, Maine.** 2002. The first field test of a new technique for mass-marking early life-stage fish was initiated in April, 2001 at Craig Brook National Fish Hatchery, Maine, where seven incubation trays containing a total of about 30,000 Atlantic salmon fry of Sheepscot River lineage were immersed into a solution of the fluorochrome dye known as calcein. In early May equal numbers of marked and unmarked fry were stocked out into the West Branch Sheepscot River at 9 locations. Subsequent field recovery of marked and unmarked young-of-year salmon was undertaken using electrofishing techniques at fry release sites. Captured young-of-year were anesthetized, measured, and classified as marked or unmarked using battery-powered field detection wands. Additionally, an anal fin tissue sample was taken from all unmarked fish for subsequent genetic analysis to determine if unmarked fish were of hatchery origin. A total of 111 calcein-marked and 155 unmarked fry (42% marked vs. 58 % non-marked) were recovered with a total of 558 minutes of electro-fishing effort. Of the 13 stations sampled, 7 had suffiecient data for analysis with 5 of those 7 stations showing marked and unmarked fish captured at the expected 1:1 ration. Replicated goodness-of-fit tests (G-statistic) applied to overall capture data showed that unmarked fry were recovered at a higher proportion than marked fry ($P<0.05$) (pending genetic analysis). Some calcein marks were weak and several marked fish could have been mis-classified in the field. Field detection equipment performed well and resulted in instantaneous mark classification most of the time. The calcein mark technique has potential as a relatively inexpensive and practical way to perform hatchery product evaluations where a batch mark is adequate. Refinement of the batch-marking technique is needed to produce consistently visible calcein marks in non-feeding Atlantic salmon fry.

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POPULATION ESTIMATE OR TRACKING

Sheehan, T. F., Brown, R. W., Lacroix, G. L., Mackey, G., Kocik , J. F., and Trasko, F. **Dennys River Smolt Stocking Assessment.** 2002. The Maine Technical Advisory Committee (TAC) developed a comprehensive plan to evaluate stocking of river-specific Atlantic salmon smolts in the Dennys River over a five year (2001-2006) period. Stocking rates were developed based on retrospective analysis of Penobscot River stocking and adult return data during the period from 1973 to 1995. Model results indicated that a range of 32,000 (low) to 56,000 (high) would result in a 75% probability of achieving 2SW Atlantic salmon returns of at least 67 (low) or 117 (high) adults. A total of 52,000 smolts were stocked at two locations (Robinsons Camp and Meddybemps Lake outlet) in April and May 2001. In addition, 1000 smolts from a late release group were marked with Passive Integrated Transponder (PIT) tags to obtain information on individual performance. Stocked fish were marked with a site and release date specific elastomer mark and adipose fin clip to allow quantitative evaluation of survival in relation to release location and time. A weir based smolt trap was operated, but proved largely ineffective at capturing smolts due to low water conditions. In an effort to monitor adult weir passage dynamics and model the early marine migration patterns and survival of Dennys River hatchery smolts, 70 ultrasonically tagged smolts were released at Robinson's Camp (river kilometer 4.08) on 9 May 2001. Prior to the release, NEFSC deployed VR2 ultrasonic receivers throughout the lower Dennys River, Cobscook Bay, and Lubec Narrows. NEFSC scientists also collaborated with DFO colleagues who deployed receiver arrays throughout the Bay of Fundy. Preliminary analyses indicate that 68 individuals were detected at the adult weir capture facility (river kilometer 0.38) while 64 fish were detected 1 kilometer downstream. Approximately 40% individuals were detected at the entrance of Cobscook Bay proper, 16.71 kilometers away from the release site, while 27% of the individuals were detected outside of Cobscook Bay within the Bay of Fundy. These data are proving essential to developing a complete understanding of these migration and mortality processes and the information gained will be applied when developing future restoration and assessment measures.

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SMOLTIFICATION AND SMOLT ECOLOGY

Brown, R. W., Loughlin, M., Hastings, E., and Paquette, T. **Origin of Atlantic Salmon Smolts Successfully Emmigrating from the Penobscot River.** 2002. We initiated sampling of outmigrating smolts in the lower Penobscot River in the vicinity of Veazie Dam in Spring 2000. To capture migrating smolts, we deployed 8-foot rotary screw traps in suitable areas of water current (3-7 ft/second). Trapping efforts were hampered in 2000 by high water conditions (25 year floods) occurring in late April and again in early May 2000. Despite these problems, a total of 78 trap days of effort were expended resulting in the capture of 74 Atlantic salmon smolts and 1 Atlantic salmon kelt. A total of 14 fin clipped and elastomer marked fish were recaptured among the 74 smolts captured during sampling. In Spring 2001, we deployed three 8-foot rotary screw traps below Veazie Dam near the head of tide. A total of 129 trap days of effort were expended resulting in the capture of 1190 Atlantic salmon smolts and 1 Atlantic salmon grilse. A total of 392 fin clipped and elastomer marked fish were captured among the 1190 smolts captured during sampling. Length, weight, scale and genetic samples, physiology samples, fin clip and elastomer mark information were collected from sampled smolts. Image analysis of scale samples indicated that greater than 97% of captured smolts were age 1+ hatchery smolts. Seasonal distributions of captures indicate that naturally reared smolts emigrated from the system approximately 6-9 days later on average than hatchery reared smolts.

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Brown, R. W., Loughlin, M., Hastings, E., Paquette, T., and Trasko, F. **Penobscot Hatchery Smolt Assessment.** 2002. In 2000, we initiated a study to evaluate the role of hatchery enhancement programs in Atlantic salmon restoration efforts in the Penobscot River. Adult returns to the Penobscot River in 2000 declined to 532 returning adults, representing less than 5% of the adult escapement objectives for the system. Adult returns from hatchery stocked age 1+ smolts are critical to maintaining suitable returns of sea-run broodstock for future restoration efforts. An important initial step in the identification and evaluation of significant mortality sources for smolts and post-smolts is to evaluate the relative importance of mortality occurring in riverine vs. estuarine and open ocean habitats. In March 2000, we elastomer marked 166,000 hatchery smolts at Green Lake National Fishery Hatchery. These fish were stocked in 13 identifiable lots to evaluate downstream migration and adult return rates from smolts stocked at different times and in different locations in the system. In 2001, we marked and released 168,000 hatchery smolts with only minor revisions to the marking and release plan. Elastomer marks recovered from 44 returning 1SW adults sampled at Veazie Dam indicated a higher return rate for early smolt releases. Recoveries of marked individuals as returning adults in 2002 and 2003 will provide additional assessment of adult returns in relation to the timing and location of stocking. Over 700 elastomer marked smolts were recovered during rotary screw trap sampling at the head of tide and post smolt trawling in Penobscot Bay and the Gulf of Maine. We anticipate that this information will be useful in refining release strategies of hatchery smolts to optimize resulting adult returns.

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Brown, R. W., Tinus, C. A., Haas-Castro, R., Fitzgerald, J., and Livensparger, E. **Post-Smolt Trawling Survey in the Penobscot Bay Estuary.** 2002. Synchronous declines in the survival of Atlantic salmon smolts throughout North America indicate a sharp decline in marine survival. Many investigators hypothesize that this decline occurs early in the marine phase, as Atlantic salmon smolts transition from freshwater to marine environments. In May 2001, we initiated a surface pelagic trawl survey in the Penobscot Bay estuary to sample hatchery and naturally reared Atlantic salmon smolts in the marine environment. Approximately 31% of age 1+ hatchery smolts were stocked in 7 identifiable lots at different times and in different locations in the lower river system. To live capture post-smolts in marine waters, we pair trawled a Norwegian designed pelagic net through surface waters utilizing a specially designed aluminum aquarium deployed in the codend of the trawl. A total of nine sampling days resulted in the capture of 1458 post-smolts and one adult Atlantic salmon. Atlantic salmon post smolts were detected at 49 of 61 stations (80%). Atlantic salmon were found at high densities in the upper estuary, and at detectible levels into the Gulf of Maine as far as 20 nm from the mouth of Penobscot Bay. A total of 340 elastomer marked and fin clipped smolts and 15 fin clipped only smolts were captured among the 1458 post-smolts examined during sampling. Relative capture frequencies of marked hatchery lots were not statistically different from frequencies observed during in rotary screw trap samples collected at the head of tide. Two early release groups represented greater than 50% of the marked smolts recovered during post-smolt trawling providing indications of differential survival among early release groups following stocking. Basic biological data, genetic samples, an examination for elastomer marks and sea lice, and physiological samples were collected from captured fish. Data collected during the initial 2001 survey will allow for refinement of the sampling program in future years.

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Haines, T. **Endocrine Disruption in Atlantic Salmon (*Salmo salar*) Exposed to Pesticides.** 2002. Sediment analyses: Surficial sediment was collected with a stainless steel grab sampler at depositional areas in the Narraguagus River, both upstream and downstream of major blueberry growing areas, and after the time when pesticides are applied to the barrens. The samples are being analyzed for the major pesticides used on blueberries, except for the herbicide Velpar (hexazinone), which is water soluble and has been frequently detected in water in this river. Results are expected shortly, and will be used in conjunction with the results of the E-SCREEN test to select the chemicals for fish exposure.
Fish Exposures: Atlantic salmon parr of Penobscot strain from Green Lake National Fish Hatchery will be exposed to a mixture of chemicals by transferring fish to an exposure tank for 24 h. The specific chemicals and concentrations will be determined by preliminary bioassays (E-SCREEN) and by results of water and sediment analyses. Preliminary results indicate that methoxychlor, hexazinone, and propiconizole have estrogenic activity of 50% or greater as compared to 17 β-estradiol, and these are candidate chemicals for fish exposures. Control fish will be exposed to untreated water throughout the course of the experiment. Test fish will be exposed on day 0, 7, 14, 21, and 28 of the experiment. Control fish will be sampled on the exposure dates and gill Na,K-ATPase and plasma Cl determined. Na,K-ATPase activity will be determined using the method of McCormick (Can. J. Fish. Aquat. Sci. 50: 656-658, 1993), and plasma Cl by ion chromatography. On days 10, 20, and 30 subgroups of fish (control and experimental) will be subjected to a 24 hour saltwater challenge test, and gill Na, K-ATPase and plasma Cl determined. Mortality rates will also be observed and recorded during the saltwater challenge test. Initial group sizes will be 100 fish for exposures and 100 control, 200 total fish requested each year for two years.
Bioassays: Unscheduled induction of vitellogenin (VTG) by estrogen-like compounds is the standard biomarker for xenoestrogen exposure. Determination of VTG levels in smolts following pesticide exposures will be done using a capture ELISA (Mourot *et al*. J. Immun. 16:365-377, 1995; Tyler *et al*. Environ. Tox. Chem. 18: 337-347, 1999). Antibodies to salmonid VTG will be obtained either from Biosense (Bergen, Norway) or from Dr. N. Denslow, University of Florida (Gainesville, FL). Both polyclonal and monoclonal antibodies against Atlantic salmon VTG are available. Plasma from estradiol-induced Atlantic salmon (Biosense) will be used as the positive control. Antibodies will be diluted at 1:100, 1:1000 or 1:10,000. The ELISA plate will be first coated with a primary antibody, then the VTG sample added, followed by a second primary antibody. Finally, the secondary antibody, conjugated to horseradish peroxidase will be added with ELISA assay reagents (Sigma). The presence of VTG is indicated by a colorimetric change at 492 nm using an ELISA plate reader. Steroid plasma levels (testosterone, -estradiol) may also be indicative of xenoestrogen exposure, and will be measured by radioimmunoassay (RIA) following the method of Wingfield as modified by Cash and Holberton (Cash, W. and R. Holberton, J. Exp. Zool. 284: 637-644, 1999).

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Kocik , J. F. and Beland, K. F. **Population dynamics of Atlantic salmon in the Narraguagus River.** 2002. Atlantic salmon populations in Maine have been at low levels of abundance for the last 75 years and have declined further in the past decade. As a result, the Gulf of Maine distinct population segment of Atlantic salmon was listed as endangered in 2000. NOAA Fisheries (NMFS) and the Maine Atlantic Salmon Commission (ASC) have been quantitatively assessing populations in the Narraguagus River since 1991 to determine population trends and the causes of variable abundance. Trap catch of adults and redd counts have confirmed that abundance has declined and remains low. To identify causes for this decline, we initiated a program to assess abundance at several life history stages to develop a stage-structured model of the dynamics of this population. We have generated a time series of pre-smolt abundance, smolt abundance, and adult returns. In addition, we age scale samples from each of these stages to facilitate assessment of cohort success. Pre-smolt production has ranged from 9,500 to over 27,000 from 1991-2000 and corresponding emigrating smolt estimates from 1996-2001 ranged from 1,800 to 3,600. Adult returns during this period have ranged from 23-87, indicating that adult Atlantic salmon are not replacing themselves despite supplemental fry stocking. Even in years with relatively large increases in large parr production (126%), smolt production has increased only modestly (3%). Total smolt production in these watersheds has averaged 44/ha (30-60/ha), well below the estimated production capacity of 300/ha. Additionally, marine survival continues to be below 1% and contributes to the declining abundance. We will extend this time series of data to facilitate further analysis to determine the ecological mechanisms responsible for production variability at each stage.

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Kocik, J. F., Sheehan, T. F., Beland, K. F., and FitzGerald, J. L. **Smolt Assessments in Wild Atlantic Salmon Rivers of Maine.** 2002. We monitored the emigration of Atlantic salmon smolts using rotary screw fish traps in the Narraguagus, Pleasant, and Sheepscot Rivers. Single traps are fished in the Pleasant and Sheepscot Rivers to document relative abundance, run timing, and to collect samples for biological samples. In the Narraguagus River, we use a total of four traps, two at river km 17 and two at river km 14 and by marking at the upstream site conduct a stratified mark-recapture population estimate. Trapping starts in mid-April and continues until 5 days of 0 catches occur, usually through early June. We captured a total of 711 smolts in the Narraguagus River. Narraguagus river smolts averaged 159 mm fork length and 38 g wet weight. The timing of emigration for these smolts was normally distributed with 18 May being the date of 50% capture, about 10 days later then most years. Utilizing a Darroch maximum likelihood model, our preliminary estimate of the emigrant smolt population in 2001 was 1,780 the lowest estimate in the time series. On the Pleasant River in Columbia Falls we captured 24 smolts compared to 160 in 2000 and 617 in 1999. Efficiency work is ongoing but it is thought that this trap intercepts a higher proportion of the smolts leaving the river than any individual trap in the other two systems. In addition to the probable wild fish, we again captured smolts with fin deformities, coloration, and body form suggesting that they were of hatchery origin (n=8). Smolts of obvious hatchery origin were sacrificed on several dates for disease sampling and physiology testing according to Atlantic Salmon Commission protocols. We initiated a feasibility assessment of smolt trapping on the Sheepscot River in the spring of 2001 at the site of the Head Tide dam. This trial year was a success with a total of 40 days fished with relatively high efficiency relative to capture options at the site. On the Sheepscot River, we collected 52 smolts and they averaged 178 mm, significantly larger than Narraguagus and Pleasant River smolts. With a median capture date of 8 May, this years data suggest that emigration may be earlier in this more southerly river. Based on results of 2001, we plan to use two traps at this site in 2002 and do a single site mark-recapture in 2002.

