Restoring Our Native Fish Resources

Kennebec River
Diadromous Fish Restoration
Annual Progress Report – 2000

Cover: FPLE, Fort Halifax project

Cover photo courtesy of Bob Richter (FPL Energy, Inc.)

KENNEBEC RIVER
DIADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT – 2000

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EXECUTIVE SUMMARY OF 2000 ACTIVITIES

In the spring of 2000, a temporary fish pump was installed below the Fort Halifax Project in Winslow, ME. Trapping of alewives began on May 4 and lasted until June 9. A record 74,775 alewives were released into Phase I habitat and an additional 49,765 were released into 28 other ponds throughout the state. 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 them on May 6 and 7 for release into both Phase I habitat and above the dam. On May 8, Florida Power Light and Energy personnel constructed a barrier made of sandbags and punch plate to prohibit alewives from entering the ledge area. Overall, the sex ratio of randomly collected samples was about 1:1 (slightly fewer females than males) and fish length/weight decreased over time. Five commercial fishermen harvested a total of 54,000 adult alewives from below the Fort Halifax project.

A total of 444 adult shad broodstock were transferred from the Connecticut and Saco Rivers, and for the first time ever, the Kennebec River. Several methods were utilized to attempt capture of adult shad below the Fort Halifax project. Initial methods consisted of 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. Of the 25 Kennebec-origin shad delivered to the hatchery, 21 were captured angling (an additional 10 were released), three were gill netted, and one was captured with the fish pump. Due to bottom morphology below the dam (irregular with boulders), the site does not lend itself to effective seining or gill netting. Techniques such as electrofishing will be investigated for 2001.

A record number of shad were produced and released from the Waldoboro Shad Hatchery. In total, 3,346,727 larval shad were released into the Kennebec River; 500,004 into the Sebasticook; and a total of 934,542 into the Androscoggin, Saco, and Medomak Rivers. Additionally, 27,598 fall fingerlings were released into the Kennebec River at the Augusta boat ramp.

In 2000, DMR contracted with the engineering and consulting firm URS to provide engineering services for the Plymouth Pond outlet, Sebasticook Lake outlet, and Guilford Industries fishway projects. Since the earliest the US Army Corp of Engineers anticipates being able to work on these projects is 2002, DMR is recommending termination of its participation in the Section 206 program and seeking alternative funding. DMR, the US Fish and Wildlife Service, and the Kennebec Coalition have already initiated fund raising efforts for these projects.

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

DMR personnel made unscheduled visits to hydroelectric dams from July to November. Bypass facilities were operating at all projects, during all visits, except at Pioneer on July 26. On September 19 and 20, dead/disoriented alosids were observed exiting the CHI-Burnham turbines at greater than 20 fish per minute. CHI project personnel were contacted immediately and over the course of September 19-21, operation was altered to provide safe passage. On October 19, Benton Falls Associates personnel informed DMR that a fish kill had occurred at the project. Immediately upon observing the kill, the second bypass entrance was opened and fish were then observed passing the project safely.

DMR personnel conducted biweekly beach seine surveys at nine sites in the Kennebec River between Augusta and Waterville. A total of 422 alewives, 437 American shad, and 249 unidentified alosids were captured throughout the summer. Additionally, six one-year old striped bass were captured in Sidney. 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, Fort Halifax, and Benton Falls projects. The primary objective of the study was to determine where juvenile eels pass, or attempt to pass, at each site. Based on three years of data, the appropriate location for upstream passage is against the retaining wall, on the south side of the dam at Fort Halifax and the east side at Benton Falls. At both projects, leakage under/around the flashboards should be minimized to facilitate attraction of eels to the passage entrance. In 2001, nighttime visual observations will be used at Burnham, Lockwood, Hydro Kennebec, Shawmut, and Weston to overcome difficulties in setting up passages at those sites.

Downstream eel passage studies were conducted using radio telemetry at both the Fort Halifax and Benton Falls projects. 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. Seven radio-tagged eels were released above the Benton Falls project. Of these, four passed through the turbines (three of which were never detected later at Fort Halifax), one passed through the downstream bypass, one over the gate or spillway, and one never passed. Since the Fort Halifax project did not operate for much of the study, passage there could not be effectively evaluated in 2000.

A new Atlantic Salmon Commission office was opened in Sidney and staffed with one biologist to coordinate salmon population and habitat assessments in Southern Maine rivers. Due to limited time and personnel, assessments in the Kennebec River were limited to redd counts in 2000. Approximately 30% of the spawning habitat in the Kennebec was examined; three redds were found in the mainstem, two in Messalonskee Stream, and one in Bond Brook. In 2001, habitat surveys will be conducted, juvenile salmon monitored through electrofishing surveys, and redd counts continued.

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."* In this plan, the goal of anadromous fish restoration in the Kennebec River was:

> "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 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 releasing fall fingerlings. Since striped bass, rainbow smelt, Atlantic sturgeon, and shortnose sturgeon will not utilize fish passage facilities, the strategy for 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 Maine Department of Marine Resources (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 beginning in 2000, the US Fish and Wildlife Service, provide funds for the continued implementation of the state fishery agencies' fishery management plan.

IMPLEMENTATION OF THE MANAGEMENT PLAN (1986-2000)

The strategy developed to meet the objectives of alosid restoration was planned in two phases. The first phase (January 1, 1986 through December 31, 2003) 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, 2004 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 Dam 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 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 1996-1999, the majority of alewives transported were collected using the fish pump at the Edwards Dam. Again in 2000, the majority of fish transported were collected with the fish pump; however, following the removal of Edwards Dam, the operation was moved upstream to the Fort Halifax project 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 2000, a record number of alewives were captured at the Fort Halifax project and released into 41 ponds throughout Maine (including all Phase I ponds that we are 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 of Maine. 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 1,1999 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 trapped below the dam were able to spawn upstream.

On June 25, 1999, DMR, in cooperation with IF&W, installed a barrier on Sevenmile Stream to exclude undesirable, non-indigenous 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. Due to high water, installation of the barrier was delayed until June 12, 2000. Once installed, it was checked weekly for cleaning and maintenance. It was removed December 5, 2000 and 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 starting in 1996. Restoration at the two remaining Phase I impoundments, Threemile Pond and Three-cornered Pond, both in the Sevenmile Stream drainage, will be delayed due to their marginal to poor water quality. Restoration at the ten remaining impoundments was contingent upon the outcome of a cooperative research project sponsored by DMR 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 Stream 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 in only Webber Pond initially. Webber was stocked in 1997 with two alewives per acre, followed by four alewives per acre in 1998, and six per acre in 1999. In 2000, Webber Pond again received the prescribed six alewives per acre. Threemile and Three-cornered Ponds will be stocked at some time in the future, based upon the level of success of the Webber Pond stocking.

