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

REPORT NO. 7 - 1994 ACTIVITIES

TURNERS FALLS, MASSACHUSETTS
FEBRUARY 6 - FEBRUARY 9, 1995

PREPARED FOR
U.S. SECTION TO NASCO

TABLE OF CONTENTS

1. INTRODUCTION

1.1. EXECUTIVE SUMMARY

The 1995 Annual Meeting of the U.S. Atlantic Salmon Assessment Committee was held during February 6-9, 1995 at the Silvio Conte Anadromous Fish Research Center, Turners Falls, Massachusetts. The committee addressed terms of reference established at the 1994 meeting including routine assessments, such as program reviews and database development, and special topics.

Stocking data, listed by age/life stage and river of release, and tagging and marking data are summarized for all New England programs. A total of 12,950,000 juvenile salmon (fry, parr, and smolts) were stocked. Of these, 2,300 parr and 653,300 smolts carried coded-wire-tags (CWT), 200 received Carlin tags, and 543 parr and 793 smolts received Visual Implant tags.. An additional 38,600 parr and 80,600 smolts were released with fin-clips only.

A total of 1,634 salmon was documented to have returned to U.S. waters in 1994, of which 78% (1,280) was counted in Maine rivers. Since many of Maine's rivers do not have counting facilities, and facilities that do operate throughout New England are not 100% effective, a system was implemented to estimate total adult returns in Maine and to New England rivers. The estimated returns using this method were 1,916 in Maine rivers and 2,318 in New England rivers. There were 444 fish with CWT (84 one-sea-winter (1SW), 359 two-sea-winter (2SW) salmon), one repeat spawner (RP), and seven with Carlin tags (2SW salmon) which returned to U.S. rivers in 1994.

In 1994 the sport fishery for Atlantic salmon in Maine was restricted to one salmon per angler per year, and no salmon longer than 64 cm could be retained. The documented catch of salmon in Maine was 262 fish, representing a harvest of 13 and an estimated 249 released. The management measures in effect, coupled with low salmon abundance, resulted in the smallest recorded sport catch of salmon in Maine since intensive records have been kept (1948).

Atlantic salmon egg production for the New England program approached 21,000,000 (2,960,000 sea-run, 15,377,000 captive/domestic, and 2,470,000 reconditioned kelts). The egg production was still less than the desired number.

As a special topic, Tim King of the National Biological Service (NBS) led a discussion related to a draft proposal entitled "Genetic stock identification of Atlantic salmon inhabiting North America with emphasis on the Downeast rivers of Maine".

1.2. BACKGROUND

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

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

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

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

1.3. RELATIONSHIP OF ICES TO NASCO

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

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

1.4. CHAIRMAN'S COMMENTS

The meeting was smoother than in the past because much of the material required for the development of the Status Of Program section of the document was completed prior to the meeting. This factor provided the committee with the ability to complete their business a day early. I am hopeful that in the future this trend will continue.

The working group agreed to do some actual data analysis at the next working group meeting.

The analysis will be directly related to comparing the adult salmon return rates between the Connecticut, Merrimack, and Penobscot rivers. This should be an interesting exercise for the entire group.

The U.S. Atlantic Assessment Committee agreed to meet in working group format for their eighth annual meeting from February 5 - 9, 1996. The tentative location will be at the Connecticut River Coordinator's office.

I and the entire committee thank those individuals at the Silvio Conte Anadromous Fish Research Center who provided the necessary support to the working group during the meeting.

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

2. STATUS OF PROGRAM

2.1. GENERAL PROGRAM UPDATE

2.1.1. CONNECTICUT RIVER

2.1.1.a. Adult Returns

A total of 326 adult Atlantic salmon returned to the Connecticut River watershed during 1994. Two hundred sixty three salmon were captured at Holyoke; 7 were seined or gillnetted below the Decorative Specialties International (DSI) dam on the Westfield River; 42 were captured at the Rainbow fishway on the Farmington River; and 13 were captured at Leesville Dam on the Salmon River. In addition, seven redds were observed below the DSI dam.

The spring run of adult Atlantic salmon lasted from May 10 to July 5. Median return dates were June 7 (Leesville), June 1 (Rainbow), and June 5 (Holyoke). Peak return dates (95% of run) were May 23 - June 12 at both Holyoke and Rainbow, and May 24 - June 11 at Leesville. Fish passage operations conducted during the fall captured seven salmon from September 19 - October 22.

A total of 300 captured salmon was retained for broodstock: 246 were held at Richard Cronin National Salmon Station (RCNSS), and 54 were held at Whittemore Salmon Station (WSS). Twenty five salmon were released from the Holyoke fishlift (river km = 138) to continue upstream. Two released salmon were captured and tagged in the Holyoke downstream bypass sampler and were subsequently recaptured in the lift. Of the remaining 23 releases, five were observed passing the fishway at Turners Falls (MA) (river km = 198), eight were observed passing the fishway at Vernon (VT) (river km = 228), three were observed passing the fishway at Bellows Falls (VT) (river km = 280), and one was observed passing the fishway at Wilder (VT) (river km = 349). One salmon was captured in the trap at the U.S. Army Corps of Engineers Townshend Dam on the West River.

Age and origin information was derived from scales, CWT, and physical examination of each salmon. Origin information on released salmon was determined by presence or absence of an adipose fin clip. Sex was determined during spawning. Of 325 observed salmon, 264 (81%) were of hatchery (smolt) origin and 61 (19%) were of wild (fry) origin. Known sea age of hatchery salmon was comprised of 246 (99.6 %) two-sea-winter salmon (2SW) and one (0.4%) grilse. All wild salmon were two-sea-winter fish (N = 52). Freshwater age of wild salmon was comprised of six (12 %) one-sea-winter (1SW), 44 (86 %) 2SW, and one (2 %) three-sea-winter (3SW) river winter fish. The sex ratio of hatchery salmon were 118F:128M, or 48.0 % female. The sex ratio of wild salmon was 34F:17M, or 66.7 % female.

Spot checks for presence of redds were conducted in some areas of the Salmon, Westfield, Deerfield, and West rivers. Seven redds were observed in the Westfield River. Only one adult salmon, believed to be a male, was observed on the redds. Based on two females per redd, these redds likely represent spawning by three or four females.

This year's Atlantic salmon run is the fourth largest to the Connecticut River since the inception of the restoration program. The total return number is 122 % of the ten-year average for the river and 128 more than last year's run.

2.1.1.b. Hatchery Operations

Fish Cultural Changes

Production and stocking of 1-year old hatchery-reared smolts was terminated in 1994. The 377,500 smolts stocked into the basin this year will be the last for the foreseeable future. White River National Fish Hatchery (WRNFH) will be raising Connecticut River domestic broodstock and incubating eggs for fry stocking with no smolt production. To protect against diseases, only well water will be used in rearing domestic broodstock. It was desired to maintain both smolt and broodstock production at WRNFH but disease and budgetary constraints allowed only one to continue. Available data indicates that the fry produced by the broodstock option will result in greater adult returns than smolt stocking. Options for resuming some smolt production without impacting fry stocking are being explored.

Berkshire National Fish Hatchery (BNFH) was converted to inactive status, and kelts held at that station have been transferred to North Attleboro National Fish Hatchery (NANFH). Kelts and domestic broodstock are also currently being held at RCNSS, and contributed about 50 % of the eggs take from that station in 1994. The smolt program at Kensington State Salmon Hatchery (KSSH) in CT was terminated due to extremely poor returns of KSSH smolts. The domestic broodstock and fry rearing and stocking programs at KSSH will be expanded.

Surplus domestic broodstock were transferred to WRNFH from KSSH and Roger Reed State Fish Hatchery to "jump start" domestic production. Eggs were taken from some of these fish in the fall. Full production of broodstock at WRNFH is expected in 1996.

Egg Collection

Sea-Run Broodstock

A total of 151 females produced 1,223,834 green eggs. Representative samples of eggs from sea-run females fertilized with milt from sea-run males were "egg banked" at Whittemore Salmon Station (WSS) in order to screen for possible pathogens. These eggs will be used for production of domestic broodstock throughout the basin. The remainder of the eggs were transported to WRNFH to be incubated for fry stocking.

Captive/Domestic Broodstock

Domestic broodstock produced 7,550,798 eggs from 1094 females. Eyed eggs for future broodstock will be supplied by WSS and raised at several program hatcheries. Additional eggs from Penobscot domestic broodstock were received. This is anticipated to be the last year for out-of-basin eggs. All future eggs will come only from Connecticut River broodstock.

Kelts

Kelts contributed substantially to the total egg take during 1994, with 208 females producing 2,427,720 eggs. No kelts died as a result of the transfer from BNFH to NANFH, and there is no evidence that the transfer adversely affected egg take. The success of the transfer was facilitated by contributions of trucks and personnel by cooperating states.

2.1.1.c. Stocking

More than 6,000,000 juvenile Atlantic salmon were stocked into the Connecticut River watershed in 1994. The majority of these were released as fry (5,979,000; 85% unfed), 377,500 were released as yearling smolts, and a relative few as 0+ and 1 parr. The record number of fry (almost 2 million more than last year's record) allowed releases into several previously unstocked areas. In all, 22 tributary systems were stocked with fry at densities ranging from 19 - 150 fry per 100 m^2 unit. Most fry were stocked at densities from 30 to 75 per 100m^2. Smolts were stocked into the Connecticut River mainstem, as well as the Farmington, Salmon, West, and Westfield rivers, primarily during late March and early April. All released smolts were marked with a CWT and adipose fin-clipped.

2.1.1.d Juvenile Population Status

Smolt Monitoring

Northeast Utilities Service Company (NUSCO) conducted a mark-recapture smolt population estimate for the second consecutive year in 1994 as part of studies at the Northfield Mountain Pumped Storage Facility (NMPSF). Smolts were marked at the Cabot Station bypass facility at Turners Falls and recaptured at the bypass facility in the Holyoke Canal. The population estimate was 30,516 (± 6,948) wild smolts passing Turners Falls. An additional 1,886 smolts were estimated entrained at NMPSF yielding an estimate of 32,402 smolts of fry and parr stocking origin passing NMPSF. Based on expanded electrofishing data from index stations and assumed overwinter mortality it was estimated that 72,429 smolts were produced in tributaries above NMPSF. Actual overwinter mortality is unknown and the estimate does not include smolt losses during migration. The differences in the two estimates is an unknown combination of error in each of the estimates and losses during migration. The two estimates were much closer in 1994, a high flow year, than in 1993, a low flow year, suggesting much of the difference may be due to mortality incurred during migration. The smolt run started in late April, peaked in mid-May, and declined by early June.

A cooperative smolt trapping project (Massachusetts Cooperative Fisheries and Wildlife Research Unit (MCFWRU), Vermont Cooperative Fisheries and Wildlife Research Unit (VTCFWRU), United States Forest Service (USFS), Vermont Fish and Wildlife (VTFW), National Marine Fisheries Service (NMFS), National Biological Service (NBS)) using fyke net weirs was conducted at several sites on tributaries of the West River. A total of 791 smolts was captured, but this was substantially less than expected based on electrofishing data and assumed trap efficiency. Trap efficiency was low and several potential peak migration nights were missed due to repeated flooding. The peak of the run in two lower tributaries was in the first week of May. The peak in an upper tributary was about a week later. Smolt captures commenced in late April and ceased by late May. Mean smolt total length was 153 mm.

Smolts were also monitored by CTDEP at the new Rainbow Dam bypass facility on the Farmington River. Lack of automation and operational problems resulted in sporadic sampling. Over 400 smolts were captured. Full automation should allow more efficient sampling next spring.

Index Station Electro Fishing Surveys

Juvenile salmon populations were assessed by electrofishing in late summer at nearly two hundred stations throughout the watershed. Sampling was conducted by Connecticut Department of Environmental Protection (CTDEP), MCFWRU, New Hampshire Fish and Game Department (NHFG), USFS, USFWS, and VTFW. Data were used to evaluate fry and parr stocking, estimate survival from stocking, and estimate smolt production. Not all data have been analyzed as yet. Densities of parr varied widely throughout the watershed. Typical 0+Parr densities were in the range of 5-30 /100 m^2, with an overall range of 0-77/100 m^2. Yearling densities were usually in the range of 1-10/100 m^2, with an overall range of 0-27/100m^2. Two-year old densities were generally low.

Some wild yearling smolt production was expected in 1995 from the Salmon, Eightmile, Farmington, and Passumpsic river watersheds. Most smolts produced in 1995 are again expected to be two year olds with some yearlings and three year olds. The 1995 smolt year-class is expected to be the largest in the history of the program.

2.1.1.e Fish Passage

Downstream passage facilities became operational at Vernon Dam on the mainstem and at Rainbow Dam on the Farmington River. An additional obstacle to downstream passage on the Westfield River was removed with the closure of the Westfield Paper Company hydroelectric turbine. Facilities will become operational at the Bellows Falls Dam on the mainstem and at Crescent Dam on the Westfield River in 1995. An experimental barrier net will be deployed at NMPSF in 1995.

Hydroelectric relicensing efforts continued on several tributary systems. Relicensing of Deerfield River projects will result in downstream fish passage at four dams and an adult trap and truck facility. Fish passage was sought through relicensing on the Black and Passumpsic rivers. The expansion of fry stocking has resulted in need for downstream passage at many additional hydroelectric facilities. Downstream fish passage efforts have focused on the Black, Sugar, Westfield, and Williams rivers.

Evaluation and studies of downstream fish passage occurred at several facilities in 1994 including Hadley Falls Station, Cabot Station, NMPSF, and Wilder. Strobe lights deployed at NMPSF failed to reduce entrainment. Results of studies will allow improvements of downstream passage facilities where needed.

No significant improvements to upstream passage occurred during 1994, although construction of an upstream passage facility at the Decorative Specialties International (DSI) Dam on the Westfield River is due to begin during the summer of 1995.

2.1.1.f. Genetics

Tissue samples collected from salmon belonging to all brood types of three year classes (spawning classes of 1990, 1991, and 1992) were frozen to await genetic analysis. The samples were analyzed during the summer of 1994 by Tim King of the NBS at Leetown. A preliminary report was received by CRASC in November.

Results of the analysis were inconclusive. The sample size was inadequate to detect rare alleles. Some loci had more variation than expected while some had less. Further sampling and analysis of the Connecticut population is needed and this analysis should be conducted to be comparable to similar studies being conducted in New England relative to listing Atlantic salmon under the Endangered Species Act. NBS will be able to fund future studies if CRASC will provide the tissue samples. The CRASC Genetics Workgroup will meet with King early in 1995 to discuss and plan future work.

Spawning activities at all CRASC facilities continued to follow the mating regime to cross salmon across all lines of distinction (brood types, year class, facilities, etc.) to create one well-mixed population.

2.1.1.g. General Program Information

Major progress has been made towards the program goal of stocking all available habitat with fry to produce wild smolts. Substantial improvements in downstream fish passage have also been made to allow smolts to safely reach the marine environment. Further downstream fish passage work is needed, especially at NMPSF and on newly stocked tributaries. Salmon of Connecticut River origin will have far lower mortality in commercial fisheries due to fishery buyouts and closures in Canada and Greenland.

The various changes that have occurred in the Connecticut River program will be addressed in updated Strategic and Action Plans. Revisions to the 1982 Plan are underway, and the updated version should become available during 1995.

2.1.2. MAINE PROGRAM

2.1.2.a Adult Returns

Adult salmon counts were made at weirs operated on the Dennys, Pleasant, and Sheepscot Rivers; while salmon counts at fishways were made on the St. Croix, Narraguagus, Penobscot, Androscoggin, and Saco rivers. Reports from anglers and redd counts in November were also utilized to estimate adult returns to Maine in 1994.

Rivers With Native Salmon Runs

Dennys River. The Dennys River weir was operated from May 25 to October 23, when it was breached by a spate. The structure was repaired on the following day and operated continuously until November 2. Known escapement of salmon upstream of the Dennys weir was eight fish of which one, a native-origin 1SW salmon was processed and released above the weir. The remaining seven fish passed the weir undetected as a result of vandalism to the weir or high water in the late fall. It is likely that at least two were of native origin based upon fin condition. Analysis of scales from an illegally-harvested 2SW salmon confirmed that it was of native origin. Including the four native-origin, 2SW salmon taken for broodstock, the native component of the 1994 run consisted of eight salmon (six documented by scale samples, two determined from fin condition). During September and October, 42 presumably immature aquaculture escapees, were trapped, marked, and released downstream of the weir. An additional four aquaculture fish were captured utilizing an electrofishing boat and marked and released; two others were legally harvested in the sport fishery for a minimum total of 48 aquaculture escapees in the Dennys River in 1994.

Narraguagus River. Fifty-two salmon were captured at the Cherryfield fishway trapping facility, a return well below the spawning escapement target of 270 adults. Most of the adult run (50) was of native origin, although two were hatchery-origin strays, one of which appeared to be of aquaculture origin. Anglers fishing the Narraguagus River caught and released 20 salmon during 1994.

Pleasant River. Adult salmon were counted on the Pleasant River for the first time since 1987. A weir was installed on June 1 and operated until breached by high water on October 22. The weir was repaired on October 25 and operated again until November 2nd. Only two adult salmon were captured, one 1SW salmon on July 7 and one 2SW salmon on August 20. For the first time since 1985 there was a reported rod catch (2 fish caught and released) from the Pleasant River.

Sheepscot River. The last adult salmon counts made on the Sheepscot River were during the period 1956-1959, with weir catches ranging from 9 to 128 adults. In 1994, a weir was installed just above tidewater and operated from May 26 to September 25, when a record rainfall washed out the structure. A total of 20 salmon were enumerated, with three 1SW salmon and 17 MSW captured and released upstream. Scale samples were only obtained from five salmon, although individual fish were observed for missing or deformed fins. Based upon this information, at least five of the 20 salmon appeared to be of hatchery origin. Daily water temperatures regularly exceed 25°C from late June through August, and the daily maximum was 30°C or higher for seven days. Three dead salmon were found above the weir, two of which presumably died as a result of the lethal water temperatures observed in July. There was no reported rod catch of Atlantic salmon in the Sheepscot River in 1994.

Machias, East Machias, and Ducktrap Rivers. Anglers caught and released five salmon on the Machias River and 12 salmon on the East Machias River. There was no reported rod catch in the Ducktrap River. A small number of the fish caught in the East Machias River were probably aquaculture escapees, based upon discussions with anglers.

Other Maine Restoration Rivers

Penobscot River. Total known adult returns to the Penobscot River was 1,049, representing a trap catch of 1,042 at the Veazie Dam fishway and a rod catch (retained) of seven salmon below the dam. All seven were 1SW salmon since all Atlantic salmon in excess of 64 cm (25 inches) must be released in Maine. About 175 salmon (primarily MSW fish) were estimated to have been caught and released throughout the angling season. About one-third of the Penobscot salmon run (344 fish) was transported to Craig Brook National Fish Hatchery (CBNFH) for broodstock purposes. The estimated spawning escapement to the Penobscot River in 1994 was 196 MSW females, which represents 6% of the target spawning escapement for the river.

St. Croix River. A total of 181 salmon was captured at the Milltown Dam fishway during 1994, and 97 (54%) were determined to be of aquaculture origin. The St. Croix is the only river in Maine where salmon of aquaculture origin are deliberately allowed to continue upstream above monitoring facilities. Thirty adult salmon broodstock were transported to Mactaquac Hatchery by the Canadian Department of Fisheries and Oceans, and 22 were spawned in November providing about 80,000 eggs for future restoration programs in the St. Croix. Three salmon (one 2SW and two 1SW salmon) were caught and released by anglers fishing below the Milltown Dam.

Androscoggin River. Twenty-five adult salmon were enumerated at the Brunswick Dam fishway (head-of-tide). Of those, six were of native-origin and 19 were of hatchery origin (apparently strays from other rivers).

Saco River. A total of 23 adult salmon, all of hatchery origin, was enumerated at the new, state-of-the-art fish passage facilities (one fish lift, one fishway) which were completed in 1993. A complete salmon count was obtained on the Saco River for the first time ever.

2.1.2.b Hatchery Operations

Broodstocks (all sources) from four Maine rivers produced the following egg takes at CBNFH in November:

Penobscot River:	1,630,700
Dennys River:	155,500
Machias River:	207,100
Narraguagus River:	145,700

Total:	2,139,000

More than 800 native-origin parr were collected from five Maine rivers in 1994. These fish will be reared to maturity at CBNFH in order to provide river-specific hatchery stocks for future restoration efforts. Numbers of fish collected from individual rivers were: Dennys-151; East Machias-166; Machias-313; Narraguagus-161; Sheepscot-84.

2.1.2.C Stocking

A total of 2,700,000 salmon were stocked in six Maine rivers in 1994. As in previous years, most (67%) were released at the fed fry stage. A complete stocking summary is presented in Table 2.1.1.a.

2.1.2.D. Juvenile Salmon Population Status

Juvenile salmon population surveys were conducted at numerous traditional index sites throughout the seven Maine drainages with native salmon runs. Densities of young-of-year and parr (age 1+ and 2+ combined) were far below average in the Dennys, Ducktrap, Pleasant and Sheepscot rivers. However, densities in the Narraguagus, Machias, and East Machias Rivers, although low, were within the range of population densities observed historically. The population of age 1+ and older parr, based upon electrofishing at over 90 sites on the Narraguagus River is approximately 9,500 ± 10%. The low juvenile salmon populations throughout Maine rivers are a direct result of insufficient spawning escapement, since recent habitat surveys in Maine rivers indicate that habitat quality has not diminished since earlier surveys which were conducted in the 1960s and 1970s.

The survival of hatchery-origin fry stocked in Penobscot River tributaries was variable with the lowest survival apparently correlated with high water temperatures. Survival to age 1+Parr was estimated to range from 4 to 27 percent.

2.1.2.e. Fish Passage

The FERC recently completed a draft environmental impact study (EIS) for the lower Penobscot River Basin in conjunction with the Basin Mills hydro development project. Comments on the draft will be received until late February and a final report issued later in 1995. If the FERC issues a permit for the Basin Mills hydroelectric project, Bangor Hydro-Electric Co. (BHE Co.) will also be required to attain permits from the Army Corps of Engineers and the Maine Public Utilities Commission.

An agreement was reached with the dam owner of the Brown's Mill Dam on the Piscataquis River (a major tributary to the Penobscot) to install a downstream fish passage facility for Atlantic salmon. Construction of the collection weir and bypass pipe will commence in the spring of 1995 and the facility is expected to be operational later in the year.

In the Union River drainage, BHE Co. has prepared design drawings for the FERC-ordered fishways at the Ellsworth and Graham Lake dams, although the FERC order is under appeal by the company.