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Magee, J. A. **Acid Rain: still a problem for Maine's Atlantic salmon?** 2002. Acidic precipitation has been responsible for the decline and extirpation of many Atlantic salmon populations, with well-documented cases in Nova Scotia and Norway. Although NO_x and especially SO_x emissions have been reduced in recent years, decades of acid rain have led to lower buffering capacity of soils and associated rivers. This may make surface water more susceptible to short pulses of low pH. The biological effects of acid rain are well documented, and recent data suggest that short pulses of acidity can cause delayed mortality and slow growth in Atlantic salmon smolts. The extent to which acid rain may have impacted Atlantic salmon in Maine is not known, but a wealth of biological and chemical data has been generated on the Atlantic salmon populations and rivers in Downeast Maine. I will discuss the effects of acid rain on surface waters and Atlantic salmon, and synthesize these into the framework of Atlantic salmon restoration in Maine.

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Magee, J. A., Obedzinski, M., McCormick, S. D., and Kocik, J. F. **Effects Of Pulses Of Acidity And Aluminum On Atlantic Salmon (*Salmo Salar*) Smolts.** 2002. Atlantic salmon smolts were held in either ambient (control, mean pH =6.3), acidified (chronic, mean = pH 5.2) or pulse-acidified (pulse, acidified to mean pH 5.2 twice weekly) river water for 36 days and then transferred to 34‰ seawater. Smolts fed little while in acidified conditions and chronic smolts did not grow in length or weight. In freshwater, chronic fish experienced increases in hematocrit and plasma potassium and reductions in plasma sodium and chloride. Upon transfer to seawater, chronic and pulse fish experienced reductions in hematocrit, increases in plasma sodium, chloride and potassium levels, and suffered mortalities. Gill Na^+,K^+-ATPase and citrate synthase activities were reduced by exposure to acid. For most parameters, the effect of pulse acidity was intermediate to that of chronic acidification. Exposure to acidic conditions, even when short in duration and followed by a two-day recovery period in suitable water (pH 6.5), led to a 35% mortality of smolts upon transfer to seawater. This study highlights the importance of measuring and assessing sublethal stresses in freshwater and their ultimate effects in marine ecosystems.

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McCormick, S. D., Brown, R. W., Kocik , J. F., Magee, J. A., and Tinus, C. A. **Physiological Changes In Wild And Hatchery Atlantic Salmon Smolts In Maine: Implications For Marine Survival.** 2002. Downstream migration and early seawater entry of smolts has been identified as a critical period for determining adult return rates in Atlantic salmon. Normal smolt development includes large increases in salinity tolerance and gill Na^+,K^+-ATPase activity. The capacity to develop salinity tolerance and other aspects of smolt physiology has been shown to be very sensitive to several classes of contaminants, including acid deposition, heavy metals and endocrine disrupting compounds. From 1998 to 2001, non-lethal gill biopsies have been taken from wild migrating smolts on the Narraguagus river, with additional sampling of other downeast rivers in 1999 and 2001. Peak levels of gill Na^+,K^+-ATPase activity did not increase above 7 µmoles ADP $\cdot$ mg protein^{-1} $\cdot$ h^{-1}, substantially lower than values seen in southern New England, and moderately lower than the limited numbers of rivers sampled in New Brunswick and Newfoundland. Hatchery-reared fish of Penobscot and Denny's River origin reared at Green Lake National Fish Hatchery were sampled from February until release in May. Gill Na^+,K^+-ATPase activity increased two-fold during hatchery-rearing, and reached peak values of 5-7 µmoles ADP $\cdot$ mg protein^{-1} $\cdot$ h^{-1}, at the time of late release (May 9-13). Additional data on changes in circulating levels of hormones involved in smolt development, and gill Na^+,K^+-ATPase activity of fish captured in ocean trawls will also be presented. The results indicate that either Maine fish have inherently low gill Na,K-ATPase activity compared to other river systems, or that the development of fish in both the hatchery and the wild has been compromised by one or more environmental factors. Further work is needed to determine whether the observed low levels of gill Na,K-ATPase are related to short-term performance (early survival and growth in seawater) and long-term performance (adult returns) of hatchery and wild Atlantic salmon smolts.

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McCormick, S. D., O'Dea, M. F., Moeckel, A. M., and Björnsson, B. Th. **Post-Release Changes In Hatchery-Reared Atlantic Salmon Smolts.** 2002. Physiological and endocrine changes during smolt development were examined in Atlantic salmon (*Salmo salar*) reared and released as part of a restoration program on the Connecticut River and its tributaries. Fish were reared in a cold water hatchery in Pittsford VT and released into the Farmington River CT (a major tributary of the Connecticut River) or into _'imprint ponds' fed by the Farmington River. Smolts were recaptured 10-20 days after their release at a smolt bypass facility 16 km downstream of their release site. Fish sampled at the hatchery from January to May had only moderate smolt development based on salinity tolerance, gill Na^+,K^+-ATPase activity and hormone profiles. In contrast, smolts released into the river or imprint ponds had higher salinity tolerance, gill Na^+,K^+-ATPase activity, plasma growth hormone, insulin-like growth factor I and thyroxine than smolts that remained in the hatchery. These physiological changes were nearly identical to those of smolts that had been released into the river two years earlier as fry and were captured as active migrants at the same bypass facility. Rearing of Pittsford fish at temperatures similar to that of the Farmington River could only partially explain the change in physiology seen in released fish. The results indicate that substantial physiological smolt development can occur after hatchery release, coincident with downstream migration.

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McCormick, S. D., O'Dea, M. F., Moeckel, A. M., Lerner, D. T., and Björnsson, B. Th. **Endocrine Pathways For The Disruption Of The Parr-Smolt Transformation By Estradiol And Nonylphenol.** 2002. Sex steroids are known to interfere with normal development of the parr-smolt transformation, and environmental estrogens such as nonylphenol have recently been implicated in reduced returns of Atlantic salmon in the wild. In this study juvenile Atlantic salmon were injected with 0.5, 2, 10, 40 and 150 ug/g branched 4-nonylphenol and 2 ug/g estradiol-17β during the parr-smolt transformation in April and sampled 1 and 2 weeks after first exposure. Estradiol and 150 ug/g nonylphenol resulted in lower salinity tolerance and decreased plasma IGF-I. Plasma growth hormone was elevated at intermediate doses of nonylphenol, but there was no effect of higher doses. There was no effect of estradiol on plasma growth hormone. Plasma cortisol was not affected by nonylphenol or estradiol. Plasma thyroxine showed a strong dose dependent decrease in response to nonylphenol and estradiol. The results indicate that plasma IGF-I is the likely endocrine pathway for the effects of estrogenic compounds on osmoregulation, and that plasma thyroxine is negatively affected by nonylphenol at relatively low doses.

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Scace, J., Letcher, B. H., and Odeh, M. **Development Of A Highly Efficient Smolt Trap For Use In Heavily Debris Laden Streams.** 2002. An increasing number of ecological studies on Atlantic salmon populations rely on data collected from a large number of individuals. The individuals are usually tagged and sampled multiple times creating an extensive history of growth and movement for each fish. Sampling of the individuals as they smolt is necessary to complete the development history of the individuals and to obtain accurate population estimates. In these studies it is ideal to sample each surviving tagged fish is when it smolts. Many study areas need a portable trap that is highly efficient at capturing all the migrating individuals. The traps also need to withstand high flow events in streams with a large amount of debris. A portable trap design that is sufficient for our needs does not exist. Therefore the objectives of this study are 1) Develop a smolt trap that can be utilized during low and high flow events under heavy debris loading, 2) evaluate the trap in the 20-foot wide flume at the S.O. Conte Anadromous Fish Research Center, 3) estimate the efficiency of the trap in the field using mark and recapture, 4) track smolt movements using radio telemetry as another estimate of efficiency and to determine how they encounter the trap. Initial tests of the trap currently used in the field were conducted in the 20-foot wide flume at the Conte Anadromous Fish Research Center during the fall of 2000. The purpose of these tests was to locate the weaknesses of the current trap under various flow regimes and determine what areas need to be addressed. Using the information gathered from those tests new traps were designed and tested in the flume in the winter of 2000-2001.The best trap design (a rotary screw trap and resistance board weir hybrid) was installed in the field in the spring of 2001. The new trap design continued to successfully fish after the old design was washed out during a high flow event. Stratified mark and recapture sampling in the field estimated the efficiency of the trap at 66.7%. Modifications of the new design were tested in flume during the fall of 2001. The modifications will be tested in the field during the spring smolt run of 2002. As in the spring before, efficiency will be determined by stratified mark and recapture samples. The efficiency of the trap will also be further evaluated through the use of radio tracking of smolts.

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STOCK IDENTIFICATION OR GENETICS

King, T. L. and Spidle, A. P. **Population Structure of Maine Atlantic Salmon and Other Atlantic Salmon in Maine.** 2002. Salmon in the drainages of Maine's Kennebec and Penobscot rivers were found to be genetically similar to those sampled from the 8 rivers recently listed as an endangered distinct population segment (DPS) under the United States' Endangered Species Act. Genetic distance estimates confirm that Maine's Atlantic salmon, both landlocked and anadromous, represent a discrete population unit, with a gene pool as discrete from any Canadian population as each Canadian population is from any other Canadian population, or any North American population from any European population. Within Maine, the anadromous and landlocked populations of Atlantic salmon were statistically distinct from each other. Extensive analysis of neutral genetic variation in Atlantic salmon also provides clear discrimination between Atlantic salmon of European vs. North American origin. An 11-locus suite of microsatellite markers is being used to determine the continent of origin of fish caught in the mixed-stock fishery off the coast of Greenland, and to detect aquaculture escapees in broodstock of Maine origin. Aquaculture escapees can thus be culled from river-specific broodstocks maintained for federally endangered Maine Atlantic salmon. An additional 18 polymorphic loci have been developed, for application to broodstock management both in Maine and in the Connecticut River, and for fine-scale resolution of individual reproductive success within and between redds in Maine rivers.

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Reddin, D., Brown, R. W., King, T. L., Short, P. B., and Kanneworf, P. **Origin of Atlantic Salmon Captured in a Mixed Stock Fishery at West Greenland.** 2002. One of the key data inputs to international stock assessments of Atlantic salmon is the origin of Atlantic salmon harvested in mixed stock fisheries. An international sampling program collects biological data, scale and genetic samples from Atlantic salmon sampled from commercial fisheries catch at West Greenland. Results for genetic samples collected during the 2000 field season were analyzed and incorporated into the 2001 ICES stock assessment. A total of 250 tissue samples from NAFO Division 1D and 241 samples from Division 1F were analyzed using mitochondrial DNA discrimination techniques. Because genetic samples were analyzed from all collected fish, previously employed linear discriminate function approaches to incorporate scale data were not utilized to analyze these data. Based on the mitochondrial DNA analyses, 89.2% of fish sampled in NAFO Division 1D and 50.4% of salmon sampled in Division 1F were of North American origin. The proportion of North American fish in this fishery has increased steadily during the 1990's, prompting concerns about trends in pre-fishery abundance of North American and European stocks. The overall proportion of salmon of North American origin sampled in the 2000 landings declined from recent record high levels, but remained above long-term average levels. The decline in the proportion of North American salmon compared with recent years may be attributed to a higher proportion of landings from southern Greenland (NAFO Divisions 1E and 1F) where higher proportions of European fish have historically been found. Continent of origin results were incorporated into the stock assessment of Atlantic salmon prepared by the ICES North Atlantic Salmon Working Group.

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5. HISTORICAL DATA

5.1 EGG PRODUCTION

A summary of egg production for Atlantic salmon restoration and recovery programs in New England for the period 1871-2001is provided in Table 5.1.a in Appendix 8.4. A summary and grand total of all historical Atlantic salmon egg production for New England salmon rivers is provided in Table 5.1.b. in Appendix 8.4. Approximately 55,000 female Atlantic salmon have produced an estimated 382 million eggs for programs throughout the history of salmon enhancement, restoration, and recovery efforts.

5.2. STOCKING

Historical stocking information is presented in Table 5.2.a and 5.2.b in Appendix 8.4. Approximately 181 million juvenile salmon have been released into the rivers of New England during the period, 1967 - 2001. About 78% of the total have been fry. The majority of the juvenile releases have occurred in the Connecticut River (> 87.3 million), the Penobscot River (> 30.4 million), and the Merrimack River (> 30.7 million).

5.3. ADULT RETURNS

Historical return information is presented in Table 5.3.a and 5.3.b in Appendix 8.4. Total returns to New England rivers from 1967 through 2001 now equals 80,424. 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%). The Penobscot River alone accounts for 68% of the total.

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

6. TERMS OF REFERENCE FOR 2003 MEETING

The U.S. Atlantic Salmon Assessment Committee agreed to address the following Terms of Reference for the 2003 meeting:

1. Program summaries for current year (2002) 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 vs. unmarked, and wild vs. hatchery; and

   c. general summary of program activities including regulation changes, program directionn and update historical databases.

2. Model: Optimum Fry Stocking for New England Rivers.

3. Domestic and International Research Program Updates.

4. Modeling Assumptions: Freshwater Survival.

5. Dam Removal and Fishway Construction.

6. Overview of Smolt Projects.

7. Habitat Restoration.

8. Habitat Inventories and Program Conservation Limits.

9. Additional Terms of Reference will be developed at a Committee meeting to be held on July 10, 2003 at the N.H. Fish and Game Department, Concord, NH.