In 2000, DMR continued to transfer American shad from the Connecticut River to the Waldoboro Shad Hatchery for use as captive broodstock in the hatchery's tank spawning egg take program. 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 the Connecticut directly to the Kennebec River since 1997. Rather, DMR has concentrated on providing broodstock for the hatchery's tank spawning effort.

In 2000, for the first time ever, DMR transferred broodstock from the Kennebec River to the shad hatchery. Since only small numbers of fish were available from both the Kennebec and Connecticut Rivers, additional broodstock from the Saco River, captured at the Cataract fish lift, were transferred to the hatchery. Along with the Kennebec and Connecticut 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 was increased in 1997, with expansion of the hatchery facility funded by the Maine Outdoor Heritage Fund and the KHDG. The 2000 shad culture operational budget was funded by the DMR and Kennebec River Restoration Fund. In 2000, DMR released more larval shad than in previous years (about 60% more than in 1999). Additionally, DMR released fall fingerlings into the Kennebec River. All larval shad and fingerlings raised at the hatchery in Waldoboro were from either Kennebec River, Connecticut River, or Saco River eggs and were marked with oxytetracycline prior to release.

ALEWIFE RESTORATION METHODS:

TRAP, TRANSPORT, AND RELEASE

In 2000, DMR utilized the 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 the Edwards Dam, prompted DMR to trap alewives in the Kennebec again in 2000.

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..."

By the end of April, FPLE had 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 10-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 10-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 micro-porous 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 micro-porous delivery system. In addition, the supplemental water supply utilized in past years was used again for the 2000 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 alewives 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 alewives 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.

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. 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 the 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. This porous pipe produced finer diameter bubbles and used less volume of oxygen than previous systems. These fine bubble, porous pipes are 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 is much less costly and more durable. That system was again used in the C-60 in 2000 and again performed and stood up well. Eventually, both tanks on the double tanker will be fitted with the flexible, porous, rubber tubing oxygen delivery system.

Alewives were transported from the loading site directly to the lake being stocked and immediately released. The name, location, and Phase I stocking goals for alewife restoration are provided in Table 1; Figure 1 illustrates the location of each lake.

ADULT ALEWIFE BIOSAMPLES

On eight different days between May 4 and June 15, 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 were collected 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; alewife 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 gram, sexed, and scale sampled. Water temperature was measured to the nearest degree Celsius at the time the fish sample was collected.

2000 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. 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, five 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

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[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.

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

In 1996 and 1997, approximately 20,000 alewives were released into the Edwards Dam impoundment. The subsequent behavior and sightings of these fish in the Sebasticook River below the Fort Halifax Dam, as well as their absence in other areas, confirmed DMR's belief that the vast majority would home to the mouth of the Sebasticook River. On April 20, 2000, DMR received the first report that a small number of alewives had been seen below Fort Halifax. Two weeks later, DMR was contacted by FPLE and informed that the fish pump was operational. On May 3, 2000, the pump was successful at capturing only a small number (<1000) of alewives, but DMR and FPLE agreed it was sufficient to perform a test trip on May 4. During the test, 1,976 alewives were successfully captured, 1,831 of which were transported to Unity Pond. The test was deemed successful and both DMR Kennebec River stocking trucks were brought to Fort Halifax on May 5. Trap and truck dates and numbers of all watersheds stocked are presented in Table 5 and Figure 2.

By May 6, a large number of adult alewives had congregated below the Fort Halifax Dam (hundreds of thousands?). 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 had no impact on the fish pump's ability to capture adult alewives (10,180 pumped on May 6 and 13,578 on May 7), there was the threat of a fish kill if water levels receded quickly. On May 5, 6, and 7, the first load of the day was completed by dip netting fish from the south side of the spillway, bucketing them to the top of the dam, and loading them into the single tank stocking truck. This was done for two reasons: 1) to remove fish from the ledges where they could potentially become stranded; and 2) to take advantage of their location, which was typically on the south side of the river in early morning (rather than the north side, where the pump was located). On May 6 and 7, under the supervision of DMR personnel, volunteers dip netted 5,000 and 2,375 adult alewives, respectively, from below the dam on the south side of the river and bucketed them for release into the Fort Halifax headpond. FPLE personnel then built a sandbag barrier to prevent alewives from accessing the ledges on the south shore, thereby alleviating any future stranding problems.

On May 6 and 7, the Androscoggin River Restoration Project stocking truck was loaned to the Kennebec River Restoration Project. The Androscoggin truck was used six times over 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 5,370 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.

Between May 4 and June 15, 2000, 128,741 alewives were collected with the fish pump and an additional 10,825 alewives were collected with dip nets. In all, a record 139,566 alewives were collected from below Fort Halifax over the course of 24 days. On average, 5,364 (standard deviation of ± 3,624) adult alewives were collected daily utilizing the fish pump. The variation in the number of fish collected with the pump is due to a number of factors, including environmental conditions (e.g., high water/depressed water temperatures), truck loading/trip length, and/or fish pump mechanical problems (e.g., leaky valve seals).

While overall pump efficiency (fish day^{-1}) at the Fort Halifax project was similar to historical pump efficiencies at the Edwards Dam, the timing of the run was about 10 days earlier than average (see table below). Historically (1994-2000), the mean date by which 50% of alewives have been collected is May 25. In 2000, the 50% date of alewife trapping was May 15 (Day 11 of pump operation). Likewise, the 25 and 75% quartiles were 11 days earlier than average in 2000. There are several factors that may have contributed to this earlier run. At the time of this report, none of these factors 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 the concentration of alewives below Fort Halifax. 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 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
Mean=	**20-May**	**25-May**	**30-May**

Based on seven years of data (1994-2000), the average peak date of alewife pumping is May 21 (see following chart). In 2000, the peak was on May 7 (13,578 alewives collected with the fish pump); however, there was a second, slightly lower, peak on May 16 (11,725 collected). Both peaks in 2000 are much 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 2000, if the pump had been operated continuously at the peak of the run.

Summary of Peak Alewife Trapping

Year	Peak date	Number pumped
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 21**	**15,357**

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 at the same time alewife stocking was underway. This meant there were usually sufficient Kennebec River Project personnel available to work on alewife trapping and transport. While two crew members traveled with each of the two stocking trucks, the fifth worker usually remained at Edwards to coordinate pump operations. In 2000, 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 into the tank prior to a truck's return. If too many alewives were likely to be trapped prior to a truck's return, 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 alewives 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 the 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, they 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 crew members 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 Fort Halifax, the waiting crew helped load the first tanker and accelerated its departure.

