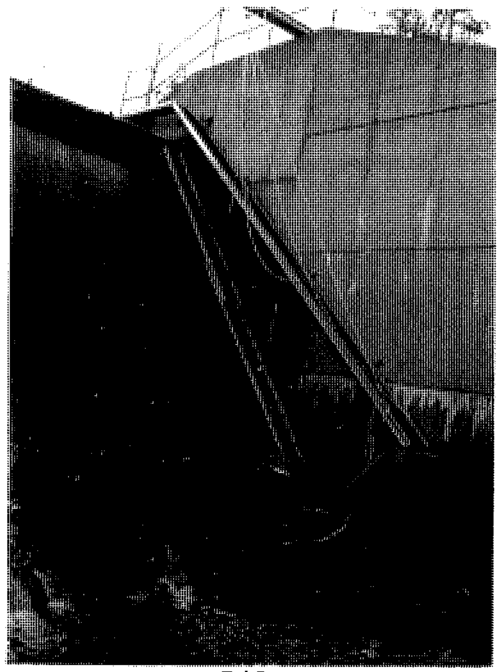
KENNEBEC RIVER
DIADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT – 2001



Eel Passage at Benton Falls

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EXECUTIVE SUMMARY OF 2001 ACTIVITIES:

On May 1, 2001, the temporary fish pump was installed below the Fort Halifax Hydroelectric Project in Winslow, ME. Trapping of alewives began on May 8 and the pump was used almost daily until May 24; it was shut down, however, on May 19 and 20 due to high water. Additionally, on four occasions between May 29 and June 12, it was used to collect small numbers of alewives for out-of-basin stocking. In all, a record 145,067 adult alewives were collected with the fish pump; a record 77,168 alewives were released into Phase I habitat; 54,339 were released into 33 other ponds throughout the state; 10,338 were released directly into the Fort Halifax headpond; and 750 were given to the Maine Warden Service. The total mortality rate of adult alewives (combined pump and trucking mortality) was only 1.6%. Due to a large number of alewives being attracted to the ledges below the Fort Halifax Project on the south side of the Sebasticook River, dip nets were used to collect and return them to the river below the dam. To prohibit alewives from returning to the ledge area, a series of sandbag and punch plate barriers were constructed along the base of the ledges by FPLE personnel. Overall, the sex ratio of randomly collected samples favored males 57:43 and fish length/weight decreased over time. The majority of adult alewives collected were Age IV males (42.4%) and females (28.8%). Permits were issued to 16 commercial fishermen who harvested a reported total of 69,000 adult alewives from below the project site.

A total of 452 adult shad broodstock were transferred from the Merrimack, Kennebec, Androscoggin, and Saco Rivers. These fish were collected from fishways on the Merrimack, Androscoggin, and Saco; several methods were utilized to attempt capture of adult shad below Fort Halifax. In 2000, FPLE utilized the fish pump and floating steeppass; however, when it became apparent those methods were ineffective, other techniques (angling, beach seining, and gill netting) were attempted. Based on knowledge gained in 2000, FPLE employed angling, gill netting, and electrofishing to capture adult shad in 2001. Of the 14 shad transferred from the Kennebec/Sebasticook, ten were captured via angling; three, electrofishing; and one, gill netting.

Due to poor egg production of the Saco River broodstock, fewer larval shad were released into the Kennebec River than in 2000. In all, 1.49 million larval shad were released above Hydro Kennebec and 618,879 above Fort Halifax. Additionally, 313,560 were released into the Saco and 308,596 into the Androscoggin Rivers. In September, 6,671 shad fingerlings were released into the Kennebec.

In 2001, DMR continued to work with the engineering and consulting firm URS to achieve upstream fish passage into Sebasticook Lake and Plymouth Pond. URS has completed final designs for fishways at these sites, as well as for a breach in the Guilford of Maine Dam in Newport. Additionally, all necessary permits have been obtained. To obtain the funding necessary to complete these projects, DMR has partnered with the Town of Newport, the US Fish and Wildlife Service, the Natural Resource Conservation Service, the National Marine Fisheries Service, the National Fish and Wildlife Foundation, and the Maine Corporate Wetland Restoration Partnership.

DMR personnel made unscheduled visits to pond outlet dams from June to December. Due to low water conditions in the Sebasticook watershed, downstream passage was not available at all ponds until late in the season, if at all. As in past low water years, beaver dams continue to be an impediment to both the upstream and downstream migration of alewives. Known problem areas were visited throughout the season and the dams were partially breached to provide passage; they were typically reconstructed within days of breaching.

DMR personnel made unscheduled visits to hydroelectric dams from June to October. Bypass facilities were operating at all projects during all visits. On September 24, CHI personnel reported to DMR that a fish kill had occurred at its project in Burnham. CHI also reported that corrective measures had been taken to reduce entrainment. A second fish kill was observed at the Burnham Project on October 22. Upon notification of the incident, CHI ceased generation until the large "pulse" of juvenile alewives had passed downstream. No other facilities experienced entrainment problems in 2001.

DMR personnel conducted biweekly beach seine surveys at eight sites in the Kennebec River between Augusta and Waterville. A total of 25,459 juvenile alewives; 1,379 juvenile American shad; 167 blueback herring; and another 324 unidentified alosids were captured throughout the summer. Additionally, 1,538 American shad eggs were collected in Ticonic Bay, downstream of the Lockwood Project. In addition to collecting fish samples, several habitat variables were measured in August: water velocity, temperature, dissolved oxygen, and measures of substrate and bank stability.

An upstream American eel passage study was conducted at the Lockwood, Hydro Kennebec, Shawmut, Weston, Fort Halifax, Benton Falls, and Burnham Projects. The primary objective of the study was to determine where juvenile eels pass, or attempt to pass, at each site. Upstream passages were installed on the south side of Fort Halifax and along the east side of the spillway at Benton Falls. Nighttime observations were conducted at the remaining five KHDG projects.

Downstream eel passage studies were conducted using radio telemetry at both Fort Halifax and Benton Falls. The primary objective of this study was to determine the seasonal and diel timing of the downstream migrating adult eels, the behavior of migrating adult eels at hydropower facilities, and the efficiency of various downstream passage measures for adult eels. Five radio-tagged eels were released above the Benton Project. Of these, two passed through the small turbine and three never passed the project. On several occasions, DMR personnel attempted to recover carcasses of the two eels that passed through the small turbine. Although DMR was unable to recover them, underwater video revealed that other eel carcasses were present in a deep hole below the Benton Falls Project. Since Fort Halifax did not operate during the study, passage there could not be effectively evaluated in 2001.

DIADROMOUS FISH RESTORATION ON THE KENNEBEC RIVER:

HISTORY OF THE MANAGEMENT PLAN

As documented in the *State of Maine Statewide River Fisheries Management Plan* (June 1982), the State's goal related to anadromous fish resources is:

> "To restore, maintain, and enhance anadromous fish resources for the benefit of the people of Maine."

With the following objectives:

1. Determine the status of anadromous fish stocks and their potential for expansion;
2. Identify, maintain, and enhance anadromous fish habitat essential to the viability of the resource; and
3. Provide, maintain, and enhance access of anadromous fish to and from suitable spawning areas

With respect to the Kennebec River, the State's goal is to:

> "Restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad and alewives to their historic range in the mainstem of the Kennebec River."

In 1985, the Maine Department of Marine Resources (DMR) developed "*The Strategic Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta.*" The goal of this plan was:

> "To restore the alewife and shad resources to their historical range in the Kennebec River System."

To meet this goal, the following objectives were developed:

1. To achieve an annual production of six million alewives above Augusta; and
2. To achieve an annual production of 725,000 American shad above Augusta

Coincidentally with the creation of this plan, the Kennebec Hydro Developers Group (KHDG) was created and a new *"Operational Plan for the Restoration of Shad and Alewives to the Kennebec River"* was implemented in 1986. This plan became the first "Agreement" between the KHDG and DMR. While its goals and objectives were the same as those of 1985, it allowed dam owners upstream of Edwards Dam to delay the installation of fish passage in exchange for funding a trap, truck, and release program to move adult alewives and shad into upstream habitat.

In 1993, the Natural Resources Policy Division of the Maine State Planning Office drafted the *"Kennebec River Resource Management Plan: Balancing Hydropower Generation and Other Uses."* Its goal for anadromous fish restoration in the Kennebec River remained the same as that established in 1982:

> "To restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad, and alewives to their historical range in the mainstem of the Kennebec River."

The objectives for striped bass, rainbow smelt, Atlantic sturgeon, and shortnose sturgeon were to restore or enhance populations in the segment of the Kennebec River from Edwards Dam in Augusta to the Milstar Dam in Waterville. At the time of the 1993 agreement, there was an ongoing DMR enhancement program for striped bass that consisted of fall fingerling releases. Since striped bass, rainbow smelt, Atlantic and shortnose sturgeon will not utilize fish passage facilities, the strategy for the restoration of these species was to remove the Edwards Dam. Its removal would also enhance the ongoing shad and alewife restoration program by reducing the cumulative impacts of dams on out-migrating juvenile alosids.

With the end of the KHDG Agreement and the removal of the Edwards Dam, a second agreement, "*The Agreement Between Members of the Kennebec Hydro Developers Group (KHDG), The Kennebec Coalition, The National Marine Fisheries Service, The State of Maine, and The US Fish and Wildlife Service,*" was implemented on May 26, 1998. Under this agreement, the DMR continues to be responsible for implementing a trap, truck, and release program for anadromous alewives and American shad. DMR is also responsible for ensuring that the goals and objectives identified for the Kennebec River in the 1982 plan are met through monitoring and assessment of other anadromous fish species. DMR, the KHDG, and the US Fish and Wildlife Service provide funds for the continued implementation of the state fishery agencies' fishery management plan.

In 1984, the Maine Atlantic Sea Run Salmon Commission (MASRSC) adopted the "*Management of Atlantic Salmon in the State of Maine: a Strategic Plan.*" In the plan, the MASRSC partitioned existing and historical salmon rivers into four categories (A, B, C, and D). The Kennebec River was one of five historical Atlantic salmon rivers assigned to category "C" primarily because salmon habitat was inaccessible due to impassable dams and lack of resources to initiate restoration.

In 1995, the MASRSC further delineated its proposed activities within the Kennebec River watershed in its "*Maine Atlantic Salmon Restoration and Management Plan, 1995 – 2000.*" The status of the Kennebec River Atlantic salmon resource was denoted as "unknown," but recognized that it included hatchery and wild origin strays with limited natural production. Restoration was deemed passive, with limited activities as resources allowed. The 1995 – 2000 goal for the Kennebec was to maintain current numbers of Atlantic salmon and increase those numbers in the future.

The Maine Atlantic Salmon Authority (MASA, formerly the MASRSC) adopted the "*Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters*" in 1997. In this document, the MASA identified a ten-year restoration goal to be undertaken in two phases. Under Phase I (1997 – 2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards Dam site. The MASA supported ongoing efforts for removal of the Edwards Dam. Phase II (2002 – 2006) objectives are to focus on developing a multi-agency fisheries management plan for the river above Lockwood, as well as initiate an Atlantic salmon stocking program.

IMPLEMENTATION OF THE MANAGEMENT PLAN (1986-2001)

The strategy developed to meet the objectives of alosid restoration was planned in two phases. The first phase (January 1, 1986 through December 31, 2001) involves restoration by means of trap and truck of alewives and shad for release into spawning and nursery habitat (Table 1). The second phase (January 1, 2002 through December 31, 2010) involves providing upstream and downstream fish passage at Phase I release sites, as well as trap and truck operations to Phase II lakes. As originally planned, the Edwards Dam (whose owner chose not to participate in the KHDG/State Agreement) was to be the primary site for capturing returning adults for the restoration program. However, fish for the restoration were not obtained at Edwards until 1993 for several reasons. No capture facilities were available during 1987 and 1988; in 1989, an experimental fish pump was installed by the owner, but proved to be ineffective in capturing sufficient numbers for release in upriver spawning habitat. As a result, from 1987 through 1992, all the alewife broodstock stocked in Phase I lakes (see Table 1 for a list of these lakes) came primarily from the Androscoggin River.

A shift in the source of alewife broodstock occurred in 1993, due to an increased number of returns in the Kennebec below Edwards and the simultaneous decline in the run of the Androscoggin donor stock. In 1993, all adult alewives transferred to upstream habitat were Kennebec River returns and were predominantly trapped by netting. The broodstock source was split between the two rivers in 1994, but the bulk of the fish (93%) were Kennebec River returns, with most collected by the fish pump. Since 1995, DMR has obtained alewife broodstock exclusively from the Kennebec River. Between 1996 and 1999, the majority of alewives transported were collected using the fish pump at the Edwards Dam. In 2000 and 2001, all of the fish transported were again collected with the fish pump; however, following the removal of Edwards Dam, the operation was moved upstream to Fort Halifax in Winslow (Figure 1).

Due to the increased number of adult alewife returns to the Kennebec River since 1994, DMR typically not only meets Phase I stocking goals, but also has additional alewives available for other restoration sites in Maine. In 1998, alewives from the Kennebec were released into four additional ponds within its drainage and 14 ponds in eight other drainages. In 1999, due to a smaller run, this stocking practice was limited to three ponds in the Androscoggin River. In 2001, a record number of alewives were captured at Fort Halifax and released into 44 ponds throughout Maine (including all Phase I ponds that we were permitted and chose to stock).

The issue of the future of the head-of-tide Edwards Dam was settled in 1998. The State of Maine took possession of the dam on January 1, 1999 as part of an agreement reached with the dam's previous owner, Edwards Manufacturing Company. The relicensing process of Edwards Dam included several landmarks that contributed to the

Company's decision to turn the dam over to the state. In the fall of 1997, the Federal Energy Regulatory Commission (FERC) released a basin-wide Environmental Impact Statement, which recommended removal of the Edwards Dam. The FERC voted on this removal recommendation and ordered it in December 1997. In addition, Edwards' power contract with FPL Energy expired December 31, 1998. Rather than participate in a protracted legal battle, Edwards Manufacturing chose to negotiate with and turn the dam over to the State of Maine, allowing its ultimate removal by the state.

Physical removal of the dam began in early June 1999 and was completed by the end of October 1999. The breaching on July 1 and resultant fish passage, coupled with the dewatering of the impoundment previously created by the dam, will allow restoration of the Kennebec and Sebasticook Rivers above Augusta. An important component of this restoration is the access to spawning and nursery areas for all anadromous fish species, including striped bass, rainbow smelt, shortnose sturgeon, and Atlantic sturgeon, none of which utilize conventional fish passage facilities. Since dam removal was not completed in time for the 1999 spring spawning runs of alewife and American shad, trap and truck operations continued at Edwards to ensure that those fish trapped below were able to spawn upstream.

On June 25, 1999, DMR, in cooperation with IF&W, installed a barrier on Sevenmile Brook to exclude undesirable, nonindigenous species. European carp (previously excluded by the Edwards Dam) have been shown to be detrimental to pond ecosystems. At this time, not enough is known about the potential impacts of this species to risk NOT having a strategic barrier on the Sevenmile drainage. The barrier was installed May 3, 2001 and was checked weekly for cleaning and maintenance until its removal December 14. The barrier will be reinstalled annually, as early as possible, until IF&W installs a permanent barrier.

Under the 'Agreement' with the Edwards Dam removal, an interim trapping facility was constructed at the Fort Halifax Dam on the Sebasticook River to collect returning adult alewives and American shad in the spring of 2000. This interim facility will be used for the trapping and trucking of adults for release upstream until 2003, when either a permanent fish lift will be in place at Fort Halifax or the dam will be removed.

Under Phase I of the restoration plan, only those lakes approved by the Department of Inland Fisheries & Wildlife (IF&W) were to be stocked with six alewives per surface acre. Of the 11 impoundments listed under Phase I, only eight were stocked at the beginning of the program in 1987; Wesserunsett Lake was stocked beginning in 1996. Restoration at the remaining Phase I impoundments, Threemile and Three-cornered Ponds, both in the Sevenmile Brook drainage, was delayed due to their marginal to poor water quality; in 2001, alewives were released into Threemile at a reduced rate of two $acre^{-1}$. Restoration at the ten remaining impoundments was contingent upon the outcome of a cooperative research project sponsored by DMR, DEP, and IF&W to assess the interactions of alewives with resident smelt and salmonids. In June 1997, IF&W confirmed that the Lake George Study indicated no negative impacts of alewife reintroduction on resident fish populations and outlined a schedule for stocking alewives into Phase II and Phase III habitat.

The initial restoration of alewives to Webber Pond had been postponed for several years to allow the Maine Department of Environmental Protection (DEP) time to establish a better long-term water quality database on this pond. In fact, DMR deferred stocking alewives into the whole Sevenmile Brook drainage (Webber, Threemile, and Three-cornered Ponds) for a number of years due to the ongoing work in water quality improvement by DEP, local residents, lake associations, and the China Region Lake Alliance. In early 1995, DMR, DEP, and IF&W agreed that alewife restoration at six alewives acre^{-1} would have no negative impact on water quality and may, in fact, have a positive long-term impact through phosphorus export from the lakes. However, a conservative plan was agreed upon which called for stocking only Webber Pond initially. Webber was stocked in 1997 with two alewives per acre, followed by four alewives per acre in 1998, and starting in 1999, six per acre annually. In 2001, DMR implemented a conservative stocking plan at Threemile Pond as well: alewives were released at a density of two alewives acre^{-1}.

DMR continued to transfer American shad from out-of-basin to the Waldoboro Shad Hatchery for use as captive broodstock in the hatchery's tank spawning egg take program. However, starting in 2001, DMR began collecting broodstock from the Merrimack River rather than the Connecticut River. Due to the increased run size on the Merrimack over the past few years and the fact that it is much closer to Maine than the Connecticut River, DMR felt it a logical spot to obtain broodstock. Shad restoration efforts in other rivers, such as the Susquehanna, have shown fry releases to be more successful than fingerling or adult releases. Therefore, no broodstock American shad have been transferred from out-of-basin (the Connecticut River was the primary source in past years) directly to the Kennebec River since 1997. Rather, DMR has concentrated on providing broodstock for the hatchery's tank spawning effort.

In 2000 and 2001, DMR transferred broodstock from the Kennebec River to the shad hatchery. Since only small numbers of fish were available from both the Kennebec and Merrimack Rivers in 2001, additional broodstock from the Saco River, captured at the Cataract fish lift, were transferred to the hatchery. Along with the Kennebec and Merrimack origin fish, the Saco shad were placed in the tank spawning system to further augment egg production for the Kennebec restoration effort.

American shad fry production increased in 1997 with the Maine Outdoor Heritage and KHDG-funded expansion of the hatchery facility. The 2000 shad culture operational budget was funded by the DMR and Kennebec River Restoration Fund. Due to low egg production in 2001 (due mainly to poor egg production from the Saco River broodstock), DMR released fewer larval shad than in previous years. Additionally, since no shad larvae were deliberately released into the hatchery ponds in 2001, the number of fall fingerlings released into the Kennebec River was much lower than in previous years. All larval shad and fingerlings raised at the hatchery were marked with oxytetracycline prior to release.

ALEWIFE RESTORATION METHODS:

TRAP, TRANSPORT, AND RELEASE

In 2001, DMR utilized only Kennebec River adult alewife returns for release into Phase I restoration lakes (see Figure 1 for a map of Phase I lakes). The large number of alewife returns to the Kennebec River in previous years, coupled with improved capture techniques using the fish pump formerly installed at Edwards, prompted DMR to again trap alewives in the Kennebec in 2001.

Pump configuration-
As outlined in Exhibit B, Section IV, Part E (1. b.), FPLE, the owners of the Fort Halifax Project were required to:

> "By no later than May 1st of the first migration season following the removal of Edwards Dam, anticipated to be removed in 1999, licensee shall install and have fully operational a temporary fish pump and trap and transport facility..."

In April 2000, FPLE constructed stairs to lead from the powerhouse to the tailrace. The vacuum chamber and intake hoses were mounted on a permanent platform directly above turbine outlets, while the mechanical portions of the pump were installed inside the powerhouse. A length of ten-inch diameter pipe was run from the vacuum chamber up the side of the dam/powerhouse and terminated above a receiving tank. The intake end of the pump was positioned towards the north (near shore) side of the tailrace so that as alewives followed the shoreline up the river, they would become susceptible to capture by the pump. As in past years, a three-foot long section of ten-inch diameter transparent lexan was attached to the intake end of the pipe. The clear tip on the pipe was added to make the pump less obtrusive to the fish and thus, more effective. The intake end of the pipe, just above the lexan tip, was fastened in place with an array of "come alongs." The horizontal and vertical positions of the intake were maintained by adjusting an attached "come along" and supporting davit on the concrete pier. The intake was also secured by several lines fastened to the pier, which helped prevent the pipe from jerking violently as the pump cycled between suction and discharge phases. This more static intake nozzle may have contributed to pump efficiency by scaring the fish less than the unstable arrangement used several years prior.

The pump lifted and deposited alewives and water into a 2,270-gallon fiberglass tank located at the top of the dam next to the powerhouse. The receiving tank measured 9' x 7'6" x 4'6" deep. The tank floor was painted white to provide better visual contrast with the alewives and allow more accurate estimates of fish numbers in the tank. Dipping alewives from this tank proved difficult until their density was very high. Alewives were also removed by draining the tank, especially when fish density was low. Draining was accomplished by stopping the pump and removing a drain plug in the tank floor. FPLE installed a microporous oxygen delivery system to maintain healthy oxygen levels to minimize stress on captured alewives. A liquid oxygen tank was located near the holding tank to supply the microporous delivery system. In addition, the supplemental water supply utilized in past years was used again for the 2001 season. This water was supplied by an electric pump and discharged onto the surface of the holding tank water through a two-inch hose; it was used to provide alewives in the tank with fresh, oxygenated water, especially if the fish pump was shut down. With this arrangement, in the absence of a stocking truck, the pump could be shut off when a sufficient number of alewives had been trapped, allowing them to be held without causing stress or mortality due to crowding or decreased dissolved oxygen levels.

During truck loading, alewives were intercepted as they exited the pipe downstream of the pump before they entered the holding tank. While standing on removable aluminum decks placed over the top of the pump tank, DMR and FPLE personnel used dip nets to capture the alewives as they entered the tank. The head of the net was usually braced against the metal deck and the fish were screened from the water as it flowed through the bag of the net; the bag was allowed to float in the tank water to reduce stress on the fish trapped in it. The full dip net was exchanged for an empty one between pump cycles, with the alewives being placed in the truck tank. Typically, one or two DMR personnel manipulated the dip nets to catch alewives while another worker was handed the full nets, and sorted/counted fish as they were released into the truck tanks. While loading the twin tank truck, two personnel counted and loaded alewives on the truck. The second person was especially helpful for loading the front tank on the twin tanker, as it is impossible to get the front of the truck close to the pump tank because of site configuration.

Stocking truck configuration-
Prior to the removal of alewives from the receiving tank, the stocking trucks were filled with water from the Fort Halifax headpond using the auxiliary water pump. Water was circulated in the stocking tanks with the truck-mounted pumps. Oxygen was introduced into the stocking tank water at approximately six liters minute^{-1}. Water circulation and oxygen introduction continued as alewife loading progressed in order to provide a healthy, stable environment in the stocking tanks. Most alewives were transported in two stocking trucks purchased with funds provided by the KHDG Agreement; however, on occasion, a truck from the Androscoggin River Project was used to expedite the Kennebec Project's efforts. A complete description of these trucks, associated equipment, and standard methods of operation are provided in the 1994 annual report, available from DMR upon request.

The configuration of the hauling tank system and the operational procedure used by the DMR/Kennebec River crew were very important in hauling large loads of alewives. In 1992, all stocking trucks were equipped with a porous pipe oxygen delivery system. This system consisted of porous polyethylene pipes four feet long, fastened to the tank floors and connected to lexan-ball type flow meters downstream of welding type regulators attached to the oxygen tank. These porous pipes produced finer diameter bubbles and used less volumes of oxygen than previous systems and are also used on the Susquehanna River shad hauling trucks to increase dissolved oxygen levels.

In efforts to decrease hauling mortalities and increase cost effectiveness, DMR has been experimenting with various oxygen delivery systems over the course of this program. For three years (1995 - 1998), one of the double tanker trucks was fitted with a Bio-Weve diffuser. This system was more durable and worked as well as the porous pipe system initially, but clogged quickly with debris and was extremely difficult to clean. In 1999, the C-60 single tanker was fitted with a flexible, porous, rubber tubing oxygen delivery system. It appeared to perform comparably to the porous polyethylene and Bio-Weve diffusers, but was much less costly and more durable. That system was again used in the C-60 in 2001 and continued to perform well. Eventually, both tanks on the double tanker will be fitted with the flexible, porous, rubber tubing oxygen delivery system.

ADULT ALEWIFE BIOSAMPLES

On ten different days between May 7 and June 12, DMR personnel sampled 50 adult alewives collected at Fort Halifax. The samples were collected either using the fish pump (they were dipped out of the pump receiving tank) or by dip net from below the dam next to the pump intake. Due to the presence of blueback herring in the Kennebec River, all samples were identified using the guidelines of Liem[1], which basically relate to body shape, size and position of the eye, and color of the peritoneum (lining of the gut cavity: alewives are white/silvery and bluebacks are charcoal). Once the fish were identified, they were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed, and scale sampled for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

COMMERCIAL ALEWIFE HARVEST

Prior to the 2000 alewife season, DMR and IF&W met to discuss the possibility of a commercial alewife fishery in the Town of Winslow below the Fort Halifax Dam. It was decided that IF&W would delay the issuance of permits until DMR was comfortable that stocking goals would be attained. This same procedure was followed in 2001. It was clear by the middle of May that goals would be met, and harvesters started applying for permits by the end of the month. In all, 16 permits were issued for the harvest of alewives below Fort Halifax. As in past years, fishermen failing to report landings data on their Kennebec alewife harvest forfeit the opportunity to obtain the special harvesting permit required to legally participate in the fishery the following season.

ALEWIFE RESTORATION RESULTS & DISCUSSION:

TRAP, TRANSPORT, AND RELEASE

Overview

On May 1, 2001, FPLE completed installation of the pump at the Fort Halifax Project. On May 2, DMR received reports that small schools of alewives were observed both at the mouth of the Cobbosseecontee Stream in Gardiner and below Fort Halifax in Winslow. On May 3, FPLE biologists reported to DMR and IF&W that an increasingly large number of white suckers were observed swimming up the ledges on the south side of the river; IF&W subsequently opened a commercial white sucker fishery below Fort Halifax. By May 6, a large number of adult alewives had congregated below the dam. Due to high spring flows, several flashboards had blown out on the south side of the spillway, causing a large amount of attraction flow to the ledges on the south side of the river. While this would have no impact on the fish pump's ability to capture adult alewives (based on observations from 2000), there was the threat of a fish kill if water levels receded quickly. FPLE personnel removed adult alewives from the ledges on May 6 and constructed small barriers of rocks and sandbags to inhibit fish from returning to the ledges. FPLE and DMR personnel continued to remove adult alewives and suckers from the ledges on May 7 via dip net, but no alewives were "bucketed" over the dam from below the ledges as in 2000. On May 8, FPLE and DMR initiated trapping and trucking operations. Trap and truck dates and numbers of all watersheds stocked are presented in Table 2 and Figure 2.

[1] Liem, A.H. 1924. The life history of the shad (Alosa sapidissima (Wilson)) with special reference to the factors limiting its abundance. Contrib. Can. Biol. 2:161-284.

On May 8 and 10, the Androscoggin River Restoration Project stocking truck was loaned to the Kennebec River Restoration Project. The Androscoggin truck was used to complete three trips over the course of those three days to distribute adult alewives captured at Fort Halifax into Kennebec/Sebasticook Phase I habitat. In total, DMR was able to transport an extra 2,563 broodstock alewives with this third truck. The Androscoggin Project truck was particularly useful in releasing fish into Pattee and Lovejoy Ponds, where the ground is typically soft/muddy. At these two sites, the heavier Kennebec River trucks can sink into the ground and may become stuck. The Androscoggin truck was also useful in stocking alewives collected at Fort Halifax to out-of-basin ponds.

Between May 8 and June 12, 2001, a record 145,067 alewives were collected with the fish pump and an additional 150 alewives were collected with dip nets for biosample data. Overall, pump efficiency (fish day^{-1}) at Fort Halifax was similar to historical pump efficiencies at Edwards. The pump operated for a total of 17 days and an average 8,533 (standard deviation of ± 5,809) adult alewives were collected daily. The variation in the number of fish collected with the pump is due to a number of factors, including environmental conditions causing variation in fish densities below the dam (e.g., high water and/or depressed water temperatures), truck loading time, and trip length.

The timing of the alewife run was about ten days earlier than average (see table below). Historically (1994 - 2001), the mean date by which 50% of alewives have been collected is May 25. In 2001, the 50% date of alewife trapping was May 14 (Day 8 of pump operation). Likewise, the 25 and 75% quartiles were 9 and 11 days earlier (respectively) than average. There are several factors that may have contributed to this earlier run. At the time of this report, none have been investigated, but possibilities include an earlier increase in water temperature, change in river flow regime due to the removal of Edwards Dam, and/or an increase in run size and therefore, an increase in concentration of alewives below Fort Halifax. Also, because the Sebasticook is narrower than the Kennebec, fish could have spread out below the Edwards spillway and not been as susceptible to the pump as they may be at Fort Halifax.

Summary of Alewife Trapping by Quartile

Year	25%	50%	75%
1994	28-May	01-Jun	02-Jun
1995	25-May	27-May	30-May
1996	27-May	03-Jun	04-Jun
1997	31-May	03-Jun	04-Jun
1998	15-May	18-May	20-May
1999	22-May	28-May	31-May
2000	9-May	15-May	19-May
2001	12-May	14-May	16-May
Mean=	**21-May**	**25-May**	**27-May**

Based on eight years of data (1994 - 2001), the average peak date of alewife pumping is May 23 (see following chart). In 2001, the peak was on May 14 (18,896 alewives collected with the fish pump); however, there were also 18,891 adult alewives collected on May 13. The peak in 2001 was lower than those of 1996 and 1997 (21,756 and 22,205, respectively). The high numbers of alewives pumped on the peak days in 1996 - 1997 were due to continuous pump operation to support the short in duration, heavily loaded, truck trips to the Edwards Dam headpond. Similar highs probably could have been attained in other years, including 2001, if the pump had been operated continuously at the peak of the run.

Summary of Peak Alewife Trapping

Year	Peak date	Number pumped
2001	May 14	18,896
2000	May 7	13,578
1999	May 23	9,965
1998	May 18	16,311
1997	June 3	21,756
1996	June 4	22,205
1995	May 27	10,634
1994	June 2	13,050
Mean=	**May 23**	**15,799**

Based on experience gained during alewife trapping at Edwards in previous years, DMR developed a standard operating procedure for using the fish pump in an efficient manner. As in past years, the majority of shad transfers did not occur until after alewife stocking was completed. This meant there were sufficient Kennebec River Project personnel available to work on alewife trapping and transport. While two crewmembers traveled with each of the two stocking trucks, a fifth worker usually remained at Edwards to coordinate pump operations. In 2001, particularly on days that the Androscoggin Project truck was used, FPLE personnel were vital in aiding in the loading of trucks and occasionally making trips to ponds along with DMR personnel.

Based on the pump's alewife trapping rate and the time trucks were due back at the site, DMR personnel could perform rough calculations to determine the number of alewives already in the pump tank and the number likely to be pumped prior to a truck's return. If too many alewives were likely to be trapped, an FPLE employee could stop the pump. A maximum of approximately 2,500 alewives could be stockpiled in the pump-receiving tank. A supplemental circulating water supply, added during the 1994 season, allowed fish to be held in the tank when the pump was switched off. If the single tanker was due to return first, a whole load of alewives (1,500 to 1,800) could be stockpiled in the pump tank. If the twin tanker or both trucks were due to return, the maximum stockpile of alewives (2,500) could be held. Ideally, these fish would be trapped immediately preceding the arrival of a truck so that they were held in the tank for a minimum amount of time. As the loading of the double tank truck commenced, the pump would be restarted and additional alewives would be trapped to finish the load. This operational mode allowed loading to be as efficient as possible without sacrificing the quality of the alewives. Because of efficient loading, alewives spent less time in the truck tanks at the loading site, which also helped minimize trucking mortalities.

Loaded trucks were immediately dispatched from Fort Halifax to the stocking sites. The remaining KHDG crewmembers were usually able to complete loading - even the double tanker - with assistance from FPLE personnel. This immediate and staggered departure method allowed tankers to return from the lakes to Winslow at alternating intervals and prevented waiting in line to load the next batch of alewives, contributing to more efficient trucking overall. If trucks did overlap at Halifax, the waiting crew helped load the first tanker and accelerated its departure.

Overall, the number of mortalities due to handling was low. In fact, the trucking mortality (mortality=965 fish) rate of 0.72% was one of the lowest ever. This low rate includes 720 alewives that died during a catastrophic plumbing failure on one of DMR's trucks that resulted in the loss of a whole load of fish. The pumping mortality rate of 0.84% (Table 2) was significantly higher ($p<0.05$) than the 0.01% rate of 1999, but lower than the 1.12% mortality rate from 2000. In 2000, it was learned that alewives become trapped in the fish pump pipe between the vacuum chamber and the pipe outlet at the receiving tank. Under normal pump operations, alewives are able to swim against the flow of water and thus remain in the pipe for extended periods of time and ultimately, overnight. Since the pump was shut down at night, there was no fresh water being introduced to the pipe and the entrained fish probably suffocated. After 315 fish died in the pump on the night of May 5, 2000, DMR and FPLE personnel attempted several methods of "pushing" fish out of the pipe at the end of the day. The first method tried was to manually operate the pump and extend the discharge cycle. This effort caused more pressure to build up in the chamber than normal, thus causing water to be pushed through the pipe leading to the holding tank for a longer period of time and at a higher flow. Using this technique several times at the end of the day, we were able to push most of the fish out of the pipe; however, every time the pump was cycled, more fish would be sucked in. To alleviate this problem, FPLE personnel constructed a screen that was placed on the intake pipe of the fish pump at the end of the day. This blocked fish from entering the pipe, but allowed the pump to cycle normally, therefore significantly reducing the number of alewives trapped and killed in the pipe at night.

Phase I Habitat

In 2001, 77,376 broodstock alewives were stocked into ten of the 11 upriver Phase I lakes in the Kennebec River watershed. In total, 12,323 acres of lake surface area were stocked to a density of approximately six alewives $acre^{-1}$. Additionally, Threemile Pond (1,077 surface acres) was stocked with approximately two alewives $acre^{-1}$. Threemile and Three-cornered Ponds have not been stocked in the past due to a history of marginal to poor water quality. Alewife stocking rates of the nine Phase I lakes which were stocked are summarized in Table 4.