After years of discussion, planning and facilitated negotiations, a Saco River Fish Passage Agreement was signed by the two hydro dam owners on the river, state and federal agencies, cities and towns in the lower river, and private organizations such as the Saco River Salmon Club and the Atlantic Salmon Federation (ASF). The agreement delineates a comprehensive upstream and downstream fish passage plan that is based upon a biologically-defensible, cost-effective plan which is not tied to traditional state and federal relicensing schedule. The design and construction of interim and permanent facilities at all hydro dams on the mainstem of the Saco River will be determined by biologically defined assessment criteria which currently are being developed by the state and federal fishery agencies in consultation with all parties to the Agreement.

2.1.2.f. Genetics

Non-lethal sampling procedures (fin excision) were utilized for on-going genetics studies of Atlantic salmon populations in the Dennys, East Machias, Machias, Narraguagus and Sheepscot rivers.

However, a small number of salmon parr collected from the Ducktrap and Pleasant rivers in 1993 were sacrificed for allozyme analyses (and as a standard for testing the non-invasive allozyme analytical techniques), DNA fingerprinting, meristic and morphometric measurements and disease survey.

Sampling in the fall of 1994 consisted of removing fin tissue from this 1+Parr broodstock collected from the Machias, East Machias and Sheepscot rivers. Additionally, samples were collected from several U.S. and Canadian rivers to investigate intra-spacial differences in genetic composition.

Five genetics studies of Maine Atlantic salmon populations were published in 1994 (four by NBS, one by a University of Maine geneticist) and all independently demonstrated significant differences among population samples of the characterized rivers. Unique markers were also reported from the Ducktrap River samples in one of those studies. Overall, results to date are unclear because of limited temporal and geographical sampling. A three-year study designed to increase the sampling program to compensate for these inadequacies is being developed.

2.1.2.g. General Program Information

Atlantic salmon runs in Maine continued to decline in 1994 despite the virtual elimination of distant water commercial fisheries and the draconian measures taken in home waters in recent years. Less than 2,000 salmon returned to the state in 1994 while total returns of 6,000-10,000 salmon per year were common in Maine a decade ago. As a result of declining salmon numbers, and the promulgation of regulations which have resulted in a catch-and-release fishery, the number of salmon caught by anglers has declined from 1,000-2,000 in the mid-1980s to about 200 in 1994. Of that number, about 10 1SW salmon were caught and retained, while the balance - mostly MSW salmon - were released. Redd counts on Maine's native salmon rivers were the lowest observed since this activity was initiated on an intensive basis in the late 1970s, confirming the low abundance of the Atlantic salmon on a statewide basis.

In 1994 disease outbreaks occurred at both of the federal hatcheries which supply all of the juvenile salmon in Maine. Although mortalities of Penobscot-origin broodstock and immature fish were held to relatively low levels, about 300,000 0+Parr were destroyed in the fall. While these fish technically met the New England Salmonid Fish Health Guidelines and could have been stocked, program managers felt that: (a) there was little to be gained by releasing them in the wild (since fall parr releases historically have contributed few, if any, adult returns), and (b) the risk to future generations of fish in the wild, though small, was unacceptable. Fortunately, the five native broodstocks from eastern Maine rivers, which are held in isolation, were not affected by these disease outbreaks.

Significant numbers of pen-reared fish entered the lower portions of several Maine (and New Brunswick) rivers as a result of a large escape (numbers unknown) of aquaculture-origin salmon in New Brunswick over the Labor Day weekend. On the Dennys River, 89% (42 of 47) of the weir catch was of aquaculture origin, while 54% (97 of 181) of the trap catch in the St. Croix River was composed of aquaculture escapees. Results of biological studies of these fish in Canada in September indicated that they were non-maturing and no parasites or diseases were detected. A second escape of more than 14,000 salmon (post-smolts) occurred on November 2 in Maine. The fate of those fish is unknown, although they would not be expected to mature for another year or two.

The Maine Atlantic Sea Run Salmon Commission (MASRSC) is in the process of re-writing its Statewide Strategic Atlantic Salmon Restoration and Management Plan. A draft of the plan was distributed for public review and comment and final publication is expected sometime in February of 1995. This plan will serve as a basis for river-specific Operational Plans for all Maine rivers, and the preparation of those plans is already in progress.

Intensive Atlantic salmon habitat surveys were completed on Old Stream, Mopang Stream, and Crooked River which are major spawning and rearing tributaries to the Machias River. A survey of the mainstem of the Dennys River was also completed in 1994, along with ground-truthing of previous survey work on Cathance Stream (a tributary to the Dennys) and the Sheepscot River. All data collected in the field were downloaded to computer disk and sent to the Connecticut River GIS Office for post-processing. Data files were loaded into a GIS database that will incorporate other coverages such as land use, land type, ownership, etc. to aid in future management decisions affecting juvenile Atlantic salmon populations. Data files from the surveys were also imported into a spreadsheet software program for the quantifications of various habitat types. This information will be used by fishery scientists to determine optimum fry stocking densities by river reach - an important aspect of the river-specific stocking program.

Project S.H.A.R.E. (Salmon Habitat and River Enhancement) was formed by a coalition of private industry, state and federal agency representatives and various private interest organizations (and individuals) in August, 1994. The goal of SHARE is "to conserve and enhance Atlantic salmon habitat in the Downeast region of Maine through voluntary and mutual cooperation of area landowners and businesses; local, state, and federal agencies; academia; and conservation organizations." To date over 30 organizations have joined SHARE, non-profit status obtained and various active committees established (an overall seven-person Steering Committee and three standing committees - management, research, education). In the fall of 1994 SHARE was active in the attempted removal of natural barriers to salmon migration in the Machias drainage and the actual replacement of a water control dam gate and fishway baffles at Meddybemps Lake, which is the primary source of water for the Dennys River. Various other activities are also pending (e.g., informational brochures, a video, funding for research, etc.).

2.1.3. MERRIMACK RIVER

2.1.3.a. Adult Returns

Managers experienced a setback in the maintenance of the donor stock of salmon used in the Merrimack River restoration program. In previous years the rate of return was greater for this stock and adult salmon returned to home waters in larger numbers than that observed in 1994. Documented adult returns numbered 21 fish in 1994, 40 fish less than the number captured in 1993 and 131 fish less than the eleven year average for the period 1983-1994.

Two fish were taken illegally by anglers in tidewater, while the remaining 19 fish were observed at the fish lift located at Essex Dam (first dam on the river at rkm 42) in Lawrence, MA. Seventeen of the 19 fish were captured and transported to the Nashua National Fish Hatchery

(NNFH) and held as broodstock for egg production. Two fish escaped capture and presumably continued to swim upstream past the dam.

Adult salmon were first captured on May 28 and continued to enter the trap throughout the month of June. The last fish was captured on July 1, and although the trap was again operated in the fall, no salmon were observed or captured during that time.

Nineteen of the adult returns originated from fry releases and two from hatchery smolt releases. For those of fry origin, 17 were age 2.2 and were part of the 1990 cohort. The additional two fish were categorized as age 1.2 and 2.1 and were part of the 1991 cohort. Fish from both cohorts remain in the marine environment and are expected to return during the period 1995 -1997. Two fish that were categorized as age 1.2 returned from the 1992 smolt release.

2.1.3.b. Hatchery Operations

Fish Cultural Changes

Major changes in the fish culture program for the Merrimack River occurred in 1994. Although the production program for hatchery smolts at the North Attleboro National Fish Hatchery (NANFH) was phased out, the hatchery will continue to produce fry for the Merrimack River. Smolts from Penobscot River sea-run adults will now be reared at the Green Lake National Fishery Hatchery (GLNFH) in Maine, with the first release of approximately 50,000 fish to occur in 1995. The change in hatchery operations was necessary due to budget constraints.

Egg Collection

Sea-Run Broodstock

Seventeen adult salmon were captured and transported to the NNFH for fall spawning, and an estimated 67,500 eggs were taken from 10 females. The majority of the eggs were transported to the NANFH to be hatched and released as fry. However, a portion of the eggs was held at the hatchery to produce the next year-class of captive/domestic broodstock. Due to the low numbers of available Merrimack River sea-run eggs for this purpose, an additional 10,000 eyed-eggs of Penobscot River sea-run stock were imported from CBNFH for future broodstock.

Captive/Domestic Broodstock

A total of 1,035 female broodstock held at the NNFH provided an estimated 5,651,800 eggs. Approximately 18,000 of the eggs were retained at the hatchery; approximately 1.5 and 4.0 million were transported to the WSFH and NANFH, respectively to be held for fry stocking; and about 170,000 were transported to the Milford State Fish Hatchery (MSFH) for use in other programs.

2.1.3.c. Stocking

Approximately two million juvenile Atlantic salmon were released into the Merrimack River during the period March-June of 1994. Although the majority was released as unfed fry, 85,000 were released in two groups as yearling smolts. One group was released in the river in mid-March and the second release occurred in mid-April. All smolts were marked by removal of the adipose fin and tagged with CWT.

The number of fry released was the largest stocking in the history of the program, but was less than the target release of 3,100,000 million fry. Seven major tributary systems were stocked with fry at densities that ranged from 29 fry to 96 fry per 100 m^2. Major tributary systems stocked included the Souhegan, Piscataquog, Suncook, Soucook, Contoocook, Winnipesaukee, and Pemigewasset rivers.

2.1.3.d. Juvenile Population Status

Evaluations Of Parr Abundance

A stratified random sampling scheme that involved parr collections at 21 sites was implemented for the Merrimack River basin in 1994. Sampling was directed at age 1+Parr and involved electrofishing during late summer and early fall. The scheme was implemented to provide an improved estimate of the total number of age 1+ Parr in the basin. A review of the past sampling program suggests that too few sites and habitat units had been sampled to develop accurate estimates. Data collection was a cooperative effort and involved staff from the Maine Department of Inland Fisheries and Wildlife (MDIFW), NHFG, USFS, USFWS, and volunteers.

The 21 sites included a total of 265 metric units (one unit = 100 m^2) of juvenile habitat. The estimated amount of juvenile habitat within the basin is 57,067 units and habitat sampled was about 0.46% of that available. In contrast, sampling conducted at index sites during the period 1983-1993 typically involved approximately 129 units, or about one half (49%) of the total units sampled in 1994.

Some asssumptions were required to calculate basin-wide population estimates due to a paucity of units sampled in some strata. However, problems associated with these data gaps can be resolved with proper allocation of sampling effort in future years. Based on two stratified sampling schemes, estimates of age 1+Parr ranged from a low of 77,752 ± 19,148 to a high of 115,311 ± 9,949. Accordingly, estimated survival from the fry to age 1+Parr stage ranged from about 7% to 10%. No natural reproduction of Atlantic salmon is known to occur in the Merrimack River basin, and these estimates of parr are the result of a fry stocking that approached 1,157,000 million fish in 1993.

The time series of data documenting the relative abundance of parr at index sites in the basin was maintained by including these sites in the 1994 sampling scheme. In most index site rivers the density at which fry were stocked per unit was doubled in 1994. Stocking densities ranged from a low of 40 fry per unit in the Mad River to a high of 102 fry per unit in the Pemigewasset River. Generally, the number of age 0+Parr at sites was greater than in previous years, a trend that reflects the increase in density at which fry were stocked throughout the basin. For age 1+Parr, the number found at sites was similar to the number in previous years with the exception of the Pemigewasset River site, a large river site where the number of parr was low.

2.1.3.e. Fish Passage

Downstream Fish Passage

Consultation and planning continued among the cooperating fishery resource agencies and hydroelectric project owner/operators in developing solutions to downstream fish passage problems at mainstem dams on the river. The Public Service Company of New Hampshire (PSNH), owner and operator of the Ayers Island Dam, may have resolved smolt passage problems by opening gates to increase spill during migration. A floating louvre integrated with open gates was also tested at the Eastman Falls Dam with favorable results. Further work at the Eastman Falls Dam is planned for 1995.

Plans are also being formulated to improve smolt passage at the Garvins Falls and Amoskeag Dams, facilities owned and operated by PSNH. Other studies are being conducted to develop solutions to fish passage problems at mainstem dams located in Lowell and Lawrence, MA. Favorable results were obtained for juvenile clupeid passage at both facilities and salmon smolt studies are planned for 1995.

Upstream Fish Passage

A two year study to address problems associated with upstream fish passage at the Lawrence Dam was completed in 1994. Results suggest a need to improve effectiveness of the passage facility for both American shad and salmon. Both species were observed to enter the entrance to the fishlift numerous times yet only a small percentage was passed upstream. Modifications to the fish passage entrance and further evaluations are planned for 1995.

2.1.3.f. Genetics

No work was conducted in this area with regard to the salmon program in 1994.

2.1.3.g. General Program Information

Atlantic Salmon Captive/Domestic Broodstock Sport Fishery

The broodstock fishery was first initiated in the Merrimack River in 1993. The fishery is managed by the NHFG via a permit system for the taking of Atlantic salmon. A mandatory angler reporting system is required as a part of the program and each angler is issued five possession tags. Any Atlantic salmon kept must be tagged. Creel limits are one fish per day, five fish per season with a minimum length limit of 15 inches. The open season is April 1 through September 30. The river is divided into two management areas: (1) a fly fishing only area and (2) a fly fishing or single hook artificial lure area.

The results of the fishery have recently been made available and show that a total of 851 Atlantic salmon permits was purchased by anglers. Of the 851 potential anglers, 715 reported that they fished for broodstock. The majority were NH residents and 3.0% were from other states. Anglers fished a total of 14,779 hours during an estimated 4,651 fishing trips. They caught an estimated 994, released 594, and harvested 400 salmon. Catch per unit of effort was 0.067 salmon/hour (anglers fished for about 15 hours before catching a salmon).

Preliminary results from the 1994 fishery indicate that 1,554 permits were purchased, 55% more than in 1993. Similar to the 1993 demographics, most anglers were from NH. However, the fishery garnered more widespread acclaim in 1994 and attracted anglers from as far away as Alaska as well as anglers from other countries.

Captive/Domestic Atlantic Salmon Broodstock Releases

In spring and late fall of 1994, 3,248 surplus broodstock were released to provide angling opportunities. The spring release included 1,982 re-conditioned adults that had been spawned in the hatchery the previous fall. The second release occurred in the fall and included 1,266 fish that were spawned prior to release.

Other broodstock releases included 82 ripe females (age 2+) into the Pemigewasset River and 136 ripe adults (age 3+ males and females) into the Baker River in the fall. Subsequent observations revealed that some of these fish exhibited spawning behavior. Six redds and several excavations were found in the Baker River near Wentworth, NH. Two of the redds held eggs and approximately 30% of the eggs were fertilized.

Education/Outreach

The "Adopt A Salmon Family" program, addressed at the 1994 meeting of the U.S. Atlantic Salmon Assessment Committee meeting, was well-received as a pilot program within the two schools and generated a great deal of media attention. This program has been expanded into a third school. Plans are underway for further expansion in the next several years.

2.1.4. PAWCATUCK RIVER

2.1.4.a. Adult Returns

Two salmon were trapped at the Potter Hill fishtrap on the Pawcatuck River in June, 1994. One female and one male were captured. The male died several days after capture. By scale analysis, both fish had spent two years at sea after migrating as two year smolts. Two escapees from the trap were documented upriver, bringing the total return to four. This return was produced from the 1992 smolt migration of 11.078 fish. Marine survival of the 1992 smolt class was higher than that for the 1991 smolt class. However, it did not approach that observed for the 1980-1982 smolt classes. A total of 6,800 eggs were spawned from the single female return and fertilized with milt obtained from male salmon at the NANFH.

2.1.4.b. Hatchery Operations

There was nothing to report for this section.

2.1.4.c. Stocking

Fry stocking was emphasized over fall parr for the second year. A total of 559,165 juvenile salmon was stocked into the watershed of which 557,165 were fry. Average stocking density on a watershed basis was 101.3 fry per unit. Salmon fry were obtained largely from the NANFH with a few thousand spawned from 1993 returns to the Pawcatuck River. Two thousand age 1 smolt were also stocked in the spring of 1993, originating from New England Fish Farming Enterprises, Inc.

2.1.4.d. Juvenile Population Status

Fry/Parr Assessment

Fry assessments were repeated in 1994. Ten index stations were sampled in the two major tributaries which form the Pawcatuck River. Fry survival varied from 0 to 24.7% and averaged 6.0%. This was somewhat higher than the 4% observed for the 1993 fry cohort which was exposed to very low flows. Fry stocking results to date have shown lower initial survival rates than 0+Parr releases. Survival of the 1993 fry cohort from fall 0+Parr to spring 1Parr averaged 64%. Survival from spring 1Parr to fall age 1+Parr was 74.5%. Survival rates during parr stages by juveniles stocked as fry, are comparable to rates exhibited by fish stocked as 0+Parr. The 1993 fry reached a mean length of 78.8 mm by October of 1993, 108 mm by April of 1994, and 162.1 mm by October of 1994. The 1994 fry cohort reached 78 mm by October of 1994. Overall, growth rate of fry has been similar to fish released as parr for comparable life stages.

Smolt Abundance

Potential smolt output was estimated by sampling 15 index stations in March and April of 1994. Mean smolt density was 1.39 per unit (SE=0.59). Total smolt output based on expansion of sample density over area stocked was 7,463 fish. This was the lowest smolt density since 1986. Smolt abundance in the spring has been significantly correlated to age 0 parr releases lagged by two years (r=0.74). Mean length of smolts in 1994 was 164.7 mm. Based on fall 1994 large parr densities (mean=1.77/unit) and a 36% over winter survival rate, smolt abundance in 1995 is projected to decline further to 3,427 fish. The 1995 smolt run will be the first produced predominantly from fry plants.

2.1.4.e. Fish Passage

There was no information for this section.

2.1.4.f. Genetics

There was no information for this section.

2.1.4.g. General Program Information

There was no information for this section.

2.1.5. NEW HAMPSHIRE COASTAL RIVERS

2.1.5.a. Adult Returns

The Lamprey and Cocheco rivers fish ladders were monitored in the months of May and June for returning adult salmon. The Lamprey River fish ladder was also monitored from mid-September to mid-November but the Cocheco River fish ladder was not operated during the fall of 1994 due to disputes between the owner of the hydroelectric facility at Cocheco Falls dam and the New Hampshire Fish and Game Department. Three fish (all females) returned to the Lamprey River in 1994; all in the month of October. No returning salmon were observed in the Cocheco River. The fish ranged in size from 79 to 89 cm total length and all were age 2.2.

2.1.5.b. Hatchery Operations

All returning fish were transported to a state fish hatchery. Eggs were taken from the three females with a total egg take of approximately 17,000 eggs.

2.1.5.c. Stocking

In 1994, a total of 149,000 Atlantic salmon fry were stocked into the Cocheco River and 98,000 were stocked into the Lamprey River..

The fry were reared at the Warren, Berlin, and Twin Mountain State Fish hatcheries and released into the two rivers at a rate of 36 to 72/100 m^2 during the month of April.

The Lamprey River also received: 7,800 Saint John River strain 1Parr and 56,300 Saint John strain 0+Parr. The Cocheco River received 5,300 smolts that were a mix of Saint John and Penobscot strains. All these fish were donations from New England Fish Farming Enterprises, Inc.

2.1.5.d. Juvenile Population Status

Annual abundance of salmon parr originating from fry releases have been documented by annual electrofishing assessments at index sites using the Zippen removal method. In 1994, survival of parr at 3 of the 4 index sites was equal to or higher than those measured in 1993.

2.1.5.e. Fish Passage

There was nothing to report for this topic.

2.1.5.f. Genetics

There was nothing to report for this topic.

2.1.5.g. General Program Information

In the fall of 1993, surplus age 2+ Atlantic salmon captive/domestic broodstock from the NNFH were stocked in the Lamprey and Cocheco river. Approximately 1,000 fish were put into the Lamprey River and 400 fish went into the Isinglass River (a tributary to the Cocheco River). Prior to stocking, the fish were tagged with sequentially numbered T-bar, streamer tags just below the dorsal fin. This stocking provided an April/early May fishery that was highly praised by anglers. Over 100 tag numbers from fish caught by anglers were reported to NHFG personnel and there were numerous reports of tagged fish that were caught and not reported.

2.2. STOCKING

2.1.1. TOTAL RELEASES

During 1994 the participating resource agencies released approximately 12,900,000 juvenile Atlantic salmon into 12 rivers (Table 2.1.1.a. in Appendix 11.1.). Included within the table is the contribution of Canada to the release program. The number of fish released was nearly a 32% increase from the total releases of 1993.

2.1.2. SUMMARY OF TAGGED AND MARKED FISH

Approximately 790,000 juvenile Atlantic salmon were marked prior to release (Table 2.1.2.a. in Appendix 11.1.). A more comprehensive look at the Atlantic salmon marking program is presented in Table 2.1.2.b. (Appendix 11.1.). Information in this table also includes smolts marked with visual implant (VI) tags and adult salmon releases having Floy tags.

2.3. ADULT RETURNS

2.3.1. TOTAL DOCUMENTED RETURNS

Documented total adult salmon returns to rivers in New England amounted to 1,634 salmon (Table 2.2.1.a. in Appendix 11.1.). The majority of the returns were recorded in the rivers of Maine with the Penobscot River accounting for nearly 64% of the total New England returns. The Connecticut River adult returns accounted for nearly 20% of the New England total and 92% of the adult returns outside of Maine. Overall, 24% of the adult returns to New England were 1SW salmon and 76% were MSW salmon; most (78%) of these fish were of hatchery smolt origin.

2.3.2. ESTIMATED TOTAL RETURNS

Many salmon rivers in New England do not have trapping facilities and the existing fish passage and/or trapping facilities are not 100% effective. As a result, the information contained in Table 2.2.1.a. (documented adult salmon returns) underestimate the total salmon returns to New England.

In order to estimate total adult returns the Assessment Committee used the same general assumptions which were described in the 1994 Annual Report, with the following additional adjustments:

1) aquaculture escapees, to the extent which they could be identified, were excluded.

2) for three rivers in Maine where weirs were operated (Dennys, Pleasant, Sheepscot), the weir catch was assumed to represent the total run, except on the Dennys, where seven additional salmon were counted above the weir.

Estimated total returns to New England rivers in 1994 were 2,318 fish (Table 2.2.2.a. in Appendix 11.1.). This is probably an overestimate, since an unknown number of aquaculture escapees were included in several eastern Maine rivers. The total estimated return represents a 34 % decrease from the total estimate of 3,433 in 1993.

2.3.3. RETURNS OF TAGGED SALMON

Returns of CWT and Carlin-tagged Atlantic salmon to rivers in New England in 1994 are shown in Table 2.2.3.a. (Appendix 11.1.). The information has been sorted by river of return and sea-age. A total of 444 salmon (84 1SW, 359 2SW, and 1 RS) having CWT returned to the rivers of New England. Adult salmon having Carlin tags totalled seven, all 2SW fish.

2.3.4. SPAWNING ESCAPEMENT, BROODSTOCK COLLECTION, AND EGG TAKE

Spawning escapement information, where available, can be found in Section 2.1. Although some adult salmon utilizing fish passage facilities in the Connecticut River basin were allowed to proceed upstream (not trapped for broodstock), no significant natural reproduction was expected. Several fish in both the Merrimack and Pawcatuck rivers were not trapped and passed upstream from the first dam on each river. Significant natural reproduction was unlikely. Adult salmon returning to various rivers in Maine will contribute to natural reproduction but the adult female numbers are far less than required for optimum seeding.