7. U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE MEMBERS

Joan Trial	Maine Atlantic Salmon Commission
Steve Rideout	U.S. Geological Survey
Mary Colligan	National Marine Fisheries Service
Christine Lipsky	RI Division of Fisheries and Wildlife
Steve Gephard	CT Department of Environmental Protection
Gabe Gries	N.H. Fish and Game Department
Doug Grout	N.H. Fish and Game Department
Rusty Iwanowicz	MA Division of Marine Fisheries
John Kocik	National Marine Fisheries Service
Russell Brown	National Marine Fisheries Service
Jerry Marancik	U.S. Fish and Wildlife Service
Joe McKeon	U.S. Fish and Wildlife Service
Jay McMenemy	VT Fish and Wildlife Department
Caleb Slater	MA Division of Fish and Wildlife
Mike Millard	U.S. Fish and Wildlife Service / Northeast Fishery Center
Janice Rowan	U.S. Fish and Wildlife Service
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8. APPENDICES

8.1. LIST OF ALL PARTICIPANTS

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8.2. GLOSSARY OF ABBREVIATIONS

Adopt-A-Salmon Family	AASF
Arcadia Research Hatchery	ARH
Central New England Fisheries Resource Office	CNEFRO
Connecticut River Atlantic Salmon Association	CRASA
Connecticut Department of Environmental Protection	CTDEP
Connecticut River Atlantic Salmon Commission	CRASC
Craig Brook National Fish Hatchery	CBNFH

Decorative Specialities International	DSI
Developmental Index	DI
Distinct Population Segment	DPS
Federal Energy Regulatory Commission	FERC
Geographic Information System	GIS
Greenfield Community College	GCC
Green Lake National Fish Hatchery	GLNFH
International Council for the Exploration of the Sea	ICES
Kensington State Salmon Hatchery	KSSH
Maine Atlantic Salmon Commission	MASC
Maine Department of Transportation	MDOT
Massachusetts Division of Fisheries and Wildlife	MAFW
Massachusetts Division of Marine Fisheries	MAMF
Nashua National Fish Hatchery	NNFH
National Academy of Sciences	NAS
National Marine Fisheries Service	NMFS
New England Atlantic Salmon Committee	NEASC
New Hampshire Fish and Game Department	NHFG
New Hampshire River Restoration Task Force	NHRRTF
North Atlantic Salmon Conservation Organization	NASCO
North Attleboro National Fish Hatchery	NANFH
Northeast Utilities Service Company	NUSCO
Passive Integrated Transponder	PIT
PG&E National Energy Group	PGE
Pittsford National Fish Hatchery	PNFH
Public Service of New Hampshire	PSNH
Rhode Island Division of Fish and Wildlife	RIFW
Richard Cronin National Salmon Station	RCNSS
Roger Reed State Fish Hatchery	RRSFH
Roxbury Fish Culture Station	RFCS
Salmon Swimbladder Sarcoma Virus	SSSV
Silvio O. Conte National Fish and Wildlife Refuge	SOCNFWR
Southern New Hampshire Hydroelectric Development Corp	SNHHDC
Sunderland Office of Fishery Assistance	SOFA
University of Massachusetts / Amherst	UMASS
U.S. Army Corps of Engineers	USACOE
U.S. Atlantic Salmon Assessment Committee	USASAC
U.S. Generating Company	USGen
U.S. Geological Survey	USGS
U.S. Fish and Wildlife Service	USFWS
U.S. Forest Service	USFS
Vermont Fish and Wildlife	VTFW
Warren State Fishery Hatchery	WSFH
White River National Fish Hatchery	WRNFH
Whittemore Salmon Station	WSS

8.3. GLOSSARY OF DEFINITIONS

GENERAL

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

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

LIFE HISTORY RELATED

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

1 Parr	The period from January 1 to August 14 one year after hatching.
1+ Parr	The period from August 15 to December 31 one year after hatching.
2 Parr	The period from January 1 to August 14 two years after hatching.
2+ Parr	The period from August 15 to December 31 two years after hatching.
Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to saltwater.
1 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is one year after hatch.
2 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is two years after hatch.
3 Smolt	The period from January 1 to June 30 of the year of migration. The migration year is three years after hatch.
Post Smolt	The period from July 1 to December 31 of the year the salmon became a smolt.
1SW Smolt	A salmon that survives past December 31 since becoming a smolt.
Grilse	A one-sea-winter (SW) salmon that returns to the river to spawn. These fish usually weigh less than five pounds.
Multi-Sea-Winter Salmon	All adult salmon, excluding grilse that return to the river to spawn. Includes terms such as two-sea-winter salmon, three-sea-winter salmon, and repeat spawners. May also be referred to as large salmon.
2SW Salmon	A salmon that survives past December 31 twice since becoming a smolt.
3SW Salmon	A salmon that survives past December 31 three times since becoming a smolt.
4SW Salmon	A salmon that survives past December 31four times since becoming a smolt.

Kelt	A stage after a salmon spawns. For domestic salmon, this stage lasts until death. For wild fish, this stage lasts until it returns to homewaters to spawn again.
Reconditioned Kelt	A kelt that has been restored to a feeding condition in captivity.
Repeat Spawners	Salmon that return numerous times to the river for the purpose of reproducing. Previous spawner.

8.4. TABLES AND FIGURES SUPPORTING THE DOCUMENT

Table 2.2.1.a Juvenile Atlantic salmon stocking summary for New England in 2001

United States

No. of fish stocked by lifestage

River	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
Cocheco	165,000	0	0	0	0	0	165,000
Total for Coheco Program							**165,000**
Connecticut	9,585,472	1,611	0	0	1,037	0	9,588,120
Total for Connecticut Program							**9,588,120**
Lamprey	111,000	0	0	300	0	0	111,300
Total for Lamprey Program							**111,300**
Androscoggin	3,000	0	0	0	0	0	3,000
Aroostook	182,000	300	0	0	0	0	182,300
Dennys	59,000	16,500	1,400	0	49,800	0	126,700
Ducktrap	0	0	0	0	0	0	0
East Machias	242,000	0	0	0	0	0	242,000
Kennebec	3,000	0	0	0	0	0	3,000
Machias	267,000	0	0	0	0	0	267,000
Narraguagus	353,000	0	0	0	0	0	353,000
Penobscot	364,000	235,800	2,100	0	454,000	0	1,055,900
Pleasant	0	0	0	0	0	0	0
Saco	479,000	0	0	0	400	0	479,400
Sheepscot	171,000	0	0	0	0	0	171,000
St Croix	1,000	0	0	0	8,100	0	9,100
Union	2,000	0	0	0	0	0	2,000
Upper StJohn	0	0	0	0	0	0	0
Total for Maine Program							**2,894,400**
Merrimack	1,707,615	0	0	0	49,500	0	1,757,115
Total for Merrimack Program							**1,757,115**
Pawcatuck	423,000	0	0	0	8,500	0	431,500
Total for Pawcatuck Program							**431,500**
Total for United States							**14,947,435**

Canada

No. of fish stocked by lifestage

River	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
Aroostook	0	0	0	0	0	0	0
St Croix	0	6,300	0	0	0	0	6,300
Total for Canada Program							**6,300**
Total for Canada							**6,300**

Grand Total **14,953,735**

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

Table 2.2.1.b. Captive and domestic adult Atlantic salmon stocking summary for New England in 2001 by river, season, and year class (= year of egg take or wild collection).

NUMBER RELEASED BY SEASON AND YEAR CLASS

	Spring / early summer					**Autumn**					
	1995	**1996**	**1997**	**1998**	**1999**	**1995**	**1996**	**1997**	**1998**	**1999**	**Total**
United States											
Dennys	0	0	0	0	0	18	0	75	0	0	93
East Machias	0	0	0	0	0	35	52	0	0	0	87
Machias	0	0	0	0	0	93	98	104	0	0	295
Narraguagus	0	0	0	0	0	91	110	0	0	0	201
Penobscot	0	0	0	0	0	0	0	809	749	0	1,558
Sheepscot	0	0	0	0	0	38	48	0	0	0	86
St Croix	0	0	0	0	0	0	0	550	0	0	550
Maine pgm :	**0**	**0**	**0**	**0**	**0**	**275**	**308**	**1,538**	**749**	**0**	**2,870**
Merrimack	0	0	1369	1333	1500	0	0	0	400	0	4,602
Merrimack pgm :	**0**	**0**	**1,369**	**1,333**	**1,500**	**0**	**0**	**0**	**400**	**0**	**4,602**
Total United States	**0**	**0**	**1,369**	**1,333**	**1,500**	**275**	**308**	**1,538**	**1,149**	**0**	**7,472**

99% of Merrimack fish stocked for recreational angling purposes.

Table 2.2.2.a. Atlantic salmon marking database for New England; marked fish released in 2001.

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments
Connecticut	PGE	1	Smolt	Hatchery	Connecticut	FLOY	358			Black R.
Connecticut	PGE	4	Adult	Wild	Connecticut	RAD	4		PIT	Deerfield R. Study
Connecticut	USGS	0	Parr	Wild	Connecticut	PIT	454		ANL	West Brook
Connecticut	USGS	0,1	Parr	Wild	Connecticut	PIT	100		ANL	West Brook
Connecticut	USGS	1	Parr	Wild	Connecticut	PIT	133		ANL	West Brook
Connecticut	USGS	1	Parr	Wild	Connecticut	PIT	75		VIEAC	West R. Study VT
Connecticut	USGS	1	Smolt	Hatchery	Connecticut	PIT	289		VIEAC	Passumpsic R. Study VT
Connecticut	USGS	1,2	Parr	Wild	Connecticut	PIT	1,351		VIEAC	Joes Brook Study VT
Connecticut	USGS	2	Parr	Wild	Connecticut	PIT	7		ANL	West Brook
Connecticut	USGS	2	Smolt	Wild	Connecticut	PING	152			CTR Mainstem
Connecticut	USGS	3	Parr	Wild	Connecticut	PIT	6		ANL	West Brook
TOTAL Tags/Marks for		**Connecticut**					**2,929**			
Dennys	NMFS	4	Adult	Net pen reared	Dennys	VPT	75	left eye orange; Type B PIT; 43 fish with PING	AD	
Dennys	USFWS	6	Adult	Captive	Dennys	PIT	18	Type A PIT		

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments
Dennys	USFWS	7	Adult	Captive	Dennys	PIT	31	Type A PIT		
Dennys	USFWS/NMFS	0	Parr	Hatchery	Dennys	LV	16,500			
Dennys	USFWS/NMFS	1	Smolt	Hatchery	Dennys	VIE	25,000	right eye orange	AD	
Dennys	USFWS/NMFS	1	Smolt	Hatchery	Dennys	VPT	24,800	left eye orange; 70 fish with ping	AD	
TOTAL Tags/Marks for		**Dennys**					**66,424**			
East Machias	USFWS	5	Adult	Captive	East Machias	PIT	52	Type A PIT		
East Machias	USFWS	6	Adult	Captive	East Machias	PIT	35	Type A PIT		
TOTAL Tags/Marks for		**East Machias**					**87**			
Machias	NMFS	4	Adult	Net pen reared	Machias	VPT	104	left eye and left lower jaw red; Type B PIT	AD	
Machias	USFWS	5	Adult	Captive	Machias	PIT	98	Type A PIT		
Machias	USFWS	6	Adult	Captive	Machias	PIT	93	Type A PIT		
TOTAL Tags/Marks for		**Machias**					**295**			
Merrimack	CHI	1	Smolt	Hatchery	Penobscot	BAL	135			Lowell
Merrimack	EssexHydro	1	Smolt	Hatchery	Penobscot	FLOY	588	lakeng…		Penacook
Merrimack	NHFG	2	Adult	Hatchery	Merrimack	RV	1,500			Amesbury
Merrimack	NHFG	3	Adult	Domestic	Merrimack	FLOY	1,500	Orange		Hooksett

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments
Merrimack	NHFG	3	Adult	Hatchery	Merrimack	RV	233			Lawrence
Merrimack	NHFG	4	Adult	Domestic	Merrimack	FLOY	1,369	Orange		Amoskeag
Merrimack	PSNH	1	Smolt	Hatchery	Penobscot	RAD	109			Amoskeag
TOTAL Tags/Marks for		**Merrimack**					**5,434**			
Narraguagus	USFWS	0	Fry	Captive	Narraguagus	CAL	2,000	green calcein		Shorey Brook
Narraguagus	USFWS	5	Adult	Captive	Narraguagus	PIT	110	Type A PIT		
Narraguagus	USFWS	6	Adult	Captive	Narraguagus	PIT	91	Type A PIT		
Narraguagus	USGS	1,2	Parr	Captive	Narraguagus	PIT	288	Type B PIT	ANL	Shorey Brook
TOTAL Tags/Marks for		**Narraguagus**					**2,489**			
Pawcatuck	RIDEM	1	Smolt	Hatchery	Pawcatuck	AD	200			
TOTAL Tags/Marks for		**Pawcatuck**					**200**			
Penobscot	USFWS/N MFS	1	Smolt	Hatchery	Penobscot	VIE	173,200	left eye orange	AD	
TOTAL Tags/Marks for		**Penobscot**					**173,200**			
Saco	FLP	1	Smolt	Hatchery	Penobscot	RAD	400	frequencies: 149.320; 149.340; 149.360		
Saco	FPL	1	Smolt	Hatchery	Penobscot	RAD	400			
TOTAL Tags/Marks for		**Saco**					**800**			

River of release	Mark Agency	Age	Life Stage	Rearing History	Stock Origin	Tag/ Mark	Num Marked	Mark Comments	Aux Mark	Comments
Sheepscot	USFWS	0	Fry	Hatchery	Sheepscot	CAL	29,000	green calcein mark		
TOTAL Tags/Marks for		**Sheepscot**					**29,000**			
St Croix	NMFS	4	Adult	Net pen reared		VPT	493	mixed; Type B PIT	AD	
St Croix	NMFS	4	Adult	Net pen reared	Dennys	VPT	1	left eye orange; Type B PIT	AD	
St Croix	NMFS	4	Adult	Net pen reared	Machias	VPT	1	left eye and left lower jaw red; Type B PIT	AD	
St Croix	NMFS	4	Adult	Net pen reared	Narraguagus	VPT	20	left eye green; Type B PIT	AD	
St Croix	NMFS	4	Adult	Net pen reared	Sheepscot	VPT	40	right eye green; Type B PIT	AD	
St Croix	USFWS/NMFS	1	Smolt	Hatchery	Penobscot	VIE	8,100	right eye purple	AD	
TOTAL Tags/Marks for		**St Croix**					**8,655**			

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

Table 2.3.1 Documented Atlantic salmon returns to New England rivers in 2001.

	1SW		2SW		3SW		Repeat		
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Total
Androscoggi	1	0	4	0	0	0	0	0	**5**
Cocheco	0	0	0	0	0	0	0	0	**0**
Connecticut	1	4	0	34	0	1	0	0	**40**
Dennys	2	2	4	9	0	0	0	0	**17**
Lamprey	0	0	0	0	0	0	0	0	**0**
Merrimack	5	2	73	3	0	0	0	0	**83**
Narraguagus	0	5	2	22	0	2	0	1	**32**
Pawcatuck	0	0	0	0	0	0	0	0	**0**
Penobscot	191	24	469	98	0	2	2	0	**786**
Pleasant	0	1	0	9	0	1	0	0	**11**
Saco	15	0	49	5	0	0	0	0	**69**
St Croix	13	0	7	0	0	0	0	0	**20**
Union	0	0	0	0	0	0	0	0	**0**
Total	**228**	**38**	**608**	**180**	**0**	**6**	**2**	**1**	**1,063**

Table 2.3.3. Summary of Atlantic salmon egg production in New England facilities in 2001.