The 77,168 alewives stocked in the Sebasticook and Kennebec drainage Phase I lakes in 2001 was the highest number of alewives ever stocked into these ponds, surpassing the previous record that occurred in 2000 (74,775; see following table). In total, 41 alewife-stocking trips were made to the upriver ponds (Table 5). All 41 trips originated from Fort Halifax, as the Kennebec River was the sole source of alewife broodstock in 2001. The alewife stocking program in the Phase I lakes required eight days to complete, May 7 to May 14, 2001 (plus one trip to Threemile Pond on May 17). This is the same number of days it took in 1998, fewer than it took in 2000 (13), and half as many as it took in 1999 (16), the only other three years when all or most Phase I ponds were stocked.

The average number of alewives released per trip in 2001 from Fort Halifax (1,882) was higher than the average number of alewives released per trip from the Edwards Dam (1,629) from 1992 - 1999 and higher than the number released per trip from Fort Halifax in 2000. However, the average number of fish per trip in 2001 was lower than the average number of fish per trip in years 1997 - 99. The reason the average fish $trip^{-1}$ was lower in 2001 is because Fort Halifax is within 20 minutes of some ponds (as opposed to over an hour from ponds in years past when trapping was conducted at the Edwards Dam); thus, we were more likely to send trucks out with "lighter" loads than in past years. Sending the trucks out with lighter loads precluded any degradation of the condition of the alewives by avoiding lengthy holding tank times.

Summary of Alewife Releases to Phase I Habitat

Year	Number released	Number of trips	Alewives ($trip^{-1}$)
2001	77,168	41	1,882
2000	74,775	43	1,739
1999	71,857	36	1,996
1998	73,148	34	2,151
1997	74,165	41	1,809
1996	67,441	41	1,645
1995	59,080	34	1,738
1994	58,701	36	1,631
1993	36,503	28	1,303
1992	23,579	31	761
Mean=	**61,642**	**37**	**1,666**

The most stocking trips completed to the Phase I ponds in one day was eight, occurring on May 13 and 14. The peak number of trips day^{-1} in 2001 was the second highest number of trips completed in a single day ever. The previous high number of trips day^{-1} was in 2000, when nine trips were made to Phase I ponds. In addition to the eight trips to Phase I ponds on May 13, the Androscoggin River crew completed three trips to Sabattus Pond in the Androscoggin drainage with alewives collected at Fort Halifax. The high number of trips day^{-1} in 2001 was due to high pump efficiency (18,891 on May 13 and 18,896 on May 14), loading efficiency, utilization of the Androscoggin Project trucks, and the proximity of Fort Halifax to Phase I ponds.

The year 2001 marked the third year of stocking Webber Pond at six alewives $acre^{-1}$. Webber was initially stocked in 1997 at a density of two alewives per acre, then at four alewives per acre in 1998, and at six per acre in 1999 and 2000. In 2000, adults were observed in Sevenmile Brook below the outlet dam of Webber Pond. However, it was unclear whether or not these fish were swimming up Sevenmile Brook or dropping out of the pond (the release point is only about 20 meters from the outlet). To help determine the "source" of these adult alewives, on May 30, fish from below the outlet dam were captured with dip nets, fin clipped, and released upstream into Webber Pond. The next day, DMR personnel again collected adult alewives from below the outlet dam with dip nets. No fish captured on May 31 were fin clipped, indicating that the adults below the dam probably swam up Sevenmile Brook from the Kennebec River. In 2001, DMR intended to stock Webber Pond with alewives that returned to the base of the outlet dam. However, by May 11, no adults were observed below the outlet dam, so DMR decided to stock Webber with fish from Fort Halifax. DMR later received anecdotal reports that alewives were observed below the outlet dam later in May. In 2002, DMR will delay stocking Webber Pond with alewives captured at Fort Halifax until later in the season to try and utilize alewives returning to Sevenmile Brook.

Nonphase I Transfers

In 2001, transfers from Fort Halifax to waters other than the Phase I lakes totaled 50,096 alewives loaded; 757 trucking mortalities; and 54,339 stocked (Table 6). The nonphase I transfers included ponds within the Kennebec drainage (seven), as well as 26 ponds in 11 other drainages. Nonphase I transfers began on May 11, to Pleasant Pond in Gardiner and Sabbatus Pond in Sabbatus, and continued until June 7. Alewives transferred to waters other than the Phase I lakes represented 41.3% of the total number trapped at Winslow.

In 2001, 10,338 adult alewives were released into the Sebasticook River directly above the Fort Halifax Dam. Typically, these fish were the ones left in the pump-receiving tank at the end of the day. However, in the June 7 biosample, it was observed that an increasing number of blueback herring were congregating below the Fort Halifax Dam. On June 12, 3,524 river herring[2] were released into the Sebasticook River above Halifax. The June 12 biosample revealed that approximately 13.6% of the fish released above the dam were blueback herring.

ADULT ALEWIFE BIOSAMPLES

Between May 7 and June 12, ten 50-fish samples were collected at Fort Halifax in Winslow. Six of these samples were collected with the fish pump, while four were collected below the dam at the pump intake with a dip net (Table 2). Of the 500 fish collected, identified, and measured, 17 were identified as blueback herring, thereby reducing the number of alewives sampled to 483. Of those 483 alewives, 43% were females and 57% were males. With the exception of two samples (May 29 and June 12), males were in greater abundance than females (Figure 3). In several instances, males outnumbered females almost 2:1 (May 11 and 15, as well as June 5 and 7).

On average, adult female alewives collected in 2001 were shorter and lighter than those collected in 2000. Adult females collected in 2001 (278mm±13.22) were 6mm shorter than in 2000 (284.99mm±15.04); additionally, those collected in 2001 (177.42g±29.94) were 9.95g lighter than in 2000 (187.37g±36.97). The differences in both length and weight were significant ($p<0.05$). There was no significant difference ($p<0.05$) in the size of adult male alewives between 2000 and 2001. Males in 2001 (272.11mm±11.77) were only 1.86mm shorter than those collected in 2000 (273.97mm±14.65). Despite being shorter in 2001, male alewives were 2.26g heavier in 2001 (161.71g±25.38) than in 2000 (159.45g±32.34).

In 2001, there were significant differences in length and weight, both between sexes and over time. On average, females (278.95±13.22 mm) were significantly ($p<0.05$)

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[2] The term river herring comprises both alewives and blueback herring.

longer than males (272mm±11.77). In addition, females (177.42g±29.91) were significantly ($p<0.05$) heavier than males (161.71g±25.37). There was a decrease in both length (Figure 4) and weight (Figure 5) of adult alewife returns to the Sebasticook River over time. Fish collected during the first sample on May 7 (283.02mm and 193.94g) were significantly ($p<0.05$) longer and heavier than fish collected during the last sample on June 12 (263.66mm and 146.5g). While length decreased throughout the season, the only significant decrease from one sample to the next was between May 13 and May 15 (Figure 4). There was no significant decrease in weight from one sample to the next (Figure 5).

Of the 483 alewives sampled, scales were collected from 153 fish (Table 7). Most of those sampled were Age IV males (42.5%) and Age IV females (28.8%). Age V males (13.7%) and Age V females (6.5%) were the next most abundant age classes. Several Age III males, Age VI males and females, and two Age VII males were also sampled. Within each sex, Age IV fish dominated the samples; 67% of males sampled and 78.6% of females sampled were four-year-olds. Within each sex, there was a decrease in mean age per sample from the first sample to the last. However, due the high amount of variation in age within each sample, the decrease in mean age over time cannot entirely explain the decrease in length over time ($R^2=0.16$).

COMMERCIAL ALEWIFE HARVEST

The Maine Department of Inland Fisheries and Wildlife issued 16 permits for the harvest of alewives below Fort Halifax Dam in Winslow. Conditions of the IF&W permit were consistent with DMR alewife harvesting permits in that 1) there is a 72-hour closure in the fishery from 6AM each Thursday until 6AM the following Sunday, and 2) landings must be reported to DMR no later than December 31. If landings are not reported, the permit may not be reissued the following year. An additional condition specific to Fort Halifax was added that read, " It is unlawful to fish within 150 feet of the fish pump..." The latter condition was added to provide DMR/FPLE personnel space to work in the river below the dam if needed. In 2001, a reported 69,000 adult alewives were harvested from the Sebasticook River below the Fort Halifax Project.

AMERICAN SHAD RESTORATION METHODS:

ADULT CAPTURE AND TRANSPORT

Per Section IV. E. 1. c. of the "Agreement," FPLE is required to "...install, have fully operational and maintain and operate below the Fort Halifax Dam all measures except for construction of permanent upstream passage facilities, necessary to capture shad unharmed in sufficient quantities to satisfy the needs of DMR for hatchery spawning of shad at its Waldoboro Shad Hatchery, so long as populations of shad have been sighted in the waters below the Fort Halifax dam." In 2001, FPLE utilized angling, gill netting, and electrofishing in attempts to capture adult shad broodstock for the Waldoboro Shad Hatchery. Angling took place mainly in the Sebasticook River at the Fort Halifax Dam and downstream to the confluence of the Sebasticook and Kennebec Rivers. Gill nets were set in the Kennebec below the Lockwood Hydroelectric Project. An electrofishing boat was used to "shock" the Sebasticook River from the Fort Halifax Project downstream to the confluence with the Kennebec. Additionally, FPLE shocked from the tailrace and bypass reach of the Lockwood Project downstream to the Father Curran

Bridge. All adult shad captured were immediately placed into either a stocking truck or a circular (seven-foot diameter) holding tank at Fort Halifax.

In 2001, DMR collected shad broodstock from two other rivers in Maine. Shad broodstock were dip netted by DMR personnel from the Brunswick Fishway (owned and operated by FPLE) on the Androscoggin River on one occasion. However, this practice was deemed inefficient and terminated after the first try when five of the six shad collected died. As in past years, shad broodstock were collected from the Cataract fish lift (owned and operated by FPLE) on the Saco River. At the Cataract lift, shad are trapped in the fishway and held in circular tanks until sufficient numbers are collected for DMR to send a truck down to transport them to the hatchery.

In past years, DMR has collected fish at the Holyoke fish lift on the Connecticut River in Holyoke, MA. However, with assistance from the US Fish and Wildlife Service-Central New England Fisheries Resource Complex, DMR investigated the possibility of obtaining shad broodstock from the Lawrence Hydroelectric Project fish lift (operated by CHI Energy, Inc.) on the Merrimack River in Lawrence, MA. The Essex lift was a desirable place for DMR to obtain broodstock because it is much closer to Maine than Holyoke, the shad run size in the Merrimack River has increased dramatically over the past few years, and the USF&WS and State of New Hampshire already trap shad and herring at that location. In 2001, the Merrimack River Technical Advisory Committee granted approval for DMR to transport 260 adult shad (60 for required fish health workup[3] and 200 for the hatchery) on an experimental basis from the Merrimack River to the Waldoboro Shad Hatchery.

The Essex fish lift is configured similar to that at Cataract: fish are trapped in a hopper at the base of the dam, the hopper is raised up the side of the dam, and the fish are deposited into a sluiceway where they can be trapped or allowed to swim freely into the headpond. However, at Essex, the hopper deposits fish into a net pen that floats in the sluiceway above the dam. This configuration is desirable because it allows biologists to remove nontarget species (e.g., striped bass and Atlantic salmon) from the shad trapping area, but still allow these fish to be trapped upstream at the existing trapping facility. Additionally, since the net pen is constructed of soft mesh netting, there is less chance that shad will suffer a high degree of scale loss and head trauma.

The stocking trucks used to transport adult shad are the same as those used to transport adult alewives. However, when transporting adult shad, the amount of oxygen introduced into the transport tanks was increased from the six liters minute^{-1} used for adult alewives to approximately 12 liters minute^{-1}. When transporting shad from the Saco and Merrimack Rivers, a combination of salts (50 pounds sodium chloride, five pounds calcium chloride, five pounds magnesium sulfate, and five pounds of potassium

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[3] A 60-fish sample of adult American shad was collected at the Essex fish lift in Lawrence, MA on May 21, 2001. They were packed in ice and transported to the Inland Fisheries & Wildlife Governor Hill Hatchery facility in Augusta, ME. Kidney, spleen, and gill samples were taken in accordance with the AFS Fish Health Blue Book Procedures. Samples were processed for the detection of bacterial and viral fish pathogens, but found to be free of any pathogens of concern to the State of Maine. These procedures are necessary to comply with state law concerning importation of live fish and eggs into Maine waters.

chloride) were added to the approximately 1,100 gallons of transport water; one pound of baking soda was also added as a buffer. Mixing salt into the transport water has been observed, qualitatively by DMR personnel and quantitatively by others[4], to reduce the mortality associated with handling of American shad. DMR has found the addition of salts particularly useful when shad are transported long distances (e.g., from the Merrimack and Saco Rivers).

LARVAL CULTURE AND TRANSPORT

The shad culture program initiated in 1991 was continued in 2001. The Kennebec River Shad Restoration Program is a cooperative effort between the DMR, the KHDG, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development Project, the latter of which was created and administered by the local Time & Tide Resource Conservation and Development Organization. The hatchery is located in the Town of Waldoboro and mainly consists of two 15-foot diameter adult spawning tanks, one 12-foot diameter adult spawning tank, and seven six-foot diameter larval rearing tanks. There are also three outdoor settling ponds on the property that were formerly used for the production of shad fingerlings.

All adult shad transported to the Waldoboro Shad Hatchery were placed immediately into either one of two 15-foot diameter spawning tanks (Saco, Androscoggin, and Merrimack fish) or into the 12-foot diameter spawning tank (Kennebec fish). Shad were allowed to spawn "naturally," the eggs collected daily and placed into upwelling incubator jars, and reared to approximately 14-21 days old before being released. While in the hatchery, all larvae are marked with oxytetracycline ("OTC," an antibiotic that leaves a mark on the otolith, or inner ear bone, when viewed under a microscope equipped with fluorescent light), so that DMR can later distinguish adult returns as either hatchery or wild in origin. Prior to releasing larval shad from the hatchery, otoliths from a 20-fish sample from each batch of fish to be released were examined for OTC mark retention. For complete details regarding hatchery operations, please refer to Appendix A, the *Waldoboro Shad Hatchery 2001 Annual Report.*

After OTC mark retention was verified, larval shad were loaded into a stocking tank and released directly into the target river. At the hatchery, larval shad are drained from their rearing tank directly into a four-foot diameter hauling tank that is affixed to the bed of a ¾ ton pickup truck. Approximately 12 liters minute^{-1} of oxygen is released into the approximately 150 gallons of hauling water via an air stone. Upon arrival at the stocking site, temperature of the hauling water and river are assessed. River water is bucketed into the hauling water to gradually equilibrate the temperatures. Larval shad are then released into the river by draining the hauling tank through a hose attached to the bottom drain of the tank. Several five-gallon buckets of river water are poured through the tank to rinse any remaining larvae into the river. In 2001, no larval shad were intentionally released into the outdoor hatchery ponds for the production of fingerlings.

[4] Meinz, Michael, 1978. Improved method for collecting and transporting young American shad. The Progressive Fish-Culturist. 40(4):150-151.

HATCHERY EVALUATION

Since all young-of-year shad released from the hatchery are marked with OTC, DMR is able to assess the relative contribution of hatchery-reared shad to the Kennebec River shad population. Starting in 2000, adult and young-of-year shad collected in the Kennebec were kept for OTC mark analysis. No adult shad were intentionally killed for this study; rather, mortalities from the hatchery were kept and analyzed. Young-of-year shad were collected during biweekly beach seine surveys (see *Community Assessment Methods* in this report for complete details on capture sites and techniques). Otoliths were removed, cleaned in distilled water, and mounted in a thermoplastic resin. Lapping film (9, 3, and 1 micron grit) was used to grind each otolith to mid-saggital plane on one side; otoliths were then flipped over and ground to mid-saggital plane on the opposite side. A drop of Type FF (low fluorescing) immersion oil was placed on each ground otolith and covered with a glass cover slip. Otoliths were then viewed under a compound microscope equipped with fluorescent light and a FITC filter set. With this microscope configuration, any fish marked with OTC would exhibit a glowing ring for the day that fish was marked.

Since 1979, DMR has conducted beach seine surveys in the Kennebec River from Augusta south to Bath. The information gathered in these surveys was used to calculate a Juvenile Abundance Index (JAI) for young-of-year shad, alewives, blueback herring, and striped bass. Starting in 2000, DMR began conducting similar beach seine surveys in the Kennebec River north of Augusta, upstream to Waterville/Winslow. Based on the information gathered during these surveys, DMR has begun to calculate a second JAI for this newly reopened stretch of river.

AMERICAN SHAD RESTORATION RESULTS & DISCUSSION:

ADULT CAPTURE AND TRANSPORT

No broodstock American shad were transferred directly to the Kennebec River from the Essex fish lift in 2001. However, three trips were made to the Merrimack River to obtain broodstock for the Waldoboro Hatchery between May 28 and June 14 (see Table 8). Of the 175 shad loaded at the Essex lift, 164 were released alive in the adult spawning tank, resulting in a hauling mortality of 6.3%, about 2% lower than the 2000 hauling mortality rate from the Connecticut River to the Waldoboro Shad Hatchery. Broodstock shad for tank spawning were also obtained from FPLE's Cataract fish lift on the Saco River. Between June 1 and July 21, seven trips were made to the Cataract lift to collect 276 adult shad. Of the 276 shad loaded alive, only two died en route to the hatchery (Table 8).

Between May 13 and June 18, a total of 17 adult American shad broodstock were captured at or near the tailrace of the Fort Halifax Dam; 13 of these were transported to the hatchery, two were released back to the river alive, and two died shortly after capture. Shad could be observed sporadically from the upper power canal deck works, situated some 25 feet above the tailrace. Small schools of shad (6-15 individuals) could be seen on some bright, sunlit days entering the tailrace of the project. The shad would linger for a brief period of time below the project and then move back downstream out of the tailrace. It is unknown how many entered the Sebasticook River or what percentage were repeat sightings of the same school. Qualitatively, fewer shad were observed below the Fort Halifax Project in 2001 than in 2000. However, angler reports indicate larger schools of shad were present in the Fort Halifax tailrace at night.

While several methods of capture were attempted (fish pump, gill net, electrofishing, hook and line), hook and line was the most successful method. The shad captured by the fish pump occurred on May 13. Since that day was one of the peak alewife pumping days, the shad was not observed entering the pump tank; it was discovered dead at the end of the day when the tank was drained. On June 4, two adult shad were angled and released. Angling was attempted by DMR and FPLE personnel several times throughout the month of June, but only resulted in ten additional shad captured. Electrofishing has been employed successfully in other states; however, only four fish were successfully captured in the Kennebec/Sebasticook electrofishing in 2001 (one of these fish died shortly thereafter). American shad have also been efficiently captured with gill nets in other states; however, only one shad was captured (on June 18) by gill net in the Kennebec River. To become more effective at capturing shad broodstock, old techniques need to be refined and/or new adult shad capture techniques need to be investigated.

There are several possible explanations for the poor catch rate of adult shad broodstock from the Sebasticook River. It is possible that due to the low number of larval shad released into the Sebasticook in 1996 and environmental conditions in June 2001 (high water temperature), the density of adult shad in the Sebasticook was relatively low. In 1996, only 320,000 larval shad were released into the Sebasticook River and 599,000 were released in the Kennebec River. Based on the average return rates observed by Pennsylvania for larvae released into the Susquehanna River[5], we would have expected only about 800 adult shad to return to the Sebasticook River and 1,490 to return to the Kennebec River (Σ=2,290 hatchery origin shad predicted to return to the Kennebec drainage). The number of larvae released into the Sebasticook and Kennebec Rivers increased in subsequent years; thus, predicted returns from hatchery stocking are higher for future years.

<u>LARVAL CULTURE AND TRANSPORT</u>

Between May 28 and July 21, DMR successfully transferred 452 adult American shad broodstock from Kennebec/Sebasticook, Saco, Androscoggin, and Merrimack Rivers to the Waldoboro Hatchery for tank spawning (Table 8). These shad were placed in a spawning tank and allowed to spawn over the next several weeks. The fertilized eggs were collected, disinfected, and placed in upwelling incubators. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp. On three separate days in late June and July, the surviving adult shad broodstock (288 fish) were released into the Medomak River (218) and the Kennebec River (70). For a complete description of 2001 shad hatchery operations, refer to Appendix A, *Waldoboro Shad Hatchery 2001 Annual Report.*

Between June 2 and August 3, an estimated 1,489,913 shad larvae ranging from 14-23 days old were released into the Kennebec River at two sites (Table 9). An estimated 535,059 shad fry were released into the Hydro Kennebec headpond at the Fairfield boat

[5] Hendricks, M. L. 2001. Analysis of adult American shad otoliths, 2000. *In St. Pierre, R., editor.* Restoration of American shad to the Susquehanna River. Annual Progress Report, 2000. Susquehanna River Anadromous Fisher Restoration Committee, Harrisburg, PA.

ramp. An estimated 954,854 shad larvae were released further upstream, just below the Shawmut Project. In addition, 618,879 larval shad were released into the Sebasticook River in the tailrace of the Benton Falls and Burnham Dams. While the 2,108,792 larvae released into the Kennebec drainage is above average (μ=1,575,200), it is the lowest number released since 1998 (2,073,000) (Figure 6). The number of larval shad released in 2001 is primarily due to the poor egg production of the Saco River adults transported to the Waldoboro Shad Hatchery (See *Waldoboro Shad Hatchery 2001 Annual Report*, Appendix A).

DMR viewed the Sebasticook River as the logical choice to receive some of the shad larvae in 2001 for several reasons. First, DMR sought to ensure that returning adult shad could be collected and used for future tank spawning egg take at the hatchery. Using broodstock collected from the Kennebec is preferred over continuing to collect broodstock from out-of-state. An upstream fish passage and trapping facility will be built at Fort Halifax in 2003 (or the dam removed) to support the burgeoning alosid restoration program on the Sebasticook River. After construction of such passage, the site becomes a natural place to trap returning broodstock shad imprinted with an upriver segment to fuel the hatchery egg take effort. Second, the lower hydroelectric dams on the Sebasticook River - Benton Falls and Fort Halifax - have installed permanent downstream passage facilities and conducted site studies relevant to alewife downstream passage. Finally, DMR chose that section of the Sebasticook below Burnham and above Benton Falls to receive the shad larvae due to the large amount of quality habitat available in this long river segment; DMR believes this area is highly productive and conducive to good shad growth.

No shad larvae were intentionally stocked into the three culture ponds at the hatchery in 2001. However, the runoff from the upwelling incubators drains into these ponds and typically some eggs/larvae were drawn out by the action of the incubators into the ponds. Since the number of larvae escaping to the ponds was unknown, the ponds were monitored and the larvae/juveniles fed accordingly. On September 10, the first two ponds were beach seined twice each and 6,718 fall fingerlings were loaded into two stocking trucks. One batch of fingerlings was released at the Augusta boat ramp and a smaller batch was released at the Hallowell boat ramp (Table 10). Overall, the hauling mortality rate was 0.7%. The number of fingerlings released in 2001 was lower than average (Figure 7), indicating either poor survival of young-of-year in the ponds or fewer egg/larval escapees.

HATCHERY EVALUATION

During the 2001 beach seine effort, 1,379 juvenile shad were captured at four different sites in 2001, with the highest number captured at Site 7 (Figure 9). As of the date of this report, all of the adult shad otolith samples had been examined, but only a few larval samples had been examined. Of the 12 adult shad captured in the Kennebec River in 2001, none were of hatchery origin. Of the examined samples of field-caught larval shad (about 90% of the samples have been evaluated), less than 10% are of hatchery origin. The remaining samples will be examined during the winter and a separate hatchery evaluation report drafted during the winter of 2002 - 2003.

A Juvenile Abundance Index was calculated for juvenile shad captured in 2001 (Table 11). The index for all sites was 19.15 (shad seine^{-1}), but for the three most downstream sites it was much higher. For the second year in a row, Site 7 had the highest index (JAI=87.75). Habitat suitability models indicate that larval shad prefer large eddies[6], one of which forms on the west side of Seven Mile Island and may explain why younger shad are found there. The models also suggest that juvenile shad may use slow, warmer areas of rivers for feeding, since there may be a higher abundance of plankton in these areas.

DMR also sampled the Fort Halifax and Hydro Kennebec headponds with beach seines and utilized bottom nets in Ticonic Bay to assess the presence of juvenile shad and shad eggs, respectively. While no young-of-year shad were captured in the headponds, 1,538 shad eggs were collected in Ticonic Bay. A sample of eggs was retained, hatched, and the larvae identified as shad to validate the egg identification.

FISH PASSAGE METHODS:

In 1997, the Federal Energy Regulatory Commission ordered the decommissioning and removal of the Edwards Dam. Subsequent to that order, state and federal fishery agencies, the KHDG, and nongovernmental agencies signed the *Lower Kennebec River Comprehensive Hydropower Settlement Accord*, which contained provisions for dam removal, fish passage requirements at upriver dams, and funds for fisheries restoration. Because an additional 17 miles of riverine habitat would be available to alewives and American shad when the Augusta dam was removed, the Settlement included a new timetable for fishways at the KHDG dams and called for interim trap-and-truck until the fishways were completed. Fishway construction at hydropower dams is the responsibility of dam owners; they bear all costs associated with fishway construction and operation.

FISH PASSAGE AT LAKE OUTLETS

Upstream passage

As part of the 'Agreement,' the State agreed to take the lead in seeking fish passage at four nonhydro dams on the Sebasticook River, which included the outlet dams on Pleasant Lake in Stetson, Plymouth Pond in Plymouth, Sebasticook Lake in Newport, and at the Guilford of Maine Dam (Figure 8). In the 1999 Annual Report, DMR proposed that passage be provided at these dams in 2001. The United States Fish and Wildlife Service (USF&WS) prepared conceptual designs and cost estimates for these sites; total estimated cost for passage at all four dams was $510,000 (1997 dollars).

DMR requested assistance for fishway construction from the US Army Corp of Engineers (ACORE) under Section 206. An initial site visit by representatives of the ACORE was made in December 1998 and a preliminary resource plan was prepared to seek approval for site feasibility studies prior to fishway construction. Under Section 206, the ACORE will fund 65% of the project cost, with the State funding the remaining 35%. If the total cost of the projects is $510,000 (as the USF&WS estimated), the State will need $178,500 to match ACORE. However, initial estimates by the ACORE indicate the total cost may be as high as $1,000,000, which is much greater than the USF&WS estimate.

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[6] Ross, R. M., T. W. H. Backman, and R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. U.S Fish and Wildlife Service Biological Report 14. 26pp.

In 1999, the Town of Stetson decided to rebuild the spillway of the Pleasant Lake outlet dam. DMR and the Town agreed it would be to everyone's benefit if a fishway were installed during spillway reconstruction. Since the ACORE could not undertake the fishway project in 1999, the Town and DMR sought alternative funding sources. The construction cost for the fishway, approximately $57,370, was completely funded by the Natural Resource Conservation Service (NRCS) ($39,734), the United States Fish & Wildlife Service ($15,000), and the Maine Department of Marine Resources ($2,635). Also in 1999, DMR and the Town of Stetson worked with the NRCS, American Rivers, and the USF&WS to remove the remnants of the Archer Sawmill Dam from Stetson Stream. This project included 1) removal and disposal of up to five concrete piers; 2) removal and disposal of up to 300 cubic yards of stone and dam debris; and 3) removal and disposal of up to 500 cubic yards of sawdust, logs, and associated debris upstream of the dam. The cost of this removal was completely funded by NRCS and the USF&WS.

The ACORE tentatively estimated that fishways at the three remaining projects might cost as much as $800,000 to $1,000,000 to build through its Section 206 program, requiring the State to come up with as much as $350,000 in match. The State initially set aside $178,500 in the Kennebec River Fisheries Restoration Fund; DMR sought and received additional money in the last Maine legislative session to cover the shortfall. In 2001, DMR recommended that participation in the Section 206 program for the other three projects be terminated. The earliest that fish passage could be built under the Section 206 Program would be in 2002. With the program's uncertainty in funding and the likely higher project costs, DMR sought alternative monies and contracted with the engineering and consulting firm URS to provide services, at least through final design, and assistance in obtaining all necessary permits for the three sites.

Downstream passage monitoring

Some lake outlet streams were surveyed during the 2001 field season. Due to tight constraints on available time in the field, only those streams known to be problems in the past were surveyed. This task is usually performed after the alewife and shad stocking seasons have ended. Generally, lake outlets are checked on the same schedule as hydropower facilities. Whenever possible, areas known to be past problems for outmigrant alosids were inspected and debris/blockages removed.

<u>FISH PASSAGE AT HYDROPOWER PROJECTS</u>

Passage effectiveness studies

Per section III (F) of the 'Agreement,' hydroelectric dam owners are required to conduct passage effectiveness studies. Specifically, the 'Agreement' states:

> "KHDG dam owners will conduct effectiveness studies of all newly constructed interim and permanent upstream and downstream fish passage facilities at project sites. <u>Study plans</u> for these effectiveness studies <u>will be filed</u> with FERC and Maine DEP <u>no later than the date on which passage at a particular project becomes operational</u>, and will be subject to a consultation process with, and written approval from the resource agencies."

DMR has been working with the hydro project owners/operators to develop and evaluate quantitative and qualitative effectiveness studies. As new passage becomes available, DMR will continue to work with hydro project owners/operators to ensure passage effectiveness.

Downstream passage monitoring
Downstream passage at hydropower facilities located on the Sebasticook and Kennebec Rivers were monitored through the summer and fall. Hydroelectric facilities were visited routinely to assess any problems that downstream migrating juveniles might encounter. The condition and operation of downstream bypass facilities, magnitude and location of spilled water, number of turbines in operation, and presence or absence of juvenile alewives at each facility were noted. The dam sites and their locations are presented in Table 12, while locations are illustrated in Figure 1.

Upstream passage
The owners of the Fort Halifax Dam are required to provide interim trapping of alewives and shad starting in 2000 in order to continue the interim trap and truck program; they are required to have operational a state-of-the art fish lift by May 1, 2003 or remove the dam. In 2000 and 2001, FPLE installed the fish pump formerly used to collect alewives at the Edwards Dam to serve as the required interim trapping facility. In 2001, FPLE submitted fish lift designs for agency review.

Upstream passages at the Benton Falls and Burnham Dams are required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and installation of permanent upstream fish passage at four upriver nonhydro dams: Pleasant Lake in Stetson, Plymouth Pond in Plymouth, and Sebasticook Lake and the Guilford of Maine Dam in Newport. In 2001, DMR contacted the owners/operators of the Benton Falls and Burnham Projects to inform them of the progress DMR was making towards the installation of fish passage at the aforementioned nonhydro dams. Later in 2001, fish passage designs were submitted for both facilities and are currently under agency review.

FISH PASSAGE RESULTS AND DISCUSSION:

FISH PASSAGE AT LAKE OUTLETS

Upstream passage
The Town of Plymouth (ME) owns the Plymouth Pond outlet dam. Upstream passage at this site would be affected through the use of two Alaskan steeppass fishways located on the north bank of Martin Stream. The Town of Plymouth has expressed concerns with the structural stability of the dam if it were modified with the installation of upstream fish passage and the amount of water required to operate the fishway throughout the migration season. Other concerns include a series of ledges below the site that may hinder natural upstream migration. The outlet of Plymouth Pond is divided into two distinct channels by a ledge projecting from the middle portion of the dam in a westerly direction. A channel will be cut into this ledge to allow fish in the south channel to pass to the north and access the fishways. DMR met with the Town at a special town meeting and subsequently obtained a mutually satisfactory Lease Agreement that would allow DMR to construct, maintain, and operate a fishway at this dam. The Plymouth Pond fishways are scheduled to be installed in the spring of 2002 once there is no threat of freezing temperatures. The aluminum Alaskan steepass fishway sections and associated

structures have been fabricated and are ready to be installed. The contract for installation has been awarded. Two fishways are being installed at this site: one in the dam and one at a small falls below the dam. It was discovered that a small section of the lower fishway was going to encroach on the property of a local phone company, so DMR had to secure a lease agreement with the company. By the time DMR secured the lease, nighttime temperatures were routinely below freezing, so it was decided to postpone installation until the spring of 2002. The construction bid came in slightly under the cost estimate. The total project cost is about $2000 over the original estimate because of a $4000 increase in engineering cost, which DMR has absorbed.

DMR has received $82,500, in funding for the Plymouth Pond Project, which includes $20,000 from the NOAA - Fish America Foundation; a $20,000 pledge from the National Fish and Wildlife Foundation's Maine Habitat Restoration Partnership grant administered by the USF&WS Gulf of Maine Project; and $42,500 from the Natural Resources Conservation Service (NRCS). The total cost of the project including engineering and construction management is $118,637.

The Town of Newport owns the Sebasticook Lake outlet dam. Built in the 1980s, the dam serves to maintain lake levels throughout the year. Upstream passage at this site will take the form of a pool and chute fishway on its eastern side. Concerns with fishway design included accessibility by the public for viewing, potential impacts on downstream bridge abutments, and maintaining minimum flow requirements in the fishway itself. DMR's approach to this project, with the design expertise of URS, was to fit the fishway into the existing abutment structure. It will be located on the east bank adjoining the town park, where the public will be able to view it. The pool and chute design will minimize the amount of water needed for effective upstream and downstream passage.

The Town of Newport also owns the 80-year-old Guilford Dam. The structure is in poor shape at best; Newport views it as a maintenance liability and has expressed a desire to remove it. However, the dam provides water for fire control at Guilford of Maine (GOM). Another issue facing removal is the Rt. 2 bridge immediately upstream of the site: there was concern regarding the potential for hydraulic damage to the bridge piers (footings) if the dam were removed. In 2001, DMR worked with the Town of Newport and GOM to provide an alternative supply of water for fire control; an existing water main was extended to the GOM property, which can be tied into when renovations of existing on-site fire control equipment are completed. The final designs for the dam removal project included a breach in the center of the dam and reduction of the height of the remaining structure to four feet. A partial breach was chosen because the remaining structure will reduce the risk of hydraulic damage to the Rt. 2 bridge piers.

In May 2001, the Guilford Dam headpond was drawn down to facilitate surveys of the Rt. 2 bridge structure and the substrate beneath the bridge piers. At that time, DMR and the Town of Newport decided it best to leave the gates at the dam open and the headpond drawn down. This would allow the headpond to revegetate over the course of the summer and thereby help stabilize the newly exposed soil. Stabilizing the riverbanks by natural means during the summer was desirable over artificial means at the time of dam removal, which was proposed for the fall of 2001.

All necessary permits have been secured for these projects and final designs have been completed. The Town of Newport solicited bids for these projects this last fall. The engineering estimate for these two projects was $241,720. The low bid came in at $327,410 or $85,690 over the estimate. In addition, the engineering cost for these two projects was $26,000 over budget. DMR paid for the engineering cost as well as the cost overrun. The Town of Newport, in consultation with DMR and NRCS, decided to reject the bids; it will solicit bids again in March or April 2002, with the hopes that better proposals will be received. The Guilford Dam removal can be done this summer. The fishway cannot be constructed until after Sebasticook Lake is drawn down, which usually occurs in early September.