Egg sources for the New England Atlantic salmon culture programs included sea-run salmon, captive/domestic broodstock, and reconditioned kelts. A total of 382 sea-run females, 2,977 captive/domestic females, and 216 female kelts (214 reconditioned and two obtained from the Machias River) contributed to the egg take. The number of females (3,575) contributing was less than in 1993 (3,773). This small decrease is attributed to a decline in the number of sea-run females available. In spite of this decrease the number of eggs obtained (20,808,000) was nearly identical to the total recorded in 1993 (20,900,000). A more detailed description of the egg production program is contained within Table 2.2.4.a. (Appendix 11.1.).

2.3.5. SPORT FISHERY

In 1994 the sport fishery for Atlantic salmon in Maine was restricted to one salmon per angler per year, and no salmon longer than 64 cm could be retained. These management measures, in effect, created a catch-and-release fishery throughout the state. The documented catch of salmon in Maine was 262 fish, representing a harvest of 13 and an estimated 249 released (Table 3.3.5.a. in Appendix 11.1.). The age composition of the 13 salmon harvested was one MSW salmon illegally retained, 10 1SW salmon and two 1SW aquaculture escapees. Most (175) of the salmon caught and released were taken in the Penobscot River, with the second highest number (20) reported from the Narraguagus River. Aquaculture escapees accounted for all (30) of the salmon caught and released in the Dennys River. The management measures in effect, coupled with low salmon abundance, resulted in the smallest recorded sport catch of salmon in Maine since intensive records have been kept (1948).

3. TERMS OF REFERENCE

3.1. PROGRAM SUMMARIES FOR CURRENT YEAR

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

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

3.2. HISTORICAL DATA - VALIDATE 1993 STOCKING AND RETURN DATA AND ADD TO HISTORICAL DATABASE

The historical data were validated by the Assessment Committee and the information can be found in Tables 3.3.a. and 3.3.b. in Appendix 11.2. and in Section 6. (sub-sections 6.1. and 6.2.) of this document.

3.3. CONTINUE TO SYNTHESIZE AVAILABLE DATA AND MODEL JUVENILE SURVIVAL AND GROWTH RATES

Implications of Density and Size Dependent Dynamics

The Committee considered the results of a stage-based projection model parameterized to simulate the dynamics of an Atlantic salmon population from southern New England. Stage abundances were projected through time using a matrix of stage-specific survival and transition probabilities. The stochastic properties of the projections were characterized by allowing key parameters to vary randomly. In this model formulation, initial recruitment of fry was kept constant. Age 1 parr abundance was determined by a transition formula using cumulative degree-days in the system:

$$N1=S0*F*\exp(-b0*F+b1*DD)$$

where N1=age 1 parr density, F equal stocked fry density, DD equal degree-days, S0 density independent term, and b0 coefficient of density dependance. Transition to the smolt stage is in turn governed by growth. The length of 50% smolting was 15cm, therefore:

$$PS=1/(1+\exp(-r*(l-150)))$$

where PS is the probability of smolting, l is total length in mm, r is the logistic curve shape parameter. This formulation produced a relatively narrow smolting ogive so that fish below 115mm rarely smolt and fish above 160 mm almost all smolt. A generalized growth curve was used based on degree-days and density dependance. Mortality of post-smolts was assumed to be smolt size dependent and incorporates a normally distributed error term. After the post-smolt year, 10% of the cohort was assumed to mature at 1 sea-winter and adult mortality was assumed to be a constant rate of M=0.1. The model was run over three regimes of high, low, and medium degree-days. Projections were run over a 25 year time horizon and represent 100 replications per time step. The model is illustrated in the network diagram in Fig. 3.3.1. (Appendix 11.1.).

The relationship between fry density and adult returns of all ages was parabolic mirroring the density dependent intermediate life stage functions (Fig. 3.3.2. in Appendix 11.1.). Maximum adult returns for a system the size of the Pawcatuck River (5,500 units) occurred at initial fry densities of slightly over 100 per 100m^2. System productivity, as indexed by degree-days, has a large impact on mean adult returns. Over 80 returns were estimated at initial fry density of 100 fry/unit in productive habitat whereas only 45 returns were realized from low productivity habitat. The production of smolts follows the same general trend. The production of age 2 smolts is nearly the same at all degree-day levels, however, there is an increased number of age 1 smolts produced in the high degree-day trial.

Sea mortality in the first year varied with initial fry density and habitat grade as mediated by smolt size (Fig. 3.3.3. in Appendix 11.1.). Larger smolts survived at higher rates than small fish, which reflects the density dependent growth modified by degree-days. The number of adults produced per 100 fry stocked is shown in Fig 3.3.4. (Appendix 11.1.). This rate fell exponentially with fry density in all three habitat grades reflecting the strong effect of density dependence and size effects on marine survival in the model. This suggests that low grade habitat should only be stocked with sufficient numbers of fry to engage the density dependent response in the better habitat reaches.

The model was most sensitive to variation in post-smolt survival rate underscoring the importance of this period in defining overall population level. The variability associated with fishing and fry mortality did not have as dramatic an impact on adult returns.

The results of these simulations illustrate the effect of density dependence on growth and survival of salmon fry. These effects function in a redundant fashion so that chance conditions which allow for high survival in one stage that will be modulated in another case. Post-smolt mortality rate was much greater then the mortality rate in freshwater and appears to have a size dependent component. These effects, coupled with the compensatory effects in freshwater, create a potent bottleneck regulating population abundance. Large increases in smolt production seem unlikely given these conditions and their interactions. Additional attention should be focused on post-smolt survival, particularly those mortality effects which are likely to be size mediated. If these predictions are accurate it would suggest a reexamination of the efficacy of releasing yearling versus two-year smolts. In addition, the time of release for hatchery fish may be a critical factor.

Temperature Monitoring In Maine

Water temperature, recorded with digital data loggers, was measured in the Sheepscot, Pleasant, Dennys, and Narraguagus rivers, Maine. Temperatures were recorded continuously, however, daily minima and maxima were based on 6h intervals. Water temperature reached 31.0 C (the maximum for the data logger used at this site) for 7.5 h at the Alna site on the Sheepscot River. This suggests the acute lethal limit for salmon (31.1 C for 100 minutes) may have been reached or exceeded in this area. In addition, the question still remains if temperature reached the acute lethal limit of 32.9 C for 10 minutes. Two adult salmon were found dead in the area. It is impossible to rule out handling stress at the trap, but the fish would have been trapped many weeks before and under protocols which minimized handling stress. This sort of temperature regime has been associated with salmon mortalities in other river systems (Huntsman 1942; McCrimmon 1954).

Where temperature did not reach acute lethal levels, concern still exists because of the relatively low duration of cool water relief during the warm periods at two other sites on the Sheepscot River (Coopers Mills and Kings Mills). Normal feeding is disrupted by episodes of warm temperature (Elliot 1991), thus concerns arise over the productivity of some areas of the Sheepscot River.

Water temperature data have been collected intermittently by a number of different agencies in Maine. These data give an indication of the potential for thermal stress on salmonids in the different Maine drainages. Data collection procedures have not been standardized, however, these historical data could serve as the basis of a design for future monitoring programs. The study design should be flexible enough for the collection of a range of data (distribution of water temperature, substrate, canopy, and distribution of impoundments) depending upon study objectives for a particular drainage. Because of the short time exposure to high temperatures necessary to produce stress or mortality, monitoring should be based on observations spaced by no greater than one hour.

Concern was expressed over land use practices in the Sheepscot drainage that may be contributing to elevated water temperatures in the drainage.

Population Statistics For Salmon In The Narraguagus River

Freshwater and marine survival rates were calculated for wild salmon in the Narraguagus River, Maine, spawned in 1989. Using an estimate of egg deposition based on redd counts and an estimate of parr abundance based on an expanded juvenile survey, egg to parr survival rate was measured at 2.56%. This compares favorably to other reports of freshwater juvenile survival rate (Meister 1962; Buck and Hay 1984; Bley and Moring 1988). Overwinter survival is not measured directly in the Narraguagus River. However, a range of estimates (30-60%) can be derived from the literature (Gibson 1994; Seelbach 1987; Symons 1979). Using these data a likely range of the number of smolts migrating in 1992 can be estimated (4,700 - 9,400 smolts).

Marine survival rate for the 1992 smolt class ranged from 0.49-1.11 %. The variability of this estimate was examined with Monte Carlo simulation, the results of which are presented in Fig. 3.3.5. (Appendix 11.1.). The distribution is highly skewed, suggesting that the mean or median rate would be lower than the mid-point of the range. The range of marine survival rate for wild stocks in North American as been characterized by Bley and Moring (1988) at 1.5 - 8.0%. Meister (1962) estimated smolt survival to homewater returns to be approximately 3.0% in Cove Brook, a tributary to the Penobscot River. This simple comparison suggests the rate observed for the Narraguagus fish is extremely low.

The available population data for the Narraguagus River indicate that the current recruitment rate (0.39 recruits/spawner) is inadequate to sustain the population. At this deficient replacement ratio, a reassessment of the management of river enhancement and sport fishery policy is warranted.

3.4. CONTINUE TO CONFIRM SMOLT STATUS UTILIZING EXISTING SMOLT WORK, STRESS EVALUATION, AND EXAMINATION OF SELECTED CHARACTERISTICS IN POTENTIAL SMOLTS AND RETURNING ADULTS

No papers were presented with respect to this topic.

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

A paper was presented that analyzed the temperatures of the river-ocean transition zones in the Connecticut and Penobscot rivers. The timing of smolt migrations and the distance that smolts must travel to reach the marine environment determine what temperatures they encounter in the lower river and in the ocean. Temperature conditions in either environment may influence smoltification and survival.

Sea-surface temperature (SST) data were collected by satellite for marine habitat within 100 km of the mouths of the rivers. River temperatures (RT) were collected at recording stations near the head of tide in both rivers. All data sets were longer than ten years.

SST in the area within 100 km from the mouth of the Connecticut and Penobscot rivers were highly correlated but the average annual SST was over 3 C warmer for the Connecticut. RT were also highly correlated with the Connecticut averaging nearly 4 C warmer. In both systems, the ocean is warmer than the river early in the year with a crossover to warmer river temperatures in spring or early summer. This crossover occurs during week 16 (around mid-April) in the Penobscot and week 17 in the Connecticut.

Assuming a hypothetical migration that would start at river temperatures warmer than 5 C and would end at 10 C, the Connecticut River has a longer, but earlier, migration window than the Penobscot. Smolts would face different environmental conditions upon entry to the ocean in each system. The Penobscot SST is over 2 C colder than the Connecticut SST and over 1 C colder than the Penobscot River RT. Conversely, the Connecticut SST is warmer than the RT by over 1 C.

These data indicate that the extirpated native stocks in the Connecticut River must have either been adapted to warmer ocean-river temperatures or had earlier timing of smolt entry to the ocean. An earlier migration appears to be the more likely mechanism based on information from anadromous salmonines in other river systems. Due to the long distance of most production areas in the Connecticut basin from the ocean relative to the Penobscot, the migration would need to be even earlier than suggested by temperature alone. Cues other than temperature may have been important to migratory timing of smolts of the native stock.

Discussion of this topic centered on the importance of early smolt migration timing in the

Connecticut River restoration stock to allow migration during high flows to minimize mortality and allow entry to the ocean at the appropriate time. Natural selection of the restoration stock should result in a more appropriate timing of smolt migration in the Connecticut River.

3.6. COMPARE MARINE SURVIVAL RATES OF U.S. ATLANTIC SALMON STOCKS AND IDENTIFY FACTORS AFFECTING THESE RATES

A paper was presented that assessed the marine survival and growth of Atlantic salmon stocks from the Connecticut and Penobscot rivers. The authors assessed the marine survival and sea-age at maturity of hatchery stocks from these two rivers. Return rates were calculated from the number of smolts stocked and the number of returning hatchery fish for smolt-years 1977 to 1990. During this period, the number of smolts released ranged from 32,000 to 476,000 in the Connecticut River and from 200,00 to 687,000 in the Penobscot River. Releases in the early part of the time series were dominated by two-year-old smolts with a transition to mostly one-year-old smolts by the end of the series. Returns to both systems were dominated by 2SW fish. Average 2SW returns for the Penobscot River (4.89‰) were significantly higher than observed in the Connecticut (1.40‰) (Figure 3.6.1. in Appendix 11.1.). Returns of 1SW fish were lower for the Connecticut River (0.0-0.1‰ range) than the Penobscot River (0.4-2.2‰ range). While differences in the magnitude of return rates were evident, the two stocks exhibited coherence in annual variability (Figure 3.6.1.).

Using circuli spacing patterns, the authors also measured indices of spring (ocean entry), summer (maximum), and winter (minimum) growth. In addition, they assessed the area of freshwater growth. Their results indicated that returning adults in the two systems had similar freshwater, spring, and winter growth. Summer growth indices indicated that Penobscot fish grew better than Connecticut River fish during this period. The authors speculated that of the conditions affecting the two stocks during the postsmolt year, some are common to both stocks accounting for the similarities in survival rate time series. In addition, significant differences in the condition sets that account for the lower survival and maturity fraction of the Connecticut River stock were hypothesized. The coherence of survival time series of these two stocks and other North American stocks is considered evidence that these stocks share a common overwintering area. The lack of correlation between spring and summer indices indicates that these two stocks are acted upon by different environmental conditions during this period.

These data suggest support the hypothesis that these stocks are not fully mixed until winter. In addition, the slower growth of Connecticut River Atlantic salmon in the post smolt year suggests that they may exhibit higher mortality rates. The working group felt that this paper provides further evidence of the important role of the postsmolt period on the on the population dynamics of these two stocks. The group supported continued research of this type, suggesting analyses of an intermediate stock (Merrimack River) and northerly stocks (Canada) to further examine the role of postsmolt growth.

3.7. DEVELOP METHODOLOGIES TO ESTIMATE SMOLT PRODUCTION AND PARR TO SMOLT OVER-WINTERING MORTALITY FOR U.S. ATLANTIC SALMON STOCKS

Two papers examined estimating basinwide abundance of presmolt Atlantic salmon. These estimates are important to understanding juvenile ecology and population dynamics because they enable calculation of presmolt production and overwinter survival to outmigration. Methods for these estimates in smaller streams that have been developed in the literature focus on Representative Reach Estimation Techniques (RRET) with extrapolation to the basin or basinwide visual estimation techniques using a multi-stage sampling design delineated by natural habitat units of varying length to provide statistically valid population estimates. In both methods, the errors of estimation within selected units are small compared to variation in abundance between discrete units. This observation indicates that proper partitioning of stream units into assessment strata would facilitate a more rigorous population estimate. The formation of appropriate strata becomes more important as basin size and the complexity of habitat increases.

The first paper focused on developing an adaptable framework to geographically and ecologically define strata to improve estimates of abundance in streams, Basinwide Geographic and Ecologic Stratification Technique (BGEST). The method provides an adaptable framework for assessing a basin and determining the location of strata boundaries. The BGEST approach functions on the hypothesis that geography and ecology can be used to develop strata that are biologically and statistically meaningful. The first level of stratification, geostratification, is based on examining large scale geographical differences (climatic, edaphic, geomorphologic) in the watershed that would influence Atlantic salmon production and distribution. The second level of stratification incorporates the ecology and biology into the geographic and spatial constraints of its ecosystem. Since many of these factors change along a continuum, utilizing the spatial dispersal patterns of juvenile fish aids in delineating appropriate boundaries between strata. These parameters are integrated into the development of ecostrata by examining available information on these factors for the species in general and for the basin for which the estimate is being developed. The final level of stratification is channel units. For most salmonine species, individual channel units such as pools, riffles, and runs will have very different carrying capacities. A hierarchical approach to defining channel units provides a reasonable strategy because of its flexibility. The appropriate level of resolution ultimately depends upon the diversity and abundance of various habitat types and the size of the basin under analysis.

Two examples using the Narraguagus and Merrimack Rivers were presented to illustrate application of the method. The authors' analysis of differences in the Narraguagus River basin indicated that five levels of geostrata, four ecostrata, and two channel unit strata for the mainstem were needed. The result was eleven BGEST strata. The variance of population estimates was typically lower using the BGEST method. Results were relatively consistent despite differences in sampling effort between the four years. Substantial differences in the density of fish occurred between strata. In addition, differences between strata across years were minimal. Strata that were good producers in one year were typically good producers in other years in the time series.

These results indicated that the precision of sampling increased using the BGEST framework. Comparisons of available habitat and production indicated those sections are strong producers and those that are weak. This provides useful stock assessment information as well as practical management information.

For the Merrimack River the method was used for two reasons. No other large scale activity has yet to be established to evaluate the success of the fry release program. Although the return of adults to the river is one measure of success, the return rate is confounded by other factors including smolt mortality due to encounters with riverine obstructions, and post-smolt and marine mortality. Also, a review of the past sampling effort suggests that too few sites had been sampled to adequately develop estimates of the number of parr in the basin. Habitat was stratified into four zones that were different for a number of reasons some of which include climate, geography, geology, hydrology, and land use. Basinwide population estimates for age-1+Parr were derived using geographic and geographic/river size schemes. In the geographic strata scheme rivers within zones were grouped regardless of their size; the number of sample sites within zones ranged from a low of two to eight. Both geographic and size strata were incorporated in the second scheme. Assumptions were made in this analysis due to data gaps. For some strata only one sample was available and the variance of abundance was assumed to calculate population estimates for these strata. Although estimates of the variance of abundance are used in the second scheme to calculate statistics, the results still are instructive. This geographic/size strata scheme is useful in planning future effort because it best fits the scheme that is likely to be used in the basin, and it provides insight into the appropriate allocation of sampling effort. Results suggest that sample sites should be increased to include, at a minimum, three sites. In addition, calculations suggest that optimal allocation of effort would require an increase in effort in some zones. Allocation results show a reduction in effort in the remaining strata, and with effort allocated as suggested, the total number of sample units could be reduced.

The results of these two investigations indicate that the BGEST method provides an adaptable framework for improving population estimates in moderate to large basins. This method inherently provides a more accurate basinwide estimate than the RRET when production and habitat vary along the length of a watershed and between channel units. Because the spatial distribution of habitat and spawners appears to vary greatly in most moderate to large river systems in North America, the BGEST method should be suitable in many situations. In addition, the BGEST method's stratified approach allows collection of information on discrete river sections throughout a basin. This framework fits well into interjurisdictional waters where multiple agencies are monitoring abundance. This information can also be useful in a research or management context since areas of good production and poor production can be identified. With the addition of redd distribution data, researchers can investigate the reasons for poor juvenile production and determine if spawner biomass or juvenile survival is the principal regulatory factor. The method also provides information that is useful in supplemental stocking programs by determining where stocking would supplement a natural population with a minimum of interference with wild fish. Given the advantages of the BGEST, further investigations into the use of this method in larger systems will be beneficial not only for making more accurate population estimates but for calibrating and refining this approach.

4. DISCUSSION TOPIC

4.1. GENETIC SURVEY OF U.S. ATLANTIC SALMON

Tim King of the National Biological Service (NBS), Leetown Science Center presented a draft proposal entitled "Genetic stock identification of Atlantic salmon inhabiting North America with emphasis on the Downeast rivers of Maine". This is a proposal for work to be done by the NBS and it was presented to the Assessment Committee to solicit review and comments. The objectives of the proposed study are: (1) develop and evaluate techniques to identify and assess genetic variability in Atlantic salmon nuclear and mitochondrial DNA at the population level; (2) identify genetic variation among juvenile Atlantic salmon from eleven Maine rivers, five rivers in the Maritime Provinces of Canada, and two European rivers; (3) determine spatial/temporal variability, assess intra-river variation, and determine the potential for distinct spawning populations within the Narraguagus, Dennys, and East Machias rivers; (4) develop a gene marker(s) that can be used to distinguish selectively bred salmon and test archived tissue samples for such makers, and (5) develop a genetically distinguishable hatchery product to assist in assessments of the fry stocking program.

It was observed that no comprehensive genetic database for Atlantic salmon in North America currently exists and the proposed study, which is an outgrowth of the Atlantic Salmon Technical Working Group (formed in October 1993), will begin to establish such. The study was prompted by the petition to list the Atlantic salmon under the Endangered Species Act (ESA), but implied that it could be useful for purposes beyond those associated with the ESA. Not all targeted rivers will be able to do tissue-analysis annually, but it is hoped that most of the rivers can be tissue-sampled annually and the tissues can be archived for future analysis. There will be no need for lethal sampling; the excision of fins (approximately 0.1 g) is sufficient to provide adequate amounts of DNA for study. There was general agreement in subsequent discussion that archiving of tissue samples from all rivers would be beneficial for a variety of reasons, including the ability to create a Atlantic salmon tissue repository to support future work. The opinion was offered that allozyme analysis seems to hold little promise for providing answers to the type of questions that salmon workers are asking.

The study proposes to spend the next year in methods development: looking at the "5S region" in collaboration with the University of Wisconsin (Milwaukee), looking at single locus probes in collaboration with Dalhousie University, working with the Atlantic Salmon Federation (ASF) at St. Andrews on analyzing its breeding program, looking for genetic markers (which may require some selective breeding), and working on DNA fingerprinting (estimated as high as $150/fish).

Discussion

In response to a question about the eventual availability of an "on-site" test to distinguish wild vs. aquaculture fish (e.g. at weirs), Tim thought it might be possible within 10 years, depending on the future genetic practices of the aquaculture industry. It was suggested that outside funding be pursued. In response to questions, it was stated that work on southern New England rivers (e.g. the Connecticut) would need to be done under a separate, but related study. There was considerable discussion of the needs of these southern New England programs.

Other miscellaneous comments that were made: DNA can be extracted from scale samples, thus making the genetic characterization of archival material feasible. These studies should be pursued. A question was poised concerning the feasibility of accelerated selected breeding by using cloning and gamete manipulation techniques. Potentially desirable traits could be tested for in the laboratory without completing the entire life cycle. It was indicated that the Leetown lab did not have this capability. This underscores the deficiency of the state-of-the-art technology being used in Atlantic salmon genetics. Traits are most likely regulated by a suite of genes. To do "real time" monitoring of fish identity (i.e. tissue sample incoming adults, perform band or DNA analysis, develop a breeding strategy which excludes deleterious genotypes, such as aquaculture fish, and during the subsequent breeding season, cross dissimilar fish to maximize genetic variability) would very helpful and would cost about $15,000 for 300 adults. There was general agreement as to the utility of this exercise but great disagreement as to the likelihood that such funds could be made available for the work.

It was asked whether there would be a real threat in allowing aquaculture escapees to ascend rivers with natural salmon populations, breed, and assume that nature would select against unfavorable traits. Tim responded that he felt that there would be threats to the population through genetic swamping and loss of valuable traits. It was also suggested that this point was proven by experience in Ireland where there was documentation of loss of variation under similar circumstances.