Source River	Origin	Females Spawned	Total Egg Production	No. eggs per Female
Connecticut	Domestic	1,955	9,837,815	5,032
Merrimack	Domestic	726	2,585,439	3,561
Pawcatuck	Domestic	2	2,250	1,125
Penobscot	Domestic	453	1,205,767	2,662
Dennys	Captive	82	358,548	4,373
East Machias	Captive	67	400,359	5,976
Machias	Captive	108	671,702	6,219
Narraguagus	Captive	93	404,034	4,344
Pleasant	Captive	13	45,661	3,512
Sheepscot	Captive	56	350,624	6,261
Total	**Captive/Domestic**	**3,555**	**15,862,199**	**4,462**
Connecticut	Kelt	101	996,318	9,865
Merrimack	Kelt	22	294,316	13,378
Pawcatuck	Kelt	1	7,750	7,750
Total	**Kelt**	**124**	**1,298,384**	**10,471**
Connecticut	Sea Run	20	173,410	8,671
Merrimack	Sea Run	37	295,826	7,995
Penobscot	Sea Run	282	2,451,300	8,693
Total	**Sea Run**	**339**	**2,920,536**	**8,615**
Grand Total for Year	**2001**	**4,018**	**20,081,119**	**4,998**

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

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

Year	Sea-Run 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
Cocheco															
1993	3	21,400	7,133	0	0		0	0		0	0		3	21,400	7,133
Total Cocheco	3	21,400	7,133	0	0	0	0	0		0	0		3	21,400	7,133
Connecticut															
1977-1991	208	6,787,166	8,407	1,063	19,840,429	5,840	0	0		109	5,034,134	9,047	1,380	31,661,729	6,478
1992	236	1,890,800	8,012	650	3,924,800	6,038	0	0		96	1,013,000	10,552	982	6,828,600	6,954
1993	121	1,053,800	8,709	714	3,878,700	5,432	0	0		164	1,767,600	10,778	999	6,700,100	6,707
1994	151	1,223,800	8,105	1,094	7,550,800	6,902	0	0		208	2,427,700	11,672	1,453	11,202,300	7,710
1995	101	945,500	9,361	1,258	7,555,400	6,006	0	0		183	2,159,300	11,799	1,542	10,660,200	6,913
1996	115	938,300	8,159	1,732	11,844,900	6,839	0	0		206	2,221,200	10,783	2,053	15,004,400	7,309
1997	110	770,700	7,006	1,809	11,602,300	6,414	0	0		188	2,003,300	10,656	2,107	14,376,300	6,823
1998	185	1,452,500	7,851	1,140	7,029,500	6,166	0	0		156	1,493,500	9,574	1,481	9,975,500	6,736
1999	83	621,544	7,488	1,862	11,172,872	6,000	0	0		193	1,813,243	9,395	2,138	13,607,659	6,365
2000	49	300,000	6,122	2,471	12,200,000	4,937	0	0		142	1,350,000	9,507	2,662	13,850,000	5,203
2001	20	173,410	8,671	1,955	9,837,815	5,032	0	0		101	996,318	9,865	2,076	11,007,543	5,302
Total Connecticut	1,379	16,157,520	11,717	15,748	106,437,51	6,759	0	0		1,746	22,279,295	12,760	18,873	144,874,33	7,676
Dennys															
1939-1991	12	113,000	9,417	0	0		0	0		0	0		12	113,000	9,417
1992	5	38,000	7,600	0	0		0	0		0	0		5	38,000	7,600
1993	3	19,340	6,447	0	0		0	0		2	8,590	4,295	5	27,930	5,586
1994	2	14,830	7,415	56	110,240	1,969	0	0		6	30,480	5,080	64	155,550	2,430
1995	0	0		0	0		105	303,870	2,894	5	34,155	6,831	110	338,025	3,073

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

	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
1996	4	28,800	7,200	0	0		86	311,000	3,616	3	29,200	9,733	93	369,000	3,968
1997	0	0		0	0		113	429,500	3,801	7	64,500	9,214	120	494,000	4,117
1998	0	0		0	0		79	337,571	4,273	10	105,599	10,560	89	443,170	4,979
1999	0	0		0	0		48	248,800	5,183	7	57,500	8,214	55	306,300	5,569
2000	0	0		0	0		64	282,900	4,420	0	0		64	282,900	4,420
2001	0	0		0	0		82	358,548	4,373	0	0		82	358,548	4,373
Total Dennys	26	213,970	8,230	56	110,240	1,969	577	2,272,189	3,938	40	330,024	8,251	699	2,926,423	4,187
East Machias															
1995	0	0		0	0		65	143,700	2,211	0	0		65	143,700	2,211
1996	0	0		0	0		96	221,100	2,303	0	0		96	221,100	2,303
1997	0	0		0	0		111	394,000	3,550	0	0		111	394,000	3,550
1998	0	0		0	0		103	362,284	3,517	0	0		103	362,284	3,517
1999	0	0		0	0		57	296,000	5,193	0	0		57	296,000	5,193
2000	0	0		0	0		68	394,000	5,794	0	0		68	394,000	5,794
2001	0	0		0	0		67	400,359	5,976	0	0		67	400,359	5,976
Total East Machias	0	0		0	0	0	567	2,211,443	3,900	0	0		567	2,211,443	3,900
Kennebec															
1979-1991	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Total Kennebec	5	50,000	10,000	0	0	0	0	0		0	0		5	50,000	10,000
Lamprey															
1992	1	2,400	2,400	0	0		0	0		0	0		1	2,400	2,400
1993	2	12,600	6,300	0	0		0	0		0	0		2	12,600	6,300
1994	3	17,000	5,667	0	0		0	0		0	0		3	17,000	5,667
Total Lamprey	6	32,000	5,333	0	0	0	0	0		0	0		6	32,000	5,333

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Machias															
1941-1991	449	3,212,980	7,326	0	0		0	0		0	0		449	3,212,980	7,326
1993	7	50,080	7,154	0	0		0	0		0	0		7	50,080	7,154
1994	0	0		88	195,505	2,222	0	0		2	11,670	5,835	90	207,175	2,302
1995	0	0		0	0		171	484,210	2,832	4	27,790	6,948	175	512,000	2,926
1996	0	0		0	0		141	513,200	3,640	2	12,800	6,400	143	526,000	3,678
1997	0	0		0	0		176	602,600	3,424	0	0		176	602,600	3,424
1998	0	0		0	0		166	547,603	3,299	0	0		166	547,603	3,299
1999	0	0		0	0		121	549,600	4,542	0	0		121	549,600	4,542
2000	0	0		0	0		110	416,800	3,789	0	0		110	416,800	3,789
2001	0	0		0	0		108	671,702	6,219	0	0		108	671,702	6,219
Total Machias	456	3,263,060	7,156	88	195,505	2,222	993	3,785,715	3,812	8	52,260	6,533	1,545	7,296,540	4,723
Merrimack															
1983-1991	583	4,237,579	7,291	0	0		0	0		0	0		583	4,237,579	7,291
1992	84	538,100	6,406	536	2,432,800	4,539	0	0		0	0		620	2,970,900	4,792
1993	42	321,600	7,657	1,573	9,664,600	6,144	0	0		0	0		1,615	9,986,200	6,183
1994	10	67,500	6,750	1,035	5,720,800	5,527	0	0		0	0		1,045	5,788,300	5,539
1995	24	187,600	7,817	694	4,353,200	6,273	0	0		0	0		718	4,540,800	6,324
1996	31	212,500	6,855	912	5,469,000	5,997	0	0		0	0		943	5,681,500	6,025
1997	31	284,300	9,171	754	4,641,700	6,156	0	0		0	0		785	4,926,000	6,275
1998	63	518,000	8,222	560	2,669,300	4,767	0	0		5	64,400	12,880	628	3,251,700	5,178
1999	88	736,572	8,370	520	2,658,755	5,113	0	0		50	539,522	10,790	658	3,934,849	5,980
2000	38	310,800	8,179	596	2,624,700	4,404	0	0		62	747,600	12,058	696	3,683,100	5,292
2001	37	295,826	7,995	726	2,585,439	3,561	0	0		22	294,316	13,378	785	3,175,581	4,045

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Total Merrimack	1,031	7,710,377	7,479	7,906	42,820,294	5,416	0	0		139	1,645,838	11,841	9,076	52,176,509	5,749
Narraguagus															
1962-1991		1,303,180		0	0		0	0		0	0			1,303,180	
1994	0	0		59	145,700	2,469	0	0		0	0		59	145,700	2,469
1995	0	0		0	0		115	394,400	3,430	0	0		115	394,400	3,430
1996	0	0		0	0		117	434,300	3,712	0	0		117	434,300	3,712
1997	0	0		0	0		172	516,800	3,005	0	0		172	516,800	3,005
1998	0	0		0	0		186	490,020	2,635	0	0		186	490,020	2,635
1999	0	0		0	0		134	542,100	4,046	0	0		134	542,100	4,046
2000	0	0		0	0		137	431,700	3,151	0	0		137	431,700	3,151
2001	0	0		0	0		93	404,034	4,344	0	0		93	404,034	4,344
Total Narraguagus	0	1,303,180		59	145,700	2,469	954	3,213,354	3,368	0	0		1,013	4,662,234	4,602
Orland															
1967-1991	39	269,645	7,265	0	0		0	0		0	0		39	269,645	7,265
Total Orland	39	269,645	6,914	0	0	0	0	0		0	0		39	269,645	6,914
Pawcatuck															
1992	4	35,600	8,900	0	0		0	0		0	0		4	35,600	8,900
1993	1	7,900	7,900	0	0		0	0		0	0		1	7,900	7,900
1994	1	7,000	7,000	0	0		0	0		0	0		1	7,000	7,000
1996	1	16,900	16,900	0	0		0	0		0	0		1	16,900	16,900
1997	1	8,200	8,200	0	0		0	0		0	0		1	8,200	8,200
1999	6	61,300	10,217	0	0		0	0		0	0		6	61,300	10,217
2000	0	0		0	0		0	0		5	43,200	8,640	5	43,200	8,640
2001	0	0		2	2,250	1,125	0	0		1	7,750	7,750	3	10,000	3,333

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

Year	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Total Pawcatuck	14	136,900	9,779	2	2,250	1,125	0	0		6	50,950	8,492	22	190,100	8,641
Penobscot															
1871-1991	14,299	125,633,310	7,872	0	0		0	0		0	0		14,299	125,633,31	7,872
1992	351	2,448,000	6,974	614	1,518,700	2,473	0	0		0	0		965	3,966,700	4,111
1993	255	1,881,870	7,380	886	2,292,000	2,587	0	0		0	0		1,141	4,173,870	3,658
1994	215	1,669,905	7,767	645	1,654,700	2,565	0	0		0	0		860	3,324,605	3,866
1995	380	2,735,645	7,199	0	0		0	0		0	0		380	2,735,645	7,199
1996	380	2,635,000	6,934	0	0		0	0		0	0		380	2,635,000	6,934
1997	313	2,224,900	7,108	639	1,381,100	2,161	0	0		0	0		952	3,606,000	3,788
1998	392	2,804,084	7,153	560	1,456,192	2,600	0	0		0	0		952	4,260,276	4,475
1999	286	2,418,500	8,456	371	1,300,300	3,505	0	0		0	0		657	3,718,800	5,660
2000	196	1,558,900	7,954	540	1,334,000	2,470	0	0		0	0		736	2,892,900	3,931
2001	282	2,451,300	8,693	453	1,205,767	2,662	0	0		0	0		735	3,657,067	4,976
Total Penobscot	17,349	148,461,414	8,557	4,708	12,142,759	2,579	0	0		0	0		22,057	160,604,17	7,281
Pleasant															
2001	0	0		0	0		13	45,661	3,512	0	0		13	45,661	3,512
Total Pleasant	0	0		0	0	0	13	45,661	3,512	0	0		13	45,661	3,512
Sheepscot															
1995	11	78,500	7,136	0	0		22	44,400	2,018	0	0		33	122,900	3,724
1996	7	46,800	6,686	0	0		36	66,000	1,833	7	66,100	9,443	50	178,900	3,578
1997	0	0		0	0		75	257,300	3,431	13	118,500	9,115	88	375,800	4,270
1998	0	0		0	0		98	343,337	3,503	17	181,485	10,676	115	524,822	4,564
1999	0	0		0	0		49	218,200	4,453	8	92,100	11,513	57	310,300	5,444
2000	0	0		0	0		60	246,100	4,102	0	0		60	246,100	4,102

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

	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	0	0		0	0		56	350,624	6,261	0	0		56	350,624	6,261
Total Sheepscot	18	125,300	6,961	0	0	0	396	1,525,961	3,853	45	458,185	10,182	459	2,109,446	4,596
St Croix															
1993	15	114,000	7,600	0	0		0	0		0	0		15	114,000	7,600
1994	11	80,000	7,273	0	0		0	0		0	0		11	80,000	7,273
1995	10	76,700	7,670	0	0		0	0		0	0		10	76,700	7,670
Total St Croix	36	270,700	7,519	0	0	0	0	0		0	0		36	270,700	7,519
Union															
1974-1991	600	4,610,865	7,912	0	0		0	0		0	0		600	4,610,865	7,912
Total Union	600	4,610,865	7,685	0	0	0	0	0		0	0		600	4,610,865	7,685

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

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

	Sea-Run			Domestic			Captive			Kelt			TOTAL		
	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female	No. females	Egg production	Eggs/ female
Cocheco	3	21,400	7,133	0	0		0	0		0	0		3	21,400	7,133
Connecticut	1,379	16,157,520	11,717	15,748	106,437,516	6,759	0	0		1,746	22,279,295	12,760	18,873	144,874,331	7,676
Dennys	26	213,970	8,230	56	110,240	1,969	577	2,272,189	3,938	40	330,024	8,251	699	2,926,423	4,187
East Machias	0	0		0	0		567	2,211,443	3,900	0	0		567	2,211,443	3,900
Kennebec	5	50,000	10,000	0	0		0	0		0	0		5	50,000	10,000
Lamprey	6	32,000	5,333	0	0		0	0		0	0		6	32,000	5,333
Machias	456	3,263,060	7,156	88	195,505	2,222	993	3,785,715	3,812	8	52,260	6,533	1,545	7,296,540	4,723
Merrimack	1,031	7,710,377	7,479	7,906	42,820,294	5,416	0	0		139	1,645,838	11,841	9,076	52,176,509	5,749
Narraguagus	0	1,303,180		59	145,700	2,469	954	3,213,354	3,368	0	0		1,013	4,662,234	4,602
Orland	39	269,645	6,914	0	0		0	0		0	0		39	269,645	6,914
Pawcatuck	14	136,900	9,779	2	2,250	1,125	0	0		6	50,950	8,492	22	190,100	8,641
Penobscot	17,349	148,461,414	8,557	4,708	12,142,759	2,579	0	0		0	0		22,057	160,604,173	7,281
Pleasant	0	0		0	0		13	45,661	3,512	0	0		13	45,661	3,512
Sheepscot	18	125,300	6,961	0	0		396	1,525,961	3,853	45	458,185	10,182	459	2,109,446	4,596
St Croix	36	270,700	7,519	0	0		0	0		0	0		36	270,700	7,519
Union	600	4,610,865	7,685	0	0		0	0		0	0		600	4,610,865	7,685
Grand Total	**20,962**	**182,626,331**	**8,712**	**28,567**	**161,854,26**	**5,666**	**3,500**	**13,054,323**	**3,730**	**1,984**	**24,816,552**	**12,508**	**55,013**	**382,351,470**	**6,950**