Overall, the number of mortalities to occur due to handling was low. In fact, the trucking mortality rate of 0.14% was the lowest ever. However, the pumping mortality rate of 1.12% (Table 5) was significantly higher ($p<0.05$) than the 0.01% rate of 1999. This increase was due to alewives becoming 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, 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. Extending the discharge cycle caused more pressure to build up in the vacuum 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 arrangement 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 2000, 74,775 broodstock alewives were stocked into nine of the 11 upriver Phase I lakes in the Kennebec River watershed. Threemile and Three Cornered Ponds were not stocked with adult alewives in 2000 due to a history of marginal to poor water quality. In total, 12,323 acres of lake surface area were stocked to a density of approximately six alewives acre^{-1}. Alewife stocking rates of the nine Phase I lakes which were stocked are summarized in Table 3.

The 74,775 alewives stocked in the Sebasticook and Kennebec drainage Phase I lakes in 2000 was the highest number of alewives ever stocked into these ponds. The previous highest number of alewives stocked at these sites occurred in 1997 (74,165; see following table). In total, 43 alewife stocking trips were made to the upriver ponds, the highest number of trips ever made to Phase I ponds (Table 4). All 43 trips originated from Fort Halifax, as the Kennebec River was the sole source of alewife broodstock in 2000. The alewife stocking program in the Phase I lakes required 13 days to complete, May 4 to May 17, 2000. This is more days than it took in 1998 (eight), but fewer than it took in 1999 (16), the only two years when all or most Phase I ponds were stocked. Fish pump shutdowns due to high water, lack of a full DMR crew early in the season, or mechanical failures probably led to the increased number of days it took to stock Phase I ponds in 2000, compared to 1998.

The average number of alewives released per trip in 2000 from Fort Halifax (1,739) was higher than the average number of alewives released per trip from the Edwards Dam (1,629) from 1992-1999. However, the average number of fish per trip in 2000 was lower than the average number of fish per trip in years 1997-99. The reason the average fish trip^{-1} was lower in 2000 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 "light" 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 ($trip^{-1}$)
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=	**58,059**	**35**	**1,641**

The most stocking trips completed to the Phase I ponds in one day was nine, occurring on May 7. The peak number of trips day^{-1} in 2000 was the highest number of trips completed in a single day ever. The previous high number of trips day^{-1} was in 1998, when five trips were made to Phase I ponds and three to ponds other then Phase I, for a total of eight trips on that day. The higher number of trips day^{-1} in 2000 was due to high pump efficiency (13,578 on that day), loading efficiency, and the proximity of Fort Halifax to Phase I ponds.

The year 2000 marked the second 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 alewives per acre in both 1999 and 2000. On several occasions, adult alewives were observed in Sevenmile Stream below the outlet dam of Webber Pond. However, it was unclear whether or not these fish were swimming up Sevenmile Stream 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 Stream from the Kennebec River. In 2001, the stocking of Webber Pond will be delayed in order to document whether or not fish are moving up Sevenmile Stream to the dam. If adult alewives are observed below the dam, they will be dip netted and moved directly into Webber Pond.

Non-Phase I Transfers

In 2000, transfers from Fort Halifax to waters other than the Phase I lakes totaled 49,843 alewives loaded, 78 trucking mortalities, and 49,765 stocked (Table 6). The non-phase I transfers included ponds within the Kennebec drainage (six), as well as 22 ponds in nine other drainages. Non-Phase I transfers began on May 10, to Pleasant Pond in Gardiner, and continued until June 9. DMR chose to release alewives into about

79% of the non-Phase I habitat that we were permitted to stock. DMR chose not to stock some ponds because either outreach had not been conducted in some areas (e.g., Great Moose Lake) or some ponds had existing, but small runs (e.g., Travel Pond, Turner Mill Pond, and Clary Lake). Alewives transferred to waters other than the Phase I lakes represented 35.7% of the total number trapped at Winslow.

On two occasions, adult alewives were released (1,007 fish total) directly into Martin Stream. DMR hopes to construct fish passage at the outlet of Plymouth Pond in 2001 (see **FISH PASSAGE**, page 24 of this report). To help determine the best location for the fish ladder, alewives were released below the set of falls downstream of the outlet dam. However, due to deep water directly below the dam and turbulent water downstream of that, the findings of this "study" are inconclusive. Of the 1,007 fish released, only a small number (<100) were observed upstream of the release point. Fish ladder site determination will continue in 2001. Additionally, one load of adult alewives was released directly into the Kennebec River in Hallowell (June 18). During transport, there was a massive plumbing failure, which resulted in the loss of over 300 gallons of water. It was decided to release the fish back to the river rather than risk losing all the water and killing the fish onboard.

ADULT ALEWIFE BIOSAMPLES

Between May 4 and June 15, eight 50-fish samples were collected at the Fort Halifax project in Winslow. The first seven of these samples were collected with the fish pump, the eighth with a dip net below the dam at the pump intake. In all, 400 fish were collected, identified, and measured. Six of the fish collected were identified as blueback herring, reducing the number of alewives sampled to 394. Of those 394, 48.8% were females and 52.2% were males. Early samples (May 4 and 7) contained higher percentages of females than males (64% and 52%, respectively), but subsequent samples contained higher percentages of males than females (except the last sample) (Figure 3).

In 2000, there were significant differences in length and weight, both between sexes and over time. On average, females (285±15.04 mm) were significantly ($p<0.05$) longer than males (274 mm±14.65). Additionally, on average, females (187.37±36.97 g) were significantly ($p<0.05$) heavier than males (159.45±32.34 g). However, since the standard deviations of both length and weight overlap between sexes, neither length nor weight alone can be used to discriminate sex ratios of adult alewives. Rather, they may be able to be used in conjunction with other variables such as age to estimate sex ratios of returning adults.

There was a decrease in both length (Figure 4) and weight (Figure 5) of adult alewife returns to the Sebasticook River as the run progressed. Fish collected on May 4 (293.48 mm and 220.2 g) were significantly ($p<0.05$) longer and heavier than fish collected on June 15 (259.27 mm and 138.59 g). Length decreased significantly between May 7 and May 12, May 24 and May 31, and again between May 31 and June 15. There was only one significant decrease in weight, between May 4 and May 7.

These data indicate that there may be a sex and size component to adult alewife upstream migration. The larger lengths and weights in the first two samples (May 4 and

7) are probably driven by the higher ratio of females to males, indicating that the larger, heavier females ascend the river earliest. After the third sample (May 12), there was a switch in the sex ratio, with males more prevalent than females. There was also a decline, sometimes significant, in length and weight of both males and females. Since age data was not available at the time of this report, it is unclear if the decline of length and weight is an artifact of a decline in age (i.e., larger, older fish ascending the river earlier than smaller, younger fish).