Downstream passage monitoring

In 2001, lake outlets were surveyed after the alewife and shad stocking season ended to note any difficulties with downstream migration of both adult and juvenile alewives. The most notable hindrance to downstream passage in 2001 was lack of water. Starting in July, DMR personnel surveyed six lake outlets regularly through late October: Sebasticook Lake in Newport, Pleasant Pond in Stetson, Plymouth Pond in Plymouth, Wesserunsett Lake in Skowhegan, Unity Pond in Unity, and Webber Pond in Vassalboro (Table 13). The **Sebasticook Lake** outlet was checked on ten days due to extreme low water conditions on the Sebasticook River to ensure minimum flow requirements were being met. Downstream passage was available on nine of the ten site inspections. **Plymouth Pond** was checked on ten days from June 22 through October 22; passage was available on two of the ten site visits (only over the dam spillway). Fish passage installation should begin at Plymouth Pond in the spring of 2002. **Pleasant Pond** in Stetson was visited 11 times from June 22 through December 5. Of those 11 visits, downstream passage was available six times. The beaver/muskrat dam problems of 2000 did not return in 2001. On or around August 13, town personnel installed the gate and padlock in the entrance to the steeppass fishway. In mid-October, the gate at the dam was opened two inches to allow enough water to provide a safe zone of passage for the alewives to leave the pond. DMR personnel observed juvenile alewives above the dam on one visit. **Wesserunsett Lake** in Skowhegan was surveyed nine times from June 22 through October 24. The last six inspections revealed no downstream passage available due to low water conditions. Generally, Wesserunsett has had few problems with downstream passage as it is available throughout most of the season over the spillway. Wesserunsett YOY alewives tend to out-migrate small and early, as the lake is fairly oligotrophic in comparison with most ponds in the Sebasticook drainage. There is evidence that some juvenile alosids did manage to leave Wesserunsett Lake. Normandeau and FPLE personnel sampled YOY alewives at the UAH Kennebec and Lockwood facilities in Waterville on three occasions in July.

The three remaining Phase I lakes stocked with alewives in 2000 - Unity Pond in Unity, Webber Pond in Vassalboro, and Pattee Pond in Winslow - were checked occasionally for downstream passage throughout the field season. Unity Pond has no outlet dam, but excellent downstream passage into Twenty-five Mile Stream on all but the driest of years. **Unity Pond** outlet was checked eight times from August 1 through December 5; passage was available on six of the visits. **Webber Pond**, like Sebasticook Lake, also uses a fall water quality drawdown and usually has sufficient water to allow passage over the spillway throughout the season. On five visits to Webber Pond, passage was available three times. **Pattee Pond** has no outlet dam and in the past, has demonstrated fair to excellent out-migration of alewives. The low water levels during the summer and early fall of 2001, however, made passage out of Pattee Pond difficult, if not impossible.

FISH PASSAGE AT HYDROPOWER PROJECTS

Passage effectiveness studies

To date, downstream passage effectiveness studies have been conducted at Benton Falls (1995) and Fort Halifax (1997). In addition, qualitative assessments are being recorded at the interim downstream passage facilities at Lockwood and Shawmut. At Hydro Kennebec, qualitative observations are being conducted to assess whether or not passing out-migrant alosids through the turbines has an impact on their survival. If the owners of Hydro Kennebec desire to utilize turbine passage once adult shad or salmon begin to inhabit the Hydro Kennebec impoundment, they will be required to conduct site specific quantitative studies, but not before 2006. At CHI-Burnham, permanent downstream passage was installed ahead of schedule. However, since CHI is choosing to pass less than the anticipated minimum bypass flow, the downstream bypass is considered an interim facility. As such, CHI is conducting qualitative studies in accordance with the 'Agreement'.

Downstream passage monitoring

In 2001, DMR made frequent site visits to hydro projects on the Sebasticook and Kennebec Rivers. At each project, observations concerning availability of downstream passage and presence/absence of juvenile alosids were noted (Table 13).

The **Fort Halifax Project** in Winslow is operated by FPL Energy and is the lowermost dam on the Sebasticook River. FPL Energy installed permanent downstream bypass facilities during the summer and fall of 1993. The permanent bypass uses the same trash sluice opening that was used in past years for the interim facility. The old trash sluice was refitted with a weir gate to control depth of flow at the entrance of the downstream bypass. The downstream side of the opening was fitted with a metal trough with an open top to carry water and fish down close to the tailrace elevation. A 12-foot deep metal punch plate trash rack overlay was installed to aid in excluding alewives from the turbine forebays. This configuration and operational regime was approved by the FERC Order issued on September 30, 1996 and was utilized again during the 2001 season.

DMR made ten visits to the Fort Halifax Dam in 2001. All visits found the downstream bypass open and functioning. Due to the events surrounding 9/11, access to the powerhouse for observations was limited to when FPLE personnel were present. Observations of the downstream bypass operation were made from the south shore when access to the powerhouse was not available.

As in 2000, high spring flows overtopped the spillway along the south side of the dam allowing water to flow onto the ledge below. This caused many hundreds of alewives to be attracted to the south side of the river and up into the pools that had formed on the ledge immediately below the dam. FPLE, DMR, and Normandeau personnel constructed a barrier of sandbags and rocks to block the alewives' access to the ledge area. Alewives were actively removed from this location to prevent their stranding when water levels dropped to below flashboard height.

The **Benton Falls** Project is equipped with permanent downstream passage facilities that have been on line since 1988. The bypass at Benton Falls consists of two surface weirs, one located above each turbine intake, which interconnect and discharge into the tailrace through a large diameter pipe. Water flow into each weir is regulated by a gate that can be lowered to allow controlled surface spill into the weir. After passing over this gate, fish become committed to the bypass and cannot reenter the headpond. The large turbine weir intake is open throughout the migration period and the small turbine weir intake is typically closed.

DMR personnel observed the Benton Falls downstream passage during 12 visits in 2001, beginning June 25 and ending October 26. The bypass was open and operating during all of the site visits except May 4. American shad fry were stocked in the river above Benton Falls during the summer of 2001, as in years past. On four visits, DMR personnel observed young-of-year alosids above the site. On two visits, YOY alosids were actively using the downstream passage facilities. Both entrances to the downstream bypass remained open throughout the season. There were no problems associated with debris from the headpond plugging the bypass entrances.

In past years, downstream passage at **Burnham Dam** had been accomplished by notching the flashboard closest to the intake structure. Under the KHDG Agreement, the Burnham Project was required to install an interim bypass facility by 1998. Instead, CHI opted to install a permanent facility, which was operational by the end of the juvenile alewife out-migration in 1999. In addition, the existing trash racks would be screened with an expanded metal overlay, similar to the one in use at Fort Halifax. The overlay would serve to aid in physically excluding fish from the wide-spaced trash rack and thus, prevent their entrainment into the penstock.

In an April 1999 letter, CHI indicated that it would operate the downstream bypass at 20 cfs until a FERC license was issued, at which time the bypass flow would be seasonally adjusted between 125 and 225 cfs. During subsequent consultation, both DMR and USF&WS recommended higher interim bypass flows, but agreed to allow CHI to operate at 20 cfs. The agreement to operate at 20 cfs carried the condition that if a fish kill took place at Burnham, then CHI would either increase bypass flow or shut down the turbines during alewife migration.

DMR personnel made 13 visits to the Burnham Dam in 2001. All inspections found the downstream bypass open and operational. However, on two occasions dead alosids were found below the project. On Monday, September 24, CHI personnel contacted DMR to report that alewives were entrained through the project on the evening of Sunday, September 23. CHI reported that at the time of the incident the downstream bypass was open to 125 cfs and two turbines were operating, one at 100% and one at 75%. CHI also reported that an especially heavy run of alewives was seen passing the project at the time of the incident and that the number of juveniles entrained was relatively small compared to the thousands safely passing downstream through the bypass facility. To prevent further entrainment, on the evening of September 23 CHI reduced operation to one turbine at 100%. No further entrainment was observed by CHI or DMR personnel on September 23 or 24.

On October 22, DMR personnel observed hundreds of dead alosids in the project tailrace. Due to the nature of the injuries to these fish (e.g., lacerations), it was apparent that the source of mortality was the turbine. On October 23, CHI reported that it would cease generation until this large school of juveniles had safely passed the project. In subsequent days, no further entrainment was reported or observed.

In 2001, downstream passage at the **Pioneer Dam** in Pittsfield consisted of passage over the stop log weir crest of the downstream bypass (located near the trash racks, with its associated concrete work and wood bypass trough) or passage via intermittent spills over the crest of the spillway. In an attempt to comply with the requirement to reduce trash rack spacing to one inch from June 15 to November 30, the owner of the project installed a metal mesh screen over the turbine intake trash racks. However, the overlay does not fit securely and oftentimes has gaps. The biggest problem with the mesh overlay is that it clogs very rapidly when a turbine is operational; water then flows under the six-foot depth of the overlay and alewives are likely to be drawn in the same direction. Cleaning the overlay appears to be another major shortcoming of the materials and design used. Of the ten site visits conducted by DMR in 2001, observations indicated that downstream passage through the bypass was available at all times. No juvenile alewives were observed using the downstream passage facilities on any visit.

DMR visited the **Waverly Avenue Dam** on ten occasions during the 2001 season. Downstream passage was available at the site on all visits. Problems encountered during the 2001 season at Waverly Avenue were similar to those of previous seasons. First, gate leakage at the stop log bays on the far side of the spillway remained a problem; this leakage causes downstream migrants to be attracted away from the bypass during low flow conditions. Second, the bypass itself frequently collects debris and loses its effectiveness with this fouling. DMR personnel observed YOY alewives in the Waverly Avenue headpond three times during the 2001 season. Additionally, young-of-year alewives were observed once in the project tailrace.

DMR visited both the **Lockwood** and **Hydro Kennebec Dams** as often as possible in 2001. Both of these projects are located on the Kennebec River and must pass all downstream migrant alewives from the Wesserunsett Lake alewife restoration effort. Additionally, most of the larval shad released into the Kennebec River are released above both Lockwood and Hydro Kennebec. During the 2001 season, interim downstream passage at Lockwood was made available through the power canal trash sluice, which is located near the turbine trash racks. Interim downstream passage at Hydro Kennebec is achieved by passing out-migrants through the project turbines. DMR personnel observed juvenile alosids in the Lockwood Project forebay on one occasion, but never observed out-migrant alosids at Hydro Kennebec.

Upstream passage

In 2001, upstream passage design plans for Fort Halifax, Benton Falls, and Burnham were submitted to the agencies for review. DMR personnel reviewed preliminary and functional designs for a fish lift to be installed at Fort Halifax. Currently, FPLE is working on final designs, as well as investigating the possibility of removing the project. DMR personnel reviewed functional designs for both Benton Falls and Burnham. At both projects, proposed passages consist of four-foot wide denil fish ladders. DMR will continue to consult with representatives from each hydro project to ensure that effective fish passage becomes available per the 'Agreement.'

FISH COMMUNITY ASSESSMENT:

With the removal of the Edwards Dam in 1999, approximately 17 miles of Kennebec River habitat was reopened for the first time since the dam was built 162 years ago. The benefits of dam removal will be substantial for the fish and wildlife populations as well as the local communities. Native anadromous fishes can now use the river above Augusta as spawning and nursery grounds. Immediately following the removal of the dam, striped bass and sturgeon were observed in Winslow.

It is the intent of this investigation to document the presence and spawning activity of anadromous fish species (e.g., American shad, blueback herring, and rainbow smelt) in this newly reopened stretch of river. This data will be useful to examine the impact current restoration programs are having on Kennebec River stocks of anadromous fish. Additionally, habitat information will be collected at each fish sample site. Data will be used to document changes in habitat types over time and determine how these changes will benefit anadromous fish.

FISH COMMUNITY ASSESSMENT METHODS:

SITES

In June 2000, Kennebec River Project personnel surveyed the 17-mile stretch of the Kennebec River from the Fort Halifax and Lockwood Dams downstream to the former Edwards Dam site. The objective of this survey was to locate potential sampling sites for the deployment of beach seines and other sampling gear. Several factors led to the selection of sites. Some areas in this segment of the Kennebec are too deep to sample with conventional seines. Currents in the Kennebec can be quite powerful, so areas with high currents, such as rapids and rips, were avoided for personnel safety. Obstructions such as ledge, logs, and boulders render potential sites unsuitable for seining and fyke net deployment. Generally, sites with even, regular bottoms were chosen. A total of eight sites were sampled between Waterville and Augusta. Once selected, each site was sampled biweekly from June/July (immediately following alewife/shad stocking) until October.

BIOLOGICAL SAMPLING

A 17-foot johnboat equipped with a jet drive was used to access all of the sampling sites; shallow water depths in many areas of the river make the jet drive a necessity. At sites where water depth exceeded the ability to wade, the johnboat was used to deploy an 8' x 150' x 3/8" delta mesh net with an 8' x 8' x 8' x ¼" delta mesh bag seine. The bag was used to better capture and, more importantly, retain the items sampled by eliminating the gap between the net and river bottom at the vertex of the seine as it was hauled. The beach seine would be flaked onto the bow of the boat. Having landed at the survey site, a crewmember would debark and hold one end of the beach seine. The boat would then be backed out into the river and continue until approximately 2/3 of the net had been deployed. At this point, the boat would back towards shore. As the boat reached wading depth, a crewmember would debark, taking the other end of the net to shore where the haul would be completed.

In order to best understand the structure of the fish community present, every species of fish (diadromous and resident) was examined. Total number of fish caught was assessed, as was number per species. Total length was assessed to the nearest millimeter for up to 100 diadromous fish per species and up to 50 per resident species. If American shad were captured, a random sample of 20 was placed on ice and brought back to the DMR office in Hallowell for otolith work (see **AMERICAN SHAD RESTORATION** section of this report).

PHYSICAL DATA COLLECTED

Over the coming years, it is expected that some of the physical characteristics of the river will change (i.e., depth, substrate composition, and temperature). To monitor how these changes may impact fish community assemblages, Kennebec Project personnel will measure physical parameters at each sample site annually. Data concerning river discharge will be obtained from USGS gauging stations.

During August - October, a more detailed investigation of site physical characteristics was conducted. In 2000, transects were constructed at each sample site perpendicular to river flow and extended from one bank to the other. At each site, starting on one bank of the river, a linear measurement was taken of the riparian zone from the water's edge to the beginning of the understory/vegetation. Notes were taken that reflected erosion levels, riparian vegetation cover, and erosion levels caused by human activity, if any. A weight with a 12-meter line attached was then cast perpendicular to the river's flow towards the far bank; where the weight landed was the transect station. Measurements of flow, dissolved oxygen, and temperature were taken with a Marsh-McBirney Model 2000 Portable Flow Meter and a YSI Model 55 Dissolved Oxygen Meter, respectively. The probes of these two instruments were attached to a staff with one-foot incremental checks. Measurements at each station were repeated for surface, middle, and bottom depths if the depth exceeded 1.5 meters (five feet). If the depth was less than 1.5 meters, then one measurement of flow, temperature, and dissolved oxygen was taken in the middle of the water column. Substrate composition (if visible), as well as aquatic vegetation coverage, was also noted. This process continued until the far shore was reached, when another measurement of the linear depth of the riparian zone was taken, along with notes on erosion levels.

DATA ANALYSIS

Comparisons of species compositions will be assessed both within years between sites and among years between sites, when the data becomes available. The data can be incorporated into an Index of Biotic Integrity (IBI). IBI models have been successfully utilized by many mid-west states as a way to measure a river's health. Some states in the northeast have developed IBI models, but the results are inconsistent. Even though the models have not been perfected, an IBI should be able to highlight any changes that are occurring in the river. Additionally, the data collected on larval and juvenile shad will be used to evaluate the shad hatchery program and the success of the restoration program in general (see the **AMERICAN SHAD RESTORATION** section of this report for more details).

FISH COMMUNITY ASSESSMENT RESULTS AND DISCUSSION:

Seining surveys for the 2001 season commenced on July 9. A total of 21 sites were tried throughout the 2000 field season. Many of them were seined only once and found to have various obstructions such as large cobble, logs, and ledge. In 2001, eight of the original 21 sites were regularly seined (Figure 9). Site #2a continued to be fouled with pulp logs and debris, so it was dropped from the regular schedule.

On June 15, gill netting operations commenced in Ticonic Bay to capture shad brood-stock for the Waldoboro Shad Hatchery. In the late evening of June 18, while putting gear away, KHDG personnel noticed a commotion caused by fish near the tail end of Ticonic Bay. The fish were thought to be American shad actively spawning. Gill netting efforts resulted in the capture of only one shad. On June 19, a D-net was set near the east shore to capture any eggs that the shad may have released during the spawn. A second D-net was set below Fort Halifax Dam, but failed to capture any eggs. The D-nets were set in relatively shallow water (<1m) at a gravel bar that forms the southern portion of Ticonic Bay. Here, the water has to well up before spilling into a gentle riffle just 120m above the confluence of the Kennebec and Sebasticook Rivers. The D-nets caught 1,537 viable shad eggs: 1,500 on the night of June 25. The eggs were incubated and hatched at the office to confirm species.

A total of 80 seine hauls were made during the community assessment survey on the Kennebec River. A total of 40,498 fish were captured and identified as to species. Of those captured and identified, total length was assessed for 3,625 fish. Fish of questionable identity were placed on ice for later identification. For a breakdown of diadromous fish captured by site, refer to Table 15.

On October 3 and 4, transects of the Kennebec and Sebasticook Rivers were taken. General observations of the dewatered Edwards impoundment are encouraging. Areas in 2000 that exhibited high levels of erosion are now mostly covered by vegetation. Bank slumping was most prevalent where the headpond was deepest. These slumping areas have not worsened and again, many species of plants have helped stabilize the exposed banks. Aquatic plants are more numerous in the once deeper regions of the headpond.

AMERICAN EEL:

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord* requires that KHDG dam owners and DMR, in consultation with NMFS and USF&WS, and subject to approval by FERC, undertake a three-year research project to determine: 1) the appropriate placement of upstream passage for American eel at each of the seven KHDG facilities based upon field observations of where eels are passing or attempting to pass upstream at each facility, and 2) appropriate permanent downstream fish passage measures, based on radio telemetry and other tracking mechanisms and field observations.

UPSTREAM PASSAGE

Introduction

The primary objective of this study was to determine where juvenile eels pass, or attempt to pass, upstream at each of the seven KHDG facilities. Secondary objectives were to determine the timing of the upstream migration, the magnitude of the migration, and the size distribution of the migrants.

Methods

In 2001, upstream passages were installed at the Fort Halifax and Benton Falls Projects, and nighttime visual observations were made at the remaining five KHDG projects. At Fort Halifax, the full-length passage used in 2000 was reinstalled in 2001. At Benton Falls, a portable passage was initially installed at the east end of the spillway, but was too small to accommodate the large number of eels attempting to migrate upstream. After several weeks, it was replaced with a full-length passage that was designed and constructed by Stacy Fitts, operator of the Benton Falls Project, and DMR personnel. The passage consisted of two 66-inch long entrance ramps angled at 47°, a level transition platform, a 36-foot long ramp angled at 39°, and a 12-foot long ramp angled at 4° that emptied into a holding pen. The entrance ramps and platform were constructed of ¼-inch marine plywood, but the rest of the passage was made of 1.5-foot wide aluminum cable tray with plywood screwed to the cross braces. Climbing substrate (Enkamat 7220 flatback) was stapled to the plywood.

At each of the remaining five projects, DMR personnel conducted nighttime visual observations on foot or by canoe to determine where eels were passing or attempting to pass upstream. The locations of eel concentrations were noted, an estimate made of their number, and in most cases, a sample taken for total length measurements. However, at Hydro Kennebec a portable passage was used for several hours to obtain a sample of eels.

In general, the passages at Halifax and Benton Falls were operated five days per week and tended at least three days per week. If the number of eels captured at a project was less than 70, all eels were counted and total weight recorded. If catches exceeded 70, all eels were weighed and the number estimated from subsamples. Eels were released above each dam into the headpond after measurements were taken. Water temperature in the Halifax headpond at a depth of eight feet was recorded every six hours, and other environmental information was recorded when the passages were tended.

Results and Discussion

An estimated 224,373 migrating eels were passed at **Fort Halifax** in 2001, nearly triple the number passed in 2000 (Table 15). Approximately 90% of the eels moved upstream within a 30-day period (Figure 10A), similar to the pattern seen in 1999 and 2000. The size range of eels was similar to that of previous years (80-199cm total length) with a median of 110-114mm (Figure 11C).

Approximately 231,859 eels were passed at **Benton Falls,** more than six times the number passed in 2000 (Table 15). Approximately 86% of the eels migrated within a 30-day period (Figure 10B); this percentage probably would have been higher if the full-length passage had been available at the beginning of the season. The size range of eels was similar to previous years (85-270mm total length), with a median of 110-114mm (Figure 12C).

Burnham was visited at night on two occasions (Table 16). On June 21, approximately 16 eels were observed on the east side of the spillway, but many more were observed on its western side, below the two easternmost set of stop logs (Figures 13A, B). On July 5, many thousands were observed in this same location. Approximately 306 eels were captured by dip net; 60 were measured. Eels ranged from 101-160mm total length with a median of 125-129mm (Figure 14A.). DMR recommends installation of an eel passage at this location.

Nighttime observations were made at **Lockwood** on July 26, 2001 (Table 16). Most of the spillway is covered with a mat of wiry live vegetation and is wet due to varying degrees of flow over or under the flashboards. Near the abandoned fishway, a rocky outcrop with interconnecting pools rises from the main channel to just below the flashboards. Small numbers of eels were observed at various locations on either side of the rocky outcrop (Figures 15A, B), but none were seen on the east side of the spillway. Eels ranged from 85-232mm total length with a mode of 115-119mm (Figure 14B). Eels are probably able to climb the dam at a number of places, but may be concentrated near the abandoned fishway. Passage for eels is probably not needed at this project, but DMR intends to make additional observations at Lockwood to confirm this initial recommendation.

Two nighttime visits were made to the west side of the spillway at the **Hydro Kennebec** Project (Table 16). On July 5, eels were not seen prior to sunset. At 8:45 PM, eels began to move in the shallow water along the shoreline and 500–1000 were seen climbing the rock ledge along the dam base, moving westward toward the corner (Figures 16A, B). Eels were observed hiding under rocks at this same location during the day on August 8. None were observed attempting to climb the concrete dam at any other point. On August 13, a portable passage was installed and attraction water was started during the day on August 14. Approximately 265 eels were caught in eight hours, but thousands were congregated in the area. Eels ranged from 91-167mm total length with a median of 125-129mm (Figure 14C). DMR recommends installation of an eel passage at this location.

The **Shawmut** Project was visited twice (Table 16). On July 12, 12-20 eels were observed swimming in the upper pool below the easternmost side of the spillway (Figures 17A, B). A few eels were observed about three feet up the dam face in the corner, although there was about an inch of spill over the flashboards. No elvers were observed in the lower pools or actively climbing the lower rocks and rivulets or at any other location. On July 26, 2001, many eels were seen resting and hiding in a smaller pool below, but adjacent to the large pool where eels were observed on the previous date. No eels were observed in any other pools or were seen climbing at any other location. Approximately 50 eels dip netted from the pool ranged from 101-291mm total length, but most were greater than 170mm (Figure 14D). DMR recommends installation of an eel passage at this location. DMR intends to make additional observations at Shawmut to confirm this initial recommendation.

Nighttime observations were made at the south channel dam of the **Weston** Project on July 18, 2001 (Table 17). No eels were observed in the underpass and culvert system under Dexter Shoe. Although this stream system is dark and has ample water flow and an abundance of cover, no eels were seen resting, moving or climbing in this complex. Eels were observed actively climbing the southernmost section of the southern channel dam after 6PM; 10–12 were seen climbing ledge and rock at the base of the southern corner of the dam and along the base concrete of the two southernmost gate chambers (Figures 18A, B). No eels were observed at the bases of the dam gates, on the walls within the gate chambers, or in any of the pools, although turbulent water made it difficult to see into the pools. Six eels collected by dip net from the rocks ranged from 129-144mm total length. Only a few eels were seen on the south channel dam during a second visit on August 29, and no eels were seen on the north channel dam, which was inspected from above with lights. DMR recommends installation of an eel passage at the eastern side of the south channel dam. DMR intends to make additional observations at Weston to confirm this initial recommendation.

DOWNSTREAM MIGRATION

Introduction

The primary objectives of this study were to determine the seasonal and diel timing of the downstream migration of adult eels, the behavior of migrating adult eels at hydropower facilities, and the efficiency of various downstream passage measures for adult eels.

Methods

The study was conducted from October 10 through December 11 at the Benton Falls and Fort Halifax Projects on the Sebasticook River (Figure 1). The Benton Falls Project is located approximately 5.2 miles above Fort Halifax and the latter is located 1400 feet above the confluence of the Sebasticook and Kennebec Rivers. Eels used for study were obtained from a commercial eel harvester whose weir is located near the mouth of Twenty-five Mile Stream, which enters the Sebasticook approximately 14 miles above the Benton Falls Project.

Radio telemetry equipment was installed and calibrated at the two sites between August 20 and October 10. Three automated scanning receivers (Model SRX-400, Lotek Engineering, Newmarket, Ontario, Ca) were deployed at the Benton Falls Project and six (same model, provided by FPLE) at the Fort Halifax Project to record the passage of radio-tagged eels. Two types of antennas (6-element Yagi and "dropper") were used to monitor different areas at each project. Yagi antennas were deployed above the water surface, while dropper antennas (co-axial cable with distal 18" of insulation removed) were inserted inside braided nylon line or one-inch plastic pipe and deployed underwater. Each antenna was connected to a scanning receiver unless otherwise stated. In general, antennas were deployed and gain settings were adjusted so they would detect signals in a particular area with little overlap.

Deployment of antennas at Benton Falls in 2001 was the same as in 2000. One 6-element Yagi was used to monitor the turbine intake area and a second was used to monitor the headpond immediately above the spillway and gates; these two antennas were attached via a switcher to a single receiver. A third 6-element Yagi monitored the water immediately below the spillway and gates (spill and main channel). One dropper antenna was deployed in the drop-box of the downstream bypass and another was installed in the draft tube of the smaller turbine. The larger turbine was not operated due to low water; therefore, an antenna was not deployed in the tailrace.

Minor changes were made in the deployment of antennas at Fort Halifax on the basis of the 2000 results. One 6-element Yagi monitored an area from several hundred yards above the dam to the east side of the powerhouse. A second Yagi scanned the water immediately above and below the Obermeyer gate. One dropper was placed in each of the two turbine intakes and in each of the two draft tubes.

Only downstream migrating female eels were used in this study because their large size ($\geq$400mm) makes them particularly susceptible to turbine injury or mortality. Eels to be radio-tagged were removed from the weir and placed individually into a cooler containing a solution of Eugenol for 5-10 minutes to anaesthetize them. A small ventral incision was made approximately 1¾" anterior to the vent and a 16-gauge needle was inserted about ½" posterior to the incision. The radio tag was inserted into the incision and the tag antenna trailed from the body cavity through the small puncture left by the needle. The incision was sutured and treated with betadine. The coded radio tags (Model MCFT-3CM, Lotek Engineering, Newmarket, Ontario, Ca) were 11mm in diameter, 36mm long, weighed 5.9g in air and 2.6g in water, and had a typical operation life of 100 days. The tags emitted a coded signal every five seconds at 149.460 MHz.

Five eels were tagged at the weir site (Table 18) between 12:45 and 3:00PM on October 10, transported in aerated water, and released at 4:30PM upstream of the Route 139 Bridge in Benton. Additional eels were not tagged because the downstream migration of eels on Twenty-five Mile Stream ended, presumably due to extremely low flows.

Data from the scanning receivers usually were downloaded two or three times during the week and notes were made on the operating conditions at each of the two projects. Water temperature was measured and recorded six times a day at a depth of eight feet in the headpond at the Fort Halifax Project.

Results

Water flow in the Sebasticook River was low during the study as a result of few rain events through the late summer and fall. Instantaneous stream flow rarely exceeded the mean daily stream flow (based on 68 years of record for USGS gauge 01049000). Because of low flow, neither turbine at Fort Halifax nor the large turbine at Benton Falls was operated during the study period. Average daily water temperature in the river at Halifax ranged from 14.5 - 3.7°C during the study period. One rainfall event occurred on October 15, but did not noticeably increase flow.

Of the five eels released above Benton Falls, three did not pass the project (Table 19). One eel (#8) was never detected, one (#1) was detected a single time in the headpond 7.56 hours after release, and one (#9) was detected in the headpond 2.9 hours after release and sporadically for the next 67.28 hours. DMR personnel attempted to locate these eels on October 26 by boat using a data logger/receiver and directional loop antenna. The area from the safety floats to about one-half mile above the bridge was searched. One signal was detected in the headpond on the east side of the spillway, but recovery was not attempted.

The two remaining eels (#7, 10) were detected at the Benton Falls Dam 0.59-170.28 hours after being released (Table 19). The time from arrival to passage ranged from 5.53-29.0 hours. Both eels (40%) passed through the small turbine. DMR personnel attempted to recover these eels on five occasions (10/22, 10/26, 10/31, 11/2, and 12/7). An underwater camera revealed a deep hole below the tailrace that contained many portions of eel carcasses in various states of decay. It was apparent these eels had been killed by turbine blades. Although radio signals originated from this hole, the tags could not be recovered.

Migrating eels were more active during darkness in 2001 than in the previous year (Table 20; Figure 19). No contacts were made between 4AM and 2PM. The two eels that passed through the turbines at Benton Falls did so at 6PM and 10PM.

Discussion and Recommendations

Three of five eels (60%) did not pass Benton Falls and two (40%) passed through the turbine. We have strong evidence (videotape) that these two eels were killed. As in 2000, passage at Fort Halifax could not be evaluated because turbines were not running during the study. Based on two years of data, the surface bypass at Benton Falls is not efficient at passing eels. DMR will continue to evaluate downstream passage at KHDG Sebasticook River projects and will begin work at main stem projects starting in 2002.

<u>ATLANTIC SALMON RESTORATION:</u>

In 2001, field activities conducted by the Maine Atlantic Salmon Commission (MASC) staff consisted of the following: juvenile salmon population assessments, spawning surveys, habitat assessments, and temperature monitoring.

<u>ATLANTIC SALMON POPULATION MONITORING:</u>

The removal of the Edwards Dam in 1999 opened approximately 17 miles of the main stem Kennebec River from Augusta to Waterville/Winslow as a migratory corridor for the small numbers of mature Atlantic salmon returning to the Kennebec River. It is also now possible for Atlantic salmon to spawn in the main stem between Augusta and Waterville/ Winslow and in tributaries entering this main stem reach that do not have impassable barriers. Methods utilized to monitor spawning activity and success were redd counts and electrofishing.

<u>JUVENILE ATLANTIC SALMON ASSESSMENTS</u>

Methods

The MASC staff from the Sidney Regional Office sampled 11 sites in five tributaries below Waterville/Winslow (Bond Brook, Togus Stream, Sevenmile Brook, Messalonskee Stream, Eastern River) by electrofishing for the presence or absence of juvenile Atlantic salmon (Table 21). Additionally, four sites were sampled on the Sandy River to determine baseline species composition in the event that the MASC were to stock juvenile Atlantic salmon in the Sandy River as part of Phase II implementation of the 1997 management plan. All sites were evaluated using a single pass method with the exception of two sites, one on Bond Brook and one on the Sandy River, where a three-pass depletion method was used. All Atlantic salmon captured were sampled for length and weight, a scale sample taken for age determination, and a tissue biopsy taken for genetic analyses. All salmon were released alive.

Results and Discussion

Of the five lower Kennebec River tributaries sampled that are accessible to Atlantic salmon for spawning, juvenile Atlantic salmon were found only in Togus Stream and Bond Brook (Table 21). Nine Atlantic salmon were sampled in Togus Stream and four in Bond Brook. Small populations of Atlantic salmon have been found in both these locations in previous years and the 2001 results are consistent with prior surveys. The Atlantic salmon parr found in Bond Brook averaged 199mm in length and 85 grams in weight, whereas parr collected in Togus Stream averaged 148mm and 36 grams (Table 21). Unfortunately, due to poor scale quality, we were unable to determine the exact ages of all the Bond Brook parr. However, two were in their third summer of life (age 2+) and it appears that the other two may have been older. All of the Togus Stream parr were in their second summer of life (age 1+). The age difference most likely explains the size differences observed between the Bond Brook and Togus Stream parr.

Even though large salmonid redds, indicative of Atlantic salmon spawning, were observed in Messalonskee Stream in the fall of 2000, no young-of-year Atlantic salmon or other salmonids were captured during our surveys. Reasons for the inability to find salmonid fry from spawning in the fall of 2000 are unknown. However, turbidity, high flows, and the temperature regime observed in Messalonskee Stream during 2001 could have collectively or partially been detrimental to egg incubation and/or fry survival. For example, the failure of the Union Gas Project Dam on June 23, 2001, located immediately upstream of the section of river where redds were observed, led to excessive silting and high flows. Atlantic salmon, and other salmonids as well, are visual feeders and excessive silting may have been detrimental to the feeding process shortly after alevin emergence. Also, high flows may have swept the small, newly emerged young-of-year salmonids downstream into the main stem Kennebec. Furthermore, temperature recorders deployed in the vicinity of the observed redds recorded summer temperatures that reached extremes for salmonid thermal tolerance. Temperature regimes are described in more detail in the habitat assessment section below.

The potential exists for reintroduction of Atlantic salmon in the Kennebec River watershed above the Lockwood Dam, including the Sandy River. Therefore, it is important to determine which fish species may prey upon and/or compete with Atlantic salmon and currently occur in potential stocking locations. Fish species found during the baseline species composition study of the Sandy River included brook trout, brown trout, slimy sculpin, blacknose dace, stickleback, and creek chub. While not all of these species are indigenous to Maine, many are present in Maine's Atlantic salmon rivers.

SPAWNING SURVEYS

Methods

Redd counts were conducted on the main stem and tributaries of the Kennebec River between November 13 and December 5. The main stem survey encompassed the portion of river between Waterville and Sidney. Tributaries surveyed during this period included Bond Brook, Togus Stream, Sevenmile Brook, and Messalonskee Stream.

Results and Discussion

No redds were found even though adult salmon were reportedly observed in the Kennebec River below the Lockwood Dam in Waterville/Winslow. However, one large test pit was found on a gravel shoal just above the confluence of the Sebasticook River and Kennebec River. Even though survey crews didn't find any redds, spawning could still have taken place. The main stem Kennebec River is very large and difficult to survey. Even under ideal conditions, it is impossible to check all main stem spawning habitat. Additionally, surveys of the tributaries were conducted on foot, limiting surveys to known areas of potential spawning activity. It is possible that small, secluded patches of spawning habitat were not surveyed.