5. RESEARCH

5.1. CURRENT RESEARCH ACTIVITIES

The following is a list of Atlantic salmon related research that was conducted during 1994. The capital letters (codes) following the listing of the authors refers to the address of the research facility (listed at the end of the Section). The information presented is by no means complete, since many of the agencies/research labs did not respond to the Working Group's request for information.

Artificial Propagation

1. Hendrix, Mike (H)
EVALUATION OF TRANSPORTATION METHODS FOR GREEN ATLANTIC SALMON EGGS.

The objective of this study was to test the effects of different green egg transportation methods upon eye-up. Specifically, the effects of water hardening in iodophor with or without ice and time delay between egg take and placement in incubator vs. temperature. These tests were conducted with eggs from sea-run Atlantic salmon broodstock held at Cronin NSS. Additionally, water hardening in iodophor with or without ice and the effects of different transport containers were evaluated with eggs of captive Atlantic salmon broodstock held at Kensington State Salmon Hatchery (KSSH), CT. It was found that KSSH eggs which underwent delayed fertilization had significantly greater eye-up than the other treatments (P=0. 05). Cronin eggs transported with ice had significantly greater eye-up than those transported without ice (P=0. 05). There was significantly greater percent eye-up in Cronin eggs transported for 4 hours vs. 8 or 12 hours. Iodophor use had no effect on percent eye-up of Atlantic salmon eggs.

2. Hendrix, Mike (H)
CARP PITUITARY HORMONE INJECTION OF ATLANTIC SALMON IN A NET PEN AQUACULTURE OPERATION.

Male and female Atlantic salmon were injected with Carp Pituitary (CCP) hormone and evaluated for milt production and egg survival. One hundred and seven males and forty seven females were injected on November 23, 1993. On December 6, 1993 an additional 96 males were injected. The best results were obtained from injected males; controls yielded only 1 - 2 ml of milt per fish compared to about 40 ml of milt per fish from the CCP injected fish. The milt was determined to be of good quality with high motility. The results for the egg production and accelerated spawning were inconclusive. A significant percentage of mortality was experienced during the initial stages of incubation and during the egg development. This mortality may be a result of over-ripe eggs, handling stress, and the water quality at the facility.

Fish Passage

1. Haro, Alex (C)
SMOLT PASSAGE EFFICIENCY OF SHARP- AND BROAD-CRESTED (NU/ALDEN) WEIRS.

Two weir types (sharp- and broad-crested) were constructed in the Conte Anadromous Fisheries Research Center (CAFRC) flume to evaluate downstream passage efficiency and behavioral responses of hatchery and fry-stocked smolts. Although fish actively avoided entry into both structures, the broad-crested weir passed a larger number of smolts over a shorter time period than the sharp-crested weir under similar flow conditions. Fish usually passed both weirs tail-first, and in groups of 2-10 individuals. The broad-crested weir design appears to have advantages over standard sharp-crested weirs for entraining downstream migrant fish into bypass structures.

Genetics

1. Kincaid. Harold (A)
MERISTIC AND MORPHOMETRIC ANALYSIS OF ATLANTIC SALMON FROM GULF OF MAINE RIVERS.

The Research and Development Laboratory completed meristic and morphometric analysis of nine Atlantic salmon stocks from sample collections in 1992 and 1993: Seven wild stocks from Maine rivers (Penobscot, Machias, Sheepscot, Narraguagus, Dennys, Ducktrap, and Pleasant rivers; one hatchery stock (Green Lake captive) and one Canadian out group from the Saint John River (Saint Andrews)). Analysis of 4 meristic and 12 morphometric traits showed variability among the stocks, but the results were inconclusive. Multiple range tests show each stock was different from all other stocks tested for one to four traits, except the Dennys River stock. Morphometric and meristic traits measure the variability in phenotypic expression of these traits and, as such, are only indirect measures of genetic variability.

2. Kincaid, Harold (A)
ALLOZYME ANALYSIS OF ATLANTIC SALMON FROM GULF OF MAINE RIVERS.

The Research and Development Laboratory, in cooperation with Dr. Bernie May, Cornell University, completed allozyme analysis of the same Atlantic salmon stocks and estimated mean heterozygosity to be 0.021 (SE=0. 0016). The analysis was based on 54 loci. Heterozygosity was lowest in the Pleasant River stock (0.012) compared to 0.020 - 0.026 in all other stocks. Genetic variability levels were within the range typically found in naturally-reproducing Atlantic salmon populations, but the degree of genetic differentiation among stocks was less than expected for native populations collected from a similar geographic range. Possible explanations for the lower differentiation among stocks in this study are: 1) the differentiation among Maine populations was historically less than observed in other parts of the species range, 2) extirpation or nearly extirpated native populations have been replaced by hatchery stocks, and 3) wide-spread stocking of hatchery fish followed by introgression into the native populations has artificially reduced the differentiation among populations. Additional work is needed to assemble and analyze the data available from all sources (meristic, morphometric, allozyme, DNA and life history traits) to resolve the question on stock structure in the Atlantic salmon populations in the northeastern United States.

Habitat

1. Parrish, Donna and Carol Folt (E & F)
AN EVALUATION OF HABITAT QUALITY FOR AGE-0 ATLANTIC SALMON IN THE WEST AND WHITE RIVERS, VERMONT.

Survival of age-0 salmon in Connecticut River tributaries has been quite variable, although the general pattern indicates higher survival in the West River than in the White River. In this study the authors summarized and analyzed all accessible physical habitat measurements collected at sites on the West and White rivers. They used a variety of statistical approaches and found that none of the individual physical habitat variables measured varied consistently among high and low salmon survival sites. However, interactions between water velocities at different depths may influence potential net energy gains available to salmon, therefore, affecting first summer salmon survival.

Juvenile Studies

1. M.E. Mather and D.L. Parrish (G)

FACTORS INFLUENCING SMOLT PRODUCTION, OVERWINTER MORTALITY, AND DOWNSTREAM MIGRATION OF THE ATLANTIC SALMON (*SALMO SALAR*) IN THE WEST RIVER SYSTEM, VERMONT.

Atlantic salmon smolts stocked as fry were sampled from late April to late May at eight locations on five tributaries of the West River, Vermont, using vertical-slot net weirs. A total of 791 smolts were collected, of which 561 were subsequently marked with visual implant tags for weir efficiency tests and migration studies. One hundred twenty tagged fish (21%) were recaptured. Smolts ranged in size from 120 to 190 mm (TL); mean length differed little between tributaries. An analysis of scales collected from smolts revealed that most had spent two winters in freshwater before migrating. Electrofishing surveys completed in June showed that a small percentage (approximately 5%) of large parr did not migrate. Qualitatively, smolt production differs between tributaries, the extent of which is believed to be mediated by differential over-winter mortality and population factors, such as rates of male precociousness. An assessment of these factors is planned for the fall and winter of 1994/1995.

Marine Studies

1. Kocik., John F. and Kevin D. Friedland (I)

PRELIMINARY ANALYSIS OF CONNECTICUT AND PENOBSCOT RIVER-OCEAN TRANSITION ZONES FOR ATLANTIC SALMON SMOLTS.

Atlantic salmon in the U.S. are at the southern extent of their range, presenting unique challenges to restoration and conservation of salmon in these systems. The Connecticut and Penobscot rivers are at the extremes of this range within the U.S. While inherent temperature differences between the two systems are assumed, they have not been quantitatively assessed. This study examines temperature regimes in the lower stretches of the Penobscot and Connecticut rivers and within 100 km of these river mouths. Comparing potential outmigration periods, the hypothetical migration window in the Connecticut River was longer and occurred earlier than in the Penobscot River. During these periods, SST in the Connecticut nearshore area was 1.23 degrees warmer than river temperature while in the Penobscot, SST was 1.27 degrees colder than river temperature. Future research will focus on modelling temperature and transit speed in these systems to further outline the environmental conditions.

2. Friedland, Kevin D., Ruth E. Haas, and Timothy F. Sheehan (I)

POST-SMOLT GROWTH AND COMPARATIVE MATURATION AND SURVIVAL OF ATLANTIC SALMON.

Marine survival and sea-age of maturation for Penobscot and Connecticut River hatchery stocks of Atlantic salmon were compared to differences in post-smolt growth measured using circuli spacing patterns. Return rates for both 1SW and 2SW were found to be significantly higher in the Penobscot stock. In addition, the fraction of the smolt year class or cohort that matured as 1SW fish was also higher for the Penobscot stock. Using image processing techniques, we extracted inter-circuli distances from scales of 2,301 2SW fish. Circuli spacing data was used as a seasonal growth index for spring (ocean entry), summer (maximum growth), and winter (minimum growth). No significant difference in growth occurred between spring or winter between the systems. Growth of the Penobscot fish during the summer season was greater than that of their Connecticut counterparts of the same smolt year. The results suggest post-smolt growth may play a significant role in deciding the age-at-maturity and survival patterns of Atlantic salmon.

Nutrition

1. Ketola, George (B)

PLANT PROTEINS IN PLACE OF FISH MEAL IN DIETS OF ATLANTIC SALMON.

Previous studies with rainbow trout demonstrated excellent protein utilization when fed plant proteins, soybean meal or corn gluten meal. Growth was excellent (90 to 100% of fish meal controls) when supplemented with several amino acids. Plant proteins have the advantage of containing much less phosphorus than fish meal, enabling formulation of diets with reduced phosphorus wastes. In this study, three plant proteins were evaluated in diets of Atlantic salmon. Salmon were fed diets containing either soybean meal, corn gluten meal, or peanut meal as a replacement for 33% herring fish meal with and without amino acid supplements. Supplements were made to meet the National Research Council's requirements for salmon or match the amino acid composition of trout eggs. Supplemental amino acids significantly increased growth for all plant protein diets. When supplements were based on trout egg composition, growth of salmon fed soybean meal or peanut meal was equal to or not significantly different from that for fish meal. These proteins permit more economical diets that generate lower levels of waste phosphorus in hatchery discharges.

Physiology

1. McCormick, Steve (C)

HORMONAL CONTROL OF PARR-SMOLT TRANSFORMATION.

The potential roles of growth hormone (GH) and insulin-like growth factor I (IGF-I) in seawater acclimation were examined in juvenile Atlantic salmon. Both the short-term and long-term actions of these hormones were examined. Compared to controls, fish in 12 ppt seawater given a single injection of ovine GH followed 48 hours later by transfer to 34 ppt seawater had significantly lower plasma sodium, osmolarity and muscle moisture content. There was a similar, dose-dependent increase in salinity tolerance after a single injection IGF-I. Fish in fresh water given GH implants for 4-10 days had greater gill Na+, K+ -ATPase activity and salinity tolerance than controls. Cortisol implants also increased gill Na+, K+ -ATPase activity and salinity tolerance, and in combination with GH had a synergistic effect. Although IGF-I implants alone for 4-10 days were without effect, IGF-I and cortisol in combination increased gill Na+, K+

-ATPase activity more than cortisol or IGF-I alone. The results indicate that 1) GH and IGF-I and cortisol can independently increase salinity tolerance, and 2) there is an important interaction between the GH/IGF-I axis and cortisol in regulating gill Na+ , K+ -ATPase activity and salinity tolerance.

2. McCormick, Steve. (C)
PHOTOPERIOD CONTROL OF THE PARR-SMOLT TRANSFORMATION.

The effect of increased daylength was examined at two temperatures: constant 10 °C and ambient river temperatures (2-3° from January to April, increasing thereafter). At 10°C, an increase in daylength (L:D 16:8) on February 12 resulted in a 4-week advance of increases in gill Na+ , K+ -ATPase activity relative to controls that remained on simulated natural photoperiod. No such advance occurred in fish at ambient river temperatures that experienced an identical increase in daylength. These results indicate that photoperiod manipulations will only be successful at elevated temperature and explain why such manipulations at hatcheries with low winter temperature have not resulted in alterations in the timing of smolting.

3. McCormick, Steve. (C)
DEVELOPMENTAL DIFFERENCES IN THE STRESS RESPONSE OF ATLANTIC SALMON.

The response of parr and smolt to an identical stressor (netting and simulated transport) was examined in spring at the time of normal downstream migration of smolts. Following stress, plasma cortisol and glucose were higher and plasma ions were lower in smolts than in parr. Under conditions of constant temperature (10° C) pre-smolts in February had lower plasma cortisol than smolts in May when subjected to the same stress, but each experienced similar increases in plasma glucose and decreases in plasma ions. The results indicate that there are large differences between parr and smolt in the stress response, but that this response is similar in pre-smolts and smolts.

4. Shrimpton, Mark. (C)
IMPORTANCE OF CORTISOL RECEPTORS IN PARR-SMOLT TRANSFORMATION.

Cortisol receptors (CR) in the gills of juvenile Atlantic salmon were examined to detect changes in tissue responsiveness to cortisol. We have found that a mechanism of interaction between cortisol and other hormones involved in smolting exists by altering CR abundance. Growth hormone (GH) administration increases CR, and triiodothyronine (T3) appears to augment this process. CR numbers and affinity are found to decline during the spring as the fish smolt. The change in CR affinity correlates with changes in Na+ , K+ -ATPase activity in the gills. Advances in photoperiod accelerated changes in affinity and concentration for fish held at 10°C, but not fish held at ambient temperature water (2-3 °C). Differences between lower mode and upper mode pre-smolts and hatchery-reared and fry stocked pre-smolts and smolts are currently being examined. The results will indicate what role rearing environment will play in the parr-smolt transformation and development of saltwater tolerance, and the effect of stress on these developmental processes.

Predation

1. Blackwell, Brad. (D)
ECOLOGY OF THE DOUBLE-CRESTED CORMORANT IN THE PENOBSCOT RIVER WITH EMPHASIS ON SMOLT PREDATION.

Field work for the project was completed between 1992 and August 1994. In addition to censusing cormorants at feeding and roosting sites, cormorants were monitored at dams this past summer to determine numbers and how these areas are used, and by how many birds. Counts of cormorants were made every 10 days from the air (to determine feeding locations) and at night roosts (to estimate total numbers) from early April through late June. Peak numbers on the Penobscot River in 1994 occurred in late May and early June, later than in 1992, but about the same time as in 1993. Weather conditions and river flow rate from April through June will be examined as possible factors affecting cormorant arrival and distribution along the Penobscot. In 1994, adult cormorants again arrived before subadults and contributed to the in-river predation on Atlantic salmon smolts. Cormorant feeding at dams during 1994 was, as in the previous two years, disproportionately high relative to use of free flowing habitat.

Prey items regurgitated by nestling cormorants were collected from 10 breeding colonies in Penobscot Bay during July, 1993. These data were analyzed and presented at the 1994 meeting of the Colonial Waterbird Society. Data for the entire project will be tabulated and analyzed this winter; a final report will be submitted by the summer of 1995.

2. Schulze, M. (G)
CONNECTICUT RIVER PISIVORY: ESTIMATING THE IMPACT OF PISCIVORES ON THE SURVIVAL AND DISTRIBUTION OF JUVENILE ANADROMOUS FISH IN THE LOWER CONNECTICUT RIVER WITH FIELD SURVEYS AND A BIOENERGETIC MODEL.

Using Connecticut River field data, a bioenergetics model was used to assess the potential impact of predator species, predator number/size, and water temperature on the abundance of juvenile anadromous fish. From these modeling simulations three conclusions were drawn. First, using a standard biomass of five common Connecticut River predators: largemouth bass, smallmouth bass, striped bass, northern pike, and walleye, the interaction of river temperature and predator physiology was tested. At the temperatures found in the Connecticut River in March and April, the warmwater *Micropterus* species had little effect; the two coldwater species, walleye and northern pike, had a greater potential impact on all hatchery releases; and the mesothermal striped bass had little effect on the early hatchery releases, when temperatures were low, but had the greatest potential impact of any predator during both the late hatchery releases and time of feral salmon migration, when temperatures were warmer. Second, using a range of striped bass population sizes and age/size structures based on recreational striped bass angler data, it was concluded that at intermediate striped bass densities, these fish have the potential to impact both salmon and shad numbers, especially during the later hatchery releases and feral smolt migration. In addition, the predatory impact of fish populations dominated by larger striped bass (e.g. 1992) will be greater than populations dominated by smaller striped bass (e.g. 1984). Third, even small increases in seasonal temperature result in measurable increases in potential predation by striped bass.

Tagging

1. Hendrix, Mike (H)
ANNOTATED BIBLIOGRAPHY ON MARKING AND TAGGING FRY.

Study objectives were: (1) To provide fishery biologists and resources managers an overview of sources that can be used to make informed decisions on marking and tagging fry; (2) To aid in the development of marking and tagging fry with subsequent non-lethal methods of mark detection. A total of six different techniques were found for marking fry. Out of 30 articles reviewed, 69% were chemical or elemental marks, 275 were external tags and marks, and 13% were internal marks.

2. Hendrix, Mike (H)
IMPLANTATION AND RETENTION OF 1/2 LENGTH CWT IN ATLANTIC SALMON (*SALMO SALAR*) SAC-FRY.

Study objectives were to determine the feasibility of tagging Atlantic salmon sac-fry with half-length CWT; concerning tag placement, retention, associated mortality, and efficiency of methods. It was found that this tagging method is not acceptable for Atlantic salmon sac-fry due to excessive time involved for actual tagging, inconsistent tag placement, poor retention, and excessive injury to fry.

Survival

1. Parrish, Donna and Carol Folt. (E & F)
HABITAT VARIABLES CONTRIBUTING TO AGE-0 ATLANTIC SALMON SURVIVAL IN THE WEST AND WHITE RIVERS, VERMONT.

The authors have previously studied food availability and habitat quality for Atlantic salmon fry in the West and White rivers. The general pattern indicated higher survival in the West than in the White River. In this study, the authors will test the relationships determined in the data analysis from their past studies by collecting habitat data at new West and White River sites. These independent data collections should indicate more clearly those variables that relate to first year survival of Atlantic salmon. Anticipated completion date: April 1995.

PUBLICATIONS AND AUTHORS

U.S.A. 1994

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List of Contributing Institutions

Code	Address
A	National Biological Service National Fishery Research & Develop. Lab. R.D. # 4, Box 63 Wellsboro, PA 16901 Phone: 717-724-3322 Fax: 717-724-2525

B	National Biological Survice Tunison Laboratory of Fish Nutrition 3075 Gracie Road Cortland, New York 13045-9357 Phone: 607-753-9391 Fax: 607-753-0259
C	National Biological Survey S.O. Conte Anadromous Fish Research Center P.O. Box 796 One Migratory Way Turners Falls, MA 01376 Phone: 413-863-9475 Fax: 413-863-9810
D	University of Maine Maine Cooperative Fish & Wildlife Research Unit 240 Nutting Hall Orono, Maine 04469 Phone: 207-581-2582
E	University of Vermont Vermont Cooperative Fish & Wildlife Research Unit School of Natural Resources Aikens Center Burlington, VT 05405 Phone: 802-656-4280
F	Dartmouth College Department of Biological Sciences Gilman Hall Hanover, New Hampshire 03755 Phone: 603-646-2378 Fax: 603-646-1347
G	University of Massachusetts Department of Forestry & Wildlife Management Holdsworth Natural Resources Center Box 34220 Amherst, MA 01003 Phone: 413-545-0080 Fax: 413-545-4358

H U.S. Fish & Wildlife Service
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I National Marine Fisheries Service
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5.2. RESEARCH NEEDS AND DATA DEFICIENCIES

The reader is referred to Annual Report 1994/6 for a detailed description of the research needs and data deficiencies regarding Atlantic salmon in New England.

6. HISTORICAL DATA (1970 - 1993)

6.1. STOCKING

The historical stocking information is presented in Table3.3.a. in Appendix 11.1. The information is also displayed graphically by major program and by lifestage at stocking in figures 6.1.1. and 6.1.2. (Appendix 11.1.).

6.2. ADULT RETURNS

The historical return information is presented in Table 3.3.b. in Appendix 11.1. The information is also displayed graphically by major program and by sea-age in figures 6.2.1. and 6.2.2. (Appendix 11.1.).

7. TERMS OF REFERENCE FOR 1996 MEETING

The U.S. Atlantic Salmon Assessment Committee agreed to address the following Terms of Reference for the 1996 meeting.

1. Program summaries for current year (1995) to include:

   a. current year's stocking program with breakdowns by time, location, marks and lifestage.

b. current year's returns by sea age, marked vs. unmarked, and wild vs. hatchery.
c. general summary of program activities including regulation changes, angling catch, and program direction.

2. Historical data - validate 1994 stocking and return data and add to historic database.

3. Continue to synthesize available data and model juvenile survival and growth rates.

4. Continue to confirm smolt status utilizing existing smolt work, stress evaluation, and examination of selected characteristics in potential smolts and returning adults.

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

6. Compare marine survival rate of U.S. Atlantic salmon stocks and identify factors affecting these rates.

7. Develop methodologies to estimate smolt production and parr to smolt over-wintering mortality for U.S. Atlantic salmon stocks.

8. U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE PARTICIPANTS

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

9. PAPERS SUBMITTED

Beland, Kenneth F. and Kevin Friedland. Estimation of population statistics for the Narraguagus River Atlantic salmon cohort spawned in 1989.

Friedland, K. D., R.E. Haas, and T.F. Sheehan. Post-smolt growth and comparative maturation and survival of Atlantic salmon.

Horton, Gregg E., Kenneth F. Beland, and Denise Beach. Summary of 1994 temperature monitoring in the Sheepscot, Narraguagus, Pleasant, and Dennys Rivers in Maine.

Gibson, Mark R. Implications of density and size dependent dynamics to smolt production and adult return in stocked Atlantic salmon.

Gibson, Mark R. Pawcatuck River Atlantic salmon restoration program summary for 1994.

Kocik, John F., Kenneth F. Beland, and Norman R. Dube. A framework for using geographical and ecological attributes to develop basinwide juvenile Atlantic salmon population estimates.

Kocik, John F. and Kevin D. Friedland. Preliminary analysis of Connecticut and Penobscot River - ocean transition zones for Atlantic salmon smolts.

Maine Atlantic Sea Run Salmon Commission and U.S. Fish and Wildlife Service. Maine Atlantic salmon restoration program summary of 1994 activities.

McKeon, Joseph F and John F. Kocik. Results of a stratified index sampling scheme to estimate Atlantic salmon parr abundance in the Merrimack River basin in 1994.