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

	Number of fish stocked by life stage						
	Fry	**0+ Parr**	**1 Parr**	**1+ Parr**	**1 Smolt**	**2 Smolt**	**Total**
Androscoggin							
2001	3,000	0	0	0	0	0	3,000
Totals:Androscoggin	**3,000**	**0**	**0**	**0**	**0**	**0**	**3,000**
Aroostook							
1978-1991	624,000	317,100	20,400	1,800	32,600	29,800	1,025,700
1992	0	0	16,400	0	0	0	16,400
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	4,000	0	0	0	0	0	4,000
1996	0	0	0	0	0	0	0
1997	578,000	0	0	0	0	0	578,000
1998	142,000	0	0	0	0	0	142,000
1999	163,000	0	0	0	0	0	163,000
2000	0	0	0	0	0	0	0
2001	182,000	300	0	0	0	0	182,300
Totals:Aroostook	**1,693,000**	**317,400**	**36,800**	**1,800**	**32,600**	**29,800**	**2,111,400**
Cocheco							
1988-1991	278,000	50,000	9,500	0	0	0	337,500
1992	128,000	0	0	0	0	0	128,000
1993	127,000	0	0	1,000	0	0	128,000
1994	149,000	0	0	0	5,300	0	154,300
1995	114,000	0	0	0	0	0	114,000
1996	126,000	0	0	0	0	0	126,000
1997	128,000	0	0	0	0	0	128,000
1998	96,000	0	0	0	0	0	96,000
1999	157,000	0	0	0	0	0	157,000
2000	146,000	0	0	0	0	0	146,000
2001	165,000	0	0	0	0	0	165,000
Totals:Cocheco	**1,614,000**	**50,000**	**9,500**	**1,000**	**5,300**	**0**	**1,679,800**
Connecticut							
1967-1991	9,315,000	2,206,900	1,524,900	218,700	2,658,100	963,200	16,886,800
1992	2,009,000	313,900	11,500	0	313,300	0	2,647,700
1993	4,147,000	237,100	28,700	0	382,800	0	4,795,600
1994	5,979,000	37,000	2,300	12,900	375,100	0	6,406,300
1995	6,818,000	4,500	0	0	1,300	0	6,823,800
1996	6,675,000	12,400	0	3,600	11,500	0	6,702,500
1997	8,526,000	8,800	0	0	1,400	0	8,536,200
1998	9,119,000	3,000	0	7,700	1,700	0	9,131,400
1999	6,428,000	1,000	0	0	22,600	0	6,451,600
2000	9,328,000	600	0	0	700	48,200	9,377,500
2001	9,585,472	1,611	0	0	1,037	0	9,588,120
Totals:Connecticut	**77,929,472**	**2,826,811**	**1,567,400**	**242,900**	**3,769,537**	**1,011,400**	**87,347,520**
Dennys							
1975-1991	131,000	8,300	3,400	0	143,100	28,300	314,100

Number of fish stocked by life stage

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
1992	0	0	0	0	0	0	0
1993	33,000	0	0	0	0	0	33,000
1994	20,000	0	0	0	0	0	20,000
1995	84,000	0	0	0	0	0	84,000
1996	142,000	0	0	0	0	900	142,900
1997	192,000	0	0	0	0	0	192,000
1998	233,000	10,400	0	0	9,600	0	253,000
1999	172,000	3,000	0	0	0	0	175,000
2000	96,000	30,500	0	0	0	0	126,500
2001	59,000	16,500	1,400	0	49,800	0	126,700
Totals:Dennys	**1,162,000**	**68,700**	**4,800**	**0**	**202,500**	**29,200**	**1,467,200**
Ducktrap							
1986-1991	68,000	0	0	0	0	0	68,000
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0
Totals:Ducktrap	**68,000**	**0**	**0**	**0**	**0**	**0**	**68,000**
East Machias							
1973-1991	140,000	6,500	42,600	0	97,600	30,400	317,100
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0
1996	115,000	0	0	0	0	0	115,000
1997	113,000	0	0	0	0	0	113,000
1998	190,000	0	0	0	10,800	0	200,800
1999	210,000	1,000	0	0	0	0	211,000
2000	197,000	0	0	0	0	0	197,000
2001	242,000	0	0	0	0	0	242,000
Totals:East Machias	**1,207,000**	**7,500**	**42,600**	**0**	**108,400**	**30,400**	**1,395,900**
Kennebec							
2001	3,000	0	0	0	0	0	3,000
Totals:Kennebec	**3,000**	**0**	**0**	**0**	**0**	**0**	**3,000**
Lamprey							
1978-1991	306,000	155,200	11,400	0	118,300	32,800	623,700
1992	127,000	12,700	0	0	0	0	139,700
1993	68,000	56,500	28,800	1,100	15,000	0	169,400
1994	98,000	56,300	7,800	0	0	0	162,100
1995	91,000	57,100	0	0	4,800	0	152,900
1996	115,000	37,000	8,400	1,000	0	0	161,400

Number of fish stocked by life stage

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
1997	141,000	52,900	0	0	0	0	193,900
1998	95,000	0	0	0	3,300	0	98,300
1999	127,000	0	0	0	0	0	127,000
2000	104,000	0	0	0	0	0	104,000
2001	111,000	0	0	300	0	0	111,300
Totals:Lamprey	**1,383,000**	**427,700**	**56,400**	**2,400**	**141,400**	**32,800**	**2,043,700**
Machias							
1970-1991	175,000	86,900	117,800	0	180,500	42,200	602,400
1992	14,000	0	0	0	0	0	14,000
1993	0	0	0	0	0	0	0
1994	50,000	0	0	0	0	0	50,000
1995	150,000	0	0	0	0	0	150,000
1996	233,000	0	0	0	0	1,900	234,900
1997	236,000	0	0	0	0	0	236,000
1998	300,000	5,900	0	0	10,800	0	316,700
1999	169,000	1,000	0	0	0	0	170,000
2000	209,000	0	0	0	0	0	209,000
2001	267,000	0	0	0	0	0	267,000
Totals:Machias	**1,803,000**	**93,800**	**117,800**	**0**	**191,300**	**44,100**	**2,250,000**
Merrimack							
1976-1991	8,021,000	222,500	398,700	157,300	695,400	630,500	10,125,400
1992	1,118,000	0	100	0	96,400	0	1,214,500
1993	1,157,000	0	0	0	59,000	0	1,216,000
1994	2,816,000	0	0	0	85,000	0	2,901,000
1995	2,827,000	0	12,700	0	70,800	0	2,910,500
1996	1,795,000	0	0	4,900	50,000	0	1,849,900
1997	1,977,000	5,000	4,700	5,300	52,500	5,400	2,049,900
1998	2,589,000	0	0	6,800	51,900	0	2,647,700
1999	1,756,013	0	0	4,350	56,407	0	1,816,770
2000	2,217,000	0	0	0	52,500	0	2,269,500
2001	1,707,615	0	0	0	49,500	0	1,757,115
Totals:Merrimack	**27,980,628**	**227,500**	**416,200**	**178,650**	**1,319,407**	**635,900**	**30,758,285**
Narraguagus							
1970-1991	74,000	30,300	12,600	0	106,100	84,000	307,000
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	105,000	0	0	0	0	0	105,000
1996	196,000	0	0	0	0	0	196,000
1997	207,000	0	2,000	0	700	0	209,700
1998	274,000	14,400	0	0	0	0	288,400
1999	155,000	18,200	0	0	1,000	0	174,200
2000	252,000	0	0	0	0	0	252,000
2001	353,000	0	0	0	0	0	353,000
Totals:Narraguagus	**1,616,000**	**62,900**	**14,600**	**0**	**107,800**	**84,000**	**1,885,300**
Pawcatuck							
1979-1991	163,000	935,600	228,000	0	23,200	500	1,350,300

Number of fish stocked by life stage

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
1992	0	70,800	2,500	0	5,000	0	78,300
1993	383,000	14,500	4,000	0	2,300	0	403,800
1994	557,000	0	0	0	0	0	557,000
1995	367,000	52,200	0	0	0	0	419,200
1996	289,000	136,100	0	0	5,000	0	430,100
1997	100,000	0	14,000	0	11,500	0	125,500
1998	910,000	0	6,100	8,600	5,700	0	930,400
1999	591,000	0	0	0	3,900	0	594,900
2000	326,000	0	0	0	0	0	326,000
2001	423,000	0	0	0	8,500	0	431,500
Totals:Pawcatuck	**4,109,000**	**1,209,200**	**254,600**	**8,600**	**65,100**	**500**	**5,647,000**
Penobscot							
1970-1991	2,733,000	752,200	1,217,800	9,100	5,134,500	2,500,100	12,293,200
1992	925,000	278,200	106,600	0	816,600	8,100	2,134,500
1993	1,320,000	202,300	9,600	0	580,400	0	2,112,300
1994	949,000	0	2,400	0	567,600	0	1,519,000
1995	502,000	325,000	5,600	0	568,400	0	1,401,000
1996	1,242,000	226,000	17,500	0	552,200	0	2,037,700
1997	1,469,000	310,900	4,200	0	580,200	0	2,364,300
1998	930,000	337,400	13,400	0	571,800	0	1,852,600
1999	1,498,000	229,600	1,500	0	567,300	0	2,296,400
2000	513,000	288,800	700	0	563,200	0	1,365,700
2001	364,000	235,800	2,100	0	454,000	0	1,055,900
Totals:Penobscot	**12,445,000**	**3,186,200**	**1,381,400**	**9,100**	**10,956,200**	**2,508,200**	**30,432,600**
Pleasant							
1975-1991	187,000	2,500	1,800	0	54,700	18,100	264,100
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0
Totals:Pleasant	**187,000**	**2,500**	**1,800**	**0**	**54,700**	**18,100**	**264,100**
Saco							
1975-1991	158,000	115,000	200,800	0	143,600	9,500	626,900
1992	154,000	50,200	400	0	19,800	0	224,400
1993	167,000	0	0	0	20,100	0	187,100
1994	190,000	0	0	0	20,000	0	210,000
1995	376,000	0	0	0	19,700	0	395,700
1996	0	45,000	0	0	20,000	0	65,000
1997	97,000	63,300	0	0	20,200	0	180,500
1998	429,000	50,000	0	0	21,300	0	500,300
1999	688,000	47,000	0	0	20,100	0	755,100
2000	599,000	48,200	0	0	22,600	0	669,800

Number of fish stocked by life stage

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
2001	479,000	0	0	0	400	0	479,400
Totals:Saco	**3,337,000**	**418,700**	**201,200**	**0**	**327,800**	**9,500**	**4,294,200**
Sheepscot							
1971-1991	159,000	70,800	20,600	0	92,200	7,100	349,700
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0
1996	102,000	0	0	0	0	0	102,000
1997	64,000	0	0	0	0	0	64,000
1998	256,000	9,300	0	0	0	0	265,300
1999	302,000	4,700	0	0	0	0	306,700
2000	211,000	0	0	0	0	0	211,000
2001	171,000	0	0	0	0	0	171,000
Totals:Sheepscot	**1,265,000**	**84,800**	**20,600**	**0**	**92,200**	**7,100**	**1,469,700**
St Croix							
1981-1991	1,087,000	107,300	143,200	0	580,600	20,100	1,938,200
1992	85,000	56,500	14,900	0	50,300	0	206,700
1993	0	101,000	0	0	40,100	0	141,100
1994	87,000	38,600	0	0	60,600	0	186,200
1995	1,000	0	0	0	0	0	1,000
1996	0	52,100	0	0	15,600	0	67,700
1997	1,000	400	0	0	0	0	1,400
1998	2,000	31,700	0	200	0	0	33,900
1999	1,000	22,500			21,300		
2000	1,000	19,000	0	0	20,000	0	40,000
2001	1,000	6,300	0	0	8,100	0	15,400
Totals:St Croix	**1,266,000**	**435,400**	**158,100**	**200**	**796,600**	**20,100**	**2,631,600**
Union							
1971-1991	21,000	0	0	0	379,700	251,000	651,700
1992	0	0	0	0	0	0	0
1993	60,000	111,700	0	0	0	0	171,700
1994	0	0	0	0	0	0	0
1995	0	54,800	0	0	0	0	54,800
1996	0	53,500	0	0	0	0	53,500
1997	12,000	69,300	0	0	0	0	81,300
1998	165,000	0	0	0	0	0	165,000
1999	165,000	82,100	0	0	0	0	247,100
2000	0	0	0	0	0	0	0
2001	2,000	0	0	0	0	0	2,000
Totals:Union	**425,000**	**371,400**	**0**	**0**	**379,700**	**251,000**	**1,427,100**
Upper StJohn							
1979-1991	838,000	1,001,800	14,700	0	5,100	27,700	1,887,300
1992	400,000	136,100	0	0	0	0	536,100
1993	361,000	102,800	0	0	0	0	463,800
1994	566,000	216,000	0	0	0	0	782,000
1995	0	0	0	0	0	0	0

Number of fish stocked by life stage

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
1996	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0
Totals:Upper StJohn	**2,165,000**	**1,456,700**	**14,700**	**0**	**5,100**	**27,700**	**3,669,200**

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

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

	Fry	0+ Parr	1 Parr	1+ Parr	1 Smolt	2 Smolt	Total
Androscoggin	3,000	0	0	0	0	0	**3,000**
Aroostook	1,693,000	317,400	36,800	1,800	32,600	29,800	**2,111,400**
Cocheco	1,614,000	50,000	9,500	1,000	5,300	0	**1,679,800**
Connecticut	77,929,472	2,826,811	1,567,400	242,900	3,769,537	1,011,400	**87,347,520**
Dennys	1,162,000	68,700	4,800	0	202,500	29,200	**1,467,200**
Ducktrap	68,000	0	0	0	0	0	**68,000**
East Machias	1,207,000	7,500	42,600	0	108,400	30,400	**1,395,900**
Kennebec	3,000	0	0	0	0	0	**3,000**
Lamprey	1,383,000	427,700	56,400	2,400	141,400	32,800	**2,043,700**
Machias	1,803,000	93,800	117,800	0	191,300	44,100	**2,250,000**
Merrimack	27,980,628	227,500	416,200	178,650	1,319,407	635,900	**30,758,285**
Narraguagus	1,616,000	62,900	14,600	0	107,800	84,000	**1,885,300**
Pawcatuck	4,109,000	1,209,200	254,600	8,600	65,100	500	**5,647,000**
Penobscot	12,445,000	3,186,200	1,381,400	9,100	10,956,200	2,508,200	**30,432,600**
Pleasant	187,000	2,500	1,800	0	54,700	18,100	**264,100**
Saco	3,337,000	418,700	201,200	0	327,800	9,500	**4,294,200**
Sheepscot	1,265,000	84,800	20,600	0	92,200	7,100	**1,469,700**
St Croix	1,266,000	410,100	158,100	200	796,600	20,100	**2,606,300**
Union	425,000	371,400	0	0	379,700	251,000	**1,427,100**
Upper StJohn	2,165,000	1,456,700	14,700	0	5,100	27,700	**3,669,200**
TOTALS	**141,661,100**	**11,221,911**	**4,298,500**	**444,650**	**18,555,644**	**4,739,800**	**180,823,305**

Summaries for each river vary by length of time series.