There appears to be no correlation between the number of fish collected and water temperature (Spearman R=0.15, p=0.51) (Figure 2). If temperature loggers become available in 2001, they will be placed in the Fort Halifax tailrace prior to the April alewife run to collect temperature data continuously throughout the season.

2000 COMMERCIAL ALEWIFE HARVEST

The Maine Department of Inland Fisheries and Wildlife issued five 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.

All five harvesters reported that they harvested alewives using dip nets between the end of May and the beginning of June. In all, 450 bushels of adult alewives were harvested, which roughly figures to 54,000 fish. Most fish were kept for personal use (lobster bait), but the bushels sold had an average value of $11.50 per bushel. It is likely that permits will be reissued next year with conditions similar to those imposed in 2000.

AMERICAN SHAD RESTORATION METHODS:

Similar methods were used in 2000 as in previous years. Therefore, please refer to any other KHDG report from 1987 through 1994 for details. Adult shad from the Saco and Connecticut Rivers were transported to the Waldoboro hatchery for spawning and egg take (see *Waldoboro Shad Hatchery 2000 Annual Report*, Appendix B). Prior to release, all larvae are marked with Oxytetracycline (an antibiotic which leaves a mark on the otolith, or inner ear bone) so that DMR can later distinguish adult returns as either hatchery or wild in origin. For general hatchery operational procedures, refer to the *1997 Waldoboro Shad Hatchery Annual Report*.

AMERICAN SHAD RESTORATION RESULTS & DISCUSSION:

A fish health inspection was performed on the Connecticut River shad stock in the spring of 2000. A 60-fish sample of adult American shad was collected at the Holyoke fish lift on May 18th, 2000. They were packed in ice and transported to the Inland Fisheries and 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.

Adult Transfers

No broodstock American shad were transferred directly to the Kennebec River from the Hadley fish lift in 2000. However, six trips were made to the Connecticut River to obtain broodstock for the Waldoboro hatchery from June 4-26 (see Table 7). Of the 302 shad loaded at the Hadley lift, 276 were released alive in the experimental egg take tank, resulting in a hauling mortality of 8.6%. Broodstock shad for tank spawning were also obtained from FPLE's Cataract fish lift on the Saco River. On June 12, 30, and July 21, a total of 144 shad were transported to the Waldoboro hatchery; one mortality was recorded during these transfers (Table 7). For the first time ever, American shad broodstock were collected from the Kennebec River. While several methods of capture were attempted (fish pump, floating steeppass, gill net, beach seine, hook and line), only hook and line was successful. This method was not efficient, however, so new capture techniques need to be investigated.

As in past years, the Connecticut River Technical Advisory Committee required DMR to transport shad upriver on the Connecticut as mitigation for the shad gill netted for egg take in the Holyoke impoundment and the adults transported to the Waldoboro hatchery. Four shad transport trips were made upriver on the Connecticut, from Holyoke to the Vernon Dam headpond at West Chesterfield, NH. These trips resulted in a total of 987 adults stocked in West Chesterfield, with 20 mortalities recorded during these trips (Table 7).

Juvenile Sampling

During the field season's beach seining effort, 383 juvenile shad were captured. Nine new beach seining sites were created on a 17-mile stretch of river from Fort Halifax Park to the old Edwards Dam site in an effort to document species composition and frequency. There were 100 separate beach seine deployments at 21 sites throughout the field season. For a complete description of study sites and methods, see **FISH COMMUNITY ASESSMENT,** page 32 of this report.

Shad Culture

The experimental shad culture program initiated in 1991 was continued in 2000. The Kennebec River Shad Restoration Program is a cooperative effort between the Maine Department of Marine Resources (DMR), the Kennebec Hydro Developers Group (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.

On the evenings of May 30-31 and June 1-10, 2000, a total of 2,658,616 eggs were taken from ripe and running females in the Connecticut River. These eggs were obtained and transported by Normandeau Associates to the hatching facility located in Waldoboro, ME. The eggs were disinfected and then placed in four custom-built upwelling egg incubators where they remained until hatch out. Of the 2.6 million eggs taken, an estimated 1,728,100 hatched (65.8%). After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp.

On June 4-26, DMR personnel successfully transferred 276 adult American shad broodstock from the Holyoke fish lift on the Connecticut River to the Waldoboro hatchery for experimental tank spawning (Table 7). 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, as described above.

Between June 12 and July 21, DMR personnel successfully transferred 143 adult American shad broodstock from the Cataract lift on Maine's Saco River to the Waldoboro hatchery for experimental tank spawning (Table 7). One stocking trip was made to the Saco to release shad fry, on July 10. In 2000, a total of 259,090 larvae were released below Bar Mills on the Saco. The remainder of the Saco-origin fry was released in the Kennebec and Sebasticook Rivers.

Between June 1-2, a total of 35 adult American shad broodstock were captured at or near the tailrace of the Fort Halifax Dam; 25 of these were transported to the hatchery. Shad could be observed with regularity from the upper power canal deck works, situated some 25 feet above the tailrace. Small schools of shad (10-15 individuals) could be seen on bright, sunlit days entering the tailrace of the project. They would linger for a brief period of time 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. On June 22, a gill net was deployed in the Halifax tailrace by DMR, E-Pro, and FPLE personnel, while the turbines were shut down. Three adult shad were captured as soon as current was re-established in the tailrace. Personnel activity by DMR, E-Pro, and FPLE in the tailrace freed debris that soon rendered the gill net ineffective and operations were ceased. The fish pump captured one American shad. On June 21, a seine net was deployed across the tailrace; no shad were captured using this method, most likely due to the irregularities of the bottom, which caused gaps under the net. The floating Alaskan steeppass installed in the Fort Halifax tailrace also failed to capture any shad. The remaining 31, 21 of which were transferred to the hatchery, were captured by angling; ten were released.

From June 23 through August 4, an estimated 2,553,994 shad larvae ranging from 14-23 days old were released into the Kennebec River at three sites in the Hydro Kennebec (UAH) headpond (Table 8). On June 23, an estimated 792,733 shad fry were released at Fort Halifax Park in Winslow. On July 3 and 17, a total of 500,004 shad larvae were released into the Sebasticook River in the tailrace of the Burnham Dam. The 3,846,731 larvae released into the Kennebec drainage is the largest number released to date (Figure 6).