10. LITERATURE CITED

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11. APPENDICES

11.1. TABLES SUPPORTING THE DOCUMENT

TABLE 2.1.1.a. ATLANTIC SALMON STOCKING SUMMARY FOR NEW ENGLAND IN 1994 BY RIVER SYSTEM AND BY PROGRAM. 1)

RIVER SYSTEM	NUMBER OF FISH 2)						TOTAL
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	
UNITED STATES							
St. John	0	0	0	0	0	0	0
Aroostook	0	0	0	0	0	0	0
St. Croix	87,000	0	0	0	60,600	0	147,600
Dennys	20,000	0	0	0	0	0	20,000
Pleasant	0	0	0	0	0	0	0
East Machias	0	0	0	0	0	0	0
Machias	50,000	0	0	0	0	0	50,000
Narraguagus	0	0	0	0	0	0	0
Union	0	0	0	0	0	0	0
Penobscot	949,000	0	2,400	0	567,600	0	1,519,000
Ducktrap	0	0	0	0	0	0	0
Sheepscot	0	0	0	0	0	0	0
Saco	190,000	0	0	0	20,000	0	210,000
Cocheco	149,000	0	0	0	5,300	0	154,300
Lamprey	98,000	56,300	7,800	0	0	0	162,100
Merrimack	2,816,000	0	0	0	85,000	0	2,901,000
Pawcatuck	557,000	0	0	0	2,000	0	559,000
Connecticut	5,979,000	37,000	2,300	12,900	375,100	0	6,406,300
TOTAL	10,895,000	93,300	12,500	12,900	1,115,600	0	12,129,300
CANADA							
Upper St. John	566,000	216,000	0	0	0	0	782,000
Aroostook	0	0	0	0	0	0	0
St. Croix	0	38,600	0	0	0	0	38,600
TOTAL	566,000	254,600	0	0	0	0	820,600
PROGRAM							
Maine							
United States	1,296,000	0	2,400	0	648,200	0	1,946,600
Canada	566,000	254,700	0	0	0	0	820,700
Cocheco	149,000	0	0	0	5,300	0	154,300
Lamprey	98,000	56,300	7,800	0	0	0	162,100
Merrimack River	2,816,000	0	0	0	85,000	0	2,901,000
Pawcatuck River	557,000	0	0	0	2,000	0	559,000
Connecticut River	5,979,000	37,000	2,300	12,900	375,100	0	6,406,300
TOTAL	11,461,000	348,000	12,500	12,900	1,115,600	0	12,950,000

1) The distinction between USA and Canadian stocking is based on the sources of the fish.
2) The number of fry is rounded to the nearest 1000 fish. All other entries rounded to the nearest 100 fish.

TABLE 2.1.2.a. SUMMARY OF JUVENILE ATLANTIC SALMON MARKING PROGRAMS NEW ENGLAND IN 1994. 1)

PROGRAM	NO. CODED WIRE TAGS 2)		NO. CARLIN TAGS		NO. FIN CLIPS ONLY		NO. VI TAGS	
	PARR	SMOLTS	PARR	SMOLTS	PARR	SMOLTS	PARR	SMOLTS
Maine Program	0	199,500	0	200	38,600	80,600	0	0
Merrimack River	0	85,000	0	0	0	0	0	0
Pawcatuck River	0	0	0	0	0	0	0	0
Connecticut River	2,300	368,800	0	0	0	0	543	793
TOTAL	2,300	653,300	0	200	38,600	80,600	543	793

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

TABLE 2.1.2.b. ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND - 1994.

MARKING AGENCY	AGE	LIFE STAGE	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Connecticut	CWT	22900	7/19/57	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22000	7/19/58	AD	4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23200	7/19/59	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22100	7/19/60	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23300	7/19/61	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23300	7/19/62	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22900	7/19/63	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23000	7/20/1	AD	3-4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	4100	7/20/10	AD	3-4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	14600	7/20/18	AD	4/94	Connecticut R.	Addl 900 used for studies
USFWS	1	smolt	H	Connecticut	CWT	10900	7/20/19	AD	4-5/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23900	7/20/2	AD	3-4/94	Connecticut R.	9100 also Floy-Tagged
USFWS	1	smolt	H	Connecticut	CWT	22600	7/20/3	AD	4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22400	7/20/4	AD	4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22300	7/20/5	AD	4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22900	7/20/6	AD	3/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23900	7/20/7	AD	3-4/94	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	18500	7/20/8	AD	3/94	Connecticut R.	5400 of 7/20/8 = study fis
SUBTOTAL (SMOLT)						368800					
USFWS	1	parr	H	Connecticut	CWT	1300	7/20/18	AD	4/94	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	1000	7/20/19	AD	4/94	Connecticut R.	
SUBTOTAL (PARR)						2300					
TOTAL - CWT, CONNECTICUT RIVER						371100		97.66% (362,400) of smolts and parr retained CWT			
NEPCO *	1	smolt	H	Connecticut	VI	245	B00-B74	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
							C00-C99	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
							D89-D99	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
							E00-E99	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
							J26-J49	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
							H90	AD	5/94	Connecticut R.	Yellow, also CWT, 7/20/1
MACFWRU **	1,2	parr	W	Connecticut	VI	543	R20-R35		6-10/94	Connecticut R.	Black
							L34-L49		6-10/94	Connecticut R.	White
							W00-W99		6-10/94	Connecticut R.	White
							C54-C98		6-10/94	Connecticut R.	Yellow
							H00-H99		6-10/94	Connecticut R.	Yellow
							K00-K99		6-10/94	Connecticut R.	Yellow
							N00-N93		6-10/94	Connecticut R.	Yellow
							P00-P99		6-10/94	Connecticut R.	Yellow
							R00-R99		6-10/94	Connecticut R.	Yellow
MACFWRU **	1,2	smolt	W	Connecticut	VI	548	B00-B99		4-5/94	Connecticut R.	Yellow
							C00-C52c		4-5/94	Connecticut R.	Yellow
							J47-J71		4-5/94	Connecticut R.	Yellow
							L00-L98		4-5/94	Connecticut R.	White
							N50-N60		4-5/94	Connecticut R.	Yellow
							RA0-RF9		4-5/94	Connecticut R.	Yellow
							RJ0-RL8		4-5/94	Connecticut R.	Yellow
							X00-X99		4-5/94	Connecticut R.	White
							Y00-Y99		4-5/94	Connecticut R.	White
TOTAL VI, CONNECTICUT RIVER						1336					

TABLE 2.1.2.b. ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND - 1994.

MARKING AGENCY	AGE	LIFE STAGE	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Merrimack	CWT	18694	7/20/14	AD	3/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	22923	7/20/15	AD	3/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	500	7/20/15	AD	4/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	500	7/19/55	AD	4/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	28744	7/20/16	AD	4/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	10862	7/20/17	AD	4/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	1500	7/19/52	AD	5/94	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	1279	7/19/55	AD	5/94	Merrimack R.	
TOTAL - CWT, MERRIMACK RIVER						85002		??? 92.6% (54,621) of smolts retained CWT			
USFWS	1	smolt	H	Penobscot	CWT	23089	7/20/21	AD	4/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25027	7/20/22	AD	4/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25272	7/20/23	AD	4/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25011	7/20/24	AD	4/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	37247	7/20/25	AD	5/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	13239	7/20/26	AD	5/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25361	7/20/27	AD	5/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25298	7/20/28	AD	5/94	Penobscot R.	
TOTAL - CWT, PENOBSCOT RIVER						199544		98.9% (197,349) of smolts retained CWT			
USFWS	1	smolt	H	Penobscot	CARLIN	96	900201-900299		5/94	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CARLIN	96	901301-901401		5/94	Penobscot R.	
TOTAL - CARLIN TAGS PENOBSCOT RIVER						192					
ASRSC		adult	W	Penobscot	FLOY	5	9436-9448		9/94	Penobscot R.	
TOTAL - FLOY & STREAMERS						5					
USFWS	1	smolt	H	Penobscot		20000		RV	4/94	Saco R.	
USFWS	1	smolt	H	Penobscot		20178		AD	4/94	St. Croix R.	
USFWS	1	smolt	H	Penobscot		20095		LV	5/94	St. Croix R.	
USFWS	1	smolt	H	Penobscot		20325		RV	5/94	St. Croix R.	
USFWS	0+	parr	H	Penobscot		38600		AD	10/94	St. Croix R.	
TOTAL - FIN CLIPS						119198					

* NEPCO = New England Power Companyo

** MACFRWRU = Massachusetts Cooperative Fish and Wildlife Research Unit

TABLE 2.2.1.a. DOCUMENTED ATLANTIC SALMON RETURNS TO NEW ENGLAND RIVER IN 1994. 1)

RIVER	NUMBER OF ATLANTIC SALMON BY SEA AGE								TOTAL FOR 1994	
	1SW		2SW		3SW		RS			
	Hat	Wild	Hat	Wild	Hat	Wild	Hat	Wild		
Penobscot River	265	48	630	93	2	0	5	6	1,049	
Aroostook River	4		16		0	0	0	0	20	2)
Union River										
Narraguagus River	1	4	0	42	0	0	0	4	51	
Pleasant River	0	1	0	1	0	0	0	0	2	
Machias River										
East Machias River										
Dennys River	0	1	0	5	0	0	0	0	6	3)
St. Croix River	23	24	17	19	0	0	1	0	84	3)
Kennebec River										
Androscoggin River	2	0	16	6	0	0	1	0	25	
Sheepscot River	0	3	5	12	0	0	0	0	20	
Ducktrap River										
Saco River	6	0	17	0	0	0	0	0	23	
Cocheco River	0	0	0	0	0	0	0	0	0	4)
Lamprey River	0	0	0	3	0	0	0	0	3	5)
Merrimack River	0	1	2	18	0	0	0	0	21	
Pawcatuck River	0	0	4	0	0	0	0	0	4	
Connecticut River	1	0	263	61	0	0	1	0	326	
TOTAL	302	82	970	260	2	0	8	10	1,634	

1) These are considered minimum numbers; reflecting only trap counts and rod catches. Fish are considered to be wild if they originated from fry plants or natural reproduction.
2) It is unknown whether the adults were of hatchery origin or wild orgin.
3) The totals exclude adults of aquaculture origin.
4) Fish ladder not operated in fall.
5) Fish ladder operated as swim through in April and May.

TABLE 2.2.2.a. INDICIES AND ESTIMATED ABUNDANCE OF ATLANTIC SALMON RETURNS TO NEW ENGLAND RIVERS IN 1994.

(EXPLANATIONS OF INDICIES AND EXTRAPOLATION METHODS ARE INCLUDED IN TEXT BODY)

RIVER	RECREATIONAL FISHERY				TRAP CATCH			REDD COUNTS		ESTIMATED ABUNDANCE
	Creel / Reporting		Estimator	Est.	100%	90%	75%	Total	Partial	
	Release	Harvest	(10% * Released)	Total						
Aroostook 1)	0	3	0	3	20					141
St. Croix 2)	3	0	0	0	[illegible]					112
Dennys 3)	0	1	0	1	5			15		12
East Machias 4)	12	0							19	20
Machias	5								50	50
Pleasant 5)	2				2			0	0	2
Narraguagus	20	0	2	2	51			57		53
Union	0	0	0	0						0
Penobscot	175	7	18	25			1389			1414
Ducktrap	0	0	0	0				36		36
Sheepscot 6)	0	0	0	0				20		20
Kennebec	1	0	0	0						Unknown
Androscoggin	0	0	0	0		33				33
Saco	1	0	0	0	23					23
Cocheco	0	0	0	0		0			0	0
Lamprey	0	0	0	0		3			0	3
Merrimack	0	2	0	2		21				23
Pawcatuck	0	0	0	0		4				4
Connecticut 7)	0	0	10	10	0	362	0	0	0	372
TOTALS	**219**	**13**	**30**	**43**	**101**	**423**	**1501**	**128**	**69**	**2318**

1) Includes trap catch of 20 adults and 121 adults trucked into the system; 3 fish angled upstream from trap.

2) Excludes 97 aquaculture escapees passed upstream.

3) Excludes 2 aquaculture escapees killed plus 30 released on Dennys, 8 known fish above weir and 4 broodstock taken to Craig Brook National Fish Hatchery.

4) Some of these were probably of aquaculture origin.

5) Weir catch = 2. rod catch = 2 below weir, no redds.

6) Assume weir catch of 20 = total run (i.e. redd count data not utilized).

7) Estimate based on 3% of trap catch.

TABLE 2.2.3.a. SUMMARY OF 1994 CODED WIRE TAGGED (CWT) AND CARLIN TAGGED ADULT ATLANTIC SALMON RETURNS TO USA RIVERS.

RIVER	TAG TYPE	AGE GROUP 1SW	2SW	3SW	RS	TOTAL
Connecticut River						
Trap	CWT	1	255	0	1	257
Merrimack River						
Trap	CWT	0	2	0	0	2
Rod	CWT	0	0	0	0	0
Penobscot River 1)						
Trap	CWT	82	100	0	0	182
Rod	CWT	1	0	0	0	1
Trap	Carlin	0	7	0	0	7
Rod	Carlin	0	0	0	0	0
Other Rivers in Maine 1)						
Trap	CWT	0	2	0	0	2
Rod	CWT	0	0	0	0	0
TOTAL	CWT	84	359	0	1	444
	Carlin	0	7	0	0	7

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

TABLE 2.2.4.a. SUMMARY OF ATLANTIC SALMON EGG PRODUCTION IN NEW ENGLAND FACILITIES IN 1994 1).

SOURCE RIVER	ORIGIN	FEMALES SPAWNED	TOTAL EGG TAKE	NO. OF EGGS PER FEMALE
Dennys River	Sea-run	2	14,800	7,400
Penobscot River	Sea-run	215	1,630,700	7,585
Lamprey River	Sea-run	3	17,000	5,667
Merrimack River	Sea-run	10	67,500	6,750
Pawcatuck River	Sea-run	1	7,000	7,000
Connecticut River	Sea-run	151	1,223,800	8,105
TOTAL SEA-RUN		382	2,960,800	7,751
Penobscot River	Domestic	645	1,654,700	2,565
Merrimack River	Domestic	1,035	5,720,800	5,527
Connecticut River	Domestic	1,094	7,550,800	6,902
Dennys River	Domestic	56	110,200	1,968
Machias River	Domestic	88	195,500	2,222
Narraguagus River	Domestic	59	145,700	2,469
TOTAL CAPTIVE/DOMESTIC		2,977	15,377,700	5,166
Dennys River	Kelts	6	30,500	5,083
Connecticut River	Kelts	208	2,427,700	11,672
Machias River	Kelts	2	11,700	5,850
TOTAL KELTS		216	2,469,900	11,435
GRAND TOTAL		3,575	20,808,400	5,821

1) Egg takes rounded to nearest 100 eggs.

TABLE 2.2.5.a. DOCUMENTED 1994 SPORT CATCH OF ATLANTIC SALMON IN MAINE.

RIVER	NO. SALMON HARVESTED 1SW	2SW	3SW	RS	TOTAL HARVEST	EST. NO. RELEASED	TOTAL ANGLED 1994	TOTAL ANGLED 1993
St. Croix						3	3	1
Dennys 1)	2	1			3	30	33	4
East Machias						12	12	3
Machias						5	5	12
Pleasant						2	2	0
Narraguagus						20	20	27
Union						0	0	0
Penobscot	7				7	175	182	574
Ducktrap						0	0	0
Sheepscot						1	1	14
Kennebec						0	0	12
Saco						1	1	12
Aroostook	3				3	0	3	0
TOTAL	12	1	0	0	13	249	262	659

1) Represents 2 1SW fish of aquaculture origin , 1 2SW fish illegally angled, and 30 fish of aquaculture origin released.

TABLE 3.3.a. ATLANTIC SALMON STOCKING SUMMARY FOR NEW ENGLAND BY RIVER 1970 THROUGH 1993

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

	NUMBER OF FISH						
RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
UPPER ST. JOHN							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	2100	0	0	0	0	2100
1980	0	0	0	0	0	2700	2700
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0
1987	306000	60000	0	0	0	0	366000
1988	128000	779400	4800	0	0	0	912200
1989	66000	0	0	0	0	10300	76300
1990	110000	21000	9900	0	0	9600	150500
1991	228000	139300	0	0	5100	5100	377500
1992	400000	136100	0	0	0	0	536100
1993	361000	102800	0	0	0	0	463800
TOTAL	**1599000**	**1240700**	**14700**	**0**	**5100**	**27700**	**2887200**
AROOSTOOK							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	5200	0	5200
1979	0	3100	0	0	0	0	3100
1980	0	0	0	0	0	2600	2600
1981	0	25200	20400	0	0	0	45600
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0
1986	84000	0	0	1800	0	0	85800
1987	41000	0	0	0	0	0	41000
1988	43000	0	0	0	0	0	43000
1989	313000	242200	0	0	0	10000	565200
1990	69000	0	0	0	27400	7600	104000
1991	74000	46600	0	0	0	9600	130200
1992	0	0	16400	0	0	0	16400
1993	0	0	0	0	0	0	0
TOTAL	**624000**	**317100**	**36800**	**1800**	**32800**	**29800**	**1042100**

TABLE 3.3.a. Continued

RIVER / YEAR		FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
ST. CROIX								
	1970	0	0	0	0	0	0	0
	1971	0	0	0	0	0	0	0
	1972	0	0	0	0	0	0	0
	1973	0	0	0	0	0	0	0
	1974	0	0	0	0	0	0	0
	1975	0	0	0	0	0	0	0
	1976	0	0	0	0	0	0	0
	1977	0	0	0	0	0	0	0
	1978	0	0	0	0	0	0	0
	1979	0	0	0	0	0	0	0
	1980	0	0	0	0	0	0	0
	1981	0	0	0	0	0	20000	20000
	1982	101000	20900	50000	0	19900	100	191900
	1983	0	0	25500	0	20000	0	45500
	1984	54000	0	13800	0	92500	0	160300
	1985	178000	46400	12900	0	59600	0	296900
	1986	193000	0	0	.0	73500	0	266500
	1987	255000	0	41000	0	59800	0	355800
	1988	0	0	0	0	78700	0	78700
	1989	0	0	0	0	50600	0	50600
	1990	255000	0	0	0	65800	0	320800
	1991	51000	40000	0	0	60200	0	151200
	1992	85000	56500	14900	0	50300	0	206700
	1993	0	101000	0	0	40100	0	141100
TOTAL		1172000	264800	158100	0	671000	20100	2286000
DENNYS								
	1970	0	0	0	0	0	0	0
	1971	0	0	0	0	0	0	0
	1972	0	0	0	0	0	0	0
	1973	0	0	0	0	0	0	0
	1974	0	0	0	0	0	0	0
	1975	0	0	3000	0	0	4200	7200
	1976	0	0	0	0	0	8900	8900
	1977	0	0	0	0	0	0	0
	1978	0	0	0	0	30200	0	30200
	1979	0	0	0	0	10200	0	10200
	1980	0	0	0	0	0	15200	15200
	1981	0	0	0	0	0	0	0
	1982	0	0	0	0	0	0	0
	1983	20000	0	0	0	5200	0	25200
	1984	0	0	0	0	3300	0	3300
	1985	0	0	0	0	4500	0	4500
	1986	0	8300	0	0	5400	0	13700
	1987	24000	0	0	0	9000	0	33000
	1988	30000	0	0	0	25700	0	55700
	1989	12000	0	0	0	12100	0	24100
	1990	20000	0	0	0	25800	0	45800
	1991	25000	0	400	0	11700	0	37100
	1992	0	0	0	0	0	0	0
	1993	33000	0	0	0	0	0	33000
TOTAL		164000	8300	3400	0	143100	28300	347100

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
PLEASANT							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	3000	3000
1976	0	0	0	0	0	1000	1000
1977	0	0	0	0	0	0	0
1978	0	0	0	0	3100	0	3100
1979	0	0	0	0	0	0	0
1980	0	0	0	0	200	10000	10200
1981	0	0	0	0	0	4100	4100
1982	0	0	0	0	5000	0	5000
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	33000	0	0	0	4100	0	37100
1986	25000	0	0	0	6500	0	31500
1987	25000	0	0	0	7500	0	32500
1988	25000	0	1800	0	10500	0	37300
1989	26000	2500	0	0	7300	0	35800
1990	30000	0	0	0	10500	0	40500
1991	23000	0	0	0	0	0	23000
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
TOTAL	**187000**	**2500**	**1800**	**0**	**54700**	**18100**	**264100**
EAST MACHIAS							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	2000	2000
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	3000	3000
1976	0	0	0	0	0	3900	3900
1977	0	0	0	0	0	0	0
1978	0	0	0	0	12200	0	12200
1979	0	0	0	0	5200	0	5200
1980	0	0	0	0	0	15900	15900
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	5600	5600
1983	0	0	0	0	0	0	0
1984	0	0	8700	0	0	0	8700
1985	13000	0	0	0	4500	0	17500
1986	8000	0	0	0	5300	0	13300
1987	10000	0	0	0	9000	0	19000
1988	10000	0	7500	0	20700	0	38200
1989	30000	6500	8000	0	15300	0	59800
1990	42000	0	10100	0	10100	0	62200
1991	27000	0	8300	0	15300	0	50600
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
TOTAL	140000	6500	42600	0	97600	30400	317100

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
MACHIAS							
1970	0	0	0	0	0	10700	10700
1971	0	0	0	0	5100	3400	8500
1972	0	0	0	0	8500	4400	12900
1973	0	0	0	0	0	6100	6100
1974	0	0	0	0	0	6500	6500
1975	0	0	0	0	0	0	0
1976	0	0	0	0	5300	11100	16400
1977	0	0	0	0	0	0	0
1978	0	0	0	0	10200	0	10200
1979	0	0	0	0	10200	0	10200
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	0	0	5500	0	5500
1983	0	12500	0	0	0	0	12500
1984	0	0	0	0	15800	0	15800
1985	0	0	7000	0	5100	0	12100
1986	8000	8000	0	0	0	0	16000
1987	0	12500	12300	0	13600	0	38400
1988	30000	0	31500	0	30900	0	92400
1989	49000	13800	28000	0	23100	0	113900
1990	75000	10100	17600	0	26100	0	128800
1991	13000	30000	21400	0	21100	0	85500
1992	14000	0	0	0	0	0	14000
1993	0	0	0	0	0	0	0
TOTAL	**189000**	**86900**	**117800**	**0**	**180500**	**42200**	**616400**
NARRAGUAGUS							
1970	0	0	0	0	0	11800	11800
1971	0	0	0	0	0	2900	2900
1972	0	0	0	0	0	15700	15700
1973	0	0	0	0	0	5600	5600
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	5000	5000
1976	0	0	0	0	0	8400	8400
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	10100	0	10100
1980	0	0	0	0	0	20400	20400
1981	0	0	0	0	0	4100	4100
1982	0	0	0	0	0	5200	5200
1983	0	7800	0	0	0	0	7800
1984	0	0	0	0	5200	0	5200
1985	10000	0	0	0	4500	0	14500
1986	0	0	0	0	7500	0	7500
1987	15000	0	0	0	9000	0	24000
1988	20000	13000	5600	0	15700	0	54300
1989	29000	9500	7000	0	22100	4900	72500
1990	0	0	0	0	16800	0	16800
1991	0	0	0	0	15200	0	15200
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
TOTAL	74000	30300	12600	0	106100	84000	307000