ATLANTIC SALMON HABITAT ASSESSMENT:

HABITAT SURVEYS

Methods

The MASC conducted habitat surveys on the main stem and tributaries of the Kennebec River to quantify adult salmon spawning and juvenile salmon rearing habitat in the basin. Surveys were conducted on the main stem from Waterville to Augusta as well as in the following tributaries: Messalonskee Stream, Sevenmile Brook, and Outlet Stream. Additionally, a section of the Sandy River from Smalls Falls to Phillips was surveyed.

Results and Discussion

The main stem of the Kennebec River contains 10,976 units (one unit = 100 m^2) of juvenile Atlantic salmon habitat, riffles and runs combined (Table 22); Messalonskee Stream contains 218 units; Outlet Stream, 410 units; and Sevenmile Brook, 104 units (Table 22). A partial survey of the Sandy River resulted in a total of 508 habitat units being identified. Surveys encompassed approximately 28 miles of riverine habitat.

TEMPERATURE MONITORING

Methods

Data loggers were deployed in Sevenmile Brook (Vassalboro), Messalonskee Stream (Waterville), Twenty-five Mile Stream (Burnham), Wesserunsett Stream (Cornville), Sandy River (Avon and Phillips), and Carrabassett River (Kingfield) to record summer river temperatures and to gain a better understanding of thermal regimes that may exist in streams with the potential for Atlantic salmon restoration. To aid in the analysis of the temperature regime for each stream, the maximum and minimum daily temperature over the summer months were graphed (Figure 20). All the loggers recorded temperatures for 136 days and were deployed on May 26th with the exception of the loggers placed in Sevenmile Brook and Messalonskee Stream. The Sevenmile Brook and Messalonskee Stream loggers were deployed on May 30th and recorded for 132 days.

Results and Discussion

Recorded temperatures for the six waters sampled indicated that Wesserunsett and Messalonskee Streams had the highest maximum daily temperatures during the summer months (June to August). Wesserunsett Stream had the highest recorded temperature at 32°C, as well as readings that exceeded 30°C for 11 days during the summer sampling period. Minimum daily temperatures ranged between 17°C and 20°C, but a peak minimum of 23°C was recorded during this time period. Messalonskee Stream never achieved the maximum temperatures observed in Wesserunsett Stream, but temperatures remained constantly warm throughout each day. Maximum temperatures were found to exceed 27°C for 22 days, while minimum temperatures were found to exceed 22°C for 43 of the 132 days the logger was deployed.

Both Wesserunsett and Messalonskee Streams exhibited temperatures in 2001 that are detrimental to Atlantic salmon survival. Temperatures above 30°C can be lethal for even very short periods of time (<2 hours). However, it is difficult to characterize the temperature profile of an entire river or stream system with only a single year of data collected at a single site. Additionally, the summer of 2001 was the driest summer on record in the 107 years that weather information has been kept, which could have exacerbated the temperature regime of both streams. It is also unknown where spring seeps that are beneficial to salmon survival are located in these streams.

Twenty-five Mile Stream and Sevenmile Brook approached temperatures observed in Messalonskee Stream, but with less frequency. Twenty-five Mile's maximum daily temperature was near 30°C and exceeded 27°C for 11 days; minimum daily temperatures were found to range between 16°C and 26°C. Sevenmile Brook hit 30°C for a maximum, but maintained temperatures between 22°C and 27°C for a majority of the sampling season. Minimum daily temperatures were similar to that found in Twenty-five Mile Stream, between 16°C and 26°C.

Both Twenty-five Mile Stream and Sevenmile Brook were very warm and are considered to be near the upper thermal extreme for Maine's Atlantic salmon rivers. However, it is possible for salmon to survive and grow in both streams depending upon the amounts and locations of spring seeps and the extent of diurnal cooling. It is necessary to record temperature in various locations over several years to aid in characterizing these streams' thermal profiles as tolerable for Atlantic salmon.

The Carrabassett River recorded a maximum temperature approaching 28°C, but the majority of the maximum daily temperature readings fell between 20°C and 25°C. Minimum daily temperatures ranged from 14°C to 20°C.

Single data loggers were deployed at two sites on the Sandy River, in Avon and Phillips. The Avon site approached 27°C for a maximum temperature, but daily readings fluctuated little, maintaining 20°C to 25°C for extremes. Minimum daily temperatures were frequently observed at 17°C, but did not exceed 19°C for a high minimum temperature. Overall, the coolest recorded temperatures found were in the Phillips section of the Sandy River. Daily maximums never exceeded 26°C and temperatures were consistently found in the 17°C to 22°C range. Daily minimums seldom went above 18°C, with a maximum daily minimum temperature recorded at 20°C. The Carrabassett and Sandy Rivers seem to be thermally favorable for Atlantic salmon production. Even though both rivers reached warm temperatures, the daily minimums were cool enough to have promoted growth even during the summer months.

TABLE 1. 2001 ALEWIFE STOCKING PLAN – PHASE I LAKES

PONDED AREA	LOCATION	RIVER SECTION	STOCKING GOAL[a]
Sebasticook River			
Douglas Pond	Pittsfield	West Branch	3,150
Lovejoy Pond	Albion	Main Stem	1,944
Pattee Pond	Winslow	Main Stem	4,272
Pleasant Pond	Stetson	East Branch	4,608
Plymouth Pond	Plymouth	East Branch	2,880
Sebasticook Lake	Newport	East Branch	25,728
Unity Pond	Unity	Main Stem	15,168
Kennebec River			
Three-cornered Pond	Augusta	Kennebec River	NS
Threemile Pond	China	Kennebec River	2,154[b]
Webber Pond	Vassalboro	Kennebec River	7,512
Wesserunsett Lake	Madison	Kennebec River	8,676
	TOTAL 2001 STOCKING GOAL:		**76,092**

a - Six adult alewives per lake surface acre unless otherwise noted
b - Two adult alewives per lake surface acre
NS - This lakes has never been stocked

TABLE 2. ALEWIFE TRAPPING AND DISTRIBUTION FROM FORT HALIFAX, SEBASTICOOK RIVER - 2001

	# OF ALEWIVES[a]					TRUCKING		
DATE	DIP NET	PUMPED	PUMP MORTALITIES	BIOLOGICAL SAMPLE	RELEASED ABOVE DAM	LOADED	MORTALITIES	RELEASED
5/7/01	50	0	0	50	0	0	0	0
5/8/01	0	2,514	40	0	0	2,474	45	2,429
5/9/01	0	5,205	30	0	0	5,175	83	5,092
5/10/01	0	9,151	59	0	0	9,092	1	9,091
5/11/01	0	15,923	51	50	0	15,822	7	15,815
5/12/01	0	13,194	35	0	0	13,159	69	13,090
5/13/01	0	18,891	78	50	0	18,763	721	18,042
5/14/01	0	18,896	79	0	1,624	17,193	2	17,191
5/15/01	0	12,178	72	50	1,802	10,254	10	10,244
5/16/01	0	11,407	86	0	996	10,325	2	10,323
5/17/01	0	10,702	65	0	352	10,285	2	10,283
5/18/01	0	6,376	74	0	0	6,302	0	6,302
5/21/01	0	1,206	118	0	568	520	1	519
5/22/01	0	6,016	87	50	750	5,129	2	5,127
5/23/01	0	4,411	132	0	722	3,557	1	3,556
5/24/01	0	3,334	71	0	0	3,263	16	3,247
5/29/01	50	0	0	50	0	0	0	0
6/5/01	50	0	0	50	0	0	0	0
6/7/01	0	2,016	57	50	0	1,909	3	1,906
6/12/01	0	3,647	73	50	3,524[b]	0	0	0
TOTALS:	**150**	**145,067**	**1,207[c]**	**450**	**10,338**	**133,222**	**965[d]**	**132,257**

a - Includes all alewives released, not just Phase I ponds
b - 13.6% blueback herring
c - Represents a 0.84% pump mortality
d - Represents a 0.72% trucking mortality

TABLE 3. 2001 ALEWIFE DISTRIBUTION IN KENNEBEC RIVER WATERSHED PHASE I LAKES

HABITAT AREA	SURFACE ACRES	STOCKING GOAL[a]	NUMBER RELEASED	NUMBER OF TRIPS	% OF TARGET # ACHIEVED	ALEWIVES PER ACRE
Douglas Pond	525	3,150	3,160	2	100	6.0
Lovejoy Pond	324	1,944	2,128	2	110	6.6
Pattee Pond	712	4,272	4,457	4	104	6.3
Pleasant Pond (Stetson)	768	4,608	4,610	3	100	6.0
Plymouth Pond	480	2,880	2,969	2	104	6.2
Sebasticook Lake	4,288	25,728	25,826	9	100	6.0
Threemile Pond	1,077	2,154[b]	2,254	1	105	2.1
Unity Pond	2,528	15,168	15,399	9	102	6.1
Webber Pond	1,252	7,512	7,618	5	102	6.1
Wesserunsett Lake	1,446	8,676	8,747	4	101	6.0
TOTALS:	**13,400**	**76,092**	**77,168**	**41**	**103**	

a - Six adult alewives per lake surface acre unless otherwise noted
b - Two adult alewives per lake surface acre

TABLE 4. 2001 ALEWIFE DISTRIBUTION BY TRIP IN KENNEBEC RIVER WATERSHED PHASE I LAKES

DATE	LOCATION[a]	NUMBER LOADED	NUMBER MORTS	NUMBER RELEASED
5/8/01	Lovejoy Pond	1,093	30	1,063
	Unity Pond	1,381	15	1,366
5/9/01	Unity Pond	1,303	1	1,302
	Sebasticook Lake	2,256	82	2,174
	Douglas Pond	1,616	0	1,616
5/10/01	Pattee Pond	502	1	501
	Pattee Pond	999	0	999
	Sebasticook Lake	3,021	0	3,021
	Stetson Pond	1,502	0	1,502
	Unity Pond	1,500	0	1,500
	Unity Pond	1,568	0	1,568
5/11/01	Plymouth Pond	1,446	0	1,446
	Sebasticook Lake	3,127	0	3,127
	Unity Pond	1,504	0	1,504
	Unity Pond	2,132	0	2,132
	Webber Pond	568	1	567
	Wesserunsett Lake	3,078	1	3,077
	Wesserunsett Lake	1,507	2	1,505
5/12/01	Sebasticook Lake	2,648	0	2,648
	Sebasticook Lake	3,061	0	3,061
	Sebasticook Lake	3,057	35	3,022
	Stetson Pond	1,510	0	1,510
	Webber Pond	1,370	0	1,370
	Wesserunsett Lake	1,513	34	1,479
5/13/01	Pattee Pond	1,446	2	1,444
	Sebasticook Lake	3,032	0	3,032
	Sebasticook Lake	3,111	1	3,110
	Sebasticook Lake	2,631	0	2,631
	Stetson Pond	1,599	1	1,598
	Unity Pond	1,500	0	1,500
	Unity Pond	1,515	0	1,515
	Webber Pond	1,647	0	1,647

(Continued next page)

5/14/01	Douglas Pond	1,544	0	1,544
	Lovejoy Pond	1,067	2	1,065
	Pattee Pond	1,513	0	1,513
	Plymouth Pond	1,523	0	1,523
	Unity Pond	3,012	0	3,012
	Webber Pond	3,080	0	3,080
	Webber Pond	954	0	954
	Wesserunsett Lake	2,686	0	2,686
5/17/01	Threemile Pond	2,254	0	2,254
Total Fish:		**77,376**	**208**	**77,168**
Total Days:	**8**			
Total Trips:	**41**			

TABLE 5. DISPOSITION OF KENNEBEC RIVER ALEWIVES DISTRIBUTED IN LOCATIONS OTHER THAN PHASE I LAKES – 2001

DRAINAGE	DATE	LOCATION	NUMBER LOADED	MORTALITIES	NUMBER RELEASED
KENNEBEC RIVER:	5/11/01	Pleasant Pond	1,701	1	1,700
	5/14/01	Pleasant Pond	1,814	0	1,814
	5/15/01	Martin Stream	500	10	490
	5/17/01	Adams Pond	501	0	501
	5/18/01	Whites Pond	460	0	460
	5/18/01	Whites Pond	448	0	448
	5/18/01	Whiskeag Creek	752	0	752
	5/24/01	Center Pond	507	0	507
	5/24/01	Nehumkeag Pond	1,042	6	1,036
	5/24/01	Sewell Pond	498	0	498
TOTAL:			**8,223**	**17**	**8,206**
ANDROSCOGGIN:	5/11/01	Sabattus Pond	759	2	757
	5/13/01	Sabattus Pond	818	7	811
	5/13/01	Sabattus Pond	710	710	0
	5/13/01	Sabattus Pond	754	0	754
	5/15/01	Sabattus Pond	3,036	0	3,036
	5/15/01	Sabattus Pond	2,547	0	2,547
	5/15/01	Sabattus Pond	1,271	0	1,271
	5/15/01	Sabattus River Launch	2,043	0	2,043
	5/16/01	Lower Range Pond	616	1	615
	5/17/01	Taylor Pond	856	0	856
	5/17/01	Taylor Pond	762	0	762
	5/17/01	Taylor Pond	956	1	955
	5/18/01	Taylor Pond	1,526	0	1,526
	5/22/01	Loon Pond	609	0	609
	5/22/01	Sabattus River Launch	936	1	935
	5/22/01	Sutherland Pond	758	0	758
TOTAL:			**18,957**	**722**	**18,235**

(Continued next page)

SHEEPSCOT:	5/15/01	Turner Mill Pond	857	0	857
	5/16/01	Branch Pond	2,095	0	2,095
	5/17/01	Savade Pond	291	0	291
	5/17/01	Travel Pond	612	0	612
	5/22/01	Sherman Lake	1,046	0	1,046
TOTAL:			**4,901**	**0**	**4,901**
EASTERN:	5/23/01	Dresden Bog	1,032	0	1,032
	5/23/01	Dresden Bog	1,025	1	1,024
TOTAL:			**2,057**	**1**	**2,056**
CATHANCE:	5/24/01	Bradley Pond	498	10	488
TOTAL:			**498**	**10**	**488**
PRESUMPSCOT:	5/16/01	Highland Lake	2,064	0	2,064
	5/16/01	Highland Lake	1,867	1	1,866
TOTAL:			**3,931**	**1**	
BAGADUCE:	5/24/01	Pierce Pond	718	0	718
TOTAL:			**718**	**0**	**718**
ST. GEORGE:	5/16/01	Sennebec Lake	1,569	0	1,569
	5/16/01	Sennebec Lake	1,583	0	1,583
	5/16/01	Seven Tree Pond	531	0	531
	5/17/01	South Pond	1,008	1	1,007
	5/23/01	Crawford Pond	1,500	0	1,500
TOTAL:			**6,191**	**1**	**6,190**

(Continued next page)

PEMAQUID:	5/18/01	Pemaquid River	2,049	0	2,049
	5/18/01	Duckpuddle Pond	1,067	0	1,067
	5/22/01	Pemaquid Pond	1,030	1	1,029
TOTAL:			**4,146**	**1**	**4,145**
ROYAL:	5/17/01	Royal River (Elm St. Bridge)	3,045	0	3,045
	5/21/01	Runaround Pond	520	1	519
TOTAL:			**3,565**	**1**	**3,564**
ALEWIFE BROOK:	6/7/01	Great Pond	809	3	806
TOTAL:			**809**	**3**	**806**
SEAL COVE:	6/7/01	Seal Cove Pond	1,100	0	1,100
TOTAL:			**1,100**	**0**	**1,100**
GRAND TOTAL:			**55,096**	**757**	**54,339**

TABLE 6. AGE DISTRIBUTION OF ADULT ALEWIVES COLLECTED AT FORT HALIFAX, 2001

SAMPLE / SEX	AGE 3		AGE 4		AGE 5		AGE 6		AGE 7		MEAN AGE	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
May 7	1	0	5	0	3	2	1	2	1	0	4.6	5.5
May 11	0	0	6	3	3	3	1	0	0	0	4.5	4.5
May 13	0	0	4	5	4	3	1	0	0	0	4.7	4.4
May 15	1	0	9	3	1	2	0	0	0	0	4	4.4
May 22	1	0	7	6	2	0	0	0	0	0	4.1	4
May 25	0	0	8	4	3	0	0	0	1	0	4.5	4
May 29	1	0	7	7	1	0	0	0	0	0	4	4
June 5	1	0	8	3	2	0	0	0	0	0	4.1	4
June 7	0	0	5	8	2	0	0	0	0	0	4.3	4
June 12	1	0	6	5	0	0	0	0	0	0	3.9	4
Σ=	**6**	**0**	**65**	**44**	**21**	**10**	**3**	**2**	**2**	**0**	**4.3**	**4.3**
% BY SEX	**6.2**	---	**67.0**	**78.6**	**21.6**	**17.8**	**3.1**	**3.6**	**2.1**	---		
% of Total	**3.9**	---	**42.5**	**28.8**	**13.7**	**6.5**	**2.0**	**1.3**	**1.3**	---		

TABLE 7. TRANSFERS OF AMERICAN SHAD BROODSTOCK, 2001

SOURCE RIVER:	TRAPPING SITE:	DATE:	NUMBER LOADED:	NUMBER MORTS:	NUMBER IN:
KENNEBEC/ SEBASTICOOK:	Various sites near Fort Halifax and below Lockwood	6/5/01	7	0	7
		6/6/01	1	0	1
		6/11/01	3	0	3
		6/12/01	1	0	1
		6/18/01	1	0	1
TOTAL:			**13**	**0**	**13**
SACO:	Cataract Lift	6/1/01	67	0	67
		6/6/01	22	0	22
		6/14/01	42	2	40
		6/19/01	81	0	81
		6/27/01	15	0	15
		6/29/01	31	0	31
		7/21/00	18	0	18
TOTAL:			**276**	**2**	**274**
ANDROSCOGGIN:	Brunswick Ladder	6/15/01	5	4	1
TOTAL:			**5**	**4**	**1**
MERRIMACK:	Essex Lift	5/28/01	52	0	52
		5/31/01	80	1	79
		6/14/01	43	10	33
TOTAL:			**175**	**11**	**164**
GRAND TOTAL:			**470**	**17**[a]	**452**

a – Represents a 3.6% trucking mortality

TABLE 8. LARVAL AMERICAN SHAD RELEASES, 2001

RIVER	DATE	EGG SOURCE	RELEASE SITE	NUMBER RELEASED
KENNEBEC:	07/02/01	Merrimack	Fairfield Boat Ramp	400,847
	07/30/01	Saco/Kennebec/Merrimack	Fairfield Boat Ramp	134,212
	07/03/01	Merrimack	Below Shawmut Dam	440,647
	07/05/01	Saco	Below Shawmut Dam	232,854
	07/12/01	Merrimack	Below Shawmut Dam	187,677
	08/03/01	Saco/Kennebec/Merrimack	Below Shawmut Dam	93,676
TOTAL:				**1,489,913**
SEBASTICOOK:	07/18/01	Saco/Kennebec/Merrimack	Below Benton Falls Dam	209,106
	07/03/01	Merrimack	Below Burnham Dam	409,773
TOTAL:				**618,879**
SACO:	06/21/01	Saco	Bar Mills	313,560
TOTAL:				**313,560**
ANDROSCOGGIN:	07/02/01	Merrimack	Lisbon	308,596
TOTAL:				**308,596**
GRAND TOTAL:				**2,730,948**

TABLE 9. AMERICAN SHAD FALL FINGERLING RELEASES, 2001

RIVER:	DATE:	RELEASE POINT:	NUMBER LOADED:	NUMBER MORTS:	NUMBER RELEASED:
KENNEBEC:	9/10/01	Augusta Boat Ramp	5,528	32	5,496
	9/10/01	Hallowell Boat Ramp	1,190	15	1,175
TOTAL:			**6,718**	**47***	**6,671**

*Trucking Mortality Rate=0.7%

TABLE 10. JUVENILE ABUNDANCE INDEX (JAI) FOR AMERICAN SHAD IN THE KENNEBEC RIVER ABOVE AUGUSTA

SITE*	2000	2001
1	0.12	0
2	0	0
3	0.67	0.3
4	0	0
5	2	56.2
7	29.43	87.75
8a	0.11	18.67
8b	0.13	0
ALL SITES:	4.6	19.15

* See Figure 9 for site locations

TABLE 11. HYDROELECTRIC FACILITIES MONITORED FOR DOWNSTREAM PASSAGE, 2001

DAM	FERC #	BODY OF WATER	TOWN
Waverly Avenue	4293	West Branch Sebasticook River	Pittsfield
Pioneer	8736	West Branch Sebasticook River	Pittsfield
Burnham	-----	Sebasticook River	Burnham
Benton Falls	5073	Sebasticook River	Benton
Fort Halifax	2552	Sebasticook River	Winslow
Lockwood	2574	Kennebec River	Waterville
Hydro Kennebec	2611	Kennebec River	Winslow

TABLE 12. DOWNSTREAM PASSAGE OBSERVATIONS AT LAKE OUTLETS, 2001

DATE	SEBASTICOOK LAKE	PLYMOUTH POND	UNITY POND	PLEASANT POND	PATTEE POND	WEBBER POND	THREE MILE POND	WESSERUNSETT LAKE
6/22	X	O		X				X
7/3	X	O		X				O
7/17	X	O		X				X
7/31	X[jl]	O[j]		X[*]				O
8/1			X					
8/13	O	O		O				O
8/14			X		X			
8/28	X	O		O				O
9/5			X[jl]			X		
9/11	X			O				O
9/13		O	X					
9/25	X	X	X	O				
9/26						X[laj]		
9/28								O
10/9	X	O[j]		X		O[l]		O
10/10			X				X	
10/22		O	O			O		
10/23				X[j]				
10/24	X						X	
12/5			X[*jal]	X	X	O		
Total Visits	**10**	**10**	**8**	**11**	**2**	**5**	**2**	**9**

X = Downstream passage available
= Not surveyed on this day
* = Dead alosids present below outlet

j = Juvenile alosids above outlet
a = Juvenile alosids using downstream passage facilities
l = Live alosids present below outlet

TABLE 13. DOWNSTREAM PASSAGE OBSERVATIONS AT HYDROELECTRIC FACILITIES, 2001

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly	Lockwood	Hydro Kennebec
6/22			X	X	X		
6/25	X	X				X	
7/3				X	X		
7/6						X	
7/10	X	X	X			X	
7/17	X	X	X	X	X	X	
7/31				X	X[l]		
8/1	X	X	X				X
8/13		X	X	X	X		
8/15	X					X[f]	X
8/28				X	X[f]		
8/30	X[f]	X	X				X
9/13	X[l]	X[fl]	X	X	X[f]	X	X
9/24		X[f]	X[falb*]				
9/25			X[al]	X	X		
9/27	X[f]	X[fa]				X	
10/9	X	X[fl]	X	X	X[f]	X	
10/12							X
10/22		X	X[*]				
10/23			X	X	X	X	
10/26	X	X[fal]	X[f]				
TOTAL:	10	12	13	10	10	9	5

X = Downstream passage available
= Not surveyed on this day
* = Dead alosids present in tailrace
b = Dead alosids in bypass reach
l = Live alosids present in tailrace
a = Juvenile alosids using downstream passage facilities
f = Juvenile alosids in turbine forebay

TABLE 14. DIADROMOUS FISH CAPTURED IN THE KENNEBEC RIVER, 2001

SITE 1	
Alewife	20,844
American eel	12
Blueback herring	98
TOTAL	**20,954**

SITE 2	
Alewife	3,285
Alosid sp.p.[1]	7
Blueback herring	13
TOTAL	**3,305**

SITE 3	
Alewife	397
Alosid sp.p.[1]	12
American eel	8
American shad	3
Blueback herring	1
TOTAL	**421**

SITE 4	
Alewife	2
American eel	4
TOTAL	**6**

SITE 5	
Alosid sp.p.[1]	4
American eel	1
American shad	506
TOTAL	**511**

SITE 7	
Alewife	39
Alosid sp.p.[1]	171
American eel	1
American shad	702
Blueback herring	41
TOTAL	**954**

SITE 8A	
Alewife	850
Alosid sp.p.[1]	130
American shad	168
Blueback herring	2
TOTAL	**1,150**

SITE 8B	
Alewife	42
American eel	3
Blueback herring	2
TOTAL	**47**

Sebasticook	
Alewife	109
Blueback herring	10
TOTAL	**119**

Taconic Bay	
American eel	5
Shad eggs	1,538
TOTAL	**1,543**

GRAND TOTAL **29,010**

TOTAL BY SPECIES	
Alewife	25,568
Shad eggs	1,538
American shad	1,379
Alosid sp.p.[1]	324
Blueback herring	167
American eel	34

1. Further laboratory analysis needed to determine species of larval samples.

TABLE 15. SUMMARY OF UPSTREAM EEL MIGRATION AT FORT HALIFAX AND BENTON FALLS PROJECTS, 1999-2001

	2001		2000		1999	
Project	Operation dates	Number of eels	Operation dates	Number of eels	Operation dates	Number of eels
Fort Halifax	5/26-8/24	224,373	6/21-7/28; 8/15-8/22	81,628	6/4-9/15	551,262
Benton Falls	6/6-8/24	231,859	6/29-7/28; 8/14-8/24	37,207	6/22-9/16	14,335

TABLE 16. SUMMARY OF VISUAL OBSERVATIONS AT FIVE PROJECTS

(observations were made at night unless otherwise noted)

Project	Observation 1	Observation 2	Observation 3
Burnham	6/21/01	7/5/01	
Lockwood	7/26/01		
Hydro Kennebec	7/3/01 day	7/5/01	8/8/01 day
Shawmut	7/12/01	7/26/01	
Weston	7/3/01 day	7/18/01	7/29/01

TABLE 17. SUMMARY OF THE TAG AND RELEASE DATE, SIZE OF TAGGED EELS, AND RELEASE LOCATION FOR THE 2001 TELEMETRY FIELD SEASON

Date tagged and released	Tag number	Eel total length (mm)	Release location
10/10	1	840	Benton Falls headpond, Rt 139 bridge
10/10	7	858	Benton Falls headpond, Rt 139 bridge
10/10	8	939	Benton Falls headpond, Rt 139 bridge
10/10	9	778	Benton Falls headpond, Rt 139 bridge
10/10	10	832	Benton Falls headpond, Rt 139 bridge

TABLE 18. TIME OF RELEASE, ARRIVAL, AND PASSAGE FOR RADIO-TAGGED SILVER EELS AT THE BENTON FALLS PROJECT DURING THE 2001 FIELD SEASON

	Release		Arrival at dam		Passage at dam				
Tag	Date	Time	Date	Time	Date	Time	Release to arrival (hr)	Arrival to passage (hr)	Route
1	10/10	1630	10/11	0003			7.56		Didn't pass
7	10/10	1630	10/10	1705	10/11	2205	0.59	29.00	turbine
8	10/10	1630							No contact; didn't pass
9	10/10	1630	10/10	1924			2.90		Didn't pass
10	10/10	1630	10/17	1847	10/18	0019	170.28	5.53	turbine

TABLE 19. TOTAL NUMBER OF CONTACTS AND NIGHTTIME CONTACTS MADE WITH RADIO-TAGGED SILVER EELS AT THE BENTON FALLS PROJECT DURING THE 2000 FIELD SEASON (IN = turbine intake; 6 UR = headpond above the gate and spillway; BY = bypass; 6 DR = channel below the gate and spillway; TR = tailrace)

	Number of contacts					Contacts during
Tag	IN	6 UR	BY	6 DR	TR	darkness
1	0	0	0	1	0	100%
7	44	22	1	9	7	99%
8	0	0	0	0	0	
9	12	6	0	0	0	72%
10	1	0	0	3	1	100%

TABLE 20. JUVENILE ATLANTIC SALMON ASSESSMENTS, KENNEBEC RIVER TRIBUTARIES, 2001

Date	Tributary	Sampling Location	Number of Salmon Parr	Ave. Fork Length (mm)	Ave. Weight (g)	Other Species Observed
8/20	Sandy River	Site 1: Below Small's Falls	0	-	-	Brook trout, blacknose dace, American eel, slimy sculpin, white sucker
8/20	Sandy River	Site 2: Reed's Mill Rd Bridge	0	-	-	Brook trout, blacknose dace, brown trout, slimy sculpin
8/21	Sandy River	Site 3: Madrid	0	-	-	Brook trout, blacknose dace, slimy sculpin
8/21	Sandy River	Site 4: Avon	0	-	-	Blacknose dace, brown trout, creek chub, stickleback, white sucker
8/22	Bond Brook	Site 1: Bond Bk Rd index site	1	209	85	Blacknose dace, brown trout, creek chub, common shiner, American eel, finescale dace, white sucker
8/22	Bond Brook	Site 2: Below mill site	3	196	85	Blacknose dace, creek chub, common shiner, American eel, finescale dace, white sucker
8/22	Bond Brook	Site 3: Behind baseball field	0	-	-	Brook trout, brown trout, creek chub, common shiner, finescale dace, white sucker
8/22	Bond Brook	Site 4: Below fishway	0	-	-	Blacknose dace, brown bullhead, creek chub, common shiner, American eel, finescale dace, golden shiner, pumpkinseed, smallmouth bass
8/23	Togus Stream	Site 1: Above Barber Rd	2	156	43	Blacknose dace, common shiner, American eel, pumpkinseed, smallmouth bass, white sucker
8/23	Togus Stream	Site 2: Barber Rd below deadwater	7	146	34	Blacknose dace, common shiner, fallfish, pumpkinseed, smallmouth bass
8/27	Messalonskee Str	Site 1: Main Island Channel	0	-	-	Common shiner, American eel, fallfish, golden shiner, largemouth bass, pumpkinseed, smallmouth bass, white sucker
8/27	Messalonskee Str	Site 2: Below Dam	0	-	-	American eel, fallfish, golden shiner, largemouth bass, pumpkinseed, white sucker, yellow perch
8/27	Sevenmile Brook	Site 1: Above Cushnoc Rd Bridge	0	-	-	Blacknose dace, American eel, fallfish, pumpkinseed, smallmouth bass, white sucker
8/27	Sevenmile Brook	Site 2: Below Cushnoc Rd Bridge	0	-	-	Blacknose dace, American eel, fallfish, pumpkinseed, smallmouth bass, white sucker
9/10	Eastern River	Site 1: Hunts Meadow Rd	0	-	-	Blacknose dace, creek chub, finescale dace, white sucker

TABLE 21. ATLANTIC SALMON HABITAT ASSESSMENTS, MAIN STEM KENNEBEC RIVER BELOW WATERVILLE AND SELECTED TRIBUTARIES, 2001

	Habitat Type and Units (unit=100m2)						
Section Surveyed	**Dead Water**	**Glide**	**Pool**	**Falls**	**Riffle**	**Run**	**Riffle+Run**
Kennebec River*	14,357	15,104	751	53	1,705	9,271	10,976
Messalonskee Stream	518	91	30	5	109	109	218
Outlet Stream	N/A	137	7	1	211	198	410
Sevenmile Brook	N/A	16	28	3	96	8	104
Sandy River**	0	65	48	55	480	28	508
Totals:	14,875	15,412	864	117	2,601	9,614	12,215

*Main stem Kennebec River from the Lockwood Project in Waterville to the head of tide in Augusta.