DMR's decision to stock a portion of the shad larvae available in 2000 into the Sebasticook River was based on several factors. 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. Larvae stocked in 2000 will return in 2005 as five-year-old spawners. Larvae stocked below Lockwood and Fort Halifax may not have the same strong urge to pass back up over these dams, as would larvae stocked and imprinted with a more upriver stretch above one of these barriers. Trapping shad in a fish passage facility at one of these sites will be a more effective means of acquiring live, healthy broodstock than gill netting or attempting to trap shad in the open segment of the Kennebec River below Waterville.

DMR viewed the Sebasticook River as the logical choice to receive some of the shad larvae in 2000 for several reasons. First, an upstream fish passage and trapping facility will be built at Fort Halifax in 2003 (or the dam removed) to support the burgeoning alewife 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 2000. The runoff from the upwelling incubators drains into these ponds, however, and it was discovered that some eggs/larvae were drawn out by the action of the incubators into the ponds. Since the numbers of larvae were unknown, the ponds were monitored and the larvae fed according to schedule. The ponds were seined on September 19th and 27,325 fall fingerlings were stocked at the Augusta boat ramp (Table 9). The number of fingerlings released in 2000 was slightly higher than average (Figure 7).

On August 2, 80 American shad were to be transferred back to the Saco River where they had originated. It was determined that the shad had been contaminated with Formalin (used as an anti-fungal treatment) one day prior and that under federal guidelines, could not be released for fear of human consumption. The shad were dispatched and data on length, weight, sex, gonad condition (post spawn), and age were collected.

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 they were completed. Fishway construction is the responsibility of hydropower dam owners; they bear all costs associated with fishway construction and operation. As part of the *Settlement Accord,* the State agreed to take the lead in seeking fish passage for four non-hydro dams on the Sebasticook River, which included the outlet dam on Pleasant Lake, the outlet dam on Plymouth Pond, and the two mainstem dams in Newport (Figure 8). The owners of the Fort Halifax Dam are required to provide interim trapping of alewives and shad in 2000 in order to continue the interim trap and truck program; they are required to provide state-of-the art passage by May 1, 2003 or remove the dam. Passages at the next two upriver hydroelectric dams are required to be operational by May 1, 2002, but this requirement is contingent upon the installation of permanent or temporary upstream fish passage at Halifax and permanent upstream fish passage at the four aforementioned non-hydro dams.

In reference to passage effectiveness studies, section III (F) of the KHDG Agreement provides that:

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

At the March 2, 2000 Annual KHDG Meeting, Mr. Kevin Webb, CHI Energy, Inc. (Burnham Hydroelectric project), presented a letter to DMR stating his intent to conduct passage effectiveness studies in 2000. However, at the time of this report, the results of that study were unavailable. DMR will pursue effectiveness studies at the remaining projects in 2001.

LAKE OUTLET MONITORING

Lake outlet streams were not surveyed during the 2000 field season due to tight constraints on available time in the field. In the past, this task was usually performed after the alewife and shad stocking seasons had ended. A busy schedule of beach seining for the community assessment project took top priority over lake outlet monitoring. Whenever possible, areas known to be past problems for out-migrant alosids were inspected and debris/blockages removed.

HYDROPOWER DOWNSTREAM PASSAGE MONITORING

Downstream passage at hydropower facilities located on the Sebasticook and Kennebec Rivers were monitored through the summer and fall (Table 2). 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 2, while locations are illustrated in Figure 1.

FISH PASSAGE RESULTS AND DISCUSSION:

The 1999 Annual Report proposed that passage be provided at the following dams on the Sebasticook River by 2001: Sebasticook Lake outlet dam (Newport); Guilford Dam (located downstream of the Sebasticook Lake outlet dam); Pleasant Pond outlet dam; and Plymouth Pond outlet dam (Figure 8). The United States Fish and Wildlife Service (USFWS) 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 USFWS 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 USFWS estimate.

In 1999, the Town of Stetson decided to rebuild the spillway of the Pleasant Lake outlet dam. DMR contacted the Town to see if it would install the fishway in conjunction with the reconstruction of the spillway. The Town agreed it would be to everyone's benefit if the fishway were installed during spillway reconstruction. The ACORE could not undertake the fishway project in 1999, so 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).

In 1999, DMR and the Town of Stetson also worked with the NRCS, American Rivers, and the USFWS to remove the remnants of the Archer Sawmill Dam. 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. All removed debris was disposed of on the easement grantor's property. Disturbed areas were stabilized with stone and vegetation as specified by NRCS biologists and left in as natural a state as practicable. The cost of this removal was completely funded by NRCS and the USFWS. DMR was the co-applicant for this project and applied for and received the necessary permits.

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. At this time, DMR is recommending that its participation in the Section 206 program for the other three projects be terminated. The earliest that fish passage could be built under this scenario would be in 2002. With the program's uncertainty in funding and the likely higher project costs, DMR is seeking alternative monies and recently contracted with the engineering and consulting firm URS to provide services, at least through final design, and including assistance in obtaining all necessary permits for the three sites.

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. Two channels 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 is in the process of obtaining a mutually satisfactory Lease Agreement that would allow DMR to construct, maintain, and operate a fishway at this dam. Currently URS is preparing conceptual designs and cost estimates for this site along with initiating the permitting process.

DMR has already applied for funds for the Plymouth Pond project; recent cost estimates indicate that the fishway would cost approximately $100,000. To date, DMR has received approximately $60,000, 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 USFWS Gulf of Maine Project; and a $20,000 pledge from the Natural Resources Conservation Service (NRCS). NRCS may be able to provide up to 75% of the actual construction costs for the Plymouth Pond fishway. DMR will provide at least $20,000 for this project, much of which will be for engineering services. Current plans are to have fish passage installed at the outlet of Plymouth Pond during the summer of 2001.

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 would take the form of a pool and chute fishway on its eastern side. Concerns with fishway design include accessibility by the public for viewing, potential impacts on downstream bridge abutment, 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.

Newport also owns the 80-year-old Guilford Dam. The structure is in poor shape at best, yet provides water for fire control at Guilford Industries. An alternative supply of water must be found prior to its removal. The Town of Newport views the dam as a maintenance liability. Another issue facing the removal of the dam is the Rt. 2 bridge, immediately upstream of the site. The potential for hydraulic damage to the bridge piers (footings) is currently being reviewed. There is concern from Newport with long term or hidden impacts to the dam's removal. DMR's approach has been to partner with the Town of Newport to remove the dam by obtaining outside funding and supporting Newport and Guilford Industries in their efforts to fund alternative fire water supply.