TABLE 3.3.a. Continued

RIVER / YEAR		FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
UNION								
	1970	0	0	0	0	0	0	0
	1971	0	0	0	0	8100	0	8100
	1972	0	0	0	0	0	7700	7700
	1973	0	0	0	0	0	19600	19600
	1974	0	0	0	0	9900	20400	30300
	1975	0	0	0	0	0	31300	31300
	1976	0	0	0	0	1800	31800	33600
	1977	0	0	0	0	13000	22500	35500
	1978	0	0	0	0	0	31900	31900
	1979	0	0	0	0	12900	29900	42800
	1980	0	0	0	0	30600	0	30600
	1981	0	0	0	0	0	29400	29400
	1982	0	0	0	0	5900	26500	32400
	1983	0	0	0	0	41600	0	41600
	1984	0	0	0	0	50200	0	50200
	1985	7000	0	0	0	45800	0	52800
	1986	7000	0	0	0	48400	0	55400
	1987	7000	0	0	0	40100	0	47100
	1988	0	0	0	0	30600	0	30600
	1989	0	0	0	0	20400	0	20400
	1990	0	0	0	0	20400	0	20400
	1991	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0
	1993	60000	111700	0	0	0	0	171700
TOTAL		**81000**	**111700**	**0**	**0**	**379700**	**251000**	**823400**
PENOBSCOT								
	1970	0	25000	0	0	0	28500	53500
	1971	0	0	15800	0	52600	0	68400
	1972	129000	0	0	0	0	73800	202800
	1973	0	0	0	0	12400	95800	108200
	1974	0	0	35100	9100	34300	65900	144400
	1975	0	0	12300	0	15800	94800	122900
	1976	0	0	83800	0	54700	180100	318600
	1977	0	0	0	0	113800	224700	338500
	1978	0	0	126800	0	61100	141400	329300
	1979	95000	0	0	0	50000	246300	391300
	1980	0	0	0	0	369000	215600	584600
	1981	202000	25400	50300	0	24700	174800	477200
	1982	248000	50900	206400	0	107400	222300	835000
	1983	0	0	31900	0	281500	161400	474800
	1984	80000	34400	0	0	481500	135600	731500
	1985	197000	59500	17600	0	476500	104400	855000
	1986	226000	25700	58600	0	520200	69000	899500
	1987	333000	58100	101100	0	456800	82400	1031400
	1988	431000	0	51400	0	599900	87100	1169400
	1989	77000	104100	179600	0	351300	65300	777300
	1990	317000	166500	155300	0	413200	15900	1067900
	1991	398000	202600	104100	0	657800	15000	1377500
	1992	925000	278200	106600	0	816600	8100	2134500
	1993	1320000	202300	9600	0	580400	0	2112300
TOTAL		**4978000**	**1232700**	**1346300**	**9100**	**6531500**	**2508200**	**16605800**

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
DUCKTRAP							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	15000	0	0	0	0	0	15000
1986	8000	0	0	0	0	0	8000
1987	15000	0	0	0	0	0	15000
1988	10000	0	0	0	0	0	10000
1989	17000	0	0	0	0	0	17000
1990	18000	0	0	0	0	0	18000
1991	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
TOTAL	83000	0	0	0	0	0	83000
SHEEPSCOT							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	1000	0	1000
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	1000	1000
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	2500	2500
1976	0	0	0	0	3000	0	3000
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	0	0	5300	0	5300
1983	0	0	0	0	5200	0	5200
1984	0	0	0	0	5000	0	5000
1985	20000	0	0	0	3900	3600	27500
1986	10000	11600	0	0	7500	0	29100
1987	15000	8200	0	0	9000	0	32200
1988	40000	12300	0	0	10200	0	62500
1989	29000	13600	10000	0	10200	0	62800
1990	27000	10100	10000	0	17500	0	64600
1991	18000	15000	600	0	14400	0	48000
1992	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0
TOTAL	159000	70800	20600	0	92200	7100	349700

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
SACO							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	9500	9500
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	47100	0	0	0	0	47100
1983	0	0	0	0	20300	0	20300
1984	0	0	0	0	5100	0	5100
1985	0	0	23600	0	5100	0	28700
1986	0	0	10000	0	35200	0	45200
1987	0	0	69800	0	22000	0	91800
1988	47000	0	0	0	25100	0	72100
1989	0	37800	49600	0	9900	0	97300
1990	0	30100	47800	0	10600	0	88500
1991	111000	0	0	0	10300	0	121300
1992	154000	50200	400	0	19800	0	224400
1993	167000	0	0	0	20100	0	187100
TOTAL	479000	165200	201200	0	183500	9500	1038400
COCHECO							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0
1988	2000	0	0	0	0	0	2000
1989	106000	0	0	0	0	0	106000
1990	32000	50000	9500	0	0	0	91500
1991	138000	0	0	0	0	0	138000
1992	128000	0	0	0	0	0	128000
1993	127000	0	0	1000	0	0	128000
TOTAL	533000	50000	9500	1000	0	0	593500

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
LAMPREY							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	19600	0	19600
1979	0	0	0	0	8600	5800	14400
1980	0	0	0	0	39900	8400	48300
1981	0	0	0	0	19500	12200	31700
1982	0	0	0	0	30700	6400	37100
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0
1989	146000	0	0	0	0	0	146000
1990	50000	87000	11400	0	0	0	148400
1991	110000	68200	0	0	0	0	178200
1992	127000	12700	0	0	0	0	139700
1993	68000	56500	28800	1100	15000	0	169400
TOTAL	**501000**	**224400**	**40200**	**1100**	**133300**	**32800**	**932800**
MERRIMACK							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	36000	0	0	0	0	0	36000
1976	63000	75900	0	16600	0	2100	157600
1977	72000	0	0	700	0	31000	103700
1978	106000	0	0	0	21300	25900	153200
1979	77000	0	0	0	15000	24700	116700
1980	126000	0	0	0	2300	28700	157000
1981	57000	0	0	0	2600	98300	157900
1982	50000	81600	0	95500	5400	65600	298100
1983	8000	5000	15000	5000	47000	62900	142900
1984	526000	0	23300	9800	24400	43800	627300
1985	148000	0	5800	0	64000	125300	343100
1986	525000	0	31500	0	39900	64100	660500
1987	1078000	0	99300	0	141600	0	1318900
1988	1718000	0	129600	0	94400	0	1942000
1989	1034000	60000	88600	0	58600	0	1241200
1990	975000	0	5600	29700	116900	0	1127200
1991	1458000	0	0	[illegible]	62000	58100	1578100
1992	1118000	0	100	0	96400	0	1214500
1993	1157000	0	0	0	59000	0	1216000
TOTAL	**10332000**	**222500**	**398800**	**157300**	**850800**	**630500**	**12591900**

TABLE 3.3.a. Continued

RIVER / YEAR	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
PAWCATUCK							
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	136000	0	0	0	0	136000
1980	0	1000	0	0	0	0	1000
1981	0	2000	108000	0	800	0	110800
1982	2000	1000	0	0	0	0	3000
1983	0	700	0	0	0	0	700
1984	0	23000	0	0	0	0	23000
1985	8000	51000	1400	0	0	0	60400
1986	0	50700	15000	0	0	0	65700
1987	3000	46200	4700	0	1000	0	54900
1988	150000	59600	7100	0	5400	0	222100
1989	0	379900	35800	0	6500	0	422200
1990	0	83500	55000	0	7500	0	146000
1991	0	101000	1000	0	2000	500	104500
1992	0	70800	2500	0	5000	0	78300
1993	383000	14500	4000	0	2300	0	403800
TOTAL	546000	1020900	234500	0	30500	500	1832400
CONNECTICUT							
1970	0	0	0	0	0	0	0
1971	60000	15000	7800	2900	5600	12400	103700
1972	0	0	2700	2300	4600	13100	22700
1973	0	15000	1000	21100	1400	31900	70400
1974	16000	0	9400	15600	10400	44000	95400
1975	31900	0	1700	16400	2800	70000	122800
1976	26600	0	5000	24200	4000	30500	90300
1977	49500	0	0	15400	0	99200	164100
1978	50000	0	0	36600	0	94300	180900
1979	53500	0	0	38400	0	145100	237000
1980	286000	0	0	11500	0	51800	349300
1981	168000	182700	1900	3600	5300	73300	434800
1982	294000	9400	25100	9600	28100	180800	547000
1983	226000	115400	293800	400	89100	8900	733600
1984	625000	178600	241200	11400	312300	0	1368500
1985	422000	130500	110700	0	255000	0	918200
1986	176000	188400	267100	0	290500	0	922000
1987	1180000	383200	345100	0	206000	0	2114300
1988	1310000	72200	75200	0	395300	0	1852700
1989	1243000	268700	76800	0	217700	0	1806200
1990	1271000	341600	25400	0	475900	0	2113900
1991	1725000	306200	33100	0	351000	0	2415300
1992	2009000	313900	11500	0	313300	0	2647700
1993	4147000	237100	28700	0	382800	0	4795600
TOTAL	15369500	2757900	1563200	209400	3351100	855300	24106400

TABLE 3.3.a. Continued

GRAND TOTAL BY RIVER (1970-1993)

RIVER	NUMBER OF FISH						
	FRY	0+PARR	1PARR	1+PARR	1SMOLT	2SMOLT	TOTAL
Upper St. John	1599000	1240700	14700	0	5100	27700	2887200
Aroostook	624000	317100	36800	1800	32600	29800	1042100
St. Croix	1172000	264800	158100	0	671000	20100	2286000
Dennys	164000	8300	3400	0	143100	28300	347100
Pleasant	187000	2500	1800	0	54700	18100	264100
East Machias	140000	6500	42600	0	97600	30400	317100
Machias	189000	86900	117800	0	180500	42200	616400
Narraguagus	74000	30300	12600	0	106100	84000	307000
Union	81000	111700	0	0	379700	251000	823400
Penobscot	4978000	1232700	1346300	9100	6531500	2508200	16605800
Ducktrap	83000	0	0	0	0	0	83000
Sheepscot	159000	70800	20600	0	92200	7100	349700
Saco	479000	165200	201200	0	183500	9500	1038400
Cocheco	533000	50000	9500	1000	0	0	593500
Lamprey	501000	224400	40200	1100	133300	32800	932800
Merrimack	10332000	222500	398800	157300	850800	630500	12591900
Pawcatuck	546000	1020900	234500	0	30500	500	1832400
Connecticut	15369500	2757900	1563200	209400	3351100	855300	24106400
TOTAL	**37210500**	**7813200**	**4202100**	**379700**	**12843300**	**4575500**	**67024300**

TABLE 3.3.b. HISTORICAL ATLANTIC SALMON RETURNS TO NEW ENGLAND RIVERS 1970 THROUGH 1993

INCLUDES TRAP AND / OR ROD CAUGHT SALMON

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

RIVER SYSTEM	HATCHERY ORIGIN				WILD ORIGIN				
YEAR	1-S-W	2-S-W	3-S-W	REPEAT	1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
PENOBSCOT									
1970	7	124	1	2	0	2	0	0	136
1971	21	89	1	1	0	2	0	0	114
1972	11	311	4	1	0	10	0	0	337
1973	10	290	2	7	0	2	0	0	311
1974	31	516	24	9	0	1	0	0	581
1975	45	917	11	19	0	8	0	0	1000
1976	75	563	4	6	0	20	0	0	668
1977	44	581	4	12	0	3	0	0	644
1978	123	1547	12	26	0	55	0	0	1763
1979	203	671	3	15	0	8	0	0	900
1980	652	2570	2	38	0	18	2	0	3282
1981	888	2454	12	24	3	18	2	0	3401
1982	155	3886	20	20	13	55	1	3	4153
1983	179	705	6	13	5	51	1	1	961
1984	239	1387	6	45	25	107	2	0	1811
1985	244	2868	6	9	22	202	1	4	3356
1986	534	3620	14	8	17	332	3	1	4529
1987	749	1477	29	49	19	162	5	20	2510
1988	716	1993	6	52	14	64	0	10	2855
1989	867	2005	4	36	67	103	1	4	3087
1990	430	2520	14	26	93	254	3	2	3342
1991	176	1085	4	21	40	427	0	4	1757
1992	932	1174	0	5	27	236	1	4	2379
1993	349	1279	7	13	22	92	1	6	1769
TOTAL	**7680**	**34632**	**196**	**457**	**367**	**2232**	**23**	**59**	**45646**
UNION									
1970									
1971									
1972									
1973	3	72	0	0	0	0	0	0	75
1974	6	13	1	0	0	0	0	0	20
1975	23	56	0	0	0	0	0	0	79
1976	90	158	0	0	0	0	0	0	248
1977	13	222	1	8	0	0	0	0	244
1978	4	147	2	4	0	0	0	0	157
1979	6	38	0	1	0	0	0	0	45
1980	42	197	0	1	0	0	0	0	240
1981	10	284	1	0	0	0	0	0	295
1982	30	118	1	7	0	0	0	0	156
1983	25	116	1	2	0	4	0	0	148
1984	3	37	0	0	0	0	0	0	40
1985	3	79	0	0	0	0	0	0	82
1986	7	59	1	0	0	0	0	0	67
1987	19	43	0	1	0	0	0	0	63
1988	0	45	0	0	0	2	0	0	47
1989	4	25	1	0	0	0	0	0	30
1990	1	20	0	0	0	0	0	0	21
1991	1	1	0	0	1	5	0	0	8
1992	0	4	0	0	0	0	0	0	4
1993	0	0	0	0	0	0	0	0	0
TOTAL	**290**	**1734**	**9**	**24**	**1**	**11**	**0**	**0**	**2069**

TABLE 3.3.b. Continued

RIVER SYSTEM YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
NARRAGUAGUS									
1970	1	13	0	0	0	120	7	5	146
1971	2	33	0	0	3	67	3	0	108
1972	1	81	7	0	3	211	17	13	333
1973	2	22	2	2	1	135	3	3	170
1974	3	20	2	1	1	118	6	12	163
1975	0	2	0	0	0	103	2	4	111
1976	0	4	0	0	0	25	0	3	32
1977	2	5	0	0	1	105	0	11	124
1978	0	35	0	0	0	94	2	2	133
1979	0	9	0	0	0	49	0	0	58
1980	0	0	0	0	0	112	0	3	115
1981	1	20	0	1	0	49	0	2	73
1982	0	11	0	1	0	57	0	10	79
1983	2	17	0	0	0	69	0	2	90
1984	0	10	0	0	0	57	0	1	68
1985	0	0	0	0	0	56	0	1	57
1986	0	20	0	0	2	23	0	0	45
1987	0	11	0	0	0	24	0	2	37
1988	1	10	0	0	2	24	0	1	38
1989	3	9	0	0	1	26	0	0	39
1990	1	22	0	0	0	27	0	1	51
1991	3	19	0	5	8	53	0	7	95
1992	6	19	0	1	11	32	0	4	73
1993	0	16	0	4	6	66	0	2	94
TOTAL	28	408	11	15	39	1702	40	89	2332
PLEASANT									
1970	0	0	0	0	0	1	0	0	1
1971	0	0	0	0	0	1	0	0	1
1972	0	0	0	0	0	1	0	0	1
1973	0	0	0	0	0	2	0	0	2
1974	0	0	0	0	2	27	1	0	30
1975	0	0	0	0	1	6	1	0	8
1976	0	0	0	0	0	1	0	0	1
1977	0	0	0	0	0	3	0	0	3
1978	0	0	0	0	0	16	0	0	16
1979	0	0	0	0	0	8	0	0	8
1980	0	0	0	0	0	5	0	0	5
1981	0	0	0	0	0	23	0	0	23
1982	4	8	0	0	0	6	0	1	19
1983	0	0	0	0	2	35	0	1	38
1984	0	0	0	0	1	16	0	0	17
1985	0	0	0	0	3	28	0	0	31
1986	0	0	0	0	0	19	0	0	19
1987	0	4	0	0	0	5	0	0	9
1988									
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0
TOTAL	4	12	0	0	9	203	2	2	232

TABLE 3.3.b. Continued

RIVER SYSTEM YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
MACHIAS									
1970	0	13	1	0	0	211	6	9	240
1971	2	26	1	0	1	137	5	4	176
1972	5	69	4	0	3	180	5	3	269
1973	0	7	0	0	0	28	0	0	35
1974	4	6	0	0	0	26	0	0	36
1975	0	10	0	0	5	36	0	0	51
1976	2	5	0	0	0	18	0	0	25
1977	2	8	0	0	0	15	0	0	25
1978	0	15	0	0	0	87	0	3	105
1979	0	8	0	0	0	58	0	0	66
1980	0	13	0	0	0	58	0	7	78
1981	0	19	0	0	0	31	0	3	53
1982	0	0	1	0	1	52	0	2	56
1983	0	0	0	0	0	16	0	1	17
1984	0	8	0	0	2	21	0	2	33
1985	0	5	0	0	0	25	0	2	32
1986	2	16	0	0	2	24	0	2	46
1987	0	0	0	0	0	4	0	0	4
1988	0	0	0	0	0	6	0	2	8
1989	3	4	0	0	4	5	0	0	16
1990	0	1	0	0	0	1	0	0	2
1991	1	0	0	0	1	0	0	0	2
1992	0	3	0	0	0	0	0	0	3
1993	0	2	0	0	1	12	0	0	15
TOTAL	21	238	7	0	20	1051	16	40	1393
EAST MACHIAS									
1970	0	0	0	0	0	1	0	0	1
1971	0	1	0	0	0	5	0	0	6
1972	0	1	0	0	0	3	0	0	4
1973	0	1	0	0	0	5	0	0	6
1974	0	1	0	0	0	1	0	0	2
1975	0	8	0	0	0	20	0	2	30
1976	2	16	0	2	0	0	0	0	20
1977	0	9	1	0	0	19	0	1	30
1978	0	13	0	0	0	46	0	0	59
1979	0	7	0	0	0	18	0	0	25
1980	0	24	0	0	2	34	0	2	62
1981	4	67	0	0	4	24	0	1	100
1982	0	15	0	0	0	22	0	0	37
1983	0	3	0	0	0	5	0	0	8
1984	0	9	0	0	3	33	0	2	47
1985	0	0	0	0	0	30	0	0	30
1986	0	5	0	0	0	8	0	0	13
1987	0	8	0	0	0	5	1	0	14
1988	1	8	0	0	0	5	0	0	14
1989	12	10	0	0	2	6	0	1	31
1990	1	30	0	0	0	16	0	1	48
1991	1	2	0	0	1	1	0	0	5
1992	0	6	0	0	0	0	0	0	6
1993	0	0	0	0	0	0	0	0	0
TOTAL	21	244	1	2	12	307	1	10	598

TABLE 3.3.b. Continued

RIVER SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
DENNYS									
1970	0	0	0	0	0	49	0	0	49
1971	0	0	0	0	0	19	0	0	19
1972	0	0	0	0	0	61	0	0	61
1973	1	0	0	0	0	40	0	0	41
1974	0	0	0	0	3	43	0	3	49
1975	0	0	0	0	0	40	0	0	40
1976	0	0	0	0	2	13	0	5	20
1977	0	0	0	0	0	26	0	0	26
1978	0	37	0	0	0	38	0	0	75
1979	0	0	0	0	0	36	0	2	38
1980	0	117	0	0	0	73	0	0	190
1981	6	74	0	0	0	43	3	0	126
1982	3	15	0	0	6	14	0	0	38
1983	0	0	0	0	0	28	0	0	28
1984	0	0	0	0	7	61	0	0	68
1985	0	6	0	0	0	14	0	0	20
1986	0	7	0	0	0	8	0	0	15
1987	0	0	0	0	0	1	0	0	1
1988	0	3	0	0	0	6	0	0	9
1989	1	10	0	0	0	1	0	0	12
1990	1	20	0	1	0	11	0	0	33
1991	1	0	0	0	0	6	0	0	7
1992	1	3	0	0	0	1	0	0	5
1993	7	2	0	0	0	4	0	0	13
TOTAL	**21**	**294**	**0**	**1**	**18**	**636**	**3**	**10**	**983**
ST. CROIX									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981	25	14	1	0	24	14	1	0	79
1982	28	1	0	0	56	13	1	0	99
1983	14	62	4	0	11	28	3	0	122
1984	138	50	5	0	39	11	1	0	244
1985	28	144	14	0	28	122	14	0	350
1986	34	116	13	0	33	116	13	0	325
1987	108	63	1	0	94	103	6	0	375
1988	76	229	0	3	18	61	0	1	388
1989	78	66	0	1	44	44	0	8	241
1990	6	59	0	7	12	26	0	2	112
1991	41	90	0	0	16	38	0	4	189
1992	1	0	0	0	0	0	0	0	1
1993	5	76	0	0	4	18	0	2	105
TOTAL	**582**	**970**	**38**	**11**	**379**	**594**	**39**	**17**	**2630**

TABLE 3.3.b. Continued

RIVER SYSTEM YEAR	HATCHERY ORIGIN 1-S-W	2-S-W	3-S-W	REPEAT	WILD ORIGIN 1-S-W	2-S-W	3-S-W	REPEAT	TOTAL
KENNEBEC									
1970									
1971									
1972									
1973									
1974									
1975	2	30	0	0	0	1	0	0	33
1976	0	2	2	0	0	0	0	0	4
1977	0	2	0	0	0	0	0	0	2
1978	0	2	0	0	0	0	0	0	2
1979	0	18	0	0	0	2	0	0	20
1980	1	3	0	0	0	0	0	0	4
1981	1	13	0	0	0	0	0	0	14
1982	1	22	1	0	0	0	0	0	24
1983	1	16	1	0	0	0	0	0	18
1984	0	1	0	0	0	0	0	0	1
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	0	2	1	0	0	2	0	0	5
1988	4	15	0	1	0	0	0	0	20
1989	1	16	0	0	0	0	0	0	17
1990	1	41	0	0	0	4	0	0	46
1991	0	4	0	0	0	0	0	0	4
1992	0	0	0	0	0	0	0	0	0
1993	0	2	0	0	0	0	0	0	2
TOTAL	12	189	5	1	0	9	0	0	216
ANDROSCOGGIN									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983	1	16	0	0	0	3	0	1	21
1984	4	79	1	0	0	7	0	0	91
1985	1	18	0	0	0	2	0	0	21
1986	0	72	1	0	0	8	0	0	81
1987	2	20	3	0	0	1	0	0	26
1988	2	11	0	0	1	0	0	0	14
1989	1	17	0	0	0	1	0	0	19
1990	6	168	0	1	1	9	0	0	185
1991	0	9	0	0	0	12	0	0	21
1992	2	9	0	0	1	3	0	0	15
1993	1	33	0	0	1	9	0	0	44
TOTAL	20	452	5	1	4	55	0	1	538