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

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

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Androscoggin									
1983-1991	17	410	5	1	2	43	0	1	**479**
1992	2	9	0	0	1	3	0	0	**15**
1993	1	33	0	0	1	9	0	0	**44**
1994	2	16	0	1	0	6	0	0	**25**
1995	2	12	0	0	0	2	0	0	**16**
1996	2	19	1	0	1	16	0	0	**39**
1997	0	0	0	0	0	1	0	0	**1**
1998	0	4	0	0	0	0	0	0	**4**
1999	0	1	0	0	1	3	0	0	**5**
2000	0	3	0	0	0	0	0	0	**3**
2001	1	4	0	0	0	0	0	0	**5**
Total for Androscoggin	27	511	6	2	6	83	0	1	**636**
Cocheco									
1990-1991									
1992	0	0	0	0	0	1	0	0	**1**
1993	0	0	1	1	1	2	0	0	**5**
1994	0	0	0	0	0	0	0	0	**0**
1995	0	0	0	0	0	1	0	0	**1**
1996	0	0	0	0	2	0	0	0	**2**
1997	0	0	0	0	0	0	0	0	**0**
1998	0	0	0	0	0	0	0	0	**0**
1999	0	0	0	0	2	1	0	0	**3**
2000	0	0	0	0	0	2	0	0	**2**
2001	0	0	0	0	0	0	0	0	**0**
Total for Cocheco	0	0	1	1	5	7	0	0	**14**
Connecticut									
1969-1991	30	2,447	27	0	3	207	6	0	**2,720**
1992	3	353	1	0	5	127	1	0	**490**
1993	0	136	0	0	0	61	1	0	**198**
1994	1	263	0	1	0	61	0	0	**326**
1995	1	158	0	0	0	29	0	0	**188**
1996	0	143	0	0	5	111	0	1	**260**
1997	0	0	0	1	6	191	1	0	**199**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1998	0	0	0	0	10	288	0	2	**300**
1999	0	0	0	0	11	142	0	1	**154**
2000	0	0	0	0	1	76	0	0	**77**
2001	1	0	0	0	4	34	1	0	**40**
Total for Connecticut	36	3,500	28	2	45	1327	10	4	**4,952**
Dennys									
1967-1991	13	289	0	1	18	706	3	10	**1,040**
1992	1	3	0	0	0	1	0	0	**5**
1993	7	2	0	0	0	4	0	0	**13**
1994	0	0	0	0	1	5	0	0	**6**
1995	0	0	0	0	0	5	0	0	**5**
1996	0	0	0	0	3	7	0	0	**10**
1997	0	0	0	0	0	0	0	0	**0**
1998	0	0	0	0	0	1	0	0	**1**
1999									
2000	1	1	0	0	0	0	0	0	**2**
2001	2	4	0	0	2	9	0	0	**17**
Total for Dennys	24	299	0	1	24	738	3	10	**1,099**
Ducktrap									
1985-1991	0	0	0	0	3	30	0	0	**33**
1992	0	0	0	0	0	0	0	0	**0**
1993	0	0	0	0	0	0	0	0	**0**
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001									
Total for Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias									
1967-1991	21	244	1	2	12	329	1	10	**620**
1992	0	6	0	0	0	0	0	0	**6**
1993	0	0	0	0	0	0	0	0	**0**
1994									
1995									
1996									
1997									

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1998									
1999									
2000									
2001									
Total for East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec									
1975-1991	12	187	5	1	0	9	0	0	**214**
1992	0	0	0	0	0	0	0	0	**0**
1993	0	2	0	0	0	0	0	0	**2**
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001									
Total for Kennebec	12	189	5	1	0	9	0	0	**216**
Lamprey									
1979-1991	10	17	1	0	0	0	0	0	**28**
1992	0	0	0	0	0	2	0	0	**2**
1993	0	0	0	0	1	7	0	0	**8**
1994	0	0	0	0	0	3	0	0	**3**
1995	0	0	0	0	0	1	0	0	**1**
1996	0	0	0	0	0	1	0	0	**1**
1997	0	0	0	0	0	0	0	0	**0**
1998	0	0	0	0	0	0	0	0	**0**
1999	0	0	0	0	6	0	0	0	**6**
2000	0	0	0	0	2	2	0	0	**4**
2001	0	0	0	0	0	0	0	0	**0**
Total for Lamprey	10	17	1	0	9	16	0	0	**53**
Machias									
1967-1991	32	324	9	2	32	1,580	41	131	**2,151**
1992	0	3	0	0	0	0	0	0	**3**
1993	0	2	0	0	1	12	0	0	**15**
1994									
1995									
1996									
1997									

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1998									
1999									
2000									
2001									
Total for Machias	32	329	9	2	33	1592	41	131	**2,169**
Merrimack									
1978-1991	120	558	14	0	60	661	23	0	**1,436**
1992	17	66	2	0	14	100	0	0	**199**
1993	0	27	1	1	2	30	0	0	**61**
1994	0	2	0	0	1	18	0	0	**21**
1995	2	18	0	0	0	14	0	0	**34**
1996	11	44	0	3	3	13	0	2	**76**
1997	9	43	0	4	9	5	0	1	**71**
1998	11	45	1	0	19	47	0	0	**123**
1999	46	65	1	0	9	64	0	0	**185**
2000	26	32	0	0	1	23	0	0	**82**
2001	5	73	0	0	2	3	0	0	**83**
Total for Merrimack	247	973	19	8	120	978	23	3	**2,371**
Narraguagus									
1967-1991	83	601	19	47	30	2,029	68	124	**3,001**
1992	6	19	0	1	11	32	0	4	**73**
1993	0	16	0	4	6	66	0	2	**94**
1994	1	0	0	0	4	42	0	4	**51**
1995	0	0	0	0	0	51	0	5	**56**
1996	1	7	0	0	9	42	0	5	**64**
1997	0	2	0	0	1	30	0	4	**37**
1998	0	0	0	0	1	18	0	3	**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**
Total for Narraguagus	91	650	19	52	86	2363	70	154	**3,485**
Pawcatuck									
1981-1991	1	127	1	0	0	0	0	0	**129**
1992	0	6	0	0	0	0	0	0	**6**
1993	0	2	0	0	0	1	0	0	**3**
1994	0	2	0	0	0	0	0	0	**2**
1995	0	2	0	0	0	0	0	0	**2**
1996	0	2	0	0	0	0	0	0	**2**
1997	0	0	0	0	0	3	0	0	**3**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1998	0	0	0	0	1	2	0	0	**3**
1999	1	6	0	0	0	4	0	0	**11**
2000	0	1	0	0	0	0	0	0	**1**
2001	0	0	0	0	0	0	0	0	**0**
Total for Pawcatuck	2	148	1	0	1	10	0	0	**162**
Penobscot									
1967-1991	6,419	32,241	192	443	318	1,905	21	49	**41,588**
1992	932	1,174	0	5	27	236	1	4	**2,379**
1993	349	1,279	7	13	22	92	1	6	**1,769**
1994	265	630	2	5	48	93	0	6	**1,049**
1995	158	1,077	7	9	6	84	0	1	**1,342**
1996	482	1,187	6	14	13	335	3	5	**2,045**
1997	241	914	4	13	6	174	2	1	**1,355**
1998	240	796	0	10	29	130	1	4	**1,210**
1999	225	568	0	9	46	110	0	10	**968**
2000	166	265	0	15	17	70	0	2	**535**
2001	191	469	0	2	24	98	2	0	**786**
Total for Penobscot	9,668	40,600	218	538	556	3327	31	88	**55,026**
Pleasant									
1967-1991	5	12	0	0	10	213	2	2	**244**
1992	0	0	0	0	0	0	0	0	**0**
1993	0	0	0	0	0	0	0	0	**0**
1994	0	0	0	0	1	1	0	0	**2**
1995									
1996									
1997	0	0	0	0	0	1	0	0	**1**
1998									
1999									
2000	0	0	0	0	1	2	0	0	**3**
2001	0	0	0	0	1	9	1	0	**11**
Total for Pleasant	5	12	0	0	13	226	3	2	**261**
Saco									
1977-1991	13	253	2	1	0	2	0	0	**271**
1992	0	0	0	0	0	0	0	0	**0**
1993	4	54	0	1	0	0	0	0	**59**
1994	6	17	0	0	0	0	0	0	**23**
1995	0	34	0	0	0	0	0	0	**34**
1996	11	39	1	3	0	0	0	0	**54**
1997	5	23	0	0	0	0	0	0	**28**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	**Total**
1998	9	7	0	0	4	7	1	0	**28**
1999	10	11	0	0	12	31	2	0	**66**
2000	31	14	0	0	0	4	0	0	**49**
2001	15	49	0	0	0	5	0	0	**69**
Total for Saco	104	501	3	5	16	49	3	0	**681**
Sheepscot									
1967-1991	5	20	0	0	26	314	9	0	**374**
1992	1	2	0	0	1	2	1	0	**7**
1993	0	9	0	0	0	0	0	0	**9**
1994	0	5	0	0	3	12	0	0	**20**
1995	0	2	0	0	0	22	0	0	**24**
1996	0	0	0	0		8	0	0	**8**
1997	0	0	0	0	0	0	0	0	**0**
1998									
1999									
2000									
2001									
Total for Sheepscot	6	38	0	0	30	358	10	0	**442**
St Croix									
1981-1991	576	894	38	11	375	576	39	15	**2,524**
1992	1	0	0	0	0	0	0	0	**1**
1993	5	76	0	0	4	18	0	2	**105**
1994	23	17	0	1	24	19	0	0	**84**
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**
Total for St Croix	695	1,103	38	12	440	670	39	17	**3,014**
Union									
1973-1991	290	1,730	9	24	1	11	0	0	**2,065**
1992	0	4	0	0	0	0	0	0	**4**
1993	0	0	0	0	0	0	0	0	**0**
1994									
1995									
1996	6	62	0	0	0	1	0	0	**69**
1997	0	8	0	0	0	0	0	0	**8**

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	**2SW**	**3SW**	**REPEAT**	**1SW**	**2SW**	**3SW**	**REPEAT**	**Total**
1998	2	7	0	4	0	0	0	0	**13**
1999	3	3	0	0	0	3	0	0	**9**
2000	1	1	0	0	0	0	0	0	**2**
2001	0	0	0	0	0	0	0	0	**0**
Total for Union	302	1,815	9	28	1	15	0	0	**2,170**

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

Totals reflect the entirety of the available historical time series for each river. Earliest year of data for Penobscot, Narraguagus, 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	511	6	2	6	83	0	1	**636**
Cocheco	0	0	1	1	5	7	0	0	**14**
Connecticut	36	3,500	28	2	45	1,327	10	4	**4,952**
Dennys	24	299	0	1	24	738	3	10	**1,099**
Ducktrap	0	0	0	0	3	30	0	0	**33**
East Machias	21	250	1	2	12	329	1	10	**626**
Kennebec	12	189	5	1	0	9	0	0	**216**
Lamprey	10	17	1	0	9	16	0	0	**53**
Machias	32	329	9	2	33	1,592	41	131	**2,169**
Merrimack	247	973	19	8	120	978	23	3	**2,371**
Narraguagus	91	650	19	52	86	2,363	70	154	**3,485**
Pawcatuck	2	148	1	0	1	10	0	0	**162**
Penobscot	9,668	40,600	218	538	556	3,327	31	88	**55,026**
Pleasant	5	12	0	0	13	226	3	2	**261**
Saco	104	501	3	5	16	49	3	0	**681**
Sheepscot	6	38	0	0	30	358	10	0	**442**
St Croix	695	1,103	38	12	440	670	39	17	**3,014**
Union	302	1,815	9	28	1	15	0	0	**2,170**

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

				Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
Year	**Total Fry (1000s)**	**Total Returns**	**Returns (per 10,000 fry)**	**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	25	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1980	89	18	2.022	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1981	151	19	1.261	0%	0%	0%	11%	89%	0%	0%	0%	0%	0%	0%	11%	89%	0%	0%
1982	128	31	2.429	0%	0%	0%	0%	90%	10%	0%	0%	0%	0%	0%	0%	90%	10%	0%
1983	70	1	0.143	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1984	455	1	0.022	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
1985	286	35	1.224	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1986	97	27	2.791	0%	0%	0%	4%	96%	0%	0%	0%	0%	0%	0%	4%	96%	0%	0%
1987	981	44	0.449	0%	16%	0%	0%	68%	2%	0%	14%	0%	0%	0%	16%	68%	16%	0%
1988	928	92	0.992	0%	0%	0%	0%	97%	1%	0%	2%	0%	0%	0%	0%	97%	3%	0%
1989	747	47	0.629	0%	6%	0%	6%	85%	0%	0%	2%	0%	0%	0%	13%	85%	2%	0%
1990	765	53	0.693	0%	13%	0%	0%	87%	0%	0%	0%	0%	0%	0%	13%	87%	0%	0%
1991	982	25	0.255	0%	20%	0%	0%	64%	0%	0%	16%	0%	0%	0%	20%	64%	16%	0%
1992	929	84	0.904	0%	1%	0%	0%	85%	1%	0%	13%	0%	0%	0%	1%	85%	14%	0%
1993	2,607	94	0.361	0%	0%	0%	2%	87%	0%	0%	11%	0%	0%	0%	2%	87%	11%	0%
1994	3,925	197	0.502	0%	0%	0%	1%	93%	0%	0%	6%	0%	0%	0%	1%	93%	6%	0%
1995	4,507	83	0.184	0%	2%	0%	6%	89%	0%	0%	2%	0%	0%	0%	8%	89%	2%	0%
1996	4,780	55	0.115	0%	4%	0%	5%	89%	2%	0%	0%			0%	9%	89%	2%	
1997	5,885	22	0.037	0%	0%	0%	5%	95%		0%				0%	5%	95%		
1998	661	2	0.030	0%	0%		100%							0%	100%			
Total	**29,171**	**937**																
Mean			**0.658**	**0%**	**7%**	**0%**	**6%**	**63%**	**5%**	**0%**	**3%**	**0%**	**0%**	**0%**	**12%**	**63%**	**8%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

Table 5.3.c.2: Return rates for Atlantic salmon that were stocked as fry in the Connecticut (basin) River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1974	16	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	32	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	27	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1977	50	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1978	50	7	1.400	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1979	54	3	0.561	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1980	286	18	0.630	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1981	168	19	1.129	0%	0%	0%	11%	89%	0%	0%	0%	0%	0%	0%	11%	89%	0%	0%
1982	294	46	1.565	0%	0%	0%	0%	89%	11%	0%	0%	0%	0%	0%	0%	89%	11%	0%
1983	226	2	0.088	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1984	584	3	0.051	0%	0%	0%	0%	33%	33%	0%	33%	0%	0%	0%	0%	33%	67%	0%
1985	422	47	1.113	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1986	176	28	1.592	0%	0%	0%	4%	96%	0%	0%	0%	0%	0%	0%	4%	96%	0%	0%
1987	1,169	51	0.436	0%	18%	0%	0%	67%	2%	0%	14%	0%	0%	0%	18%	67%	16%	0%
1988	1,310	108	0.825	0%	0%	0%	0%	97%	1%	0%	2%	0%	0%	0%	0%	97%	3%	0%
1989	1,243	67	0.539	0%	22%	0%	7%	69%	0%	0%	1%	0%	0%	0%	30%	69%	1%	0%
1990	1,346	68	0.505	0%	19%	0%	0%	79%	0%	0%	1%	0%	0%	0%	19%	79%	1%	0%
1991	1,724	35	0.203	0%	17%	0%	0%	63%	0%	0%	20%	0%	0%	0%	17%	63%	20%	0%
1992	2,009	118	0.587	0%	5%	0%	0%	82%	1%	0%	12%	0%	0%	0%	5%	82%	13%	0%
1993	4,147	185	0.446	0%	4%	0%	3%	87%	0%	0%	6%	0%	0%	0%	6%	87%	6%	0%
1994	5,978	294	0.492	0%	5%	0%	2%	88%	0%	0%	5%	0%	0%	0%	7%	88%	5%	0%
1995	6,817	143	0.210	1%	13%	0%	7%	78%	0%	0%	2%	0%	0%	1%	20%	78%	2%	0%
1996	6,677	101	0.151	0%	16%	0%	11%	71%	1%	0%	1%			0%	27%	71%	2%	
1997	8,526	35	0.041	0%	3%	0%	3%	94%		0%				0%	6%	94%		
1998	3,133	4	0.013	0%	0%		100%							0%	100%			
Total	**46,461**	**1,382**																
Mean			**0.503**	**0%**	**13%**	**0%**	**6%**	**62%**	**2%**	**0%**	**4%**	**0%**	**0%**	**0%**	**19%**	**62%**	**6%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