DMR has had several meetings with the Newport Town Manager and other town officials to discuss fish passage at the Guilford Dam and the Sebasticook Lake Dam. One of these meetings was also attended by representatives from the Kennebec River Coalition, IF&W, the ASC, the USFWS, and the National Marine Fisheries Service. Town officials have expressed support for fish passage at these two dams and are interested in looking at the option of removal of the Guilford Dam. Currently, URS is preparing conceptual designs and cost estimates for these two sites, along with initiating the permitting process. The current plans are to provide fish passage at both sites in 2001.

LAKE OUTLET MONITORING

In 2000, lake outlets were surveyed after the alewife trap, truck, and release season ended to note any difficulties with downstream migration of both adult and juvenile alewives. 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 10). The **Sebasticook Lake** outlet was checked on eight days due to extreme low water conditions on the Sebasticook River, to ensure minimum flow requirements were being met. **Plymouth Pond** was checked on seven days from July 14 through October 17. Passage was available on three of the seven visits. Two of those visits found passage available only over the dam spillway. DMR is currently seeking assistance from the ACORE for the installation of fish passage on Plymouth Pond to improve both up- and downstream passage. **Pleasant Pond** in Stetson was visited eight times from July 14-October 17. Of those eight visits, downstream passage was available only three times. The outlet of Pleasant Pond had beaver dam construction at the inlet to the steeppass on three visits. On each occasion, the beaver dam was removed to allow flow down the steeppass section. Between August 18 and August 28, town workers installed a gate and lock on the steeppass entrance, effectively blocking downstream passage until fall water levels rose. In mid-October, DMR requested that the dam operator pass water down the fishway to provide alewives with a means to exit the pond, as well as provide water for zone of passage downstream. In subsequent visits, no water was passing through the fishway, but the gates were left open about an inch on the bottom and the operator was opening/closing the gates when schools of alewives were present. DMR personnel observed juvenile alewives above the dam on two visits. **Wesserunsett Lake** in Skowhegan was surveyed six times from July 14-October 17. The last three inspections found 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.

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 sporadically for downstream passage throughout the field season. Unity Pond has no outlet dam and has excellent downstream passage into the Twenty-five Mile Stream on all but the driest of years. **Unity Pond** outlet was checked three times. In early October, pond levels had risen enough to allow juvenile alewives to leave Unity Pond. **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 three visits to Webber Pond, there was adequate spill to allow passage. **Pattee Pond** has no outlet dam and in the past has demonstrated excellent out-migration of alewives. The low water levels during the summer and early fall of 2000 made passage out of Pattee Pond difficult, if not impossible. Reports of alewives trapped in the pond after ice-up have been numerous. It is not known whether new beaver dams have been built on the outlet or water levels were so low that passage became impossible.

HYDROPOWER DOWNSTREAM PASSAGE MONITORING

In 2000, DMR made frequent site visits to hydro projects on the Sebasticook and Kennebec Rivers. At each hydro project, observations concerning availability of downstream passage and presence/absence of juvenile alosids were noted (Table 11).

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 aide in excluding alewives from the turbine forebays. This downstream bypass configuration and operational regime was approved by the FERC order issued on September 30, 1996 and was utilized again during the 2000 season.

DMR made 13 complete visits to the **Fort Halifax** Dam in 2000. All visits found the downstream bypass open and functioning. During the late September and early October visits, alewives were observed using the downstream bypass; a few dead fish were observed stuck to the overlay to the entrance of the turbine forebays. DMR personnel were granted access to the site without FPLE supervision, which greatly eased the burden of coordinating schedules.

Along the south side of the Sebasticook River, below the **Fort Halifax** spillway, lies a large ledge. Due to high spring flows, several flashboards along the south side of the spillway were missing, allowing water to flow over the spillway and onto the ledge. This caused thousands of alewives to be attracted to the south side of the river and up into the pools that had formed on the ledge. On May 8, FPLE personnel constructed a barrier of sandbags and aluminum punch plate to block the alewives access to the ledge area. Additionally, FPLE personnel monitored that area daily and removed any alewives that made it past the barrier to the pools upstream of the barrier. On June 3, FPLE biologists reported to DMR that approximately 200 adult alewives were found dead amongst the ledges along the south side of the Sebasticook River below the Fort Halifax Dam. DMR scientists determined that the fish had become stranded in a ledge pool due to a sudden drop in river level. FPLE has been investigating more effective means of blocking alewives from entering the ledges.

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 21 visits in 2000, beginning May 4 and ending November 11. The bypass was open and operating during all of the site visits except May 4. American shad fry were stocked in the river above the Benton Falls project during the summer of 2000, as they were in years past. On two visits, DMR personnel observed young-of-the-year alosids either above or below the site. On October 19, Kleinschmidt Associates (KA) personnel observed dead alosids below the project. They immediately informed both the project operator and DMR. The project operator immediately opened the second entrance to the juvenile bypass, which alleviated the problem. Both entrances to the downstream bypass remained open for the remainder of the season. There were no problems associated with debris from the headpond plugging the bypass entrances, as in 1999.

In August 2000, a consent agreement was signed by Benton Falls Associates (BFA) and the State of Maine to resolve the alleged violations by BFA identified in the DEP's Notice of Violation (December 7, 1999). The violations were based on the failure of BFA to keep the downstream passage facility clear of debris and fully operational on or about October 11 and 12, 1999, which resulted in the death or injury of out-migrant juvenile alewives. The terms of the agreement were that BFA would pay $3,500 to the State of Maine General Fund and $14,000 to the Kennebec Restoration Fund. Additionally, BFA is responsible for making visual observation of the tailrace area twice a day for the presence of dead/distressed alosids. A report of these observations is due to DMR by December 31 of each year. If dead or distressed alosids are present, BFA is to contact DMR and make modifications to project operation to provide safe downstream passage of out-migrant alosids. In conjunction with DMR, BFA may study means of providing safe and effective (temporary) downstream passage while maintaining full project generation.

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 cfs and 225 cfs. During subsequent consultation, both DMR and USFWS 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 were to take place at the Burnham project, then CHI would either increase the bypass flow or shut down the turbines during alewife migration.

At an April 2000 meeting of CHI, USFWS, and DMR, it was agreed that a site visit be made by the agencies to observe the bypass in operation when out-migrant alewives were present. On September 19, 2000, Kevin Webb (CHI-Burnham) met with USFWS personnel during the day and DMR representatives in the evening. During the DMR visit, CHI-Burnham personnel informed DMR that 20 cfs was passing through the downstream bypass and one turbine was operating at 100% and the second at 50%. Along with Mr. Webb, DMR scientists observed juvenile alewives in the headpond, at the trash racks, but not passing downstream. There were some alewives impinged on the trash rack screens from earlier flow tests observed by the USFWS. Upon Mr. Webb's departure, the DMR scientists moved downstream to make observations in the tailrace of the project. At 1800 hours, they observed over 20 fish $minute^{-1}$ exiting the turbine, either dead or distressed. DMR immediately recommended to the project operator and supervisor that turbine inflow should be reduced and/or bypass flow increased. At the time, neither CHI-Burnham representative was willing to make those changes. Upon returning to the DMR office that night, there was a message from the project supervisor indicating that generation had been reduced to one turbine and there were plans to increase bypass flow the next day.