**Partial survey, Sandy River between Smalls Falls to Avon only.

FIGURE 1. KENNEBEC RIVER DRAINAGE - PHASE I LAKES

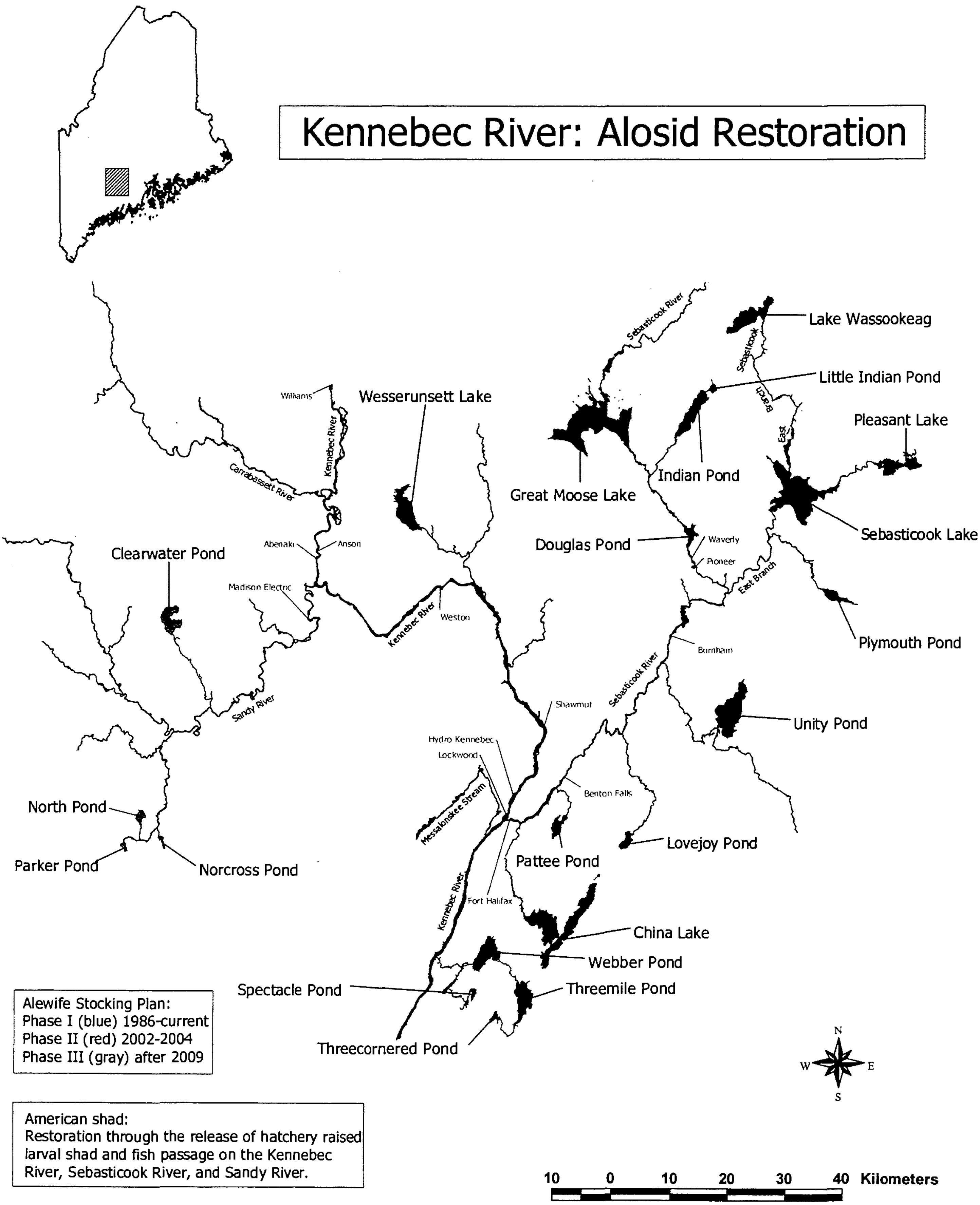


FIGURE 2. ALEWIVES CAPTURED AT FORT HALIFAX, 2001

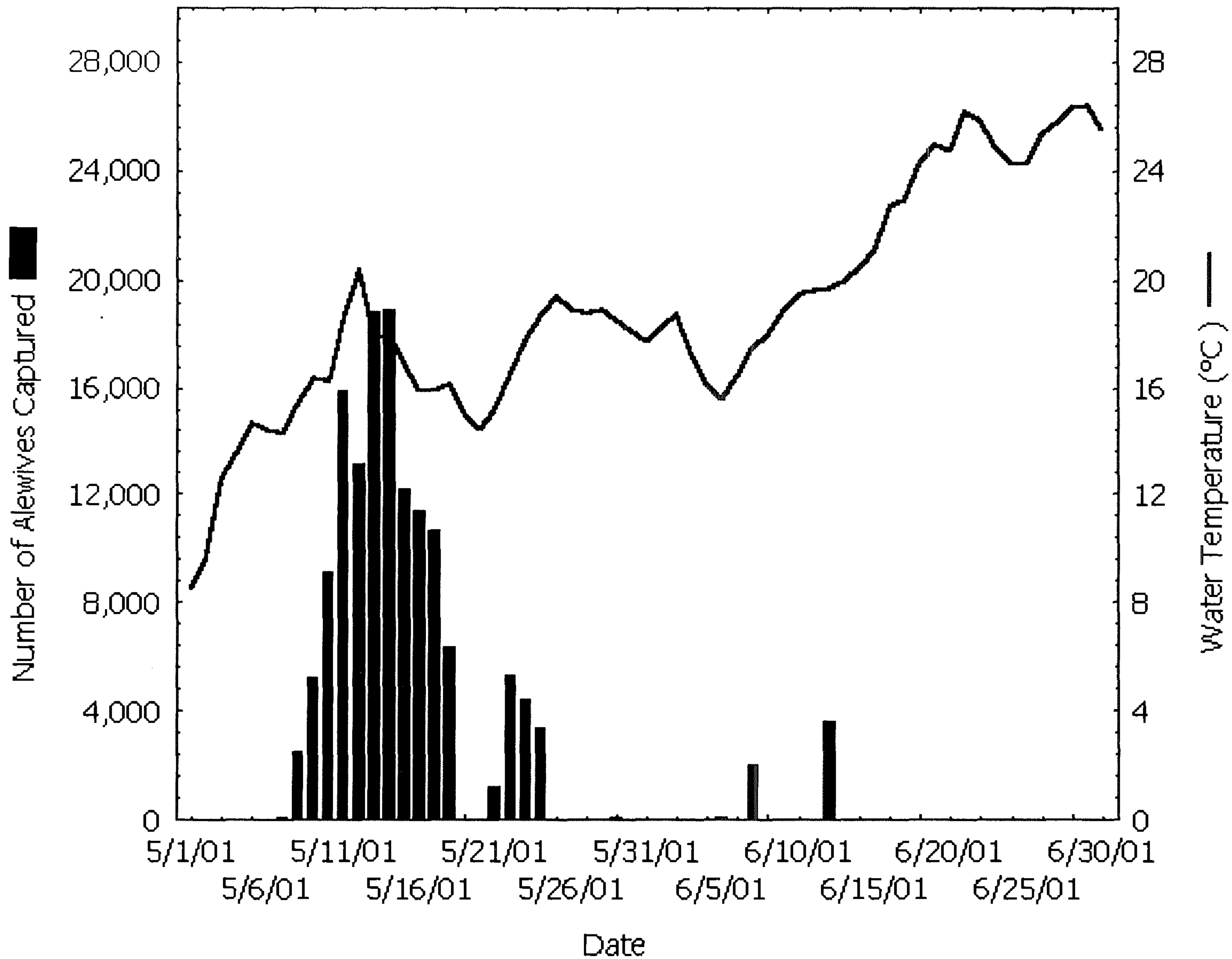


FIGURE 5. SEX RATIO OF ADULT ALEWIVES CAPTURED AT FORT HALIFAX, 2001

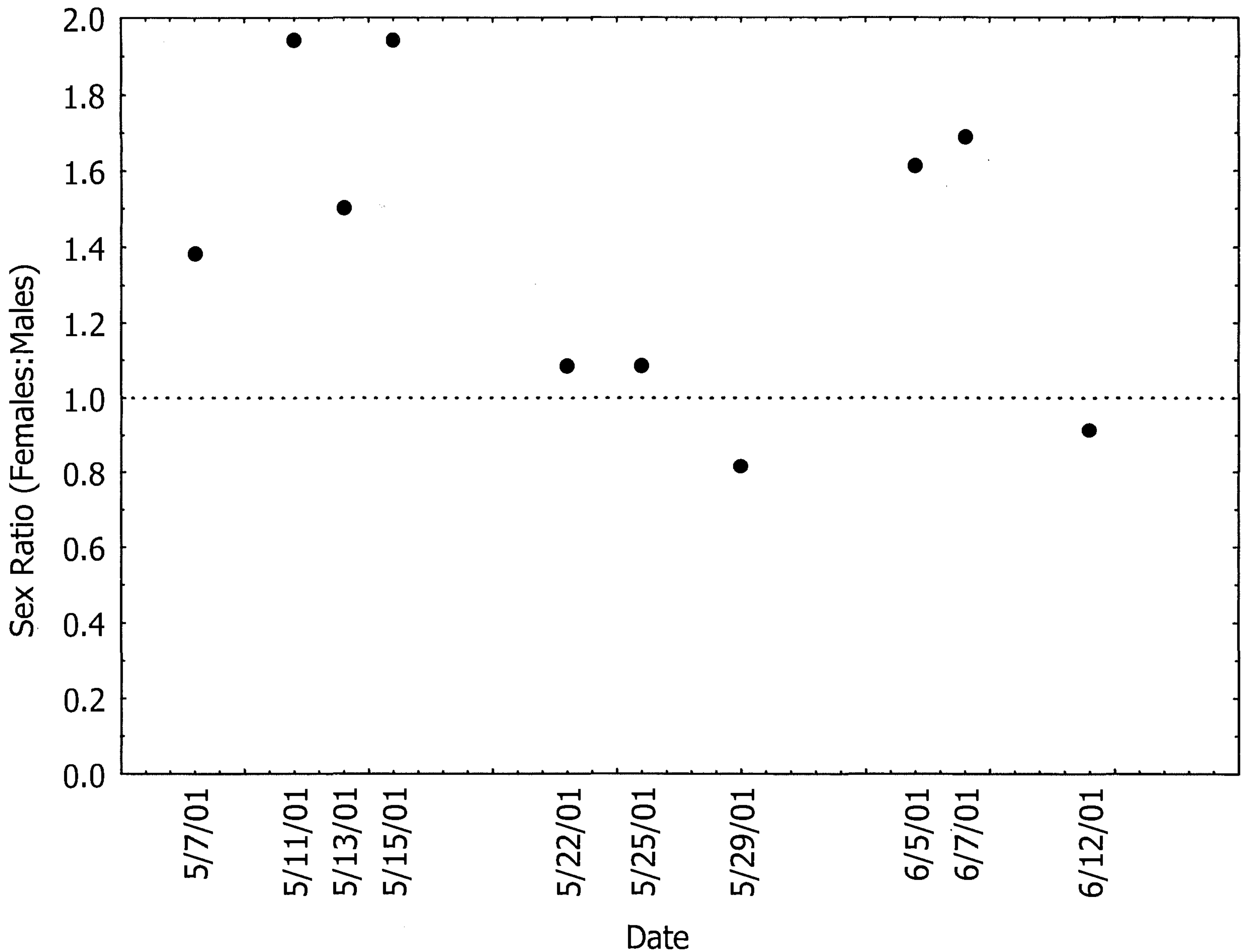


FIGURE 4. LENGTH OF ADULT ALEWIVES COLLECTED AT FORT HALIFAX, 2001

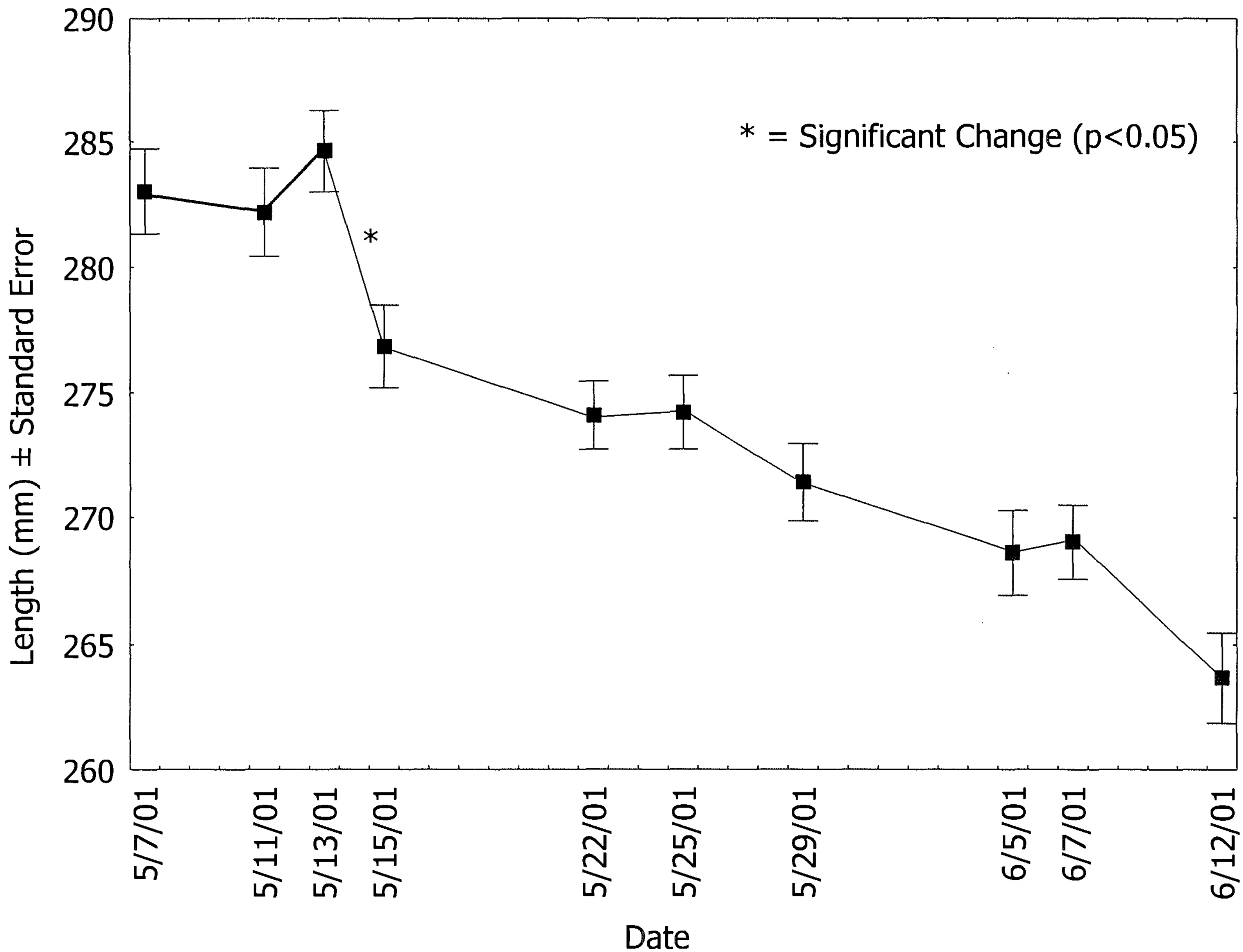


FIGURE 5. WEIGHT OF ADULT ALEWIVES CAPTURED AT FORT HALIFAX, 2001

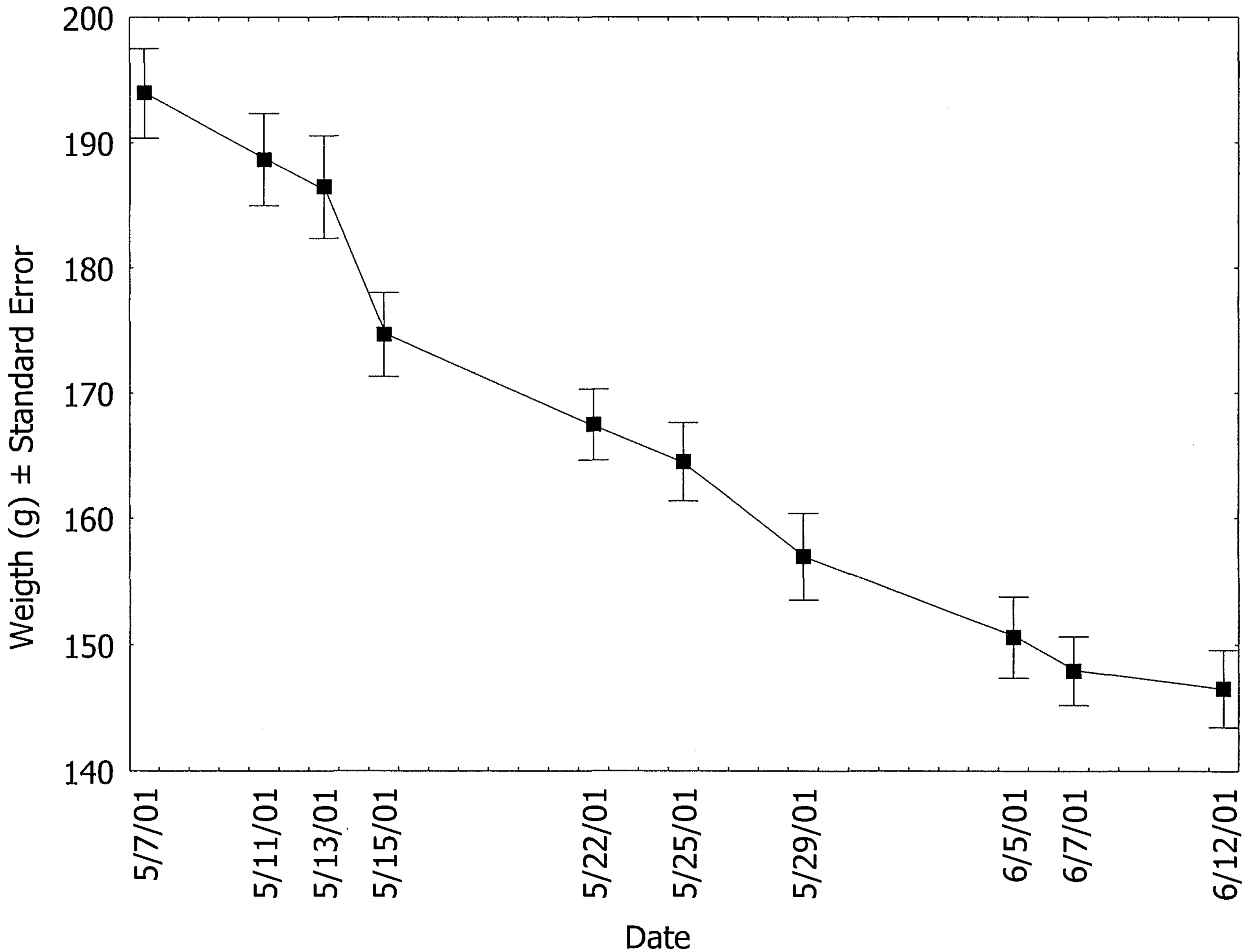


FIGURE 6. NUMBER OF AMERICAN SHAD LARVE RELEASED IN THE KENNEBEC DRAINAGE

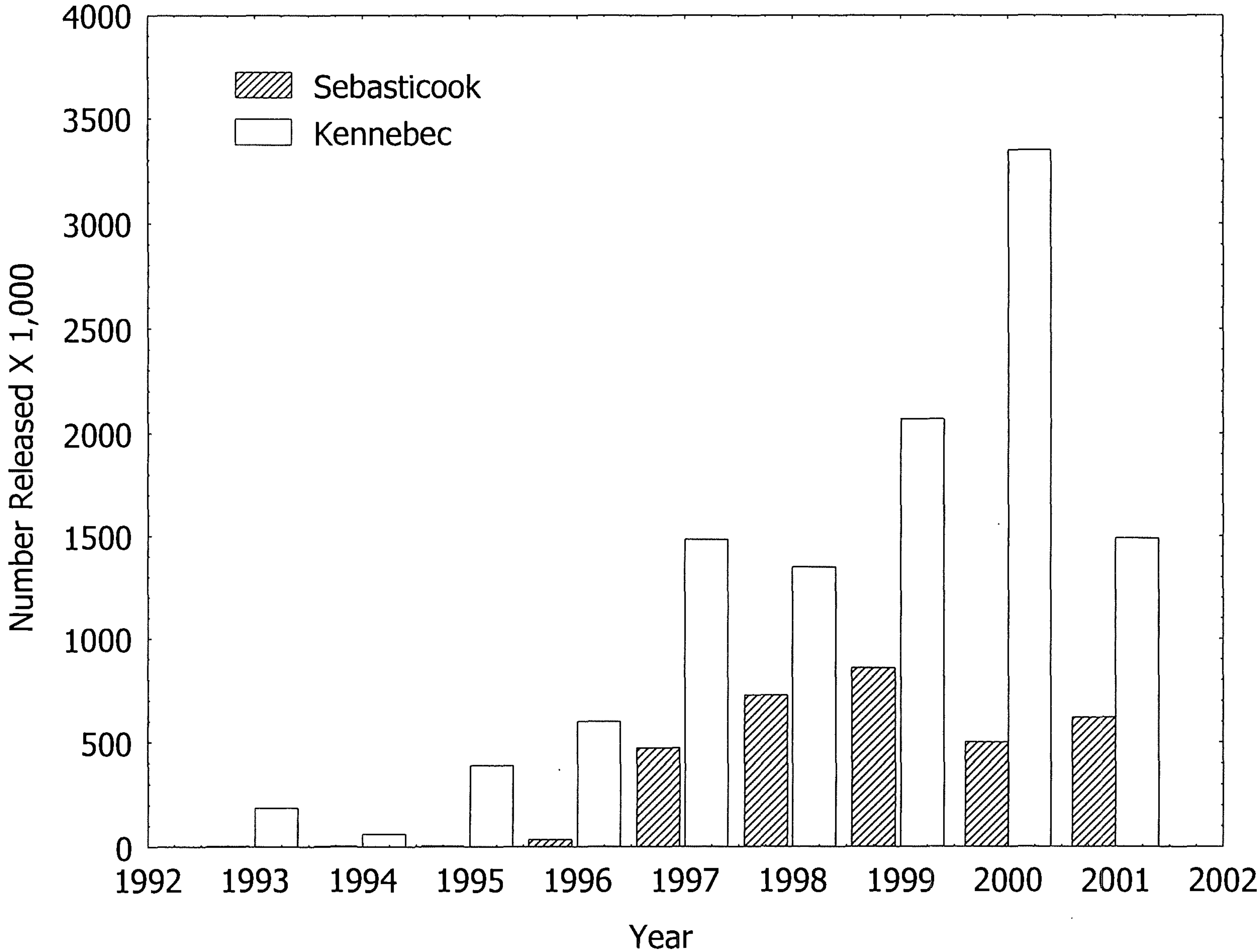


FIGURE 7. NUMBER OF AMERICAN SHAD FINGERLINGS RELEASED IN THE KENNEBEC RIVER

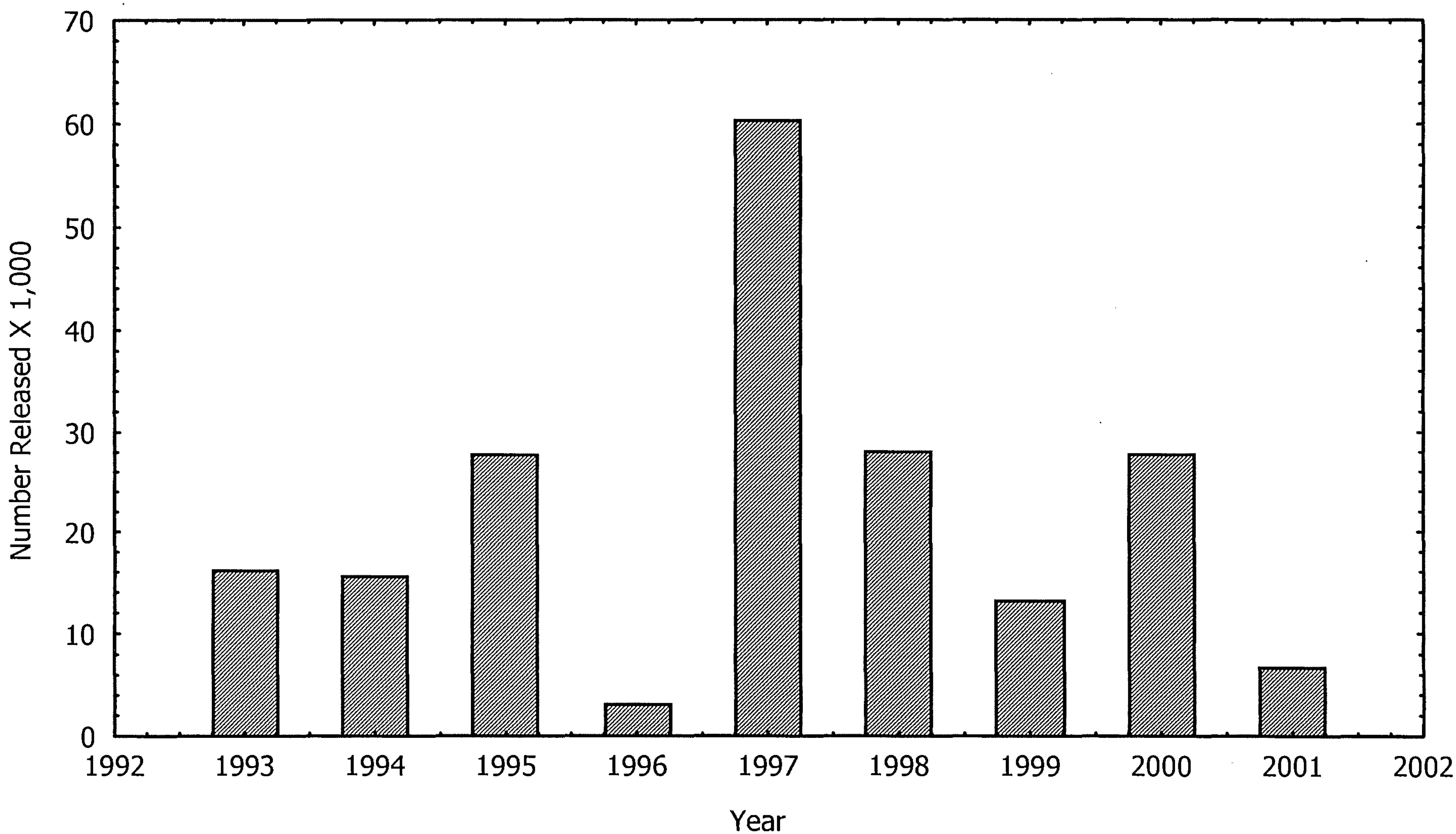


FIGURE 8. SEBASTICOOK RIVER, NONHYDRO DAMS

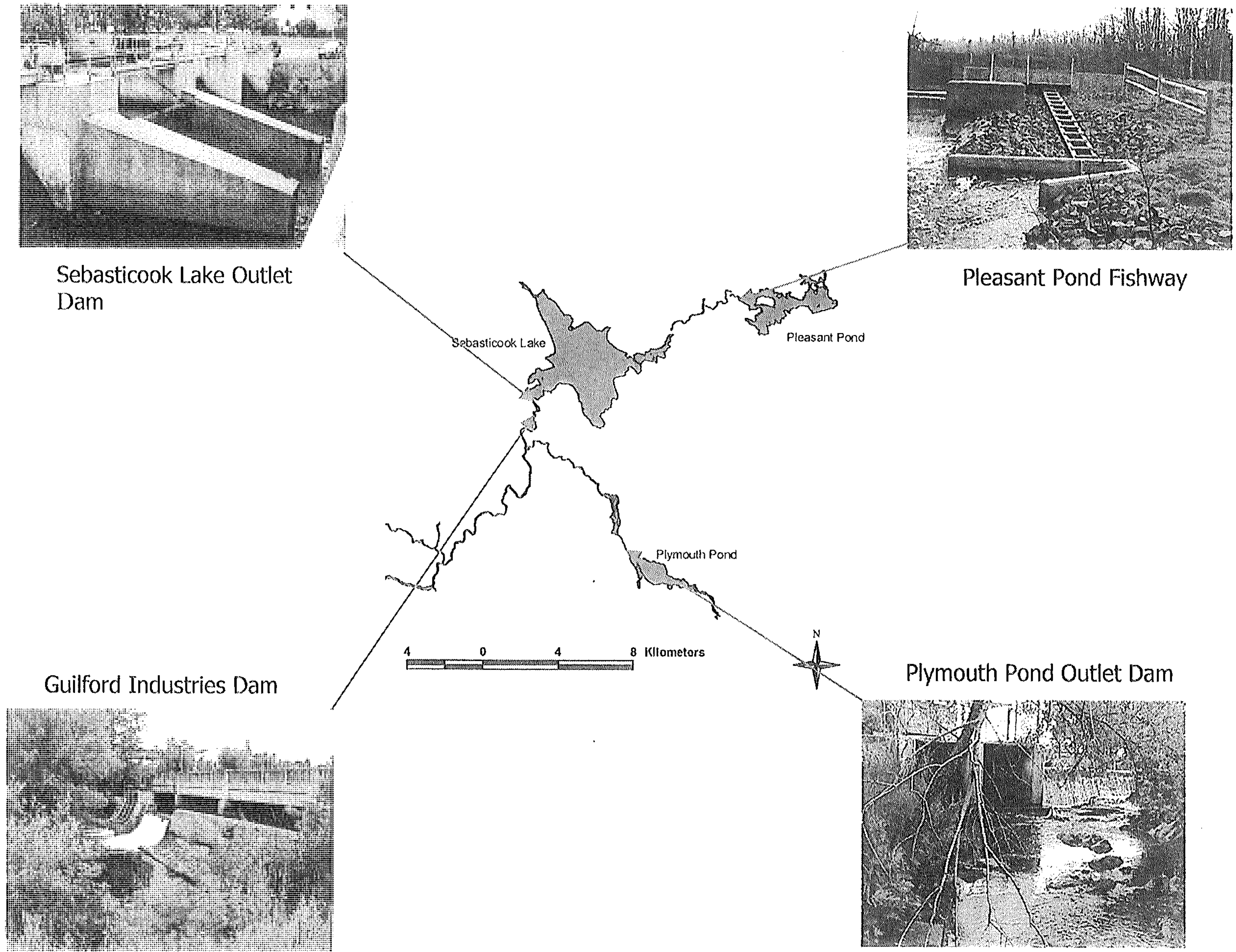


FIGURE 9. KENNEBEC RIVER FISH COMMUNITY ASSESSMENT SAMPLE SITES

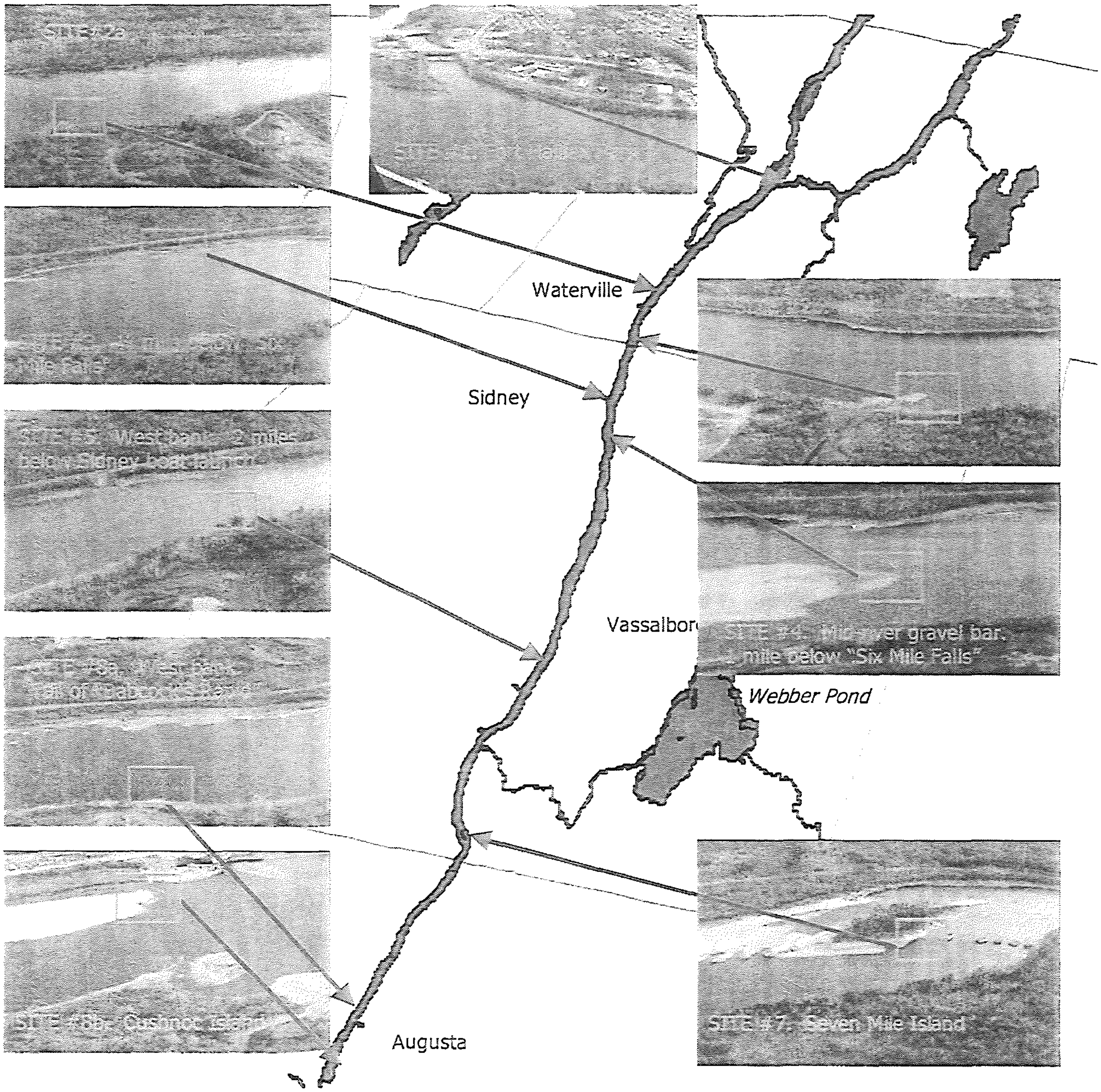
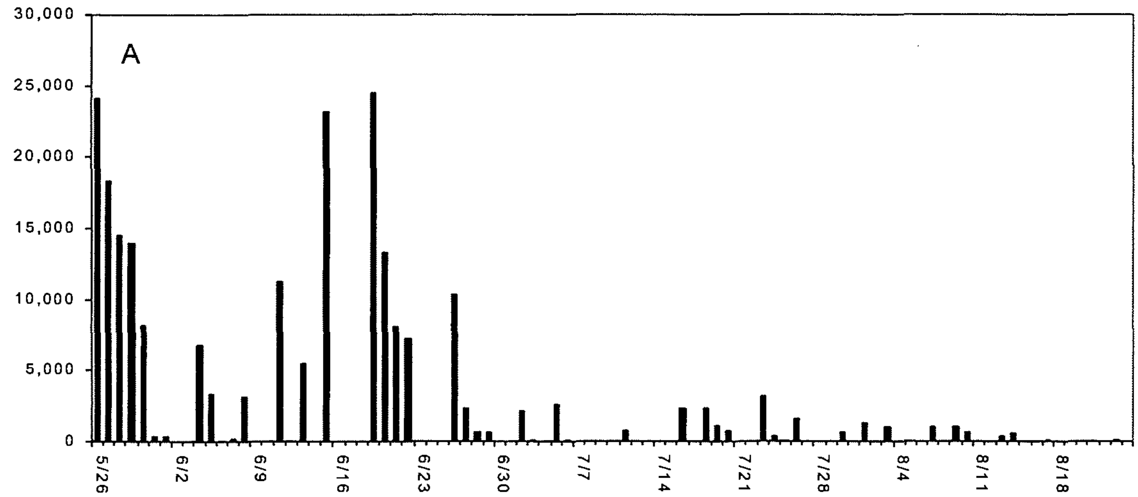