TABLE 3.3.b. Continued

RIVER SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
SHEEPSCOT									
1970	0	0	0	0	1	5	0	0	6
1971	0	0	0	0	2	27	1	0	30
1972	0	0	0	0	1	18	1	0	20
1973	0	0	0	0	1	18	1	0	20
1974	0	0	0	0	1	18	1	0	20
1975	0	0	0	0	1	10	0	0	11
1976	0	0	0	0	1	9	0	0	10
1977	0	0	0	0	1	22	1	0	24
1978	0	0	0	0	2	32	1	0	35
1979	0	0	0	0	1	7	0	0	8
1980	0	0	0	0	2	27	1	0	30
1981	0	0	0	0	1	14	0	0	15
1982	0	0	0	0	1	14	0	0	15
1983	0	0	0	0	1	11	0	0	12
1984	0	0	0	0	1	20	1	0	22
1985	0	0	0	0	1	5	0	0	6
1986	0	0	0	0	1	10	0	0	11
1987	2	7	0	0	1	5	0	0	15
1988	1	0	0	0	0	0	0	0	1
1989	1	1	0	0	2	1	0	0	5
1990	1	8	0	0	0	0	0	0	9
1991	0	4	0	0	0	0	0	0	4
1992	1	2	0	0	1	2	1	0	7
1993	0	9	0	0	0	0	0	0	9
TOTAL	6	31	0	0	24	275	9	0	345
DUCKTRAP									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983									
1984									
1985	0	0	0	0	0	15	0	0	15
1986	0	0	0	0	3	12	0	0	15
1987	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	3	0	0	3
1991	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	3	30	0	0	33

TABLE 3.3.b. Continued

RIVER SYSTEM	YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
SACO										
	1970									
	1971									
	1972									
	1973									
	1974									
	1975									
	1976									
	1977									
	1978									
	1979									
	1980									
	1981									
	1982									
	1983									
	1984									
	1985	2	58	0	0	0	0	0	0	60
	1986	0	36	1	0	0	0	0	0	37
	1987	4	34	1	0	0	1	0	0	40
	1988	1	37	0	0	0	0	0	0	38
	1989	2	16	0	1	0	0	0	0	19
	1990	4	68	0	0	0	1	0	0	73
	1991	0	4	0	0	0	0	0	0	4
	1992	0	0	0	0	0	0	0	0	0
	1993	4	54	0	1	0	0	0	0	59
TOTAL		17	307	2	2	0	2	0	0	330
COCHECO										
	1970									
	1971									
	1972									
	1973									
	1974									
	1975									
	1976									
	1977									
	1978									
	1979									
	1980									
	1981									
	1982									
	1983									
	1984									
	1985									
	1986									
	1987									
	1988									
	1989									
	1990									
	1991									
	1992	0	0	0	0	0	1	0	0	1
	1993	0	0	1	1	1	2	0	0	5
TOTAL		0	0	1	1	1	2	0	0	5

TABLE 3.3.b. Continued

RIVER SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
LAMPREY									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979	2	0	0	0	0	0	0	0	2
1980	2	5	0	0	0	0	0	0	7
1981	2	0	0	0	0	0	0	0	2
1982	2	9	0	0	0	0	0	0	11
1983	2	0	1	0	0	0	0	0	3
1984	0	3	0	0	0	0	0	0	3
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	2	0	0	2
1993	0	0	0	0	1	0	7	0	8
TOTAL	10	17	1	0	1	2	7	0	38
MERRIMACK									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982	3	14	0	0	4	2	0	0	23
1983	7	54	5	0	1	41	6	0	114
1984	64	20	0	0	16	12	3	0	115
1985	8	112	1	0	5	85	2	0	213
1986	19	33	0	0	4	44	3	0	103
1987	8	94	4	0	2	26	5	0	139
1988	4	16	2	0	4	38	1	0	65
1989	3	24	1	0	0	55	1	0	84
1990	3	115	1	0	24	104	1	0	248
1991	1	76	0	0	0	254	1	0	332
1992	17	66	2	0	14	100	0	0	199
1993	0	27	1	1	2	30	0	0	61
TOTAL	137	651	17	1	76	791	23	0	1696

TABLE 3.3.b. Continued

RIVER SYSTEM / YEAR	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
PAWCATUCK									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982	0	38	0	0	0	0	0	0	38
1983	1	37	0	0	0	0	0	0	38
1984	0	26	0	0	0	0	0	0	26
1985	0	1	0	0	0	0	0	0	1
1986	0	0	0	0	0	0	0	0	0
1987	0	1	0	0	0	0	0	0	1
1988	0	5	1	0	0	0	0	0	6
1989	0	6	0	0	0	0	0	0	6
1990	0	8	0	0	0	0	0	0	8
1991	0	5	0	0	0	0	0	0	5
1992	0	6	0	0	0	0	0	0	6
1993	0	2	0	0	0	1	0	0	3
TOTAL	1	135	1	0	0	1	0	0	138
CONNECTICUT									
1970									
1971									
1972									
1973									
1974	0	1	0	0	0	0	0	0	1
1975	0	3	0	0	0	0	0	0	3
1976	0	2	0	0	0	0	0	0	2
1977	0	7	0	0	0	0	0	0	7
1978	3	90	0	0	0	0	0	0	93
1979	4	50	4	0	0	0	0	0	58
1980	4	164	7	0	0	0	0	0	175
1981	6	513	10	0	0	0	0	0	529
1982	3	57	0	0	0	10	0	0	70
1983	0	39	0	0	0	0	0	0	39
1984	7	65	0	0	2	18	0	0	92
1985	0	293	0	0	0	17	0	0	310
1986	0	275	0	0	0	43	0	0	318
1987	0	343	5	0	0	0	5	0	353
1988	1	93	0	0	0	1	0	0	95
1989	1	58	0	0	1	48	1	0	109
1990	1	226	0	0	0	36	0	0	263
1991	0	168	1	0	0	34	0	0	203
1992	3	353	1	0	5	127	1	0	490
1993	0	136	0	0	0	61	1	0	198
TOTAL	33	2936	28	0	8	395	8	0	3408
GRAND TOTAL	8873	43233	320	515	960	8294	164	228	62630

TABLE 3.3.b. Continued
GRAND TOTAL BY RIVER (1970-1993)

RIVER SYSTEM	HATCHERY ORIGIN 1-S-W	HATCHERY ORIGIN 2-S-W	HATCHERY ORIGIN 3-S-W	HATCHERY ORIGIN REPEAT	WILD ORIGIN 1-S-W	WILD ORIGIN 2-S-W	WILD ORIGIN 3-S-W	WILD ORIGIN REPEAT	TOTAL
PENOBSCOT	7680	34632	196	457	367	2232	23	59	45646
UNION	290	1734	9	24	1	11	0	0	2069
NARRAGUAGUS	28	408	11	15	39	1702	40	89	2332
PLEASANT	4	12	0	0	9	203	2	2	232
MACHIAS	21	238	7	0	20	1051	16	40	1393
E. MACHIAS	21	244	1	2	12	307	1	10	598
DENNYS	21	294	0	1	18	636	3	10	983
ST. CROIX	582	970	38	11	379	594	39	17	2630
KENNEBEC	12	189	5	1	0	9	0	0	216
ANDROSCOGGIN	20	452	5	1	4	55	0	1	538
SHEEPSCOT	6	31	0	0	24	275	9	0	345
DUCKTRAP	0	0	0	0	3	30	0	0	33
SACO	17	307	2	2	0	2	0	0	330
COCHECO	0	0	1	1	1	2	0	0	5
LAMPREY	10	17	1	0	1	2	7	0	38
MERRIMACK	137	651	17	1	76	791	23	0	1696
PAWCATUCK	1	135	1	0	0	1	0	0	138
CONNECTICUT	33	2936	28	0	8	395	8	0	3408
TOTAL	**8883**	**43250**	**322**	**516**	**962**	**8298**	**171**	**228**	**62630**

Fig. 3.3.1. Network diagram salmon projection model

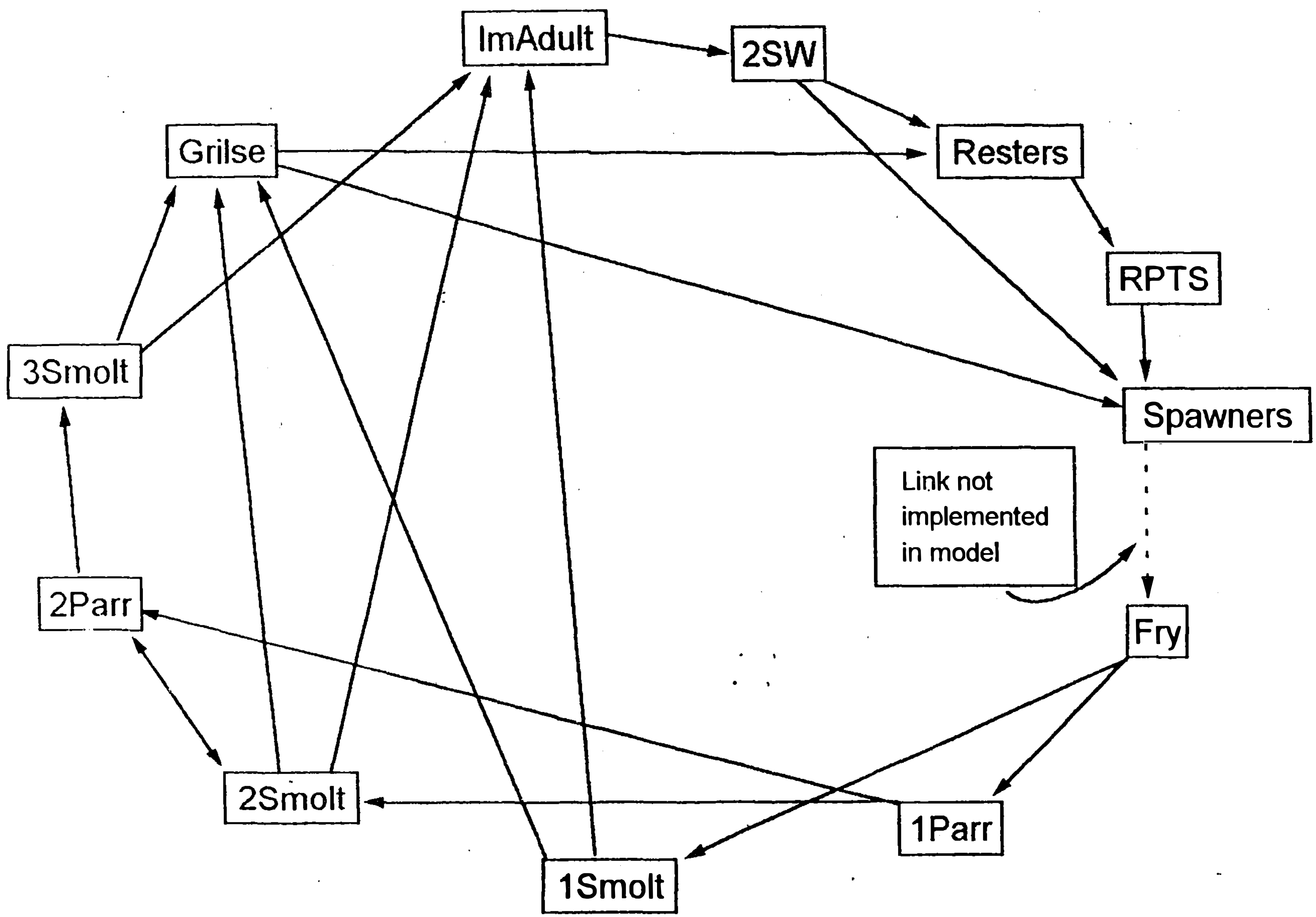
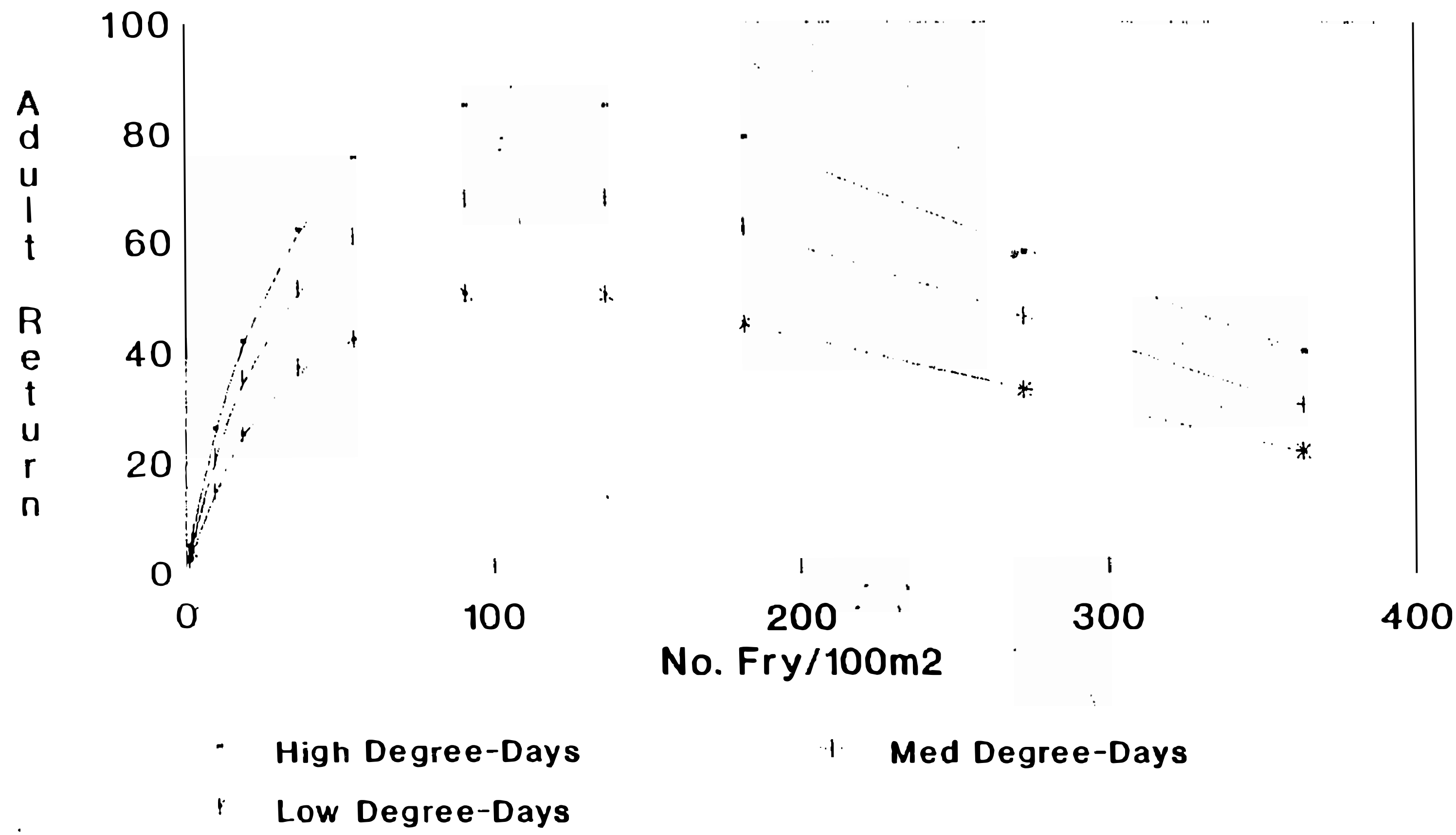


Fig.3.3.2-Adult Return vs. Density of Fry at Three Productivity Levels



RAMAS/stage model

Fig.3.3.4-Adult Return per 1000 Fry vs. Fry Density at Three Productivities

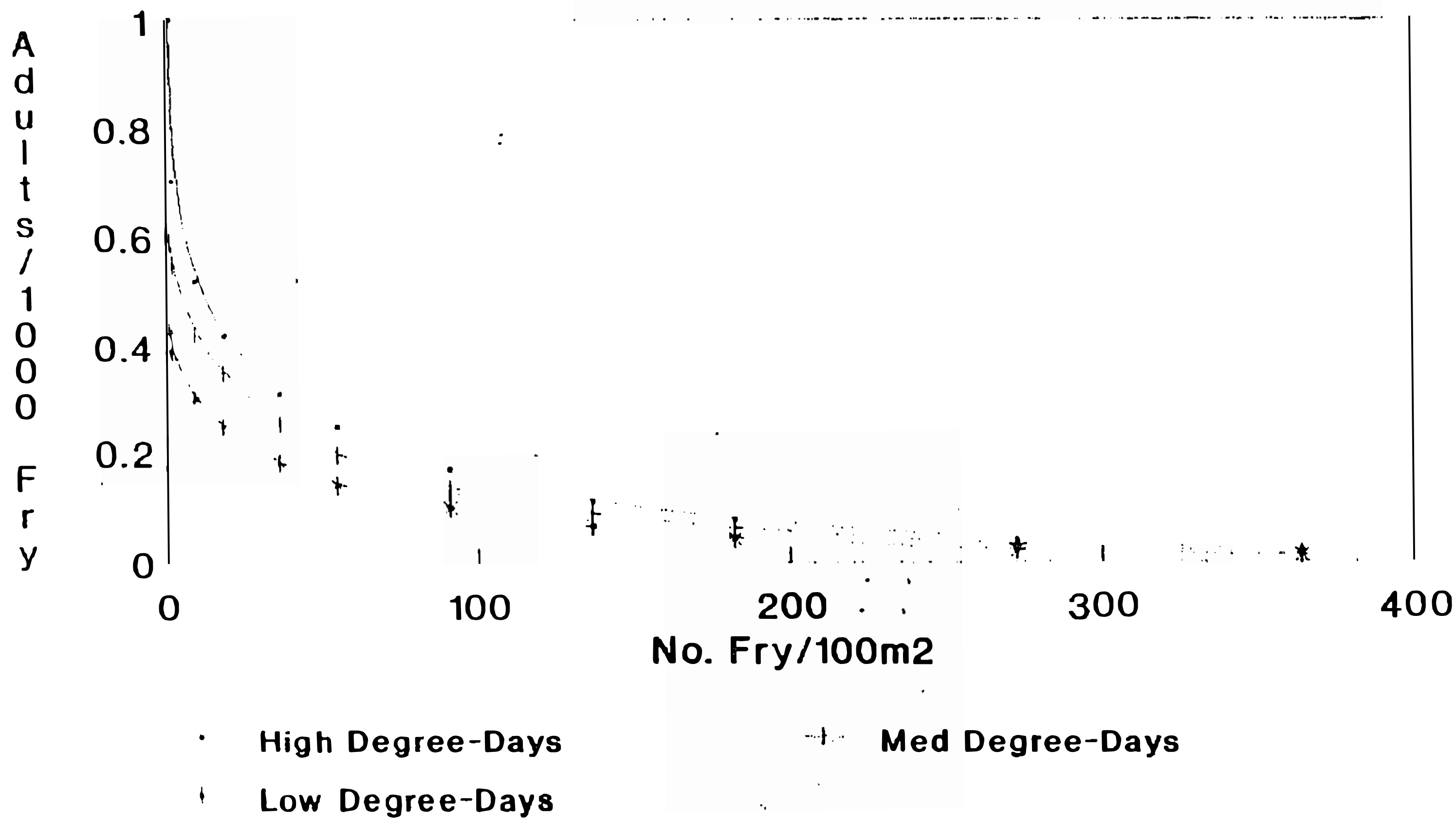
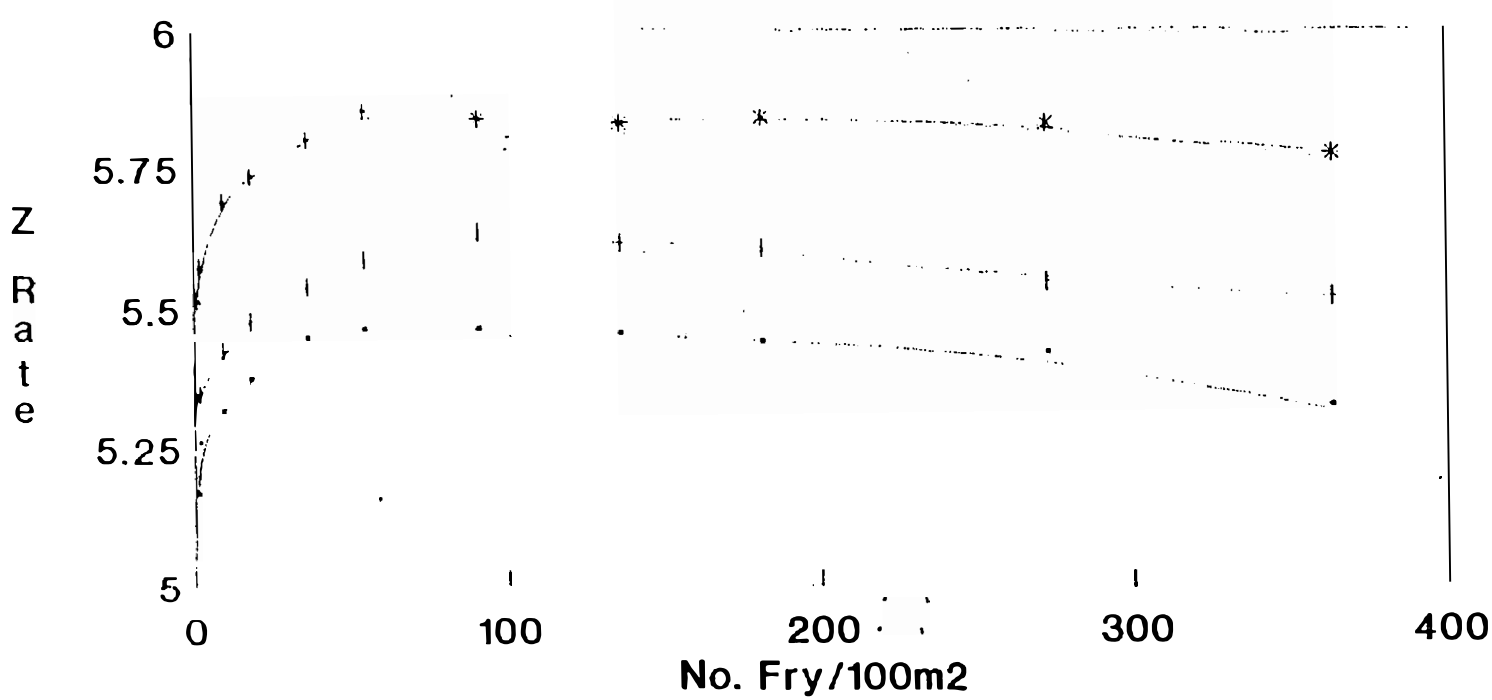


Fig.3.3.3-1st Year Sea Mortality Rate vs. Fry Density at Three Productivities



· High Degree-Days

ǀ Med Degree-Days

ǂ Low Degree-Days

Fig. 3.3.5 Monte Carlo simulation of marine survival rate of the Narraguagus River stock.