On September 20, DMR scientists returned to Burnham to observe what changes had been made to project operation and what impact those changes had on out-migrant alewives. During this visit, all three turbines were operating, but bypass flow was increased to 125 cfs. While juvenile alewives were using the downstream bypass, DMR personnel did observe over 20 dead/distressed alewives $minute^{-1}$ exiting the turbines. DMR personnel again recommended a reduction in generation or increase of bypass flow. On the morning of September 21, DMR scientists made a third visit to the Burnham project. During this visit, one turbine was operating at 100%, a second at 75%, and the downstream bypass flow was 125 cfs. While juvenile alewives were observed in the headpond, at the trash racks, using the downstream bypass, and in the river below the dam, none were observed exiting the turbines. During that visit, no dead or distressed alewives were observed above or below the Burnham site. At the Annual Kennebec River Diadromous Fisheries Meeting on February 14, 2001, and in a February 27, 2001 letter, CHI indicated that the downstream bypass flow would be kept at 20 cfs in 2001 except during Sebasticook Lake drawdown, at which time the bypass flow will be increased to 125 cfs.

In 2000, 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. Pioneer's owner, Chris Anthony, has made some attempt to comply with the requirement to reduce trash rack spacing to one inch from June 15 to November 30. The metal mesh overlay, which was hung over the project racks in past years and utilized for the 2000 season, does have a small, clear space which would probably physically exclude alewives from passing through it. 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 nine site visits conducted by DMR in 2000, observations indicated that downstream passage through the bypass was available eight times. Juvenile alewives were observed using the downstream passage facilities on August 7 and 18.

DMR visited the **Waverly Avenue Dam** on 10 days during the 2000 season. All 10 visits revealed some type of downstream passage available at the site. Problems encountered during the 2000 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 twice during the 2000 season.

DMR visited both the **Lockwood** and **Hydro Kennebec Dams** as often as possible in 2000. Both of these projects are located on the Kennebec River and must pass all downstream migrant alewives from the Wesserunsett Lake alewife restoration effort. During the 2000 season, interim downstream passage at Lockwood was made available over the crest of a trash sluice, which is located near the turbine trash racks or through a notch located near the power canal gates. This notch was clogged with large river borne debris consisting mainly of massive tree trunks. No interim downstream bypass was available at the Hydro Kennebec project other than passage through the two large turbines. No post spawner or YOY alewives were observed at either site by DMR personnel. More regular visits will be attempted during the summer and fall of 2001.

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 these species, as well as other anadromous species (e.g., American shad, blueback herring, and rainbow smelt) in this newly reopened stretch of river. 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

Beginning in late June, Kennebec Project personnel surveyed the 17-mile stretch of the Kennebec River from the Fort Halifax and Lockwood Dams to the 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 as sites 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 nine sites will be sampled between Waterville and Augusta. Once selected, each site will be sampled biweekly from June/July (immediately following alewife/shad stocking) until October.

BIOLOGICAL SAMPLING

A 17-foot johnboat equipped with a jet drive will be 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 the seine. The beach seine would be flaked onto the bow of the johnboat. Having landed at the survey site, a crew member 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 crew member would debark, taking the other end of the net to shore where the haul would be completed.

BIOLOGICAL DATA TO BE COLLECTED

In order to best understand the structure of the fish community present, every species of fish (diadromous and resident) will be examined. Total number of fish caught will be assessed, as will number per species. Total length will be assessed up to 100 diadromous fish per species and up to 50 per resident species. A random sample of 20 American shad *(Alosa sapidissima)* will be placed in 70% ETOH (ethyl alcohol) and brought back to the DMR office in Hallowell for otolith work. The otolith work will be conducted to determine if shad are of hatchery origin or naturally spawned.

PHYSICAL DATA TO BE 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. Data concerning river discharge will be obtained from USGS gauging stations.

Once a year (during August), a more detailed investigation of site physical characteristics will be conducted. Transects will be constructed at each sample site perpendicular to river flow and will extend from one bank to the other. River depth, water velocity, dissolved oxygen, and temperature will be measured. Additionally, qualitative estimates will be made concerning presence of aquatic vegetation, riverbank stability, riparian zone widths, and riverbank vegetation.

DATA ANALYSIS

Comparisons of species compositions will be assessed both within years between sites and among years between sites, when the data becomes available. Additionally, the data can be incorporated into an Index of Biotic Integrity (IBI). IBI models have been utilized successfully 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.

FISH COMMUNITY ASSESSMENT RESULTS AND DISCUSSION:

On June 12, a survey trip was made from the Waterville boat launch to the Sidney boat launch. Several sites were selected on this trip. On June 13, the remainder of the river was surveyed from the Sidney boat launch to the Augusta boat launch and another group of sites were selected. Seining surveys commenced on June 27. A total of 21 sites were tried throughout the season. Many of them were seined only once and found to have various obstructions such as large cobble, logs, and ledge. Others appeared to be excellent survey sites until the seine was deployed and the current took over. In the end, nine locations were chosen as regular survey sites due to the repeatability of seining effort (Figure 9).

Species composition varied widely both from site to site and within sites over time. Twice throughout the field season, high water flow on the Kennebec delayed regular beach seining schedules. Three to four project personnel were present during beach seining operations. Two separate beach seines were used throughout the sampling season. From June 27-July 7, a 6′ x 60′ x ¼″ delta mesh net was deployed. From July 19-October 25, an 8′ x 150′ x 3/8″ delta mesh net with an 8′ x 8′ x 8′ x ¼″ delta mesh bag was deployed. This latter beach seine provided nearly three times the area sampled for only a fraction more effort. The bag is 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 is hauled. A total of 100 seine hauls were made during the community assessment survey. A total of 5,660 fish were captured, identified as to species, and measured for total length. Fish of questionable identity were placed in 70% ethyl alcohol (ETOH) and will be identified at a later date. For a breakdown of anadromous and sportfish captured by site, refer to Table 12.

On August 28 and September 8, transects of the Kennebec and Sebasticook Rivers were taken. 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 were less than 1.5 meters, then one measurement of flow, temperature, and dissolved oxygen would be taken in the middle of the water column. Substrate composition (if visible), as well as aquatic vegetation coverage, was also noted. This process would continue until the far shore was reached. At the far shore, another measurement of the linear depth of the riparian zone was taken, along with notes on erosion levels. General observations of the dewatered Edwards impoundment are encouraging. Erosion levels are highest close to the dam site and diminish as you move towards Waterville. Bank slumping is most prevalent where the headpond was deepest. Multiple species of vegetation have moved in to re-colonize the exposed shoreline. Where once the headpond was too deep to support aquatic vegetation, there now exist small colonies of plants taking hold.

AMERICAN EEL:

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord* requires that KHDG dam owners and DMR, in consultation with NMFS and USFWS, 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 eel 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 2000, upstream passages were installed at five of the seven KHDG facilities. A full-length passage was designed, built, and installed at the Fort Halifax project and one portable passage was installed at each of four additional projects (Benton Falls, Lockwood, Hydro Kennebec, and Shawmut). A full-length passage was used at Fort Halifax because of study results in 1999, when the number of migrating eels far exceeded the capacity of the portable passages that had been installed.

The passage at **Halifax** was two feet wide, four inches deep and included an 8.75-foot ramp parallel to the dam, angled at 30°; a two-foot level resting area; a 16-foot ramp extending from the resting area to the top of the flashboards, angled at 43°; an eight-foot ramp extending over the headpond, angled at 10°; a collection chute made of flexible tubing and stovepipe; and collection box (Figure 1). Because electricity was not available on the south side of the dam, a hydro-ram pump supplied attraction water. Approximately two gallons minute^{-1} were delivered to the top of the collection chute and eight gallons minute^{-1} were supplied to the lower end of the ramp about two feet above the resting area. Climbing substrate (Enkamat 7220 flatback) was stapled to the bottom of the passage along its entire length.

Portable passages were installed at the remaining sites. At three sites, the passage was a self-supporting wooden ramp, six feet long, one foot wide, and four inches deep; a shorter two-foot ramp was used at the Shawmut project. Climbing substrate was stapled to the bottom of the passage, and an aluminum cover was added to reduce predation. The ramp of each passage was angled at approximately 35°. Eels that used the passage were captured and retained alive in a bucket suspended from the top of the passage. A siphon hose in the headpond delivered two to five gallons minute^{-1} of water to the passage. Half of the water was directed down the passage to attract eels, and the other half was used to wash eels from the top of the passage into the capture bucket.

Installation of the passage at the south side of the **Fort Halifax** Dam began on June 5, after flashboards were erected, and was completed on June 21. The passage was operational until July 28, when attraction water was discontinued due to shortage of staff. It was restarted on August 15 and operated until August 22. Catches from June 21-29 are probably underestimated because eels were able to escape from the collection box. The pump supplying attraction water stopped working sometime during the night on July 6 and again on the 15th.

The passage at **Benton Falls** originally was installed on June 29, approximately 100 feet south of the dam in a secondary channel created by spill over the flashboards. It was moved to a location immediately below the east side of the dam (Figure 2) on July 14 on the basis of nighttime observations made on July 12. The catch from July 17 may be underestimated because of a snapping turtle that had taken up residence beneath the passage entrance overnight. The passage was operated until July 28, when attraction water was discontinued. It was operated again from August 15-24.

At the **Lockwood** project, a portable passage was installed on July 7, the day the flashboards were erected. FPLE installed taller flashboards (sheets of plywood) on the east side of the spillway, as requested by DMR. However, when the headpond was refilled, leakage under the plywood completely inundated the passage and prevented its redeployment. On July 14, FPLE personnel reduced the leakage with a plastic tarpaulin and retrieved the passage. The following day, the mainstem Kennebec River received three inches of rain and the passage was washed away. By the time it was safe to work below the dam, the upstream eel migration had nearly ceased and a new passage was not deployed.

A passage was installed June 27 at the **Hydro Kennebec** project above the western side of the tailrace. It operated until July 28, except for June 27, July 17, 21, and 26, when either high water rendered the passage inoperable or algae blocked the siphon hose and stopped the attraction water. It was restarted on August 14 and operated until August 24.

Because equipment must be carried a considerable distance, a short portable passage was set up at the **Shawmut** project on June 29, below the eastern side of the dam where spill enters the main channel of the river. The passage was rendered inoperable by spill and reset on three consecutive days (July 5-7). Flashboards were lost at the Shawmut project following three inches of rain on July 15 and the passage could not be reset for the remainder of the month. By the time flashboards were replaced, the upstream eel migration had nearly ceased at other locations and the passage was not redeployed.

In general, passages were operated continuously and tended daily, Monday through Friday. Occasionally, a passage was tended on the weekend if large numbers of eels were migrating. If the number of eels captured at a project was less than 150, all eels were counted and total weight recorded. If catches exceeded 150, all eels were weighed and the number estimated from subsamples. Approximately every 10 days, subsamples of 100 eels each were weighed and measured and these were used to estimate numbers of eels in large catches. After biological data were recorded, eels were released above each dam into the headpond. Environmental data were also recorded daily.

Results

An estimated 81,626 migrating eels were passed at **Fort Halifax** in 2000, an 86% decrease compared to 1999 (Table 1). Although different methods were used in the two years, nighttime observations indicated that the enormous numbers of eels seen in 1999 did not materialize in 2000. Approximately 90% of the eels moved upstream within a 30-day period (Figure 3A), similar to the pattern seen in 1999. The size distribution in the two years was similar; eels ranged from 8.0-19.9 cm total length, but most were 10.5-10.9 cm (Figure 4A). During a nighttime visit to the site, DMR personnel observed that eels accumulated along the base of the dam (southern 220 feet), presumably attracted by leakage under the flashboards. As in 1999, very few were seen on the face of the dam.

Approximately 37,207 eels used the passage at **Benton Falls** during a 10-day period (Figure 4B), more than twice the number passed in 1999 (Table 1). The apparent difference in the migration pattern in the two years (protracted in 1999, contracted in 2000) may be the result of using different types of gear deployed in different locations. The size distribution was similar to the previous year; eels ranged from 8.5-27.0 cm, but most were 10.5-10.9 cm (Figure 4B). Eels apparently swim along the main channel of the river until they reach the dam and then ascend the ledge to the highest pool on its eastern side. During a nighttime visit, DMR personnel observed eels climbing the ledge below the dam with apparent difficulty, judging by their slow progress.

Approximately 6,462 eels used the passage at the **Hydro Kennebec** project in 2000, representing a tenfold increase from 1999 (Table 1). The eels appeared in a very short five-day pulse between July 24 and 28 (Figure 3C), 17 days after flashboards were installed at Lockwood and 10 days after heavy rainfall. This pattern was