FIGURE 10. EEL PASSAGE AT A) FORT HALIFAX AND B) BENTON FALLS DURING THE 2001 FIELD SEASON



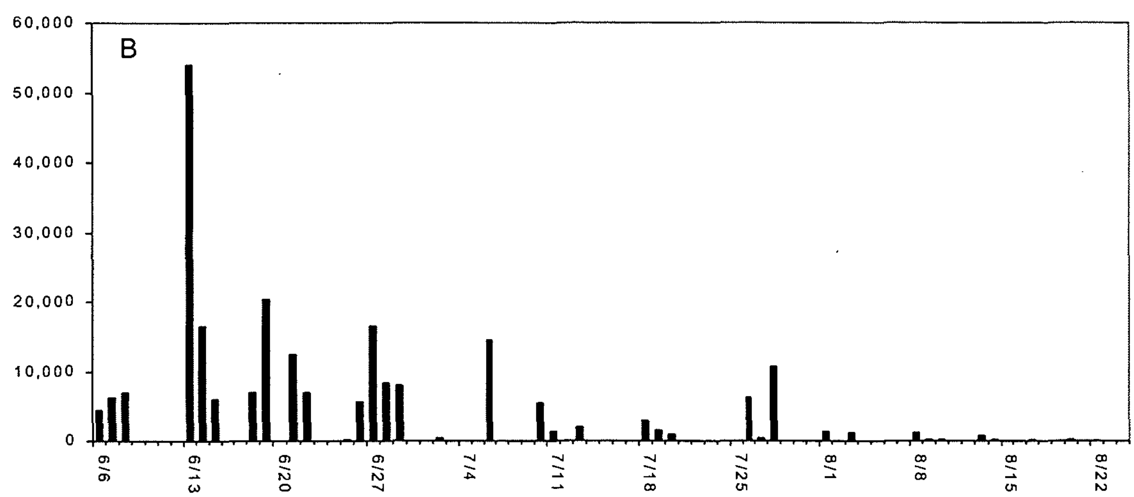


FIGURE 11. TOTAL LENGTH OF EELS PASSED AT FORT HALIFAX IN A) 1999, B) 2000, AND C) 2001

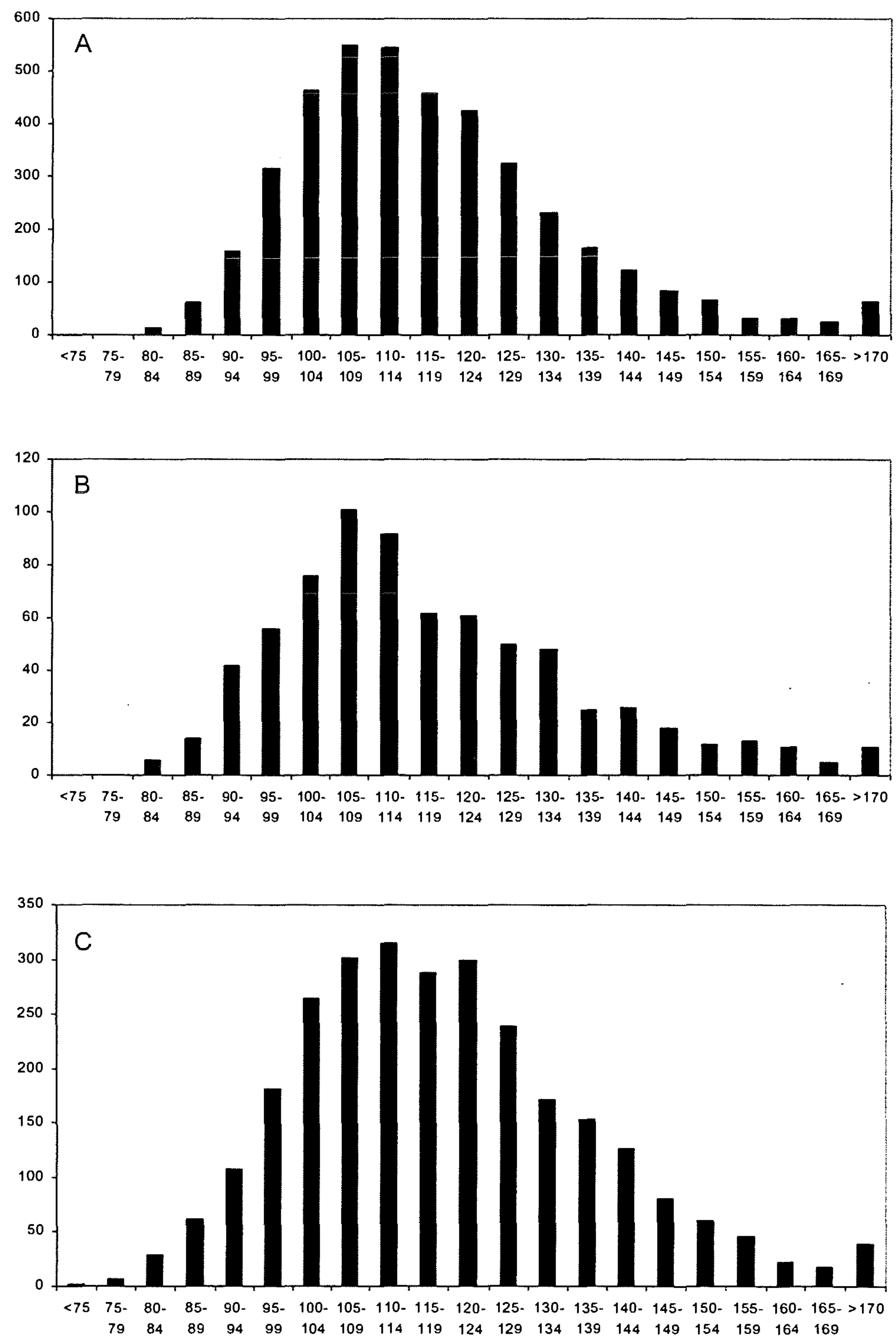


FIGURE 12. TOTAL LENGTH OF EELS PASSED AT BENTON FALLS IN A) 1999, B) 2000, AND C) 2001

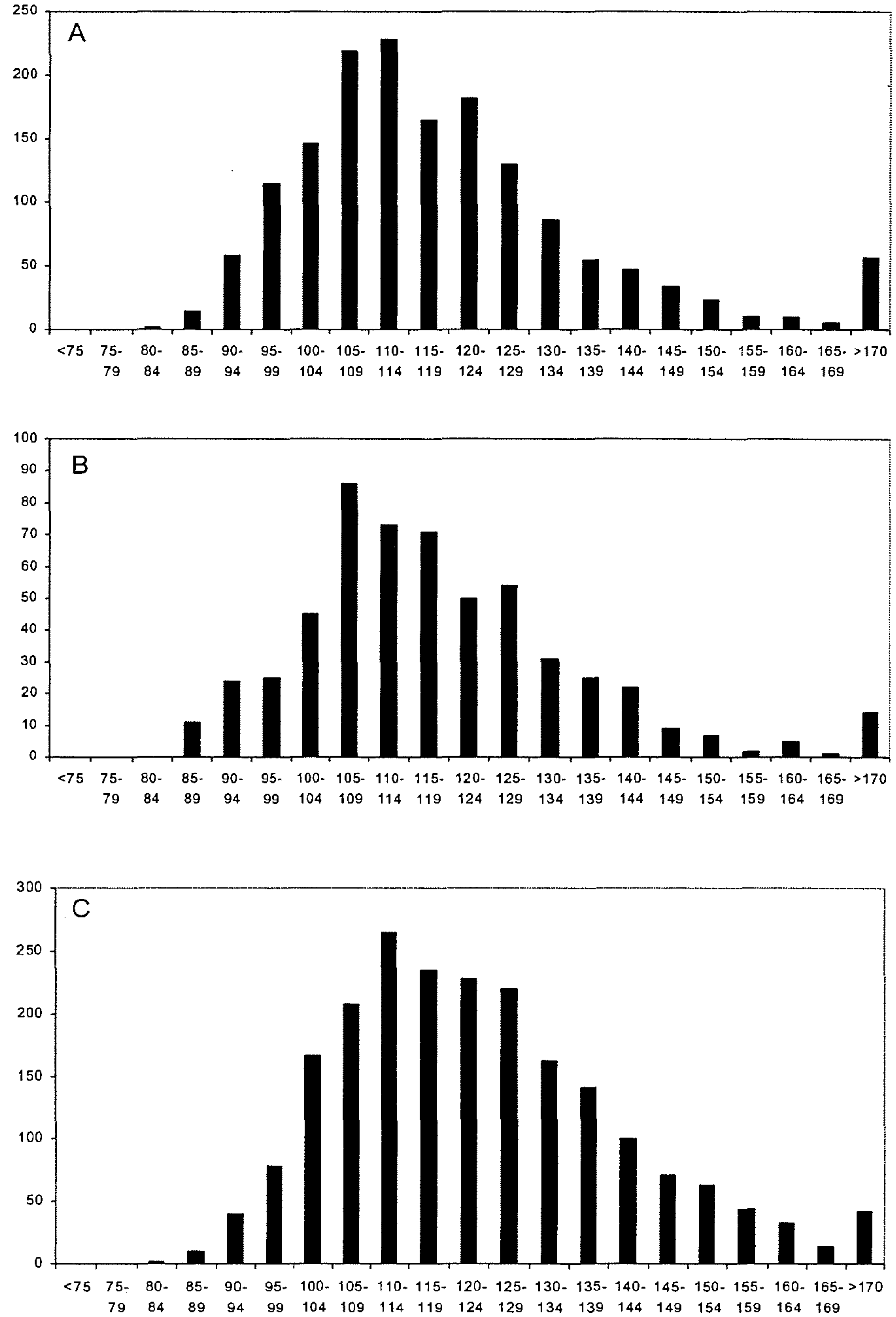


FIGURE 13A. RED ARROW INDICATES LOCATION OF EELS ATTEMPTING TO PASS AT BURNHAM

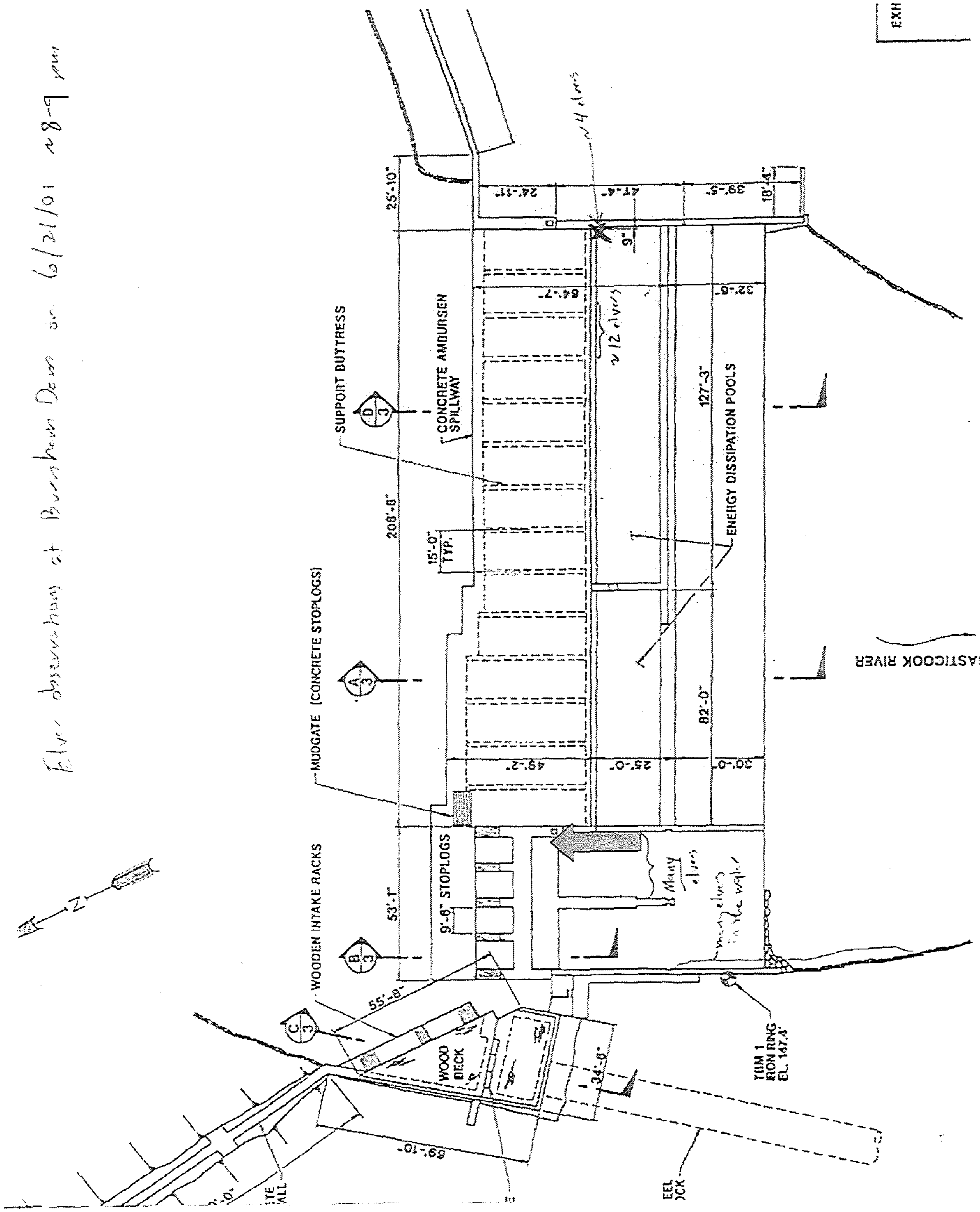


FIGURE 13B. DETAIL AT BURNHAM

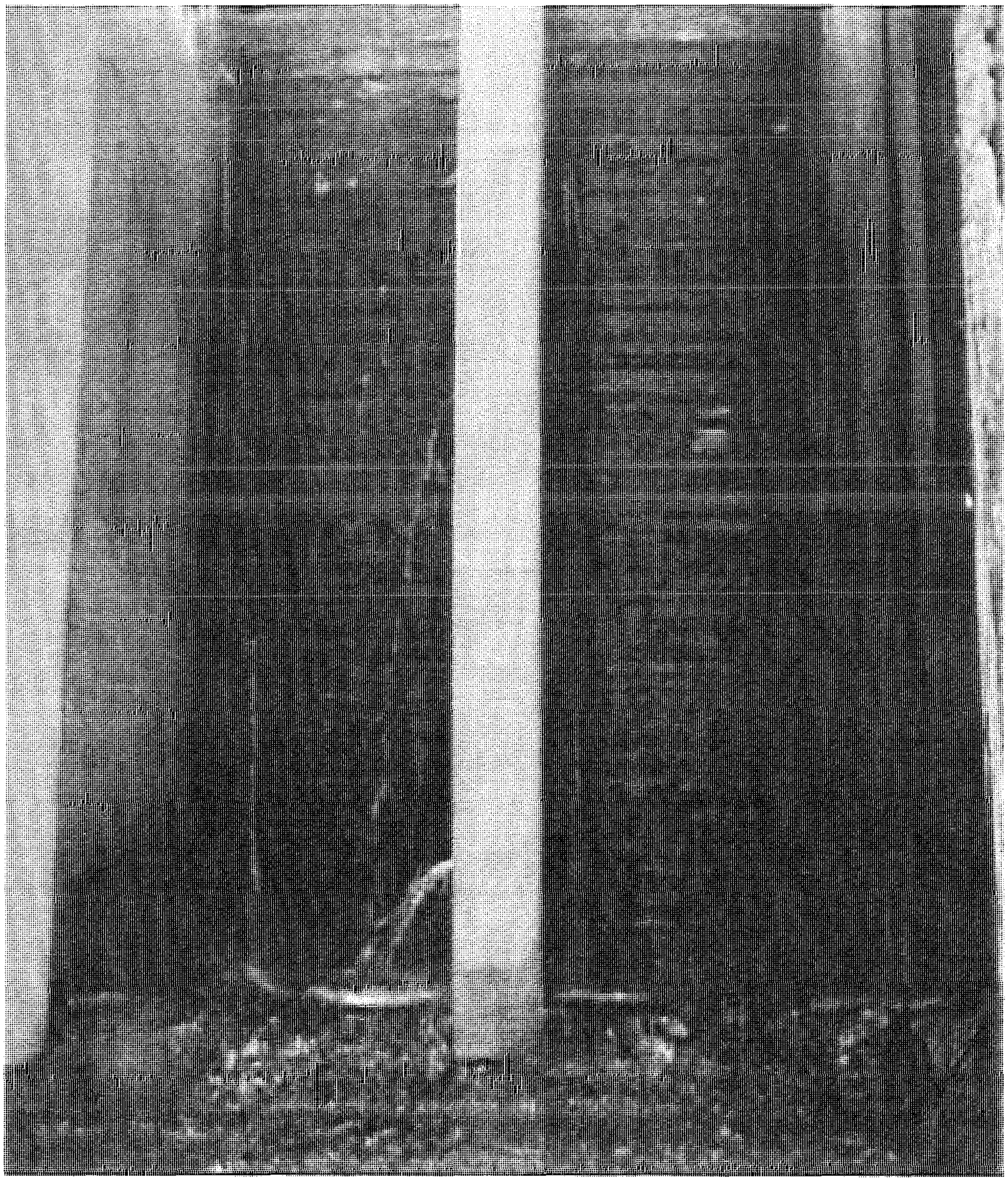


FIGURE 14. TOTAL LENGTHS OF EELS COLLECTED AT A) BURNHAM, B) LOCKWOOD, C) HYDRO KENNEBEC, AND D) SHAWMUT

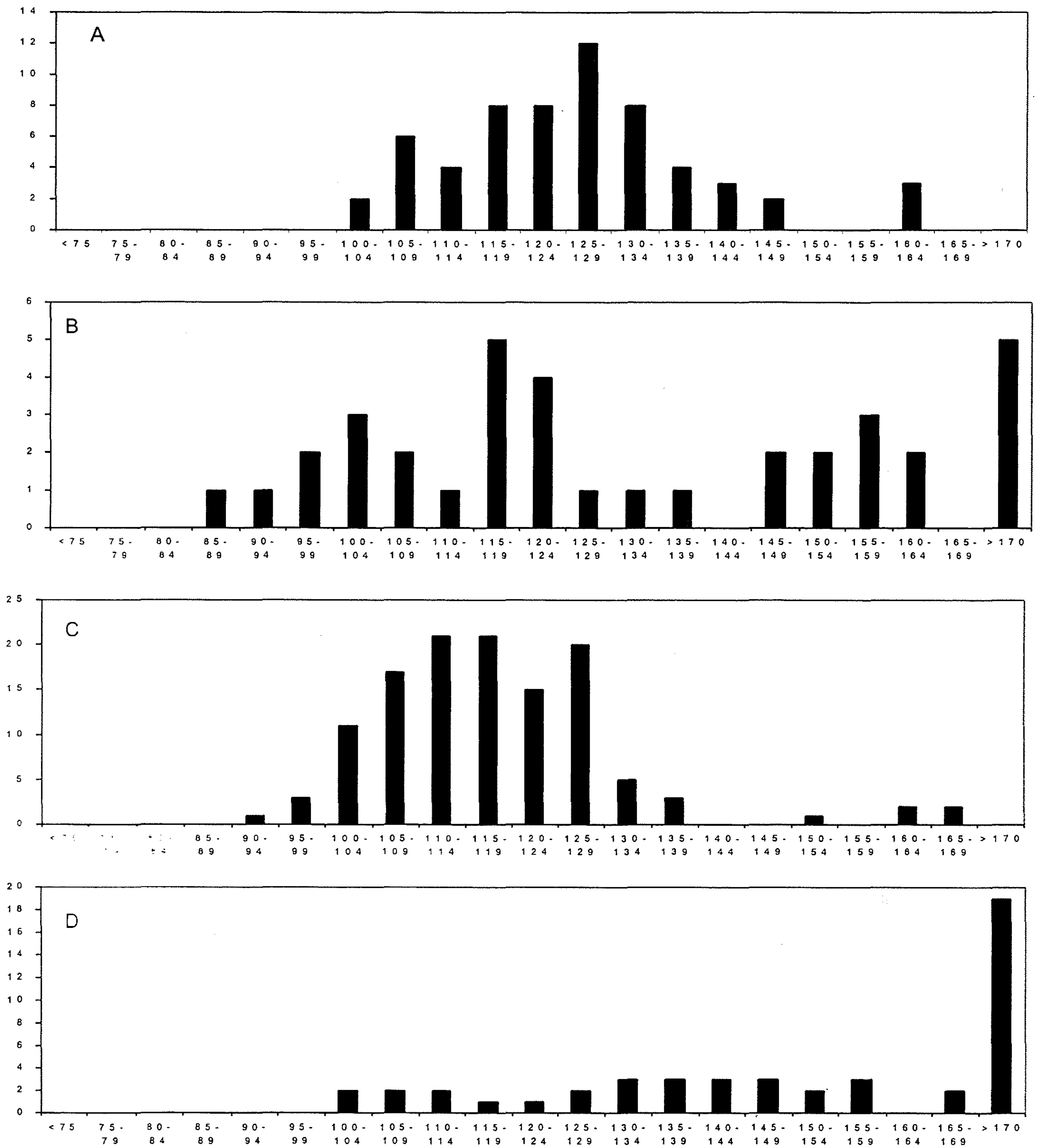


FIGURE 15A. RED ARROW INDICATES LOCATION OF EELS ATTEMPTING TO PASS AT LOCKWOOD

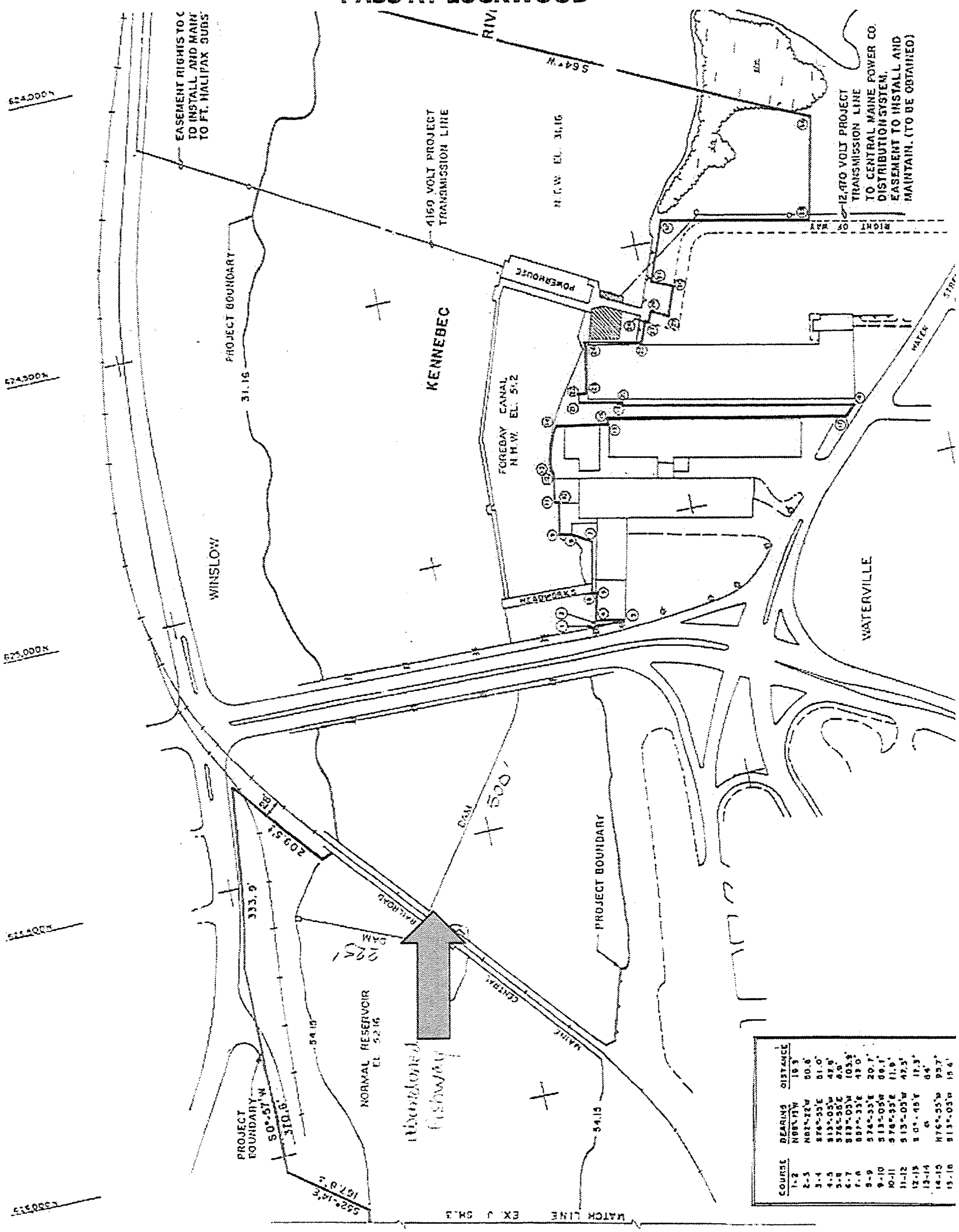
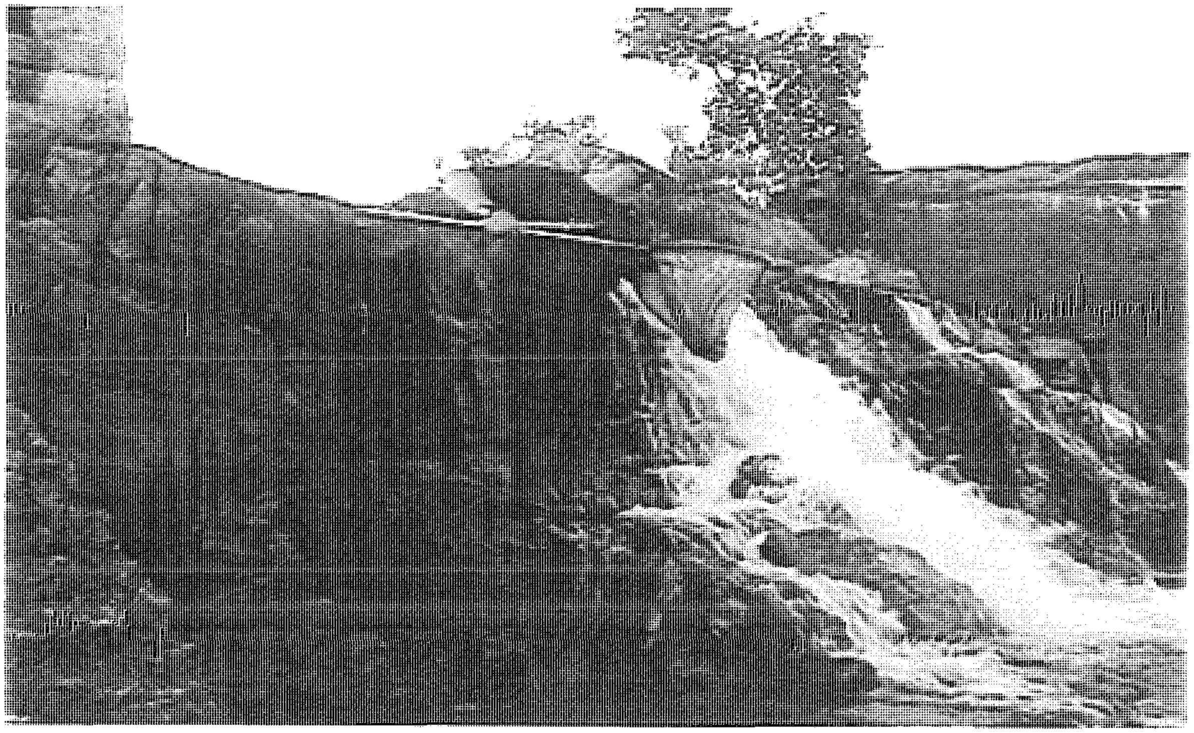