Table 5.3.c.3: Return rates for Atlantic salmon that were stocked as fry in the Farmington River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1979	29	3	1.034	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1980	197	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1981	18	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1982	166	15	0.902	0%	0%	0%	0%	87%	13%	0%	0%	0%	0%	0%	0%	87%	13%	0%
1983	157	1	0.064	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1984	128	2	0.156	0%	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%	50%	50%	0%
1985	136	12	0.881	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1986	79	1	0.126	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1987	68	5	0.740	0%	0%	0%	0%	80%	0%	0%	20%	0%	0%	0%	0%	80%	20%	0%
1988	333	13	0.391	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1989	279	19	0.680	0%	63%	0%	11%	26%	0%	0%	0%	0%	0%	0%	74%	26%	0%	0%
1990	270	11	0.407	0%	45%	0%	0%	45%	0%	0%	9%	0%	0%	0%	45%	45%	9%	0%
1991	265	2	0.076	0%	50%	0%	0%	0%	0%	0%	50%	0%	0%	0%	50%	0%	50%	0%
1992	553	15	0.271	0%	20%	0%	0%	67%	0%	0%	13%	0%	0%	0%	20%	67%	13%	0%
1993	772	52	0.673	0%	13%	0%	6%	77%	0%	0%	4%	0%	0%	0%	19%	77%	4%	0%
1994	1,097	49	0.447	0%	31%	0%	4%	63%	0%	0%	2%	0%	0%	0%	35%	63%	2%	0%
1995	1,146	42	0.367	2%	38%	0%	5%	52%	0%	0%	2%	0%	0%	2%	43%	52%	2%	0%
1996	912	19	0.208	0%	58%	0%	11%	26%	0%	0%	5%			0%	68%	26%	5%	
1997	1,480	4	0.027	0%	0%	0%	0%	100%		0%				0%	0%	100%		
Total	**8,084**	**265**																
Mean			**0.392**	**0%**	**27%**	**0%**	**2%**	**51%**	**1%**	**0%**	**9%**	**0%**	**0%**	**0%**	**29%**	**51%**	**9%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

Table 5.3.c.4: Return rates for Atlantic salmon that were stocked as fry in the Merrimack River .

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%) 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
1975	36			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	63			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1977	72			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1978	106	18	1.697	0%	0%	0%	0%	11%	33%	22%	28%	6%	0%	0%	0%	33%	61%	6%
1979	77	43	5.592	0%	0%	0%	0%	84%	5%	2%	9%	0%	0%	0%	0%	86%	14%	0%
1980	126	43	3.426	0%	0%	0%	0%	19%	5%	21%	51%	5%	0%	0%	0%	40%	56%	5%
1981	57	81	14.211	0%	0%	0%	10%	78%	0%	5%	7%	0%	0%	0%	10%	83%	7%	0%
1982	50	48	9.600	0%	0%	2%	2%	77%	8%	0%	10%	0%	0%	0%	2%	79%	19%	0%
1983	8	23	27.479	0%	4%	4%	17%	65%	4%	0%	4%	0%	0%	0%	22%	70%	9%	0%
1984	526	47	0.894	0%	13%	0%	4%	77%	2%	0%	4%	0%	0%	0%	17%	77%	6%	0%
1985	148	59	3.977	0%	2%	0%	7%	69%	2%	0%	20%	0%	0%	0%	8%	69%	22%	0%
1986	525	110	2.097	0%	11%	0%	0%	78%	1%	0%	8%	0%	2%	0%	11%	78%	9%	2%
1987	1,078	278	2.578	0%	2%	0%	8%	86%	0%	0%	4%	0%	0%	0%	10%	86%	4%	0%
1988	1,718	95	0.553	1%	5%	0%	0%	91%	0%	0%	3%	0%	0%	1%	5%	91%	3%	0%
1989	1,034	43	0.416	0%	7%	0%	30%	63%	0%	0%	0%	0%	0%	0%	37%	63%	0%	0%
1990	975	21	0.215	5%	0%	0%	10%	81%	0%	0%	5%	0%	0%	5%	10%	81%	5%	0%
1991	1,458	17	0.117	0%	6%	0%	6%	76%	12%	0%	0%	0%	0%	0%	12%	76%	12%	0%
1992	1,118	14	0.125	0%	0%	0%	0%	93%	7%	0%	0%	0%	0%	0%	0%	93%	7%	0%
1993	1,157	11	0.095	0%	0%	0%	27%	45%	0%	9%	18%	0%	0%	0%	27%	55%	18%	0%
1994	2,816	54	0.192	0%	0%	0%	15%	83%	0%	0%	2%	0%	0%	0%	15%	83%	2%	0%
1995	2,827	87	0.308	0%	0%	0%	22%	72%	0%	6%	0%	0%	0%	0%	22%	78%	0%	0%
1996	1,795	27	0.150	0%	0%	0%	15%	85%	0%	0%	0%			0%	15%	85%	0%	
1997	2,000	4	0.020	0%	0%	0%	25%	75%		0%				0%	25%	75%		
1998	2,589	2	0.008	0%	0%		100%							0%	100%			
Total	**22,359**	**1,125**																
Mean			**3.512**	**0%**	**2%**	**0%**	**12%**	**61%**	**4%**	**3%**	**8%**	**0%**	**0%**	**0%**	**15%**	**64%**	**12%**	**1%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

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

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%) 1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	Age (years) dist'n (%) 2	3	4	5	6
1993	383	3	0.078	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1994	351	2	0.057	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1995	367	5	0.136	0%	0%	0%	20%	80%	0%	0%	0%	0%	0%	0%	20%	80%	0%	0%
1996	289	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1997	100	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	**1,490**	**10**																
Mean			**0.054**	**0%**	**0%**	**0%**	**4%**	**56%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**4%**	**56%**	**0%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

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

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1987	121	2	0.165	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
1988	43	3	0.693	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1989	111	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1990	38	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1991	25	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1992	124	4	0.322	0%	50%	0%	0%	50%	0%	0%	0%	0%	0%	0%	50%	50%	0%	0%
1993	105	2	0.190	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1994	241	4	0.166	0%	25%	0%	0%	75%	0%	0%	0%	0%	0%	0%	25%	75%	0%	0%
1995	242	1	0.041	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1996	247	15	0.607	0%	20%	0%	33%	47%	0%	0%	0%			0%	53%	47%	0%	
1997	223	3	0.134	0%	33%	0%	0%	67%		0%				0%	33%	67%		
Total	**1,522**	**34**																
Mean			**0.211**	**0%**	**21%**	**0%**	**3%**	**49%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**24%**	**49%**	**0%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

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

Year	Total Fry (1000s)	Total Returns	Returns (per 10,000 fry)	Age class (smolt age.sea age) distribution (%)										Age (years) dist'n (%)				
				1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2	2	3	4	5	6
1988	6	0	0.000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1989	106	1	0.095	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1990	274	4	0.146	0%	25%	0%	0%	75%	0%	0%	0%	0%	0%	0%	25%	75%	0%	0%
1991	454	8	0.176	0%	0%	0%	0%	75%	0%	0%	25%	0%	0%	0%	0%	75%	25%	0%
1992	402	15	0.373	0%	0%	0%	0%	93%	0%	0%	7%	0%	0%	0%	0%	93%	7%	0%
1993	662	37	0.559	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
1994	674	44	0.652	0%	0%	0%	2%	91%	0%	0%	7%	0%	0%	0%	2%	91%	7%	0%
1995	885	17	0.192	0%	0%	0%	18%	82%	0%	0%	0%	0%	0%	0%	18%	82%	0%	0%
1996	706	12	0.170	0%	0%	0%	8%	92%	0%	0%	0%			0%	8%	92%	0%	
1997	909	6	0.066	0%	0%	0%	0%	100%		0%				0%	0%	100%		
1998	1,022	2	0.020	0%	0%		100%							0%	100%			
Total	**6,099**	**146**																
Mean			**0.223**	**0%**	**2%**	**0%**	**12%**	**81%**	**0%**	**0%**	**4%**	**0%**	**0%**	**0%**	**14%**	**81%**	**4%**	**0%**

Mean return rate computation includes incomplete return rates for 1997- and 1998-year class fish.

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

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

Year Stocked	Number adult returns per 10,000 fry stocked						
	Merrimac	Pawcatuck	CT Basin	Connecticut (above Holyoke)	Salmon	Farmington	Westfield
1974			0.000	0.000			
1975	0.000		0.000	0.000			
1976	0.000		0.000	0.000			
1977	0.000		0.000	0.000			
1978	1.697		1.400	1.400			
1979	5.592		0.561	0.000		1.034	
1980	3.426		0.630	2.022		0.000	
1981	14.211		1.129	1.261		0.000	
1982	9.600		1.565	2.429		0.902	
1983	27.479		0.088	0.143		0.064	
1984	0.894		0.051	0.022		0.156	
1985	3.977		1.113	1.224		0.881	
1986	2.097		1.592	2.791		0.126	
1987	2.578		0.436	0.449	0.165	0.740	
1988	0.553		0.825	0.992	0.693	0.391	0.000
1989	0.416		0.539	0.629	0.000	0.680	0.095
1990	0.215		0.505	0.693	0.000	0.407	0.146
1991	0.117		0.203	0.255	0.000	0.076	0.176
1992	0.125		0.587	0.904	0.322	0.271	0.373
1993	0.095	0.078	0.446	0.361	0.190	0.673	0.559
1994	0.192	0.057	0.492	0.502	0.166	0.447	0.652
1995	0.308	0.136	0.210	0.184	0.041	0.367	0.192
1996	0.150	0.000	0.151	0.115	0.607	0.208	0.170
1997	0.020	0.000	0.041	0.037	0.134	0.027	0.066
1998	0.008		0.013	0.030			0.020
Mean	**3.073**	**0.054**	**0.503**	**0.658**	**0.211**	**0.392**	**0.223**
StndDev	**6.244**	**0.057**	**0.507**	**0.801**	**0.240**	**0.335**	**0.215**

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

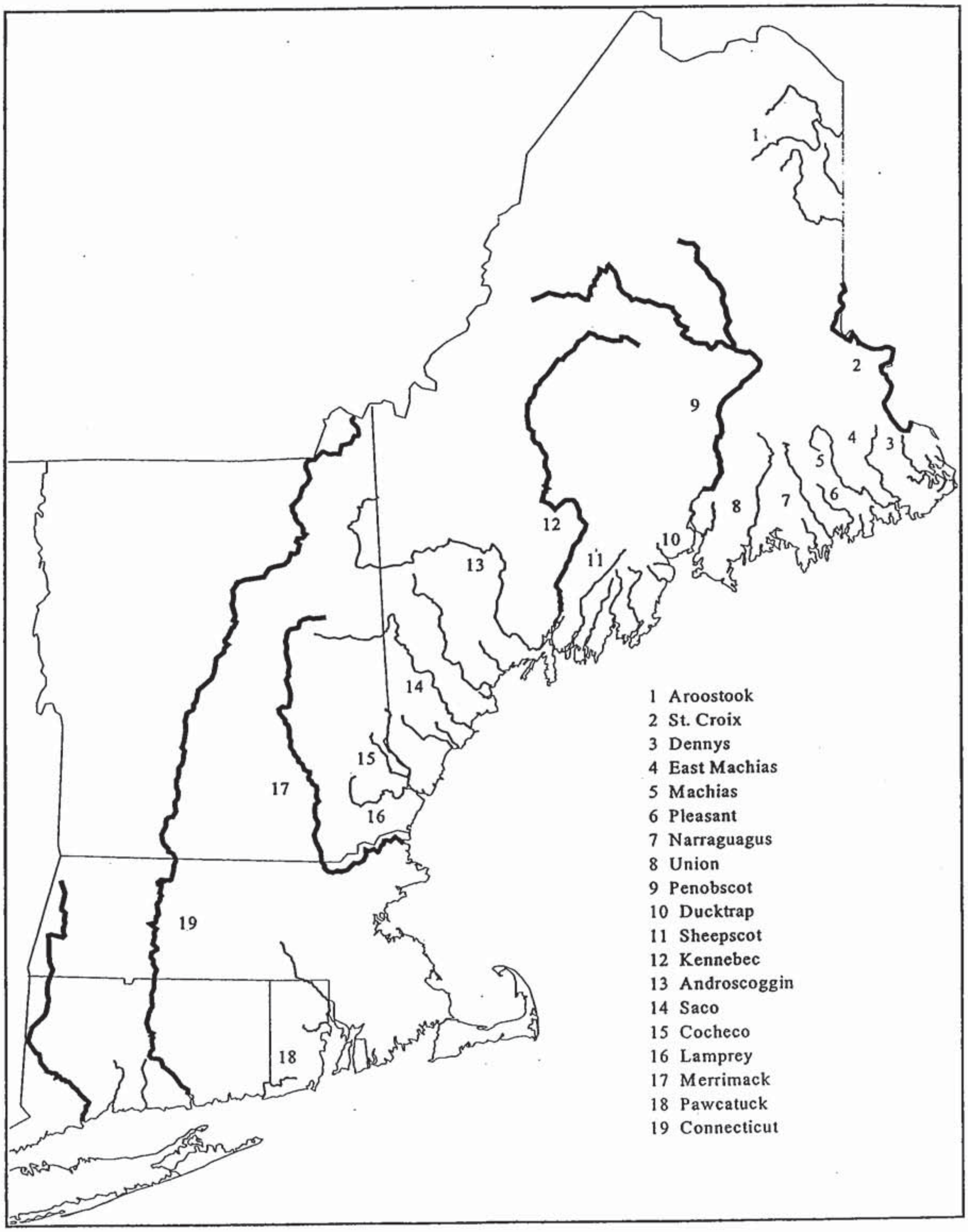
Note: Summary mean and standard deviation computations includes incomplete return rates from 1997 (5 year olds) and 1998 (4 year olds).