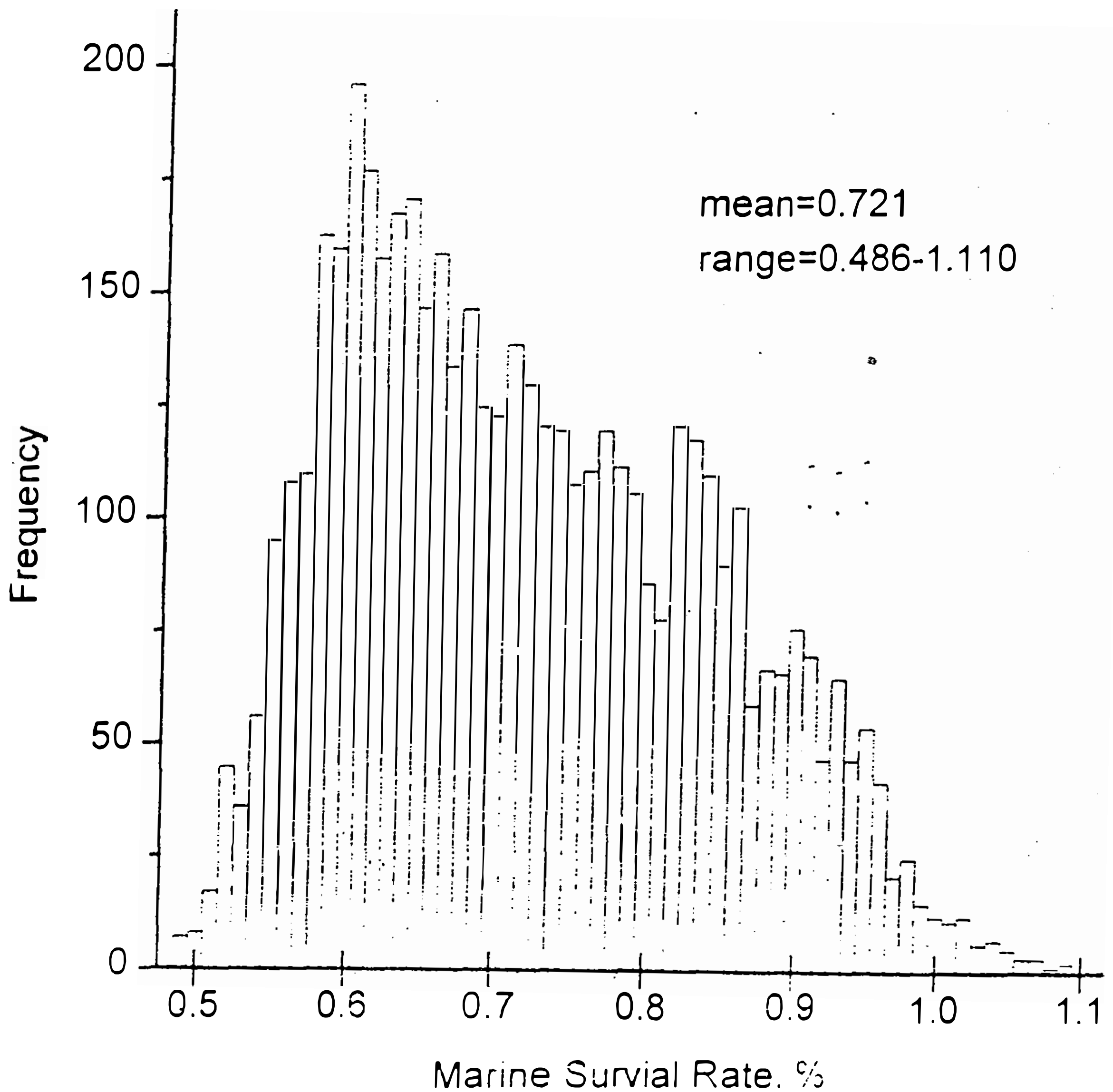


FIGURE 3.6.1

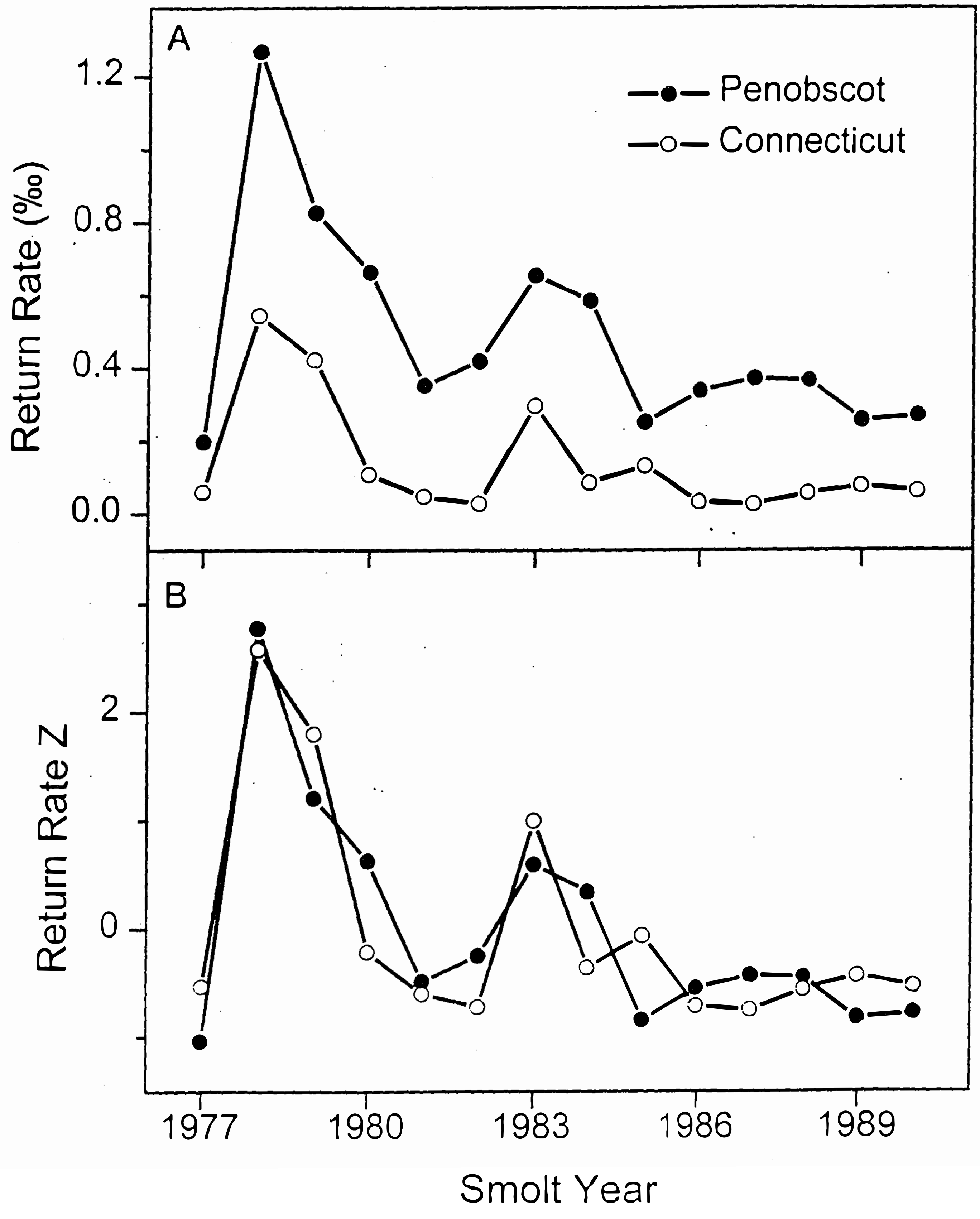

A
B
1.2
0.8
0.4
0.0
2
0
Return Rate (‰)
Return Rate Z
Penobscot
Connecticut
1977
1980
1983
1986
1989
Smolt Year

FIGURE 6.1.1.

New England Atlantic Salmon Stocking Program
1970 - 1993 (67,024,300 fish)

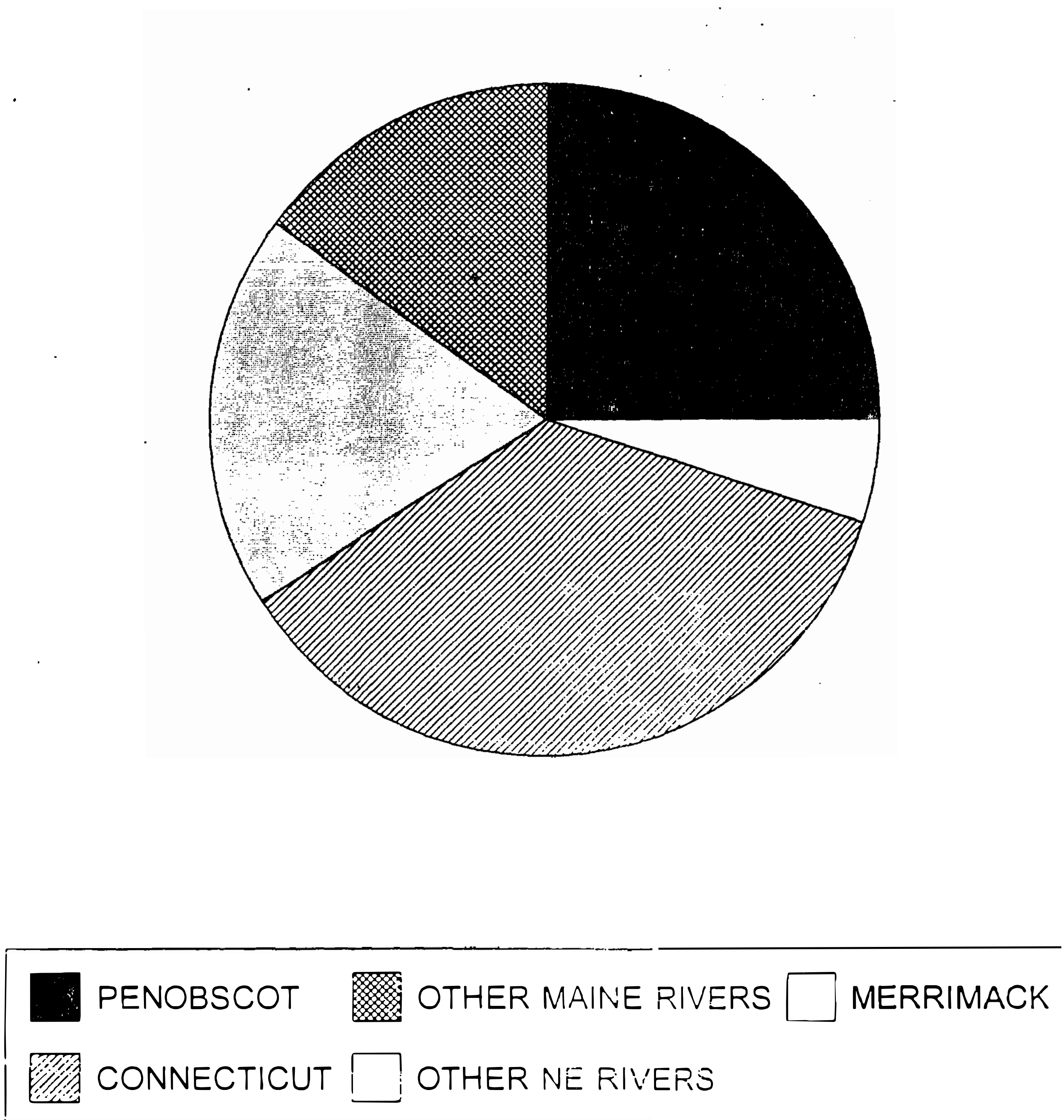


FIGURE 6.1.2.

New England Atlantic Salmon Stocking Program
1970 - 1993 (67,024,300 fish)

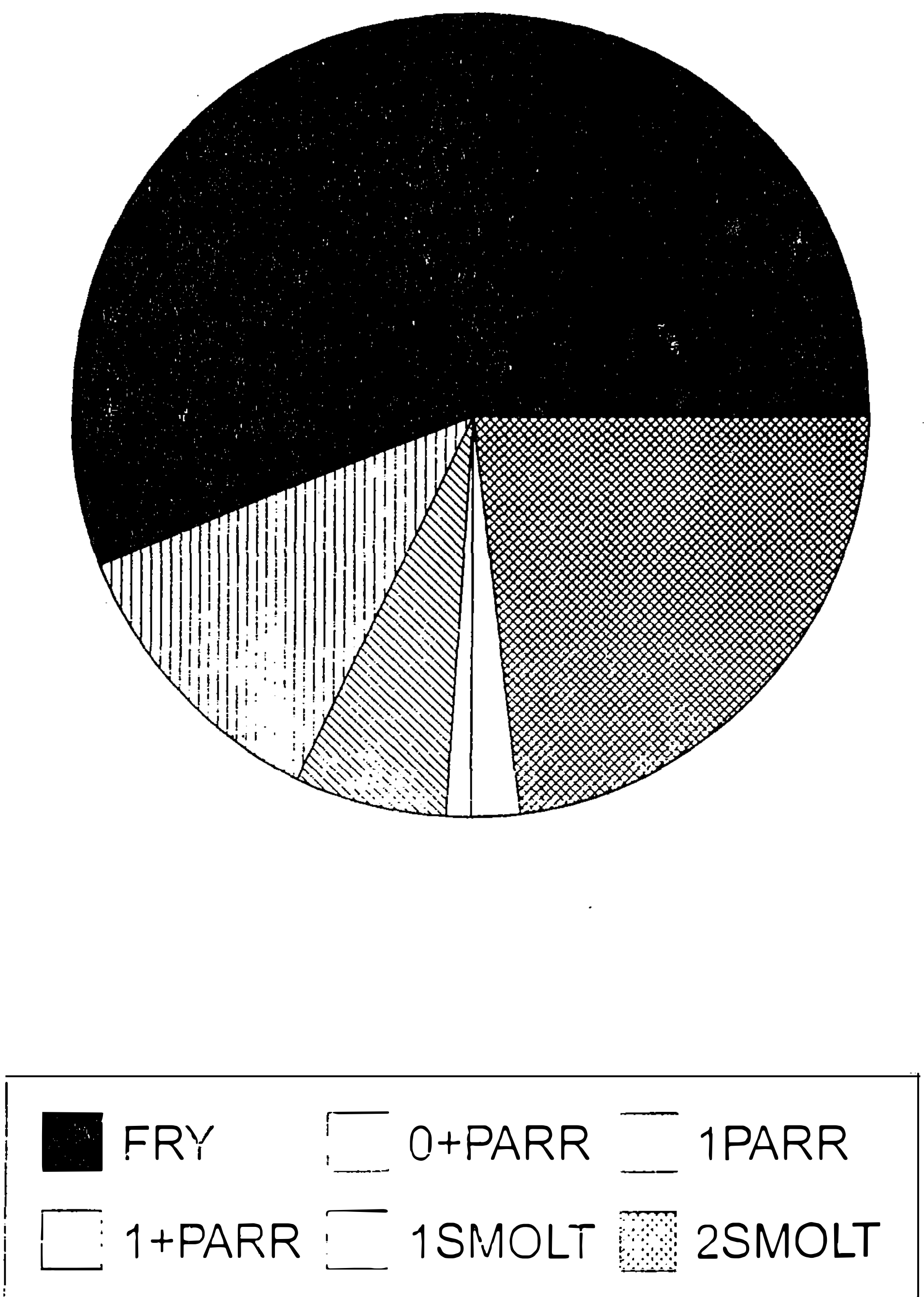


FIGURE 6.2.1.

New England Atlantic Salmon Returns
1970 - 1993 (62,630 adult salmon)

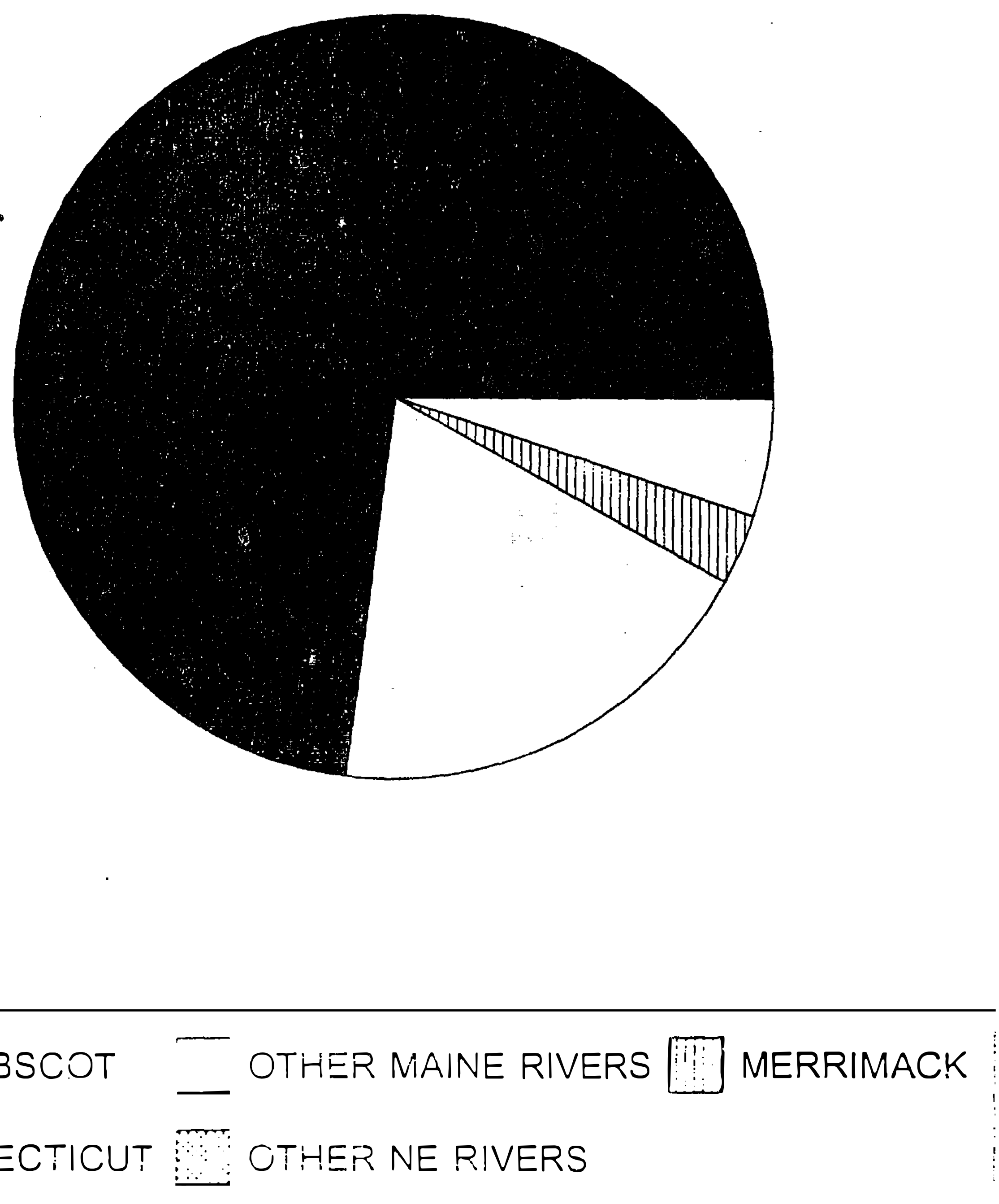
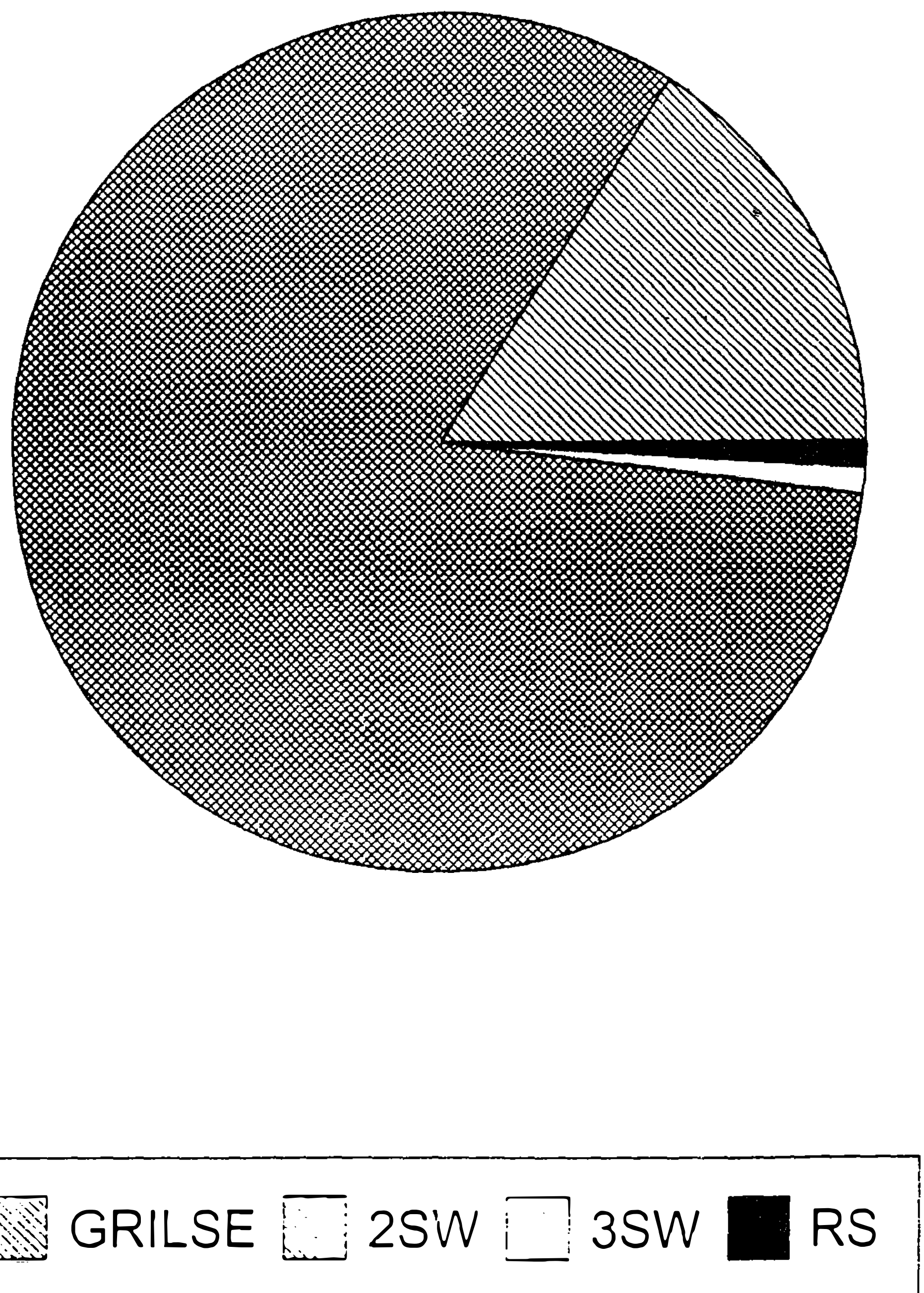


FIGURE 6.2.2.

New England Atlantic Salmon Returns
1970 - 1993 (62,630 adult salmon)



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