FIGURE 15B. DETAIL AT LOCKWOOD



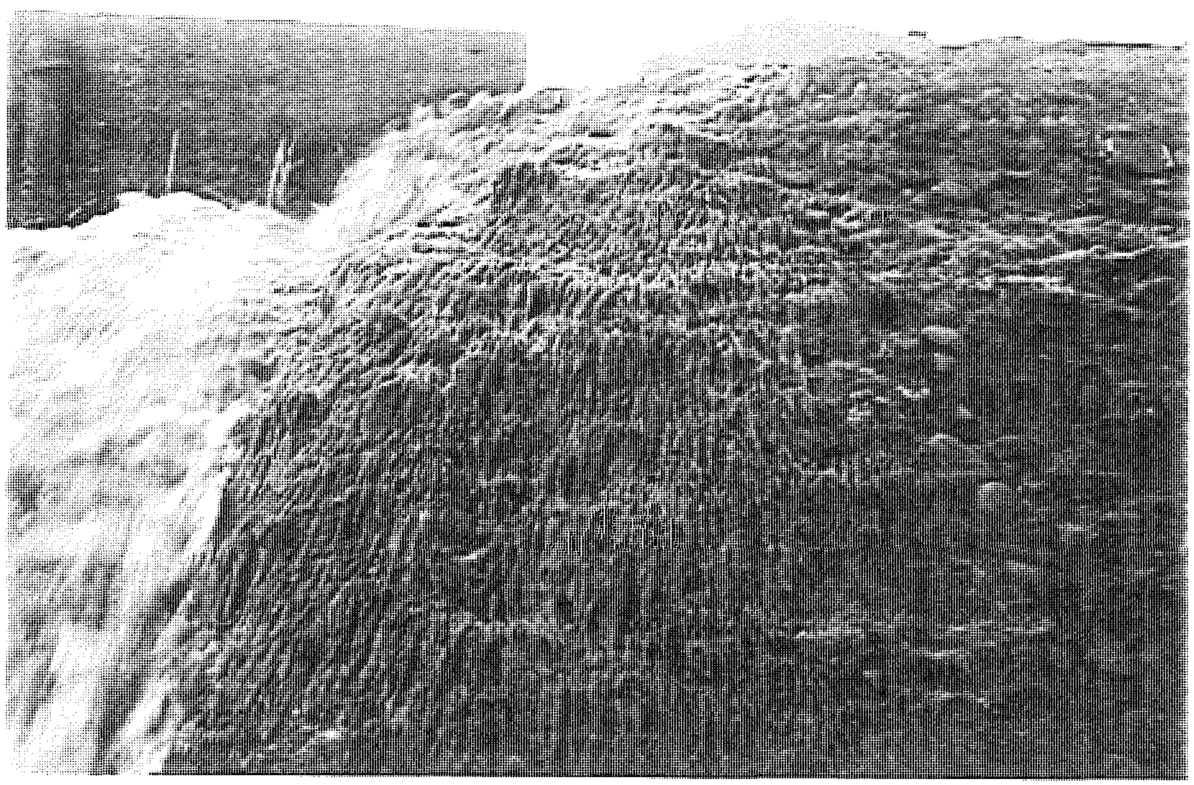


FIGURE 16A. RED ARROW INDICATES LOCATION OF EELS ATTEMPTING TO PASS AT HYDRO KENNEBEC

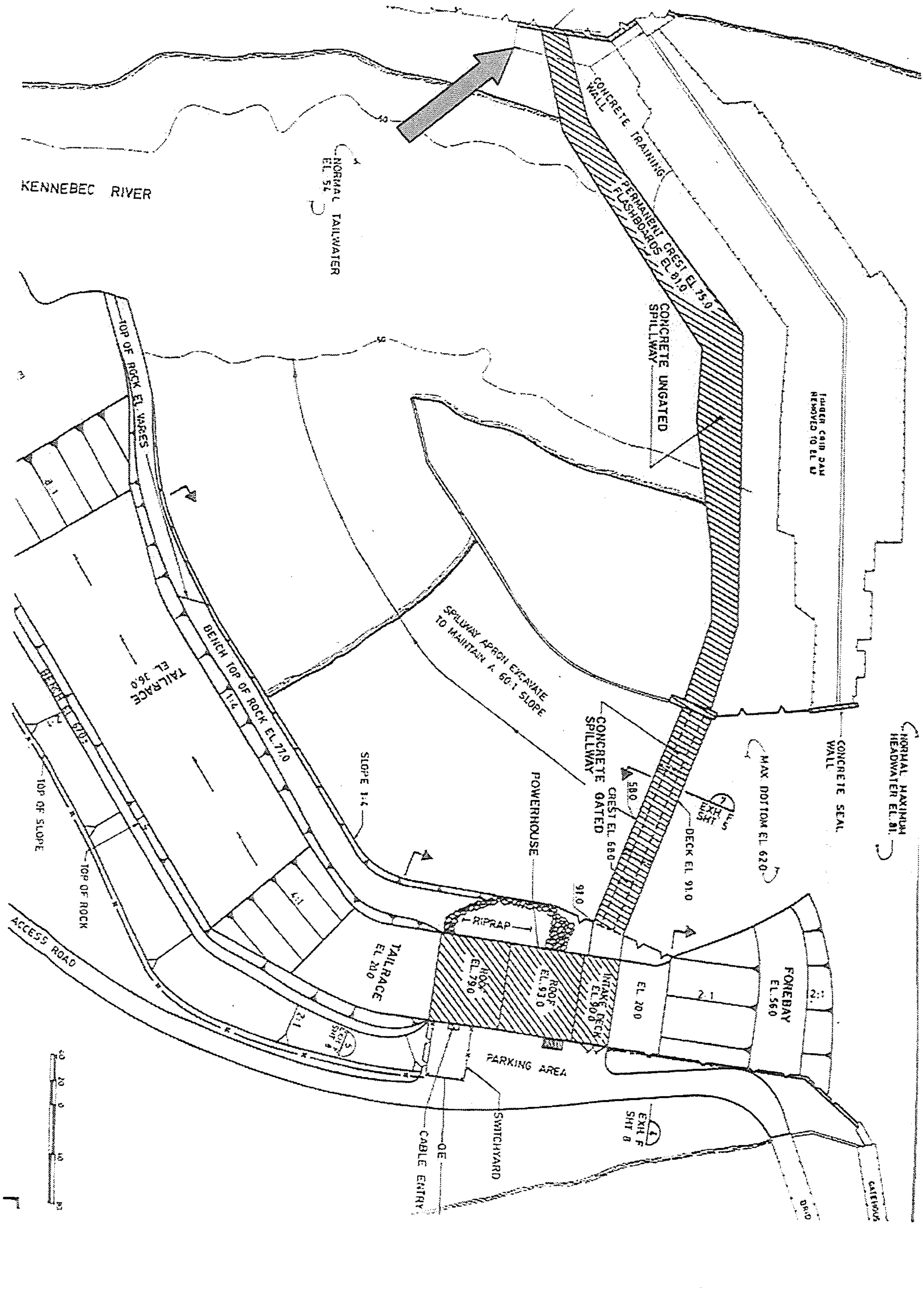


FIGURE 16B. DETAIL AT HYDRO KENNEBEC

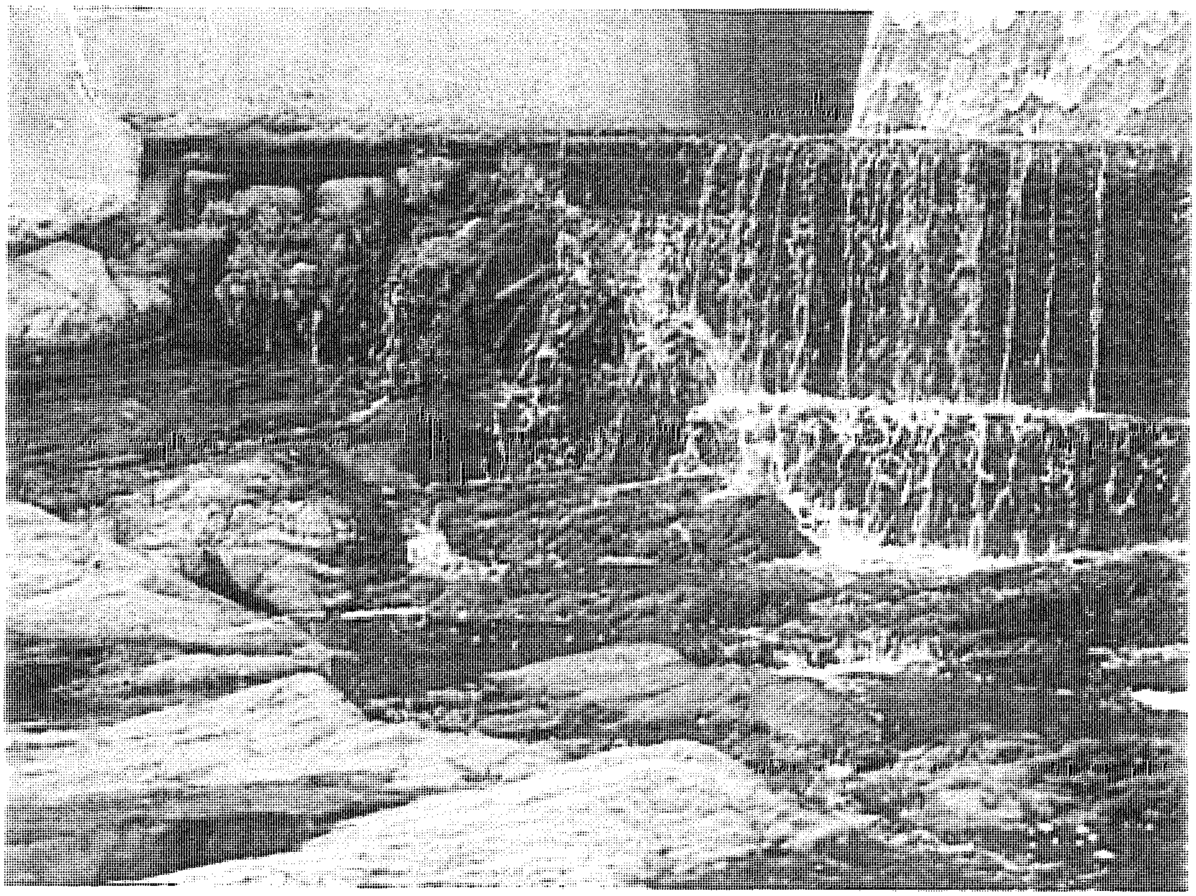


FIGURE 17A. RED ARROW INDICATES LOCATION OF EELS ATTEMPTING TO PASS AT SHAWMUT

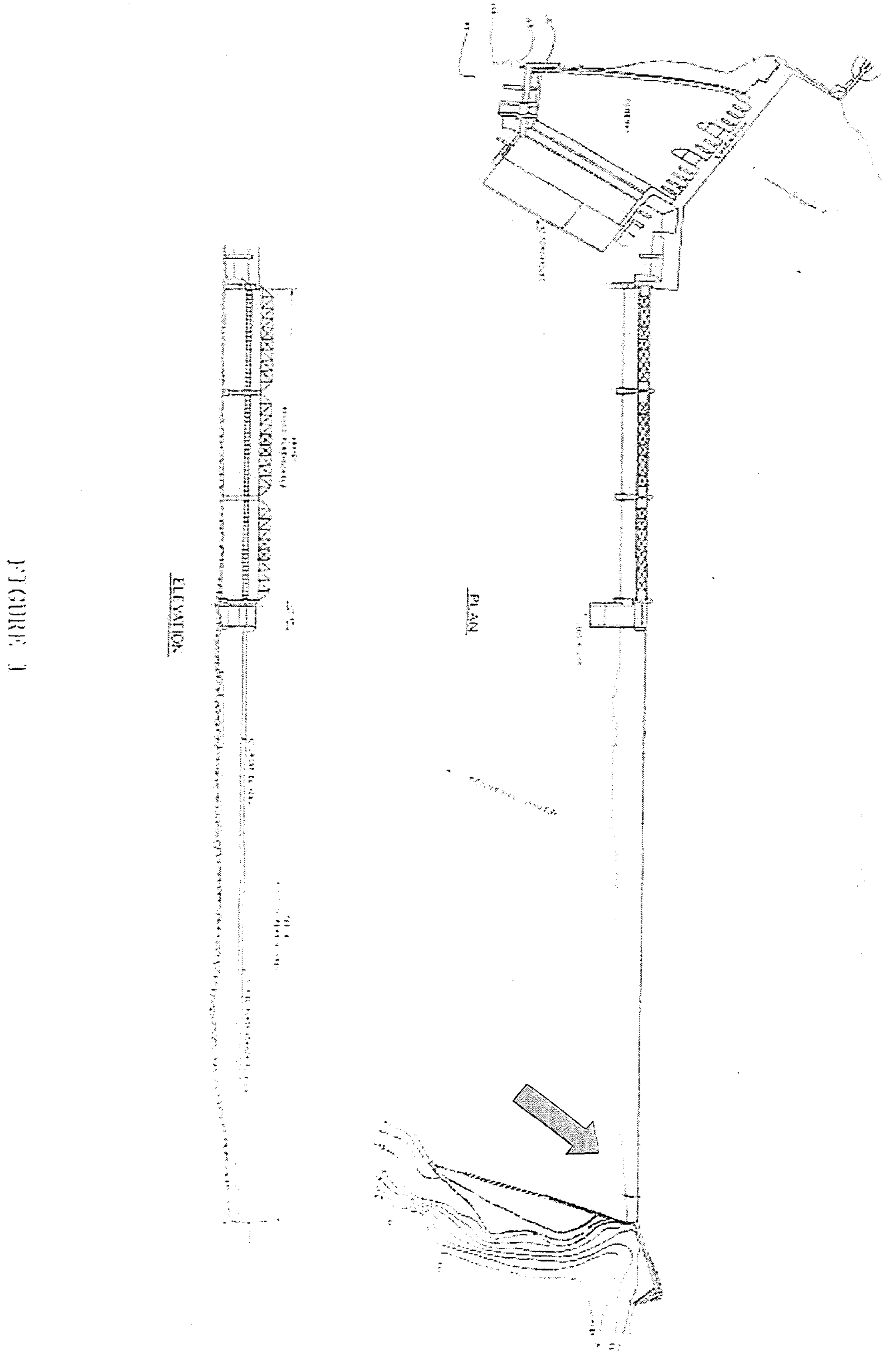


FIGURE 17B. DETAIL AT SHAWMUT

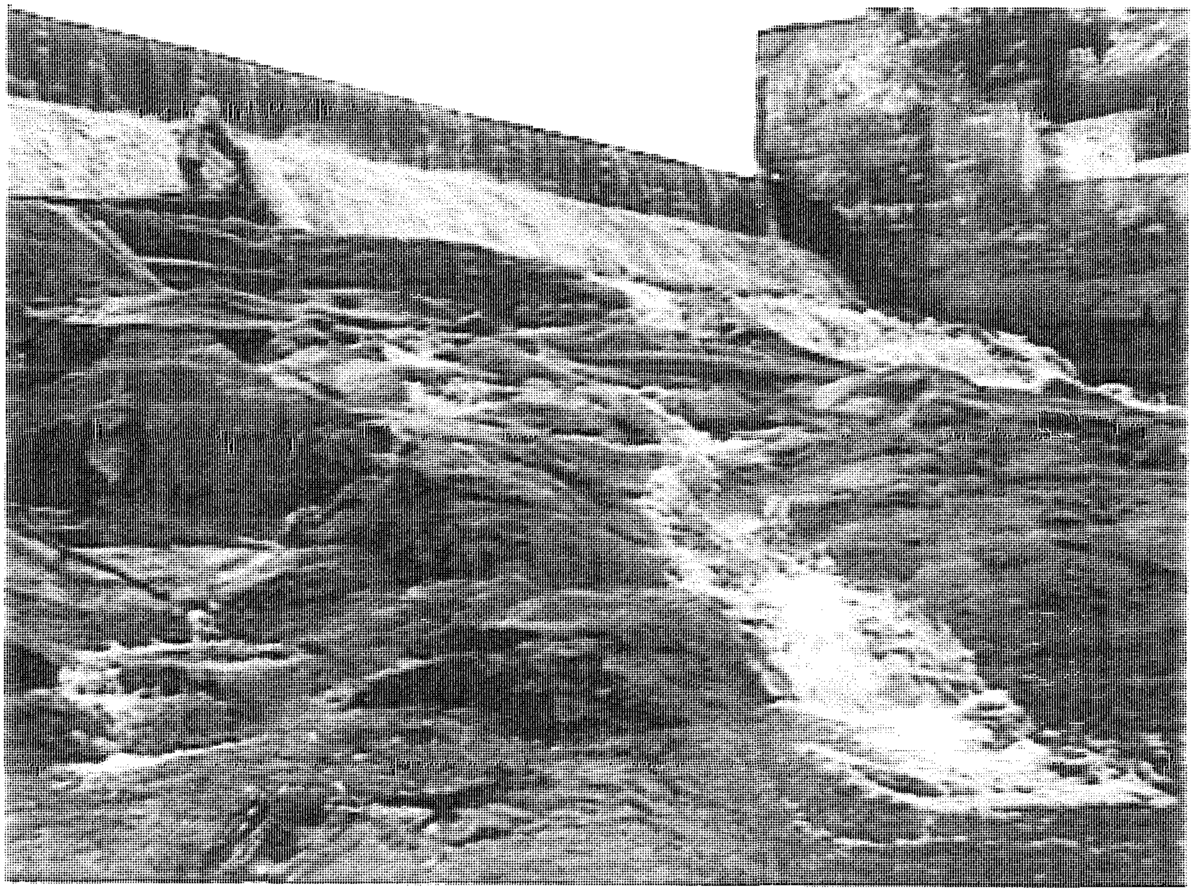


FIGURE 18A. RED ARROW INDICATES LOCATION OF EELS ATTEMPTING TO PASS AT WESTON

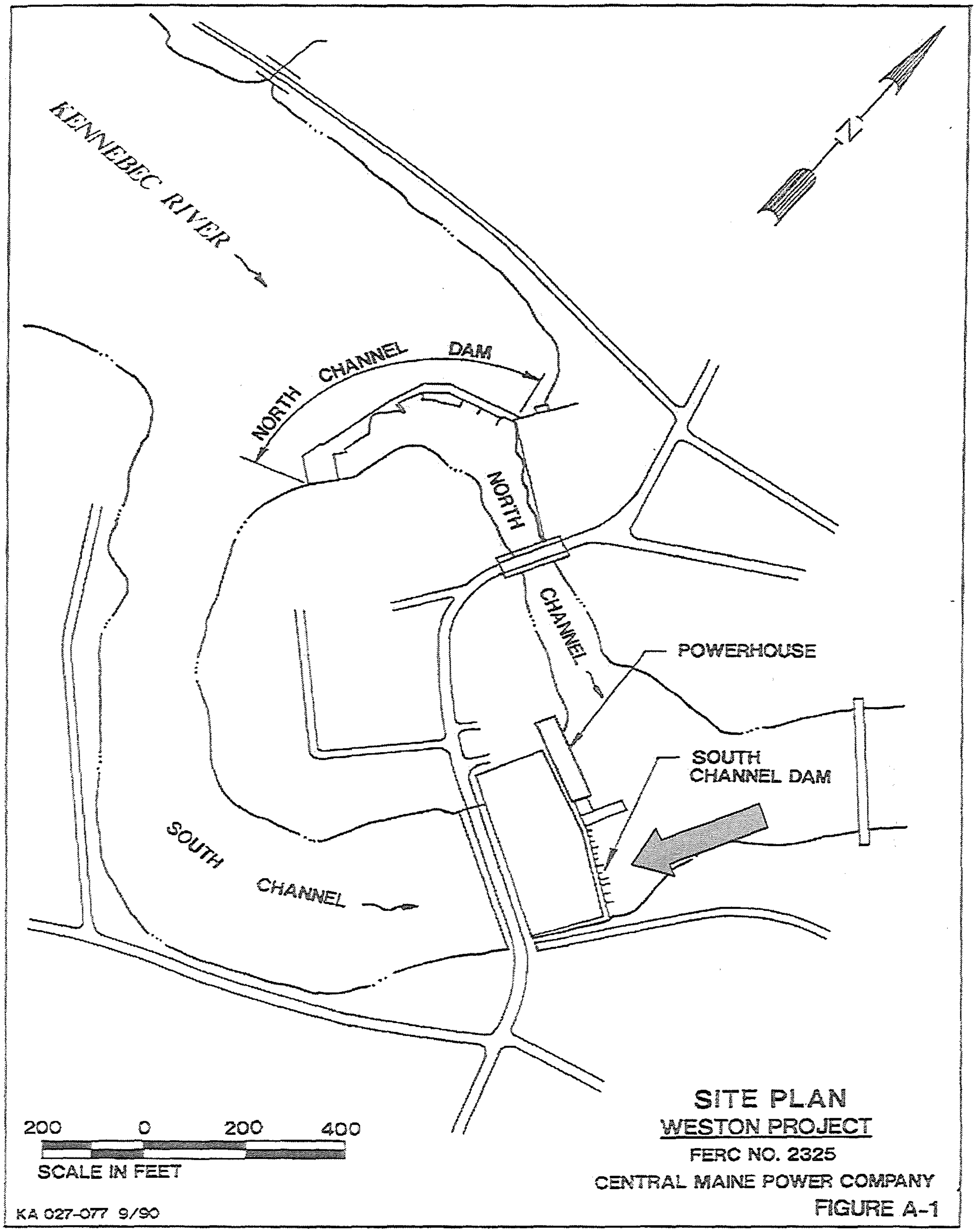


FIGURE 18B. DETAIL OF WESTON

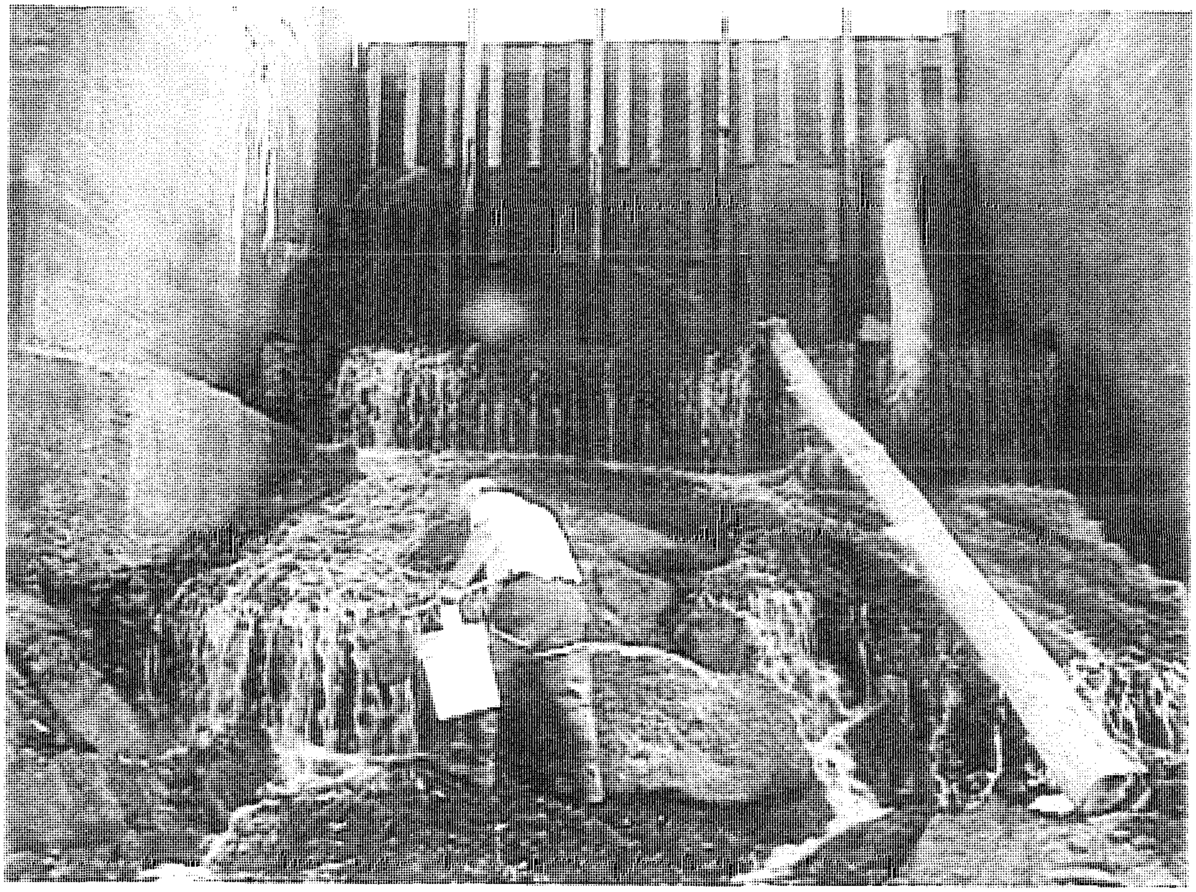
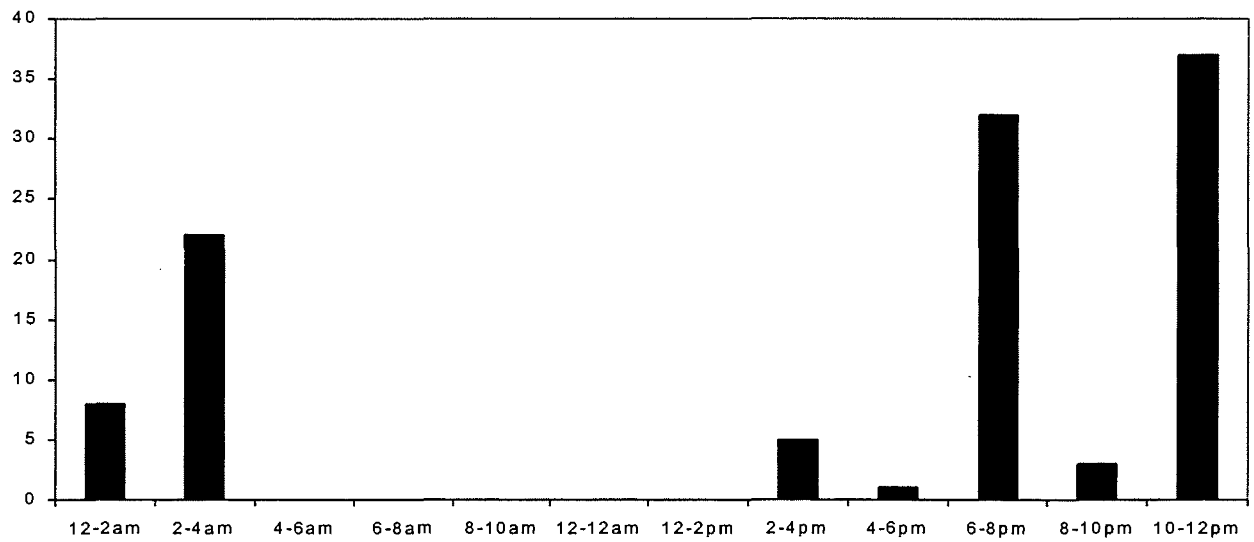


FIGURE 19. NUMBER OF TELEMETRY CONTACTS MADE BY TIME OF DAY FOR A) 2001 AND B) 2000



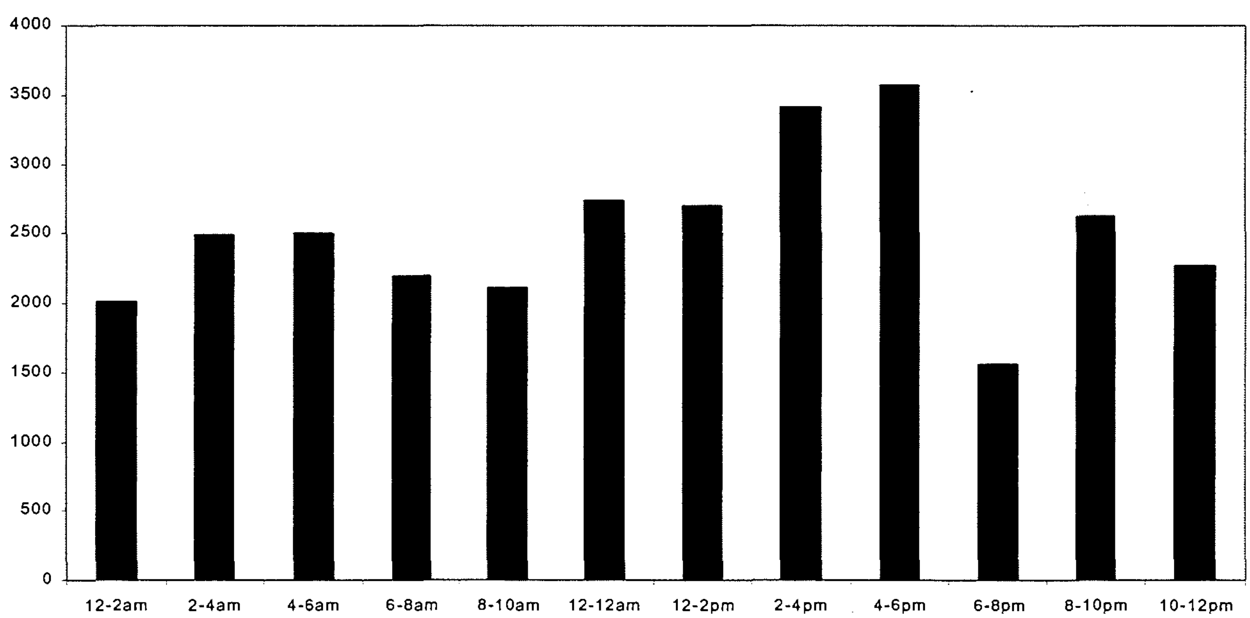


FIGURE 20. DAILY MAXIMUM AND MINIMUM TEMPERATURES FOR SELECTED KENNEBEC RIVER TRIBUTARIES, JUNE - SEPTEMBER, 2001

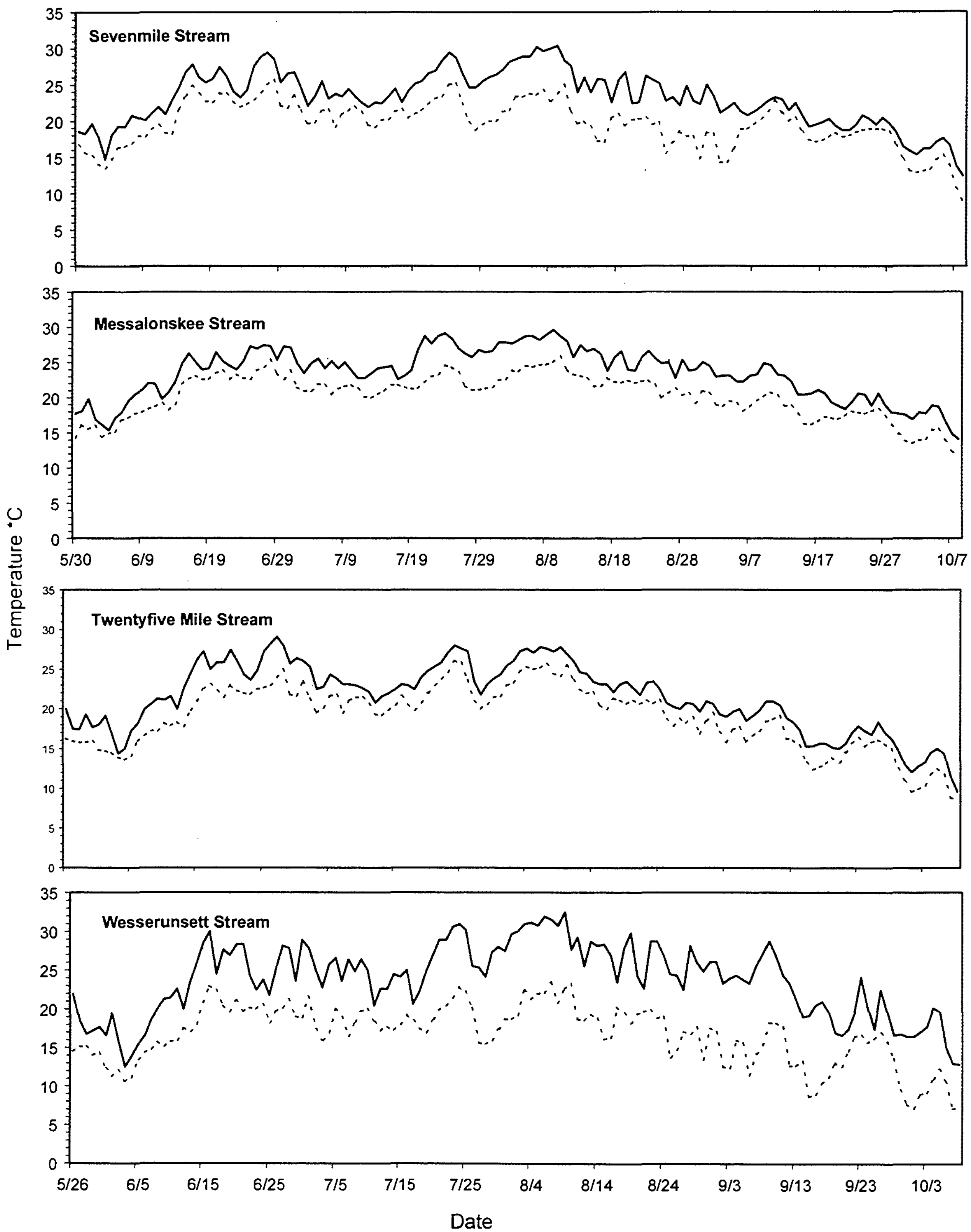
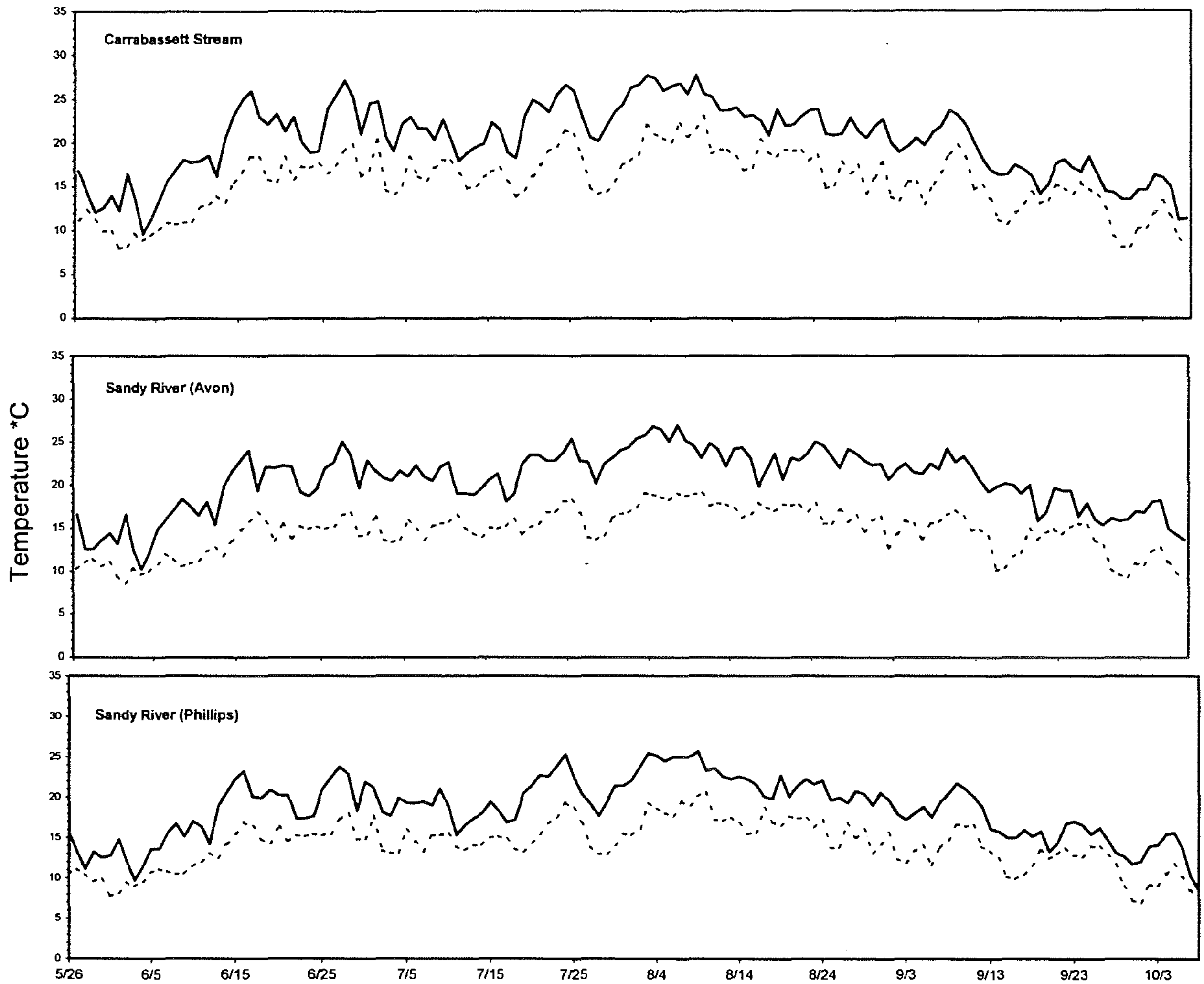
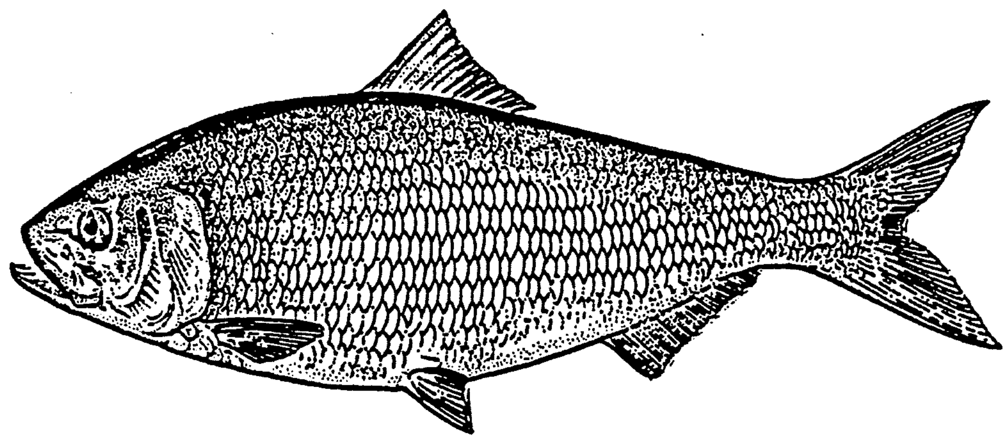


FIGURE 20. CONTINUED



APPENDIX A – Shad Hatchery Report

WALDOBORO SHAD HATCHERY



2001

ANNUAL REPORT

Carolyn, Samuel and Andrew Chapman

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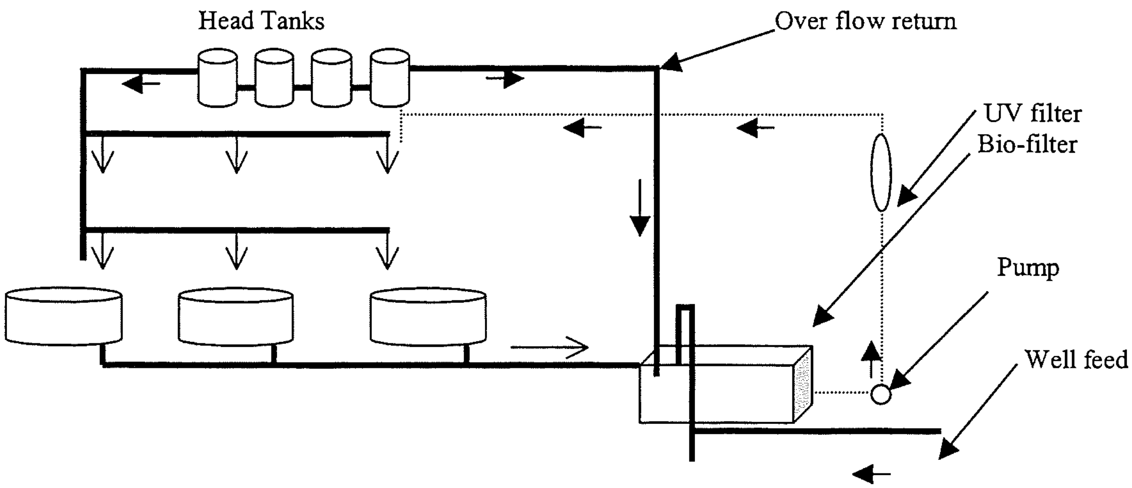
INTRODUCTION

In 1992, the Time and Tide Resource Conservation and Development Area Council, in cooperation with and financed by the Maine Department of Marine Resources, established a pilot shad hatchery in the town of Waldoboro, Maine. This operation was run in an 18' x 19' aluminum shed that had no running water or sanitary facilities. Water for the hatchery's operation was piped in from an artesian well overflow 325' from the site. Technology developed at the Susquehanna River Van Dyke Shad Hatchery proved to be very sound and reliable and was adopted for use at the Waldoboro Shad Hatchery. The Waldoboro Hatchery has successfully operated from 1992 to 2001 and during that period, provided 16,016,023 fry for distribution by the DMR.

BASIC HATCHERY CULTURE SYSTEM

Well water to the culture area comes through a raised head tank, a bank of four separate tanks, which provides constant low-pressure gravity fed water through a 2" PVC pipe system.



DETAILED SYSTEM INFORMATION

Water coming into the building goes through a 50-micron filter and UV sterilizer before entering the head tank. The tank is built on a shelf close to the ceiling to provide water pressure and some height for the pipes above the culture tanks. Excess flow to the head tanks is allowed to return to a bio-filter recirculation tank where it is mixed with new water coming into the building, heated, aerated, and pumped back up into the head tanks. Seven 6' diameter x 3' deep fiberglass tanks were constructed locally and are positioned under the pipe system in a floor plan that allows easy access for culture and cleaning. Plastic upwelling incubators sit on tables beside the tanks. Newly hatched fry swim up to the top of the incubators and are automatically drained into the fry culture tanks; they are held in the tanks 10-20 days after hatching. Brine shrimp are the primary fry diet and a system to conveniently provide feed to all the tanks is required. Two fiberglass 125-gallon, conical bottom tanks were set up to supply the hatched brine shrimp for the fry. A 250-gallon fiberglass tank holds a day's supply of brine shrimp and is connected to a system of pipes, valves, and a timer that automatically feeds a plentiful diet of newly hatched shrimp over a 22-hour period to all the culture tanks at once. The fiberglass tanks used to culture the fry are 6' in diameter and 3' deep, with a slight slope to the center drain. This drain is a threaded 2" fitting that is designed to accept a 2" standpipe, which in turn maintains the tank water level. All water flow out of the fry culture tanks is filtered and piped into the outflow end of the head tank bio-filter recirculation system. If a water crisis should develop, the larval culture tanks can be put into a temporary recirculation loop through the bio-filter tank with no stress to the fish in the tanks.

Tank effluent normally drains to a nearby pond, but the drain arrangement may be changed by opening and closing a series of valves in order to allow fry ready to be stocked to drain directly into the stocking tank on the bed of a ¾ -ton pickup.

TANK SPAWNING SETUP

The system consists of one 12' and two 15' diameter x 4' deep adult shad holding tanks that gravity drain into separate 3'x 3' x 8' bio-filter tanks from which treated water is pumped back into the spawning tanks at a rate of approximately 30 gallons per minute. Depending upon its size, each round spawning tank receives 5-7.5 gallons of new water per minute. Each bio-filter tank is now fitted with three 3000-watt stainless steel immersion heaters, each set of which provides as much heating capacity as a standard 30,000 BTU, 40-gallon home hot water heater. The previous use of 4000-watt immersion heaters was an under-sized heating capacity for maintaining optimal tank spawning temperatures early in the season. Each bio-filter tank has had its degassing capabilities augmented with the addition of aeration towers with extra surface-to-water enhancing media.