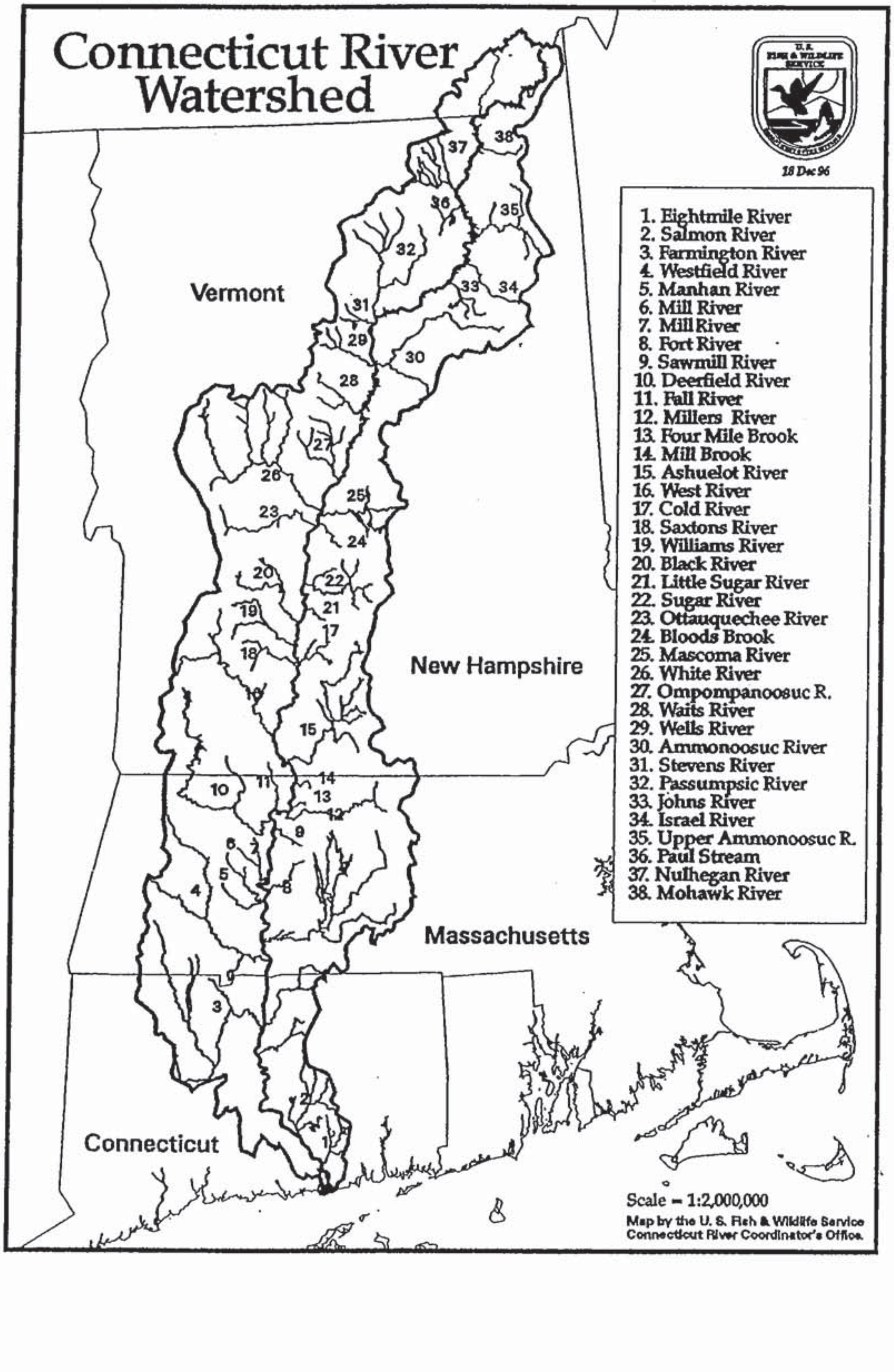
Table 5.3.e. Summary of age distributions of adult Atlantic salmon that were stocked in southern New England as fry.

	Mean age class (smolt age.sea age) distribution										Mean age (years) (%)				
	1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.2**	**2**	**3**	**4**	**5**	**6**
Connecticut (above Holyoke)	0.0%	3.0%	0.0%	2.2%	88.9%	0.9%	0.0%	5.0%	0.0%	0.0%	0.0%	5.2%	88.9%	5.9%	0.0%
CT Basin	0.1%	8.1%	0.0%	3.2%	83.3%	0.7%	0.0%	4.6%	0.0%	0.0%	0.1%	11.3%	83.3%	5.4%	0.0%
Farmington	0.4%	27.9%	0.0%	4.2%	62.6%	0.8%	0.0%	4.2%	0.0%	0.0%	0.4%	32.1%	62.6%	4.9%	0.0%
Salmon	0.0%	26.5%	0.0%	14.7%	58.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	41.2%	58.8%	0.0%	0.0%
Westfield	0.0%	0.7%	0.0%	4.8%	90.4%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	5.5%	90.4%	4.1%	0.0%
Merrimack	0.2%	3.1%	0.2%	8.4%	76.2%	1.9%	2.1%	7.5%	0.3%	0.2%	0.2%	11.6%	78.5%	9.3%	0.4%
Overall Mean:	**0.1%**	**11.5%**	**0.0%**	**6.3%**	**76.7%**	**0.7%**	**0.4%**	**4.2%**	**0.0%**	**0.0%**	**0.1%**	**17.8%**	**77.1%**	**4.9%**	**0.1%**

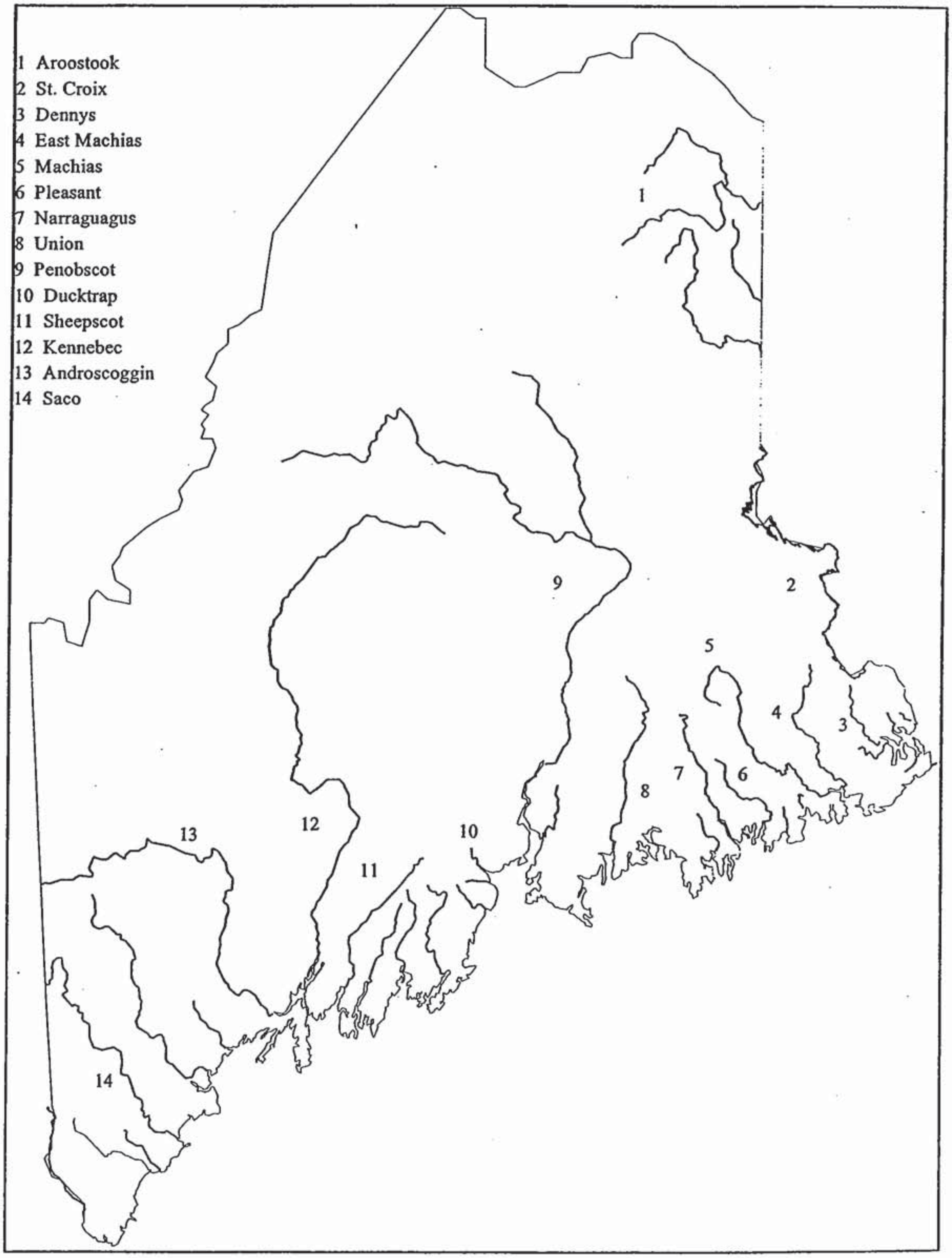
Program summary age distributions vary in time series length; refer to specific tables for numbers of years utilized.
Note: Maine rivers not reported until adult returns from natural reproduction and fry stocking can be distinguished.

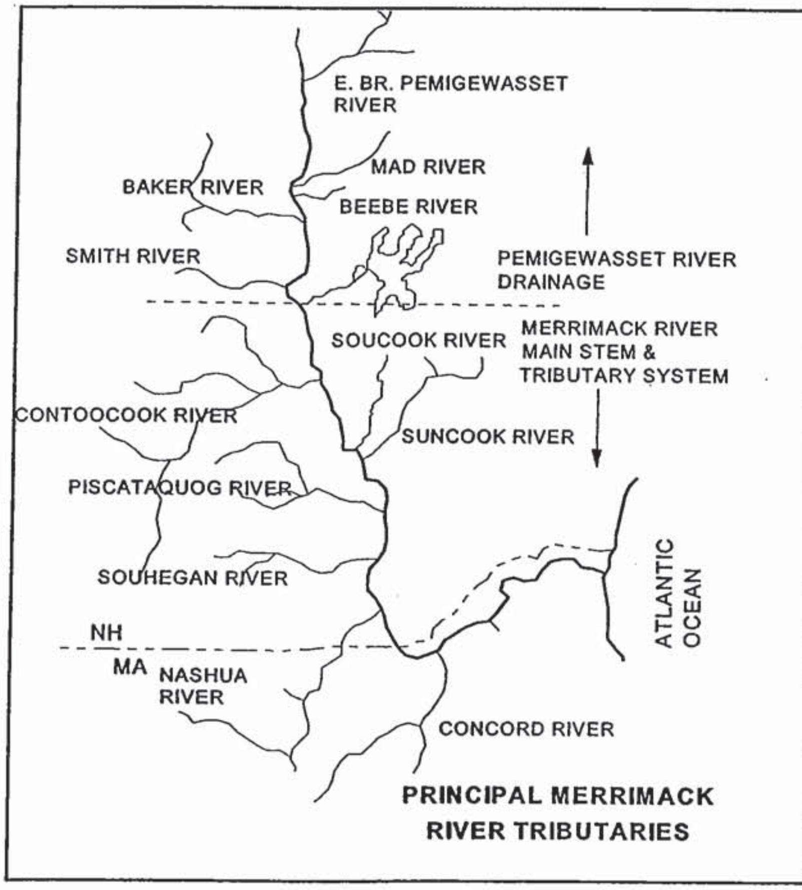
Important Atlantic Salmon Rivers of New England



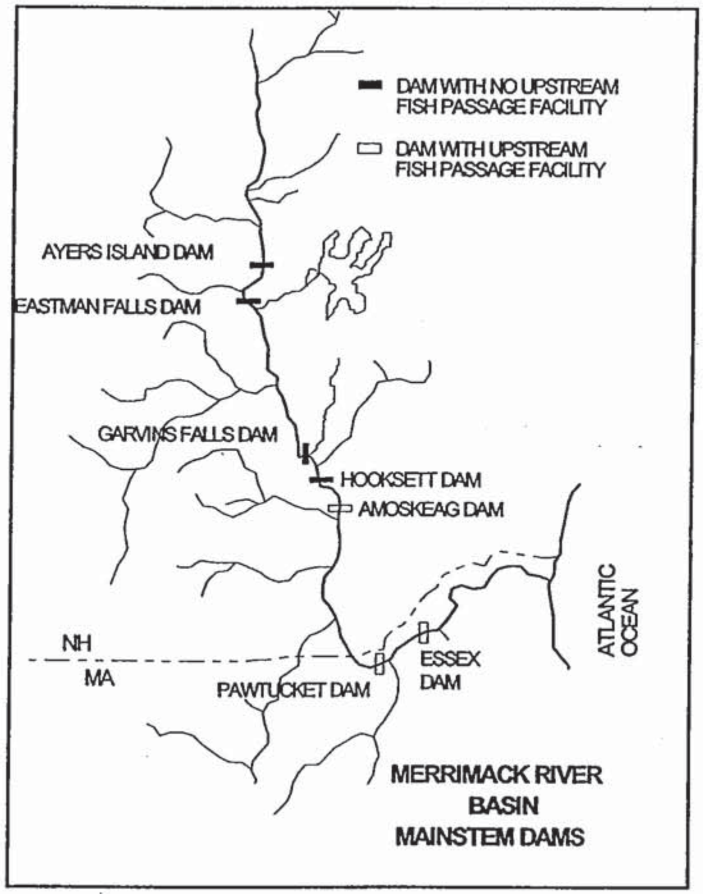

Connecticut River Watershed
U.S. Fish & Wildlife Service
18 Dec 96
1. Eightmile River
2. Salmon River
3. Farmington River
4. Westfield River
5. Manhan River
6. Mill River
7. Mill River
8. Fort River
9. Sawmill River
10. Deerfield River
11. Fall River
12. Millers River
13. Four Mile Brook
14. Mill Brook
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
Vermont
New Hampshire
Massachusetts
Connecticut
Scale = 1:2,000,000
Map by the U. S. Fish & Wildlife Service
Connecticut River Coordinator's Office.

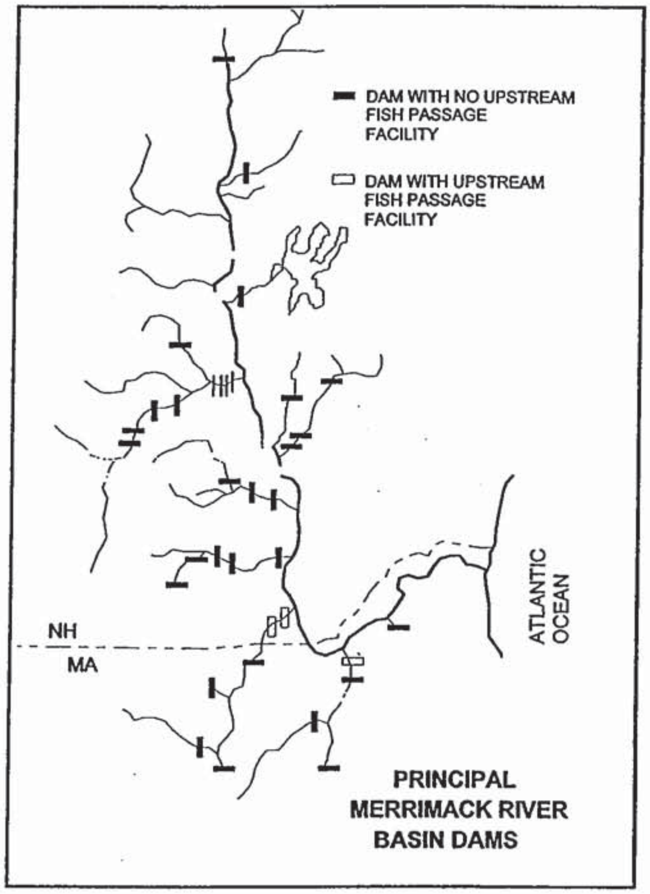
Important Atlantic Salmon Rivers of Maine





PRINCIPAL MERRIMACK RIVER TRIBUTARIES


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


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