Because shad eggs sink, the spawning tank has to drain from the center bottom. To accomplish this, an 8" plastic collar is placed around the 4" overflow. This collar causes the water to drain from the center bottom of the tank, carrying along with it any eggs that naturally drift to the center. Water coming from the spawn-ing tank enters the bio-filter tank through a 3" pipe tee that is drilled with ¾" holes and acts as a muffler in slowing down the water velocity and evenly diffusing water currents. Knitted polyethylene bags of 0.5mm mesh are tied onto both legs of the water muffler to collect eggs released by adult shad; the bags are changed each morning and the collected eggs placed in incubators.

TANK SPAWNING SYSTEM

2001 OPERATION:

The system was operated in the same manner as that described in the 1999 report. The eggs from the tank spawning systems were produced without the use of hormones.

QUALITY OF BROODSTOCK:

Broodstock adult shad transported to the hatchery by truck can exhibit obvious bruising about the head and inside the eyes, as well as severe scale loss. Any incoming shad that exhibit bruising about the head are either DOA or die soon after being transferred to the spawning tank. In addition to the bruised and traumatized shad, there is a significant percentage that are lightly battered and descaled. These shad soon become festooned with heavy patches of fungus and eventually die. Careful selection by the transport crew of only vigorous and blemish-free fish has shown to have a dramatic positive effect on the overall survival of the transported shad.

Maintaining several spawning systems allows a separation of specific river origin shad at the hatchery, thus enabling hatchery personnel to observe a difference in survival rates between the populations and batches within said population. In 2001, it was clear that handling during capture was a major factor in the survival of one batch of broodstock shad after they were introduced into the hatchery tank spawning system. This particular batch was a group of 81 Saco fish delivered to the hatchery on June 19; they were segregated into their own tank and maintained in an environment similar to all other hatchery broodstock. It was noted at the time of delivery that these shad were in "very poor shape" and indeed, 76 mortalities [93.8%] were experienced by the morning of June 24. This compares to an 87% survival of Merrimack River shad held and released, and an overall broodstock survival - to release - of 58.9%.

EGG VIABILITY

It has been noticed that some batches of eggs exhibit low viability due to the presence of small immature eggs. These eggs contribute to nutrient loading and the promotion of fungal growth in the egg incubators that would be lessened if the small eggs were removed. Since 1998, all eggs delivered to or produced at the hatchery are sieved on a variety of mesh sizes. Past investigation has revealed that most eggs <2mm are not viable. Generally, only the eggs that are retained on a 2mm screen are selected for incubation.

ENUMERATION OF CULTURE TANK MORTALITY

During the hatchery season, waste that is routinely siphoned from the bottom of the culture tanks is sampled to determine larval mortality after hatching and up to the time of stocking. Individual tanks were/are not cleaned daily. It takes several days for detritus to develop and show on a tank bottom; therefore, the cleaning time interval varies from one batch of larvae to the next. When a tank is cleaned, the bottom waste is siphoned into several plastic buckets and diluted to 15 liters per bucket; the contents are suspended by mixing with an open hand. While a bucket is being mixed, three 10-ml samples are removed and emptied into three individual petri dishes. The live and dead larvae are counted separately, but both are counted as mortality. An average of the three samples, including live and dead larvae, are determined as larvae mortality per milliliter. The number of mortalities per bucket is estimated by multiplying the average of the three samples by 15,000. Finally, total mortality is estimated as the sum of the means of all the buckets. Mortalities were determined for two batches of cultured shad and are listed as "combined mortalities" in the data tables.

HATCHERY PRODUCTION SUMMARY FOR 2001

Waldoboro Hatchery Tank Spawning System:

Merrimack River Shad

A total of 164 Merrimack River shad were delivered to the Waldoboro Shad Hatchery between May 29 and June 14. While in the hatchery system, the Merrimack fish produced a total of 58.24 liters of eggs >2mm, equaling 3,216,715 eggs with an average viability of 79%. A total of 1,747,540 fry were produced/stocked. On June 27, 144 Merrimack River shad were released back into the wild (Table 1).

Saco River Shad

A total of 248 Saco River shad were delivered to the Waldoboro Shad Hatchery between June 1 and July 6. While in the hatchery system, the Saco fish produced a total of 9.36 liters of eggs >2mm, equaling 475,280 eggs with an average viability of 78.5%. Merrimack River eggs were hatched from incubators M14 (89,231 eggs @91.8% = 81,914 fry) and M15 (105,009 eggs @82.7% = 86,842 fry) into Saco fry Tank #2 per instruction from DMR. This combination produced a total of 546,414 fry for stocking. On June 25, 70 Saco River shad were released back into the wild (Table 2).

A second batch of Saco River fish that were delivered between July 2 and July 6, totaling 58 fish, produced no viable eggs >2mm (Table 3). These fish were delivered after the release of the first Saco batch; 31 surviving shad were combined into the Maine Mix on July 19.

Kennebec/Androscoggin River Shad

A total of 14 shad - 13 Kennebec and one Androscoggin - were delivered to the Waldoboro Shad Hatchery between June 5 and June 17. While in the system, these broodstock fish produced no viable eggs >2mm.

Maine Mix (Kennebec/Androscoggin/Saco/Merrimack River)

A total of 52 shad - two Merrimack, 46 Saco, and four Kennebec/Androscoggin - were combined into one 15' tank between June 26 and June 29. While in the hatchery system, this Maine Mix produced a total of 7.84 liters of eggs>2mm, equaling 545,659 eggs with an average viability of 86%. A total of 436,994 fry were produced/stocked. On July 26, 76 Maine Mix shad were released back into the wild (Table 4).

Of the 426 broodstock shad held in the tank spawning system, 251 (58.9%) were released back into the wild; 87% of the Merrimack River shad held in the system were released.

Fry Stocking Summary:

The following list of dates, names, locations, and numbers of fry are the American shad fry released back into Maine waters during the 2001 season:

Stock Date	Egg Source	Receiving Site	Number Released
06/21/01	Saco	Saco River - Bar Mills	313,560
07/02/01	Merrimack	Androscoggin River - Lisbon	308,596
07/02/01	Merrimack	Kennebec River - Fairfield	400,847
07/03/01	Merrimack	Kennebec River - Shawmut	440,647
07/03/01	Merrimack	Sebasticook River - Burnham	409,773
07/05/01	Saco	Kennebec River - Shawmut	232,854
07/12/01	Merrimack	Kennebec River - Shawmut	187,677
07/18/01	Saco/Kennebec/Merrimack mix	Sebasticook River - Benton Falls	209,106
07/30/01	Saco/Kennebec/Merrimack mix	Kennebec River - Fairfield	134,212
08/03/01	Saco/Kennebec/Merrimack mix	Kennebec River - Shawmut	93,676
09/10/01	Saco/Kennebec/Merrimack mix	Kennebec River - Augusta	5,496
09/10/01	Saco/Kennebec/Merrimack mix	Kennebec River - Hallowell	1,175

Total fry released = 2,730,948
Total fingerlings released = 6,671
Total Released 2,737,619

POND CULTURE

No shad fry were intentionally stocked into the ponds for rearing; however, fall fingerlings were produced as a result of fry either escaping from the hatchery culture tanks or caught when waste was removed from the bottom of the tanks. The culture tanks have a 500-micron nylon screen that fits tightly over the tank standpipe to prevent fry from escaping down the drains. Even so, when the standpipe screens are changed a few larvae escape into the drains.

Table 1. Merrimack River Egg Production

Date	Source	Tank	Incubator	Mls eggs	Eggs/10"	Eggs/L	Total Eggs	% Viability[1]	# Viable	Combined Mortality	Date Stk	# Stocked
6-Jun	Merrimack	Merr-1	M1	3,000	92	55,217	165,651	68	112,477		2-July	
7-Jun	Merrimack	Merr-1	M2	2,375	90	52,286	124,179	71	88,167		2-July	
8-Jun	Merrimack	Merr-1	M3	4,300	92	55,217	237,433	69	163,117		2-July	
9-Jun	Merrimack	Merr-1	M4	6,395	92	55,217	353,113	88	310,033	365,198	2-July	308,596
10-Jun	Merrimack	Merr-2	M5	1,000	89	50,897	50,897	83	42,194		2-July	
11-Jun	Merrimack	Merr-2	M6a	6,000	91	53,724	322,344	93	301,069		2-July	
11-Jun	Merrimack	Merr-2	M6b	2,340	91	53,724	125,714	93	117,417	59,833	2-July	400,847
12-Jun	Merrimack	Merr-3	M7	6,690	90	52,286	349,793	87	304,670		3-July	
13-Jun	Merrimack	Merr-3	M8	3,850	90	52,286	201,301	81	163,054	57,950	3-July	409,773
14-Jun	Merrimack	N/A	N/A	0	0	0	0	0	0		N/A	
15-Jun	Merrimack	Merr-4	M9	4,400	92	55,217	242,955	73	177,357		3-July	
16-Jun	Merrimack	Merr-4	M10a	2,500	93	57,569	143,923	77	110,820		3-July	
16-Jun	Merrimack	Merr-4	M10b	2,700	93	57,569	155,436	77	119,686		3-July	
17-Jun	Merrimack	Merr-4	M11	2,275	92	55,217	125,619	88	110,544		3-July	
18-Jun	Merrimack	Merr-4	M12	1,800	93	57,569	103,624	48	49,740		3-July	
19-Jun	Merrimack	Merr-4	M13	1,200	94	60,039	72,047	84	60,519	127,500	3-July	440,647
20-Jun	Merrimack	Saco-2	M14	1,550	93	57,569	89,232	92	81,915		5-July	Saco #2
21-Jun	Merrimack	Saco-2	M15	1,700	95	61,770	105,009	83	86,842		5-July	Saco #2
22-Jun	Merrimack	Merr-5	M16	625	96	63,570	39,731	89	35,361		11-July	
23-Jun	Merrimack	Merr-5	M17	900	95	61,770	55,593	55	30,576		11-July	
24-Jun	Merrimack	Merr-5	M18	850	92	55,217	46,934	93	43,649		11-July	
25-Jun	Merrimack	Merr-5	M19	600	89	50,897	30,538	93	28,401		11-July	
26-Jun	Merrimack	Merr-5	M20	400	96	63,570	25,428	64	16,274		11-July	
27-Jun	Merrimack	Merr-5	M21	790	96	63,570	50,220	68	33,949	532	11-July	187,677
							Σ=3,216,715	**μ=79**	**Σ=2,587,830**			**Σ=1,747,540**

[1] Viability of eggs >2mm

Table 2. Saco River Egg and Fry Production

Date	Source	Tank	Incubator	Mls eggs	Eggs/10"	Eggs/L	Total Eggs	% Viable[2]	# Viable	Combined Mortality	Date Stk	# Stocked
5-Jun	Saco	Saco-1	S1	450	84	42,433	19,095	95.3	18,197	.	21-Jun	
6-Jun	Saco	Saco-1	S2	750	92	55,217	41,413	83.9	34,745		21-Jun	
7-Jun	Saco	Saco-1	S3	800	90	52,286	41,829	90.0	37,646		21-Jun	
8-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
9-Jun	Saco	Saco-1	S4	2505	89	50,897	104,339	94.5	98,600		21-Jun	
10-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
11-Jun	Saco	Saco-1	S5	2980	92	55,217	164,547	84.7	139,371	15,000	21-Jun	313,560
12-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
13-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
14-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
15-Jun	Saco	Saco-2	S6	900	93	57,569	51,812	50.0	25,906		5-Jul	
16-Jun	Saco	Saco-2	S7	150	93	57,569	8,635	55.0	4,750		5-Jul	
17-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
18-Jun	Saco	Saco-2	S8	450	89	50,897	22,904	89.0	20,384		5-Jul	
19-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
20-Jun	Saco	N/A	N/A	0	0	0	0	0	0		N/A	
21-Jun	Saco	Saco-2	S9	375	92	55,217	20,706	63.7	13,190	133	5-Jul	232,854
							Σ=475,280	**μ=78.5**	**Σ=392,790**			**Σ=546,414**

[1] Viability of eggs >2mm

Table 3. Saco River Egg and Fry Production Batch II

Date	Source	Tank	Incubator		Mls eggs	Eggs/10"	Eggs/L	Total Eggs	% Viable	# Viable	Combined Mortality	Date Stk	# Stocked
6-Jul	Saco	N/A	N/A		48	99	69,404	3,331	0	0	N/A	N/A	N/A
6-Jul	Saco	N/A	N/A		225	<2mm	150,000	33,750	0	0	N/A	N/A	N/A
7-Jul	Saco	N/A	N/A		160	<2mm	150,000	24,000	0	0	N/A	N/A	N/A
7-Jul	Saco	N/A	N/A	Day eggs	110	<2mm	150,000	16,500	0	0	N/A	N/A	N/A
8-Jul	Saco	N/A	N/A		76	<2mm	150,000	11,400	0	0	N/A	N/A	N/A
9-Jul	Saco	N/A	N/A		190	<2mm	150,000	28,500	0	0	N/A	N/A	N/A
10-Jul	Saco	N/A	N/A		160	<2mm	150,000	24,000	0	0	N/A	N/A	N/A
10-Jul	Saco	N/A	N/A	Day eggs	175	<2mm	150,000	26,250	0	0	N/A	N/A	N/A
11-Jul	Saco	N/A	N/A		0	0	0	0	0	0	N/A	N/A	N/A
12-Jul	Saco	N/A	N/A		0	0	0	0	0	0	N/A	N/A	N/A
13-Jul	Saco	N/A	N/A		75	<2mm	150,000	11,250	0	0	N/A	N/A	N/A
14-Jul	Saco	N/A	N/A		210	<2mm	150,000	31,500	0	0	N/A	N/A	N/A
15-Jul	Saco	N/A	N/A	Day eggs	175	<2mm	150,000	26,250	0	0	N/A	N/A	N/A
16-Jul	Saco	N/A	N/A		145	<2mm	150,000	21,750	0	0	N/A	N/A	N/A
17-Jul	Saco	N/A	N/A		95	<2mm	150,000	14,250	0	0	N/A	N/A	N/A
18-Jul	Saco	N/A	N/A		40	<2mm	150,000	6,000	0	0	N/A	N/A	N/A
19-Jul	Saco	N/A	N/A		0	0	0	0	0	0	N/A	N/A	N/A
								Σ=278,731					

19-Jul Saco adults added to Maine Mix Adult Tank

Table 4. Maine Mix Egg Production

Date	Source[1]	Tank	Incubator	Mls eggs	Eggs/10"	Eggs/L	Total Eggs	% Viable[2]	# Viable	Combined Mortality	Date Stk	# Stocked
1-Jul	SKM	MM 1	MM 1	1,000	96	63,570	63,570	72	45,770		18-July	
2-Jul	SKM	MM 1	MM 2	1,250	99	69,404	86,755	81	70,272		18-July	
3-Jul	SKM	MM 1	MM 3	695	98	66,896	46,493	92	42,773		18-July	
4-Jul	SKM	MM 1	MM 4	250	92	55,217	13,804	79	10,905		18-July	
5-Jul	SKM	MM 1	MM 5	750	98	66,896	50,172	86	43,148	3,761	18-July	209,106
6-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
7-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
8-Jul	SKM	MM 2	MM 6	450	102	75,976	34,189	87	29,744		37,102	
9-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
10-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
11-Jul	SKM	MM2	MM7	450	104	80,823	36,370	78	28,223		37,102	
12-Jul	SKM	MM2	MM8	1,150	99	69,404	79,815	88	70,237.		37,102	
13-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
14-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
15-Jul	SKM	MM2	MM9	290	102	75,967	22,033	93	20,447	14,438	30-July	134,212
16-Jul	SKM	N/A	N/A	0	0	0	0	0	0		N/A	N/A
17-Jul	SKM	MM3	MM10	390	104	80,823	31,521	85	26,793		3-Aug	
18-Jul	SKM	MM3	MM11	775	100	71,507	55,418	92	50,984		3-Aug	N/A
19-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
20-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
21-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
22-Jul	SKM	MM3	MM12	390	97	65,436	25,520	96	24,499	8,599	3-Aug	93,676
23-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
24-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
25-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
26-Jul	SKM	N/A	N/A	0	0	0	0	0	0			
							Σ=545,659	**μ=86**	**Σ=463,794**			**Σ=436,994**

[1] SKM=Saco, Kennebec, and Merrimack mix
[2] Viability of eggs >2mm

APPENDIX B – Proposed 2001 Trap and Truck Budget

Job 1. Trap and Truck Alewives.
Transfer of broodstock alewives via tank truck will begin in May and conclude in June. With the removal of the Edwards Dam in 1999, alewives are free to migrate to the first dam on the Sebasticook River: Fort Halifax. About 90% of the alewife habitat that has been stocked in past years is in the Sebasticook drainage, which means that the majority of returning adult alewives will home to the Sebasticook River. In fact, last year (2000) about two million adult alewives were observed below the Fort Halifax Dam.

Alewives will be trapped using the Transvac fish pump and storage tank that were employed last year at Fort Halifax and in previous years at the Edwards Dam site. DMR personnel will remove trapped fish from the tank, sort all fish collected, remove undesirable species, pass other target species, and count and load alewives in the tank trucks. DMR personnel will transport the alewives and release them in the designated lake spawning habitat.

If blueback herring are captured, they may be stocked into riverine habitat above the Fort Halifax Dam. Alewife stocking goals for 2001 are summarized in Table 1.

Job 2. Trap and Truck of American Shad.
Transfer of broodstock American shad via tank truck will begin in May and conclude in July. The American shad broodstock transfers planned for 2001 can be split into two different types based upon the origin of the shad:

1) DMR's first priority in 2001 will be to obtain adult shad broodstock at the Fort Halifax Dam. The owner of the dam, Florida Power Light and Energy (FPLE) is required by the Kennebec River Settlement Accord to install, operate, and maintain all measures necessary for the capture of adult shad broodstock. DMR will transport adult shad captured at the Fort Halifax Project to the shad hatchery where they will be placed into a tank spawning system. Lengths, scales, and otoliths will be collected from all adult mortalities occurring at the Fort Halifax Project, during transport, or at the hatchery.

2) DMR will transport American shad broodstock from the Cataract fish lift on the Saco River to the DMR-funded shad hatchery. These shad will also be utilized in tank spawning, as outlined above. The Saco shad are normally collected as their run picks up in June. Light loads will be used to transport Saco shad since few fish are available per day and the lower hauling densities help to reduce hauling and delayed mortality at the hatchery.

Since DMR is obtaining broodstock from only two sites this year, each source of shad will be kept in separate tanks at the hatchery. It is expected that the minimum need for broodstock from both sources is 400 to 500 gravid adults.

Job 3. Transportation of American Shad Larvae.
DMR will load, transport, and release shad larvae produced at the hatchery. As the larvae reach 7 to 21 days old, they will be removed from the hatchery, loaded into a transportation tank, trucked to the appropriate habitat, and released. This operation begins in mid-June and may continue through mid-August.

Job 4. Assessment of Young-of-the-Year American Shad and Alewives.
DMR will sample young-of-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, or adult broodstock. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, or sampling downstream migrants at hydroelectric sites. Representative numbers of juvenile shad will be retained for otolith extraction and checked for tetracycline marks applied at the hatchery.

DMR will sample young-of-year alewives in both Great Moose Pond and Big Indian Lake, which are being stocked with broodstock alewives for the first time. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, dip or cast netting, in addition to sampling downstream migrants at hydroelectric sites or lake outlet dams.

Job 5. Assessment of Downstream Passage of American Shad and Alewives.
DMR will survey the outlet streams of lakes or ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the postspawner adult and young-of-year alewives. Potential obstacles to passage will be recorded and revisited as the emigration of alewives is observed in the river system. Much of the stream survey work will take place in late June and early July, with follow-up visits occurring as needed throughout the summer and fall.

DMR will visit hydroelectric dams, as well as others, located below shad and alewife stocking sites and make and record observations regarding the availability, quality, and effectiveness of downstream passage at these sites. The proper authorities will be notified if problems are observed. Dam surveys may begin as early as June and will take place through November and the termination of alosid emigration.

Job 6. Studies of the Fish Assemblage of the Kennebec River: Augusta to Waterville - Before and After Edwards Dam Removal.
DMR collected some baseline data on the fish community in the impounded river above the Edwards Dam during the summer and fall of 1998 and summer of 1999. In 2000, DMR sampled several sites between Augusta and Waterville to collect data on community assemblage. DMR also collected habitat type data including DO, substrate type, water temperature and depth, and flow, and made measurements of bank stability and vegetation. This effort will continue in 2001.

Sampling methods will include fyke netting, electrofishing, minnow trapping, trawling, and beach seining. Beach seines will be used as the primary means of capturing YOY fish; however, other means may need to be employed to capture adult fishes. Samples will be collected biweekly from all sites and otoliths will be extracted from all American shad captured to determine the presence of an OTC mark.

Job 7. Temporary Fish Weir on Sevenmile Brook.
DMR will install and maintain a temporary fish weir on Sevenmile Brook until the Maine Department of Inland Fisheries and Wildlife installs a permanent fish barrier and counting station. Once the permanent barrier and station are installed, DMR will tend the trap daily during the alewife run to identify and enumerate all species and to selectively pass fish upstream.

Table 1. Lakes and Ponds to be Stocked with Alewives (6 $acre^{-1}$) in 2001

Ponded Area	Surface Acreage	Stocking Target
Sebasticook Lake	4,288	25,728
Lovejoy Pond	324	1,944
Plymouth Pond	480	2,880
Stetson Pond	768	4,608
Douglas Pond	525	3,150
Pattee Pond	712	4,272
Unity Pond	2,528	15,168
Webber Pond	1,252	7,512
Wesserunsett Lake	1,446	8,676
Big Indian Pond	990	5,940
Great Moose Lake	3,584	21,504

(CALENDAR YEAR)

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$22,734.29	$39,045.82	$39,396.90	$ 24,115.58	**$125,292.59**
Materials/Supplies	$ 1,580.00	$ 1,907.35	$ 425.00	$ 825.00	**$ 4,275.14**
Operations/Maintenance	$ 910.00	$ 9,931.00	$ 3,881.00	$ 1,324.00	**$ 16,046.00**
State Indirect Cost (2%)	$ 504.49	$ 1,017.68	$ 874.06	$ 525.29	**$ 2,912.27**
Capital					
TOTALS:	**$25,728.78**	**$51,901.85**	**$44,576.95**	**$ 26,789.87**	**$148,526.00**

APPENDIX C - Proposed 2001 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

Job 1. Perform Habitat Surveys on the Main Stem and Tributaries of the Kennebec River.
A standard habitat survey will be conducted on the main stem of the Kennebec River from Waterville to Augusta. Maine Atlantic Salmon Commission (MASC) staff from the Sidney office will record quantitative measurements (length, width, depth, etc.), substrate composition, suitability for juvenile rearing, spawning, and holding habitat for salmon from the site of the recently removed Edwards Dam up to the first dam in Waterville/Winslow and provide Global Positioning System (GPS) points for habitat breaks.

In addition, the standard habitat survey will also be conducted on the tributaries entering the Kennebec River between Augusta and Waterville. The MASC staff will focus on two tributaries currently identified as potentially containing salmon habitat: Messalonskee Stream and Sevenmile Brook. The habitat survey will be handled in the same manner as the main stem survey described above. In addition to habitat surveys, temperature in both streams will be monitored during summer months.

Job 2. Produce Geographic Information System Coverages.
Using the habitat information collected above, MASC staff will produce Geographic Information System (GIS) coverages to display the location and estimate the amount of salmon habitat types available between Augusta and Waterville. Coverages will also give us the ability to display redd locations and areas of critical importance to salmon in the lower main stem.

Job 3. Assess Current Atlantic Salmon Populations in the Kennebec River and Tributaries.
The MASC staff will electrofish Messalonskee and Togus Streams and Sevenmile and Bond Brooks to establish presence/absence and/or densities of salmon. In addition, other tributaries identified as having salmon habitat will be electrofished for presence or absence of salmon.

In addition to assessing juvenile salmon populations in Bond Brook, an adult salmon trap will be installed in the fishway to enumerate and sample adults returning to spawn. The adult trap will be installed and monitored from early September to mid-November.

In a further effort to assess adult returns to the lower Kennebec River and its tributaries, a complete redd count will be conducted on all spawning habitat identified by the habitat survey described above. This will entail surveying the main stem Kennebec from Waterville to Augusta and all lower main stem tributaries to the first upstream obstruction.

Job 4. Produce Annual Report and Recommendations.
The MASC staff will produce an annual report with recommendations for future salmon efforts in the Kennebec River and its tributaries. These recommendations will be based on available habitat, current populations status, and estimated salmon production potential in the waters currently accessible to salmon.

	Q1	Q2	Q3	Q4	Totals
Personal Services	$ -	$4,175.19	$6,459.72	$6,544.59	$17,179.50
Materials/Supplies	$ 223.03	$4,337.08	$2,514.99	$1,132.19	$ 8,207.29
Operations/Maintenance	$ -	$ -	$ -	$ -	$ -
Capital	$4,410.60	$ -	$ -	$ -	$ 4,410.60
Totals:	$4,633.63	$8,512.27	$8,974.71	$7,676.78	$29,797.39

APPENDIX D – Proposed 2002 Trap and Truck Budget

Job 1. Trap and Truck Alewives.

Transfer of broodstock alewives via tank truck will begin in May and conclude in June. With the removal of the Edwards Dam in 1999, alewives are free to migrate to the first dam on the Sebasticook River: Fort Halifax. About 90% of the alewife habitat that has been stocked in past years is in the Sebasticook drainage, which means that the majority of returning adult alewives will home to the Sebasticook River.

Alewives will be trapped using the Transvac fish pump and storage tank that were employed last year at Fort Halifax and in previous years at the Edwards Dam site. DMR personnel will remove trapped fish from the tank, sort all fish collected, remove undesirable species, pass other target species, and count and load alewives in the tank trucks. DMR personnel will transport the alewives and release them in the designated lake spawning habitat.

If blueback herring are captured, they may be stocked into riverine habitat above the Fort Halifax Dam. Alewife stocking goals for 2002 are summarized in Table 1.

Job 2. Trap and Truck of American Shad.

Transfer of broodstock American shad via tank truck will begin in May and conclude in July. DMR expects to transfer about 1,000 broodstock to the shad hatchery. The transfers planned for 2002 can be split into three different types based upon the origin of the shad:

1) DMR's first priority in 2002 will be to obtain adult shad broodstock at the Fort Halifax Dam. The owner of the dam, Florida Power Light and Energy (FPLE) is required by the Kennebec River Settlement Accord to install, operate, and maintain all measures necessary for the capture of adult shad broodstock. DMR will transport adult shad captured at the Fort Halifax Project to the shad hatchery where they will be placed into a tank spawning system. Lengths, scales, and otoliths will be collected from all adult mortalities occurring at the Fort Halifax Project, during transport, or at the hatchery.

2) DMR will transport American shad broodstock from the Cataract fish lift on the Saco River to the DMR-funded shad hatchery. These shad will also be utilized in tank spawning, as outlined above. The Saco shad are normally collected as their run picks up in June. Light loads will be used to transport Saco shad since few fish are available per day and the lower hauling densities help to reduce hauling and delayed mortality at the hatchery.

3) DMR will transport American shad broodstock from the Essex fish lift on the Merrimack River to the DMR-funded shad hatchery. These shad will also be utilized in tank spawning, as outlined above. DMR hopes to saturate the hatchery with Merrimack River broodstock early in the season. Once Kennebec and Saco River shad become available, DMR will remove Merrimack origin shad from the hatchery to make room for the Maine river origin shad.

Job 3. Transportation of American Shad Larvae.

DMR will load, transport, and release shad larvae produced at the shad hatchery. As the larvae reach 7 to 21 days old, they will be removed from the hatchery, loaded into a transportation tank, trucked to the appropriate habitat, and released. This operation begins in mid-June and may continue through mid-August.

Job 4. Assessment of Young-of-the-Year American Shad and Alewives.
DMR will sample young-of-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, or adult broodstock. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, or sampling downstream migrants at hydroelectric sites. Representative numbers of juvenile shad will be retained for otolith extraction and checked for tetracycline marks applied at the hatchery.

DMR will sample young-of-year alewives in both Great Moose Pond and Big Indian Lake, which are being stocked with broodstock alewives for the first time. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, dip or cast netting, in addition to sampling downstream migrants at hydroelectric sites or lake outlet dams.

Job 5. Assessment of Downstream Passage of American Shad and Alewives.
DMR will survey the outlet streams of lakes or ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the postspawner adult and young-of-year alewives. Potential obstacles to passage will be recorded and revisited as the emigration of alewives is observed in the river system. Much of the stream survey work will take place in late June and early July, with the follow-up visits occurring as needed throughout the summer and fall.

DMR will visit hydroelectric dams, as well as others, located below shad and alewife stocking sites and make and record observations regarding the availability, quality, and effectiveness of downstream passage at these sites. The proper authorities will be notified if problems are observed. Dam surveys may begin as early as June and will take place through November and the termination of alosid emigration.

Job 6. Studies of the Fish Assemblage of the Kennebec River: Augusta to Waterville - Before and After Edwards Dam Removal.
DMR collected some baseline data on the fish community in the impounded river above the Edwards Dam during the summer and fall of 1998 and summer of 1999. In 2000 and 2001, DMR sampled several sites between Augusta and Waterville to collect data on community assemblage. DMR also collected habitat type data including DO, substrate type, water temperature and depth, and flow, and made measurements of bank stability and vegetation. This effort will continue in 2002.

Sampling methods will include fyke netting, electrofishing, minnow trapping, trawling, and beach seining. Beach seines will be used as the primary means of capturing YOY fish; however, other means may need to be employed to capture adult fishes. Samples will be collected biweekly from all sites and otoliths will be extracted from all American shad captured to determine the presence of an OTC mark.

Job 7. Temporary Fish Weir on Sevenmile Brook.
DMR will install and maintain a temporary fish weir on Sevenmile Brook until the Maine Department of Inland Fisheries and Wildlife installs a permanent fish barrier and counting station. Once the permanent barrier and station are installed, DMR will tend the trap daily during the alewife run to identify and enumerate all species and to selectively pass fish upstream.

Table 1. Lakes and Ponds to be Stocked with Alewives (6 $acre^{-1}$) in 2002

Ponded Area	Surface Acreage	Stocking Target
Sebasticook Lake	4,288	25,728
Lovejoy Pond	324	1,944
Plymouth Pond	480	2,880
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Unity Pond	2,528	15,168
Webber Pond	1,252	7,512
Wesserunsett Lake	1,446	8,676
Big Indian Pond	990	5,940
Great Moose Lake	3,584	21,504

(CALENDAR YEAR)

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$24,943.26	$41,679.25	$43,646.37	$ 26,120.62	**$136,389.50**
Materials/Supplies	$ 1,700.00	$ 1,925.00	$ 375.00	$ 500.00	**$ 4,500.00**
Operations/Maintenance	$ 1,310.00	$ 3,881.00	$ 2,581.00	$ 1,319.88	**$ 9,091.88**
State Indirect Cost (2%)	$ 559.07	$ 949.71	$ 932.05	$ 558.81	**$ 2,999.63**
Capital					
TOTALS:	**$28,512.33**	**$48,434.96**	**$47,534.41**	**$ 28,499.31**	**$152,981.00**

APPENDIX E - Proposed 2002 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

Job 1. Perform Habitat Surveys on Tributaries of the Kennebec River.
A standard habitat survey will be conducted on selected tributaries of the Kennebec River. Maine Atlantic Salmon Commission (MASC) staff from the Sidney office will record quantitative measurements (length, width, depth, etc.), substrate composition, suitability for juvenile rearing, spawning, and holding habitat for salmon and provide Global Positioning System (GPS) points for habitat breaks. Work will continue within the Sebasticook River drainage and the Sandy River.

Job 2. Produce Geographic Information System Coverages.
Using the habitat information collected above, MASC staff will produce Geographic Information System (GIS) coverages to display the location and estimate the amount of salmon habitat types available in the surveyed streams. Coverages produced from the 2001 and 2002 habitat surveys will also give us the ability to display redd locations and areas of critical importance to salmon in the lower main stem and tributaries.

Job 3. Assess Current Atlantic Salmon Populations in the Kennebec River and Tributaries.
The MASC staff will continue to electrofish Messalonskee and Togus Streams and Sevenmile and Bond Brooks to 1) add to the historical database for Togus Stream and Bond Brook, and 2) establish presence/absence and/or densities of salmon in lower main stem Kennebec River tributaries. In addition, other tributaries identified as having salmon habitat will be electrofished for presence/absence of salmon or to establish baseline fish species composition information.

In a further effort to assess adult returns to the lower Kennebec River and its tributaries, complete redd counts will be conducted on all spawning habitat identified by the habitat surveys. This will entail surveying for evidence of spawning salmon in the main stem Kennebec from Waterville/Winslow to Augusta and all lower main stem tributaries to their first upstream obstruction.

Job 4. Obtain Temperature Profiles of Selected Kennebec River Tributaries.
The MASC will monitor water temperature throughout the summer months in selected Kennebec River tributaries. Data loggers will be deployed in lower Kennebec River tributaries (e.g., Sevenmile Brook, Messalonskee Stream), in the Sebasticook River basin (e.g., Twenty-five Mile Stream), and in the mid-Kennebec River portion of the drainage (e.g., Wesserunsett Stream, Sandy River, Carrabassett River) to record summer river temperatures and to gain a better understanding of thermal regimes that may exist in streams with the potential for Atlantic salmon restoration.

Job 5. Annual Report and Recommendations.
The MASC staff will produce an annual report with recommendations for future salmon efforts in the Kennebec River and its tributaries. These recommendations will be based on available habitat, current populations status, and estimated salmon production potential in the waters currently accessible to salmon.

Job 6. Development, Updating, and Implementation of a Long-Range Restoration and Management Plan.
The MASC staff will participate in joint planning and development of a comprehensive basin-wide fish management plan with the Departments of Marine Resources and Inland Fisheries and Wildlife. Long-term planning is necessary for the proper management of the existing Atlantic salmon resource and potential future expansion of a restoration program in the Kennebec River.

Job 7. Public Outreach.

The MASC staff will participate in meetings, forums, round-tables, etc. as necessary to apprise public and private groups of MASC activities within the Kennebec River drainage. This will include interpretation, explanation, and promotion of MASC programs, policies, and concerns to the public, private organizations, stakeholders, and the media in the Kennebec River watershed.

	Q1	Q2	Q3	Q4	Totals
Personal Services	$2,013.72	$2,013.72	$6,653.53	$6,744.29	$17,425.26
Materials/Supplies	$1,200.00	$1,600.00	$1,500.00	$1,200.00	$ 5,500.00
Operations/Maintenance	$ 500.00	$1,250.00	$1,250.00	$ 500.00	$ 3,500.00
Capital	$4,500.00	$2,500.00	$ -	$ -	$ 7,000.00
Totals:	$8,213.72	$7,363.72	$9,403.53	$8,444.29	$33,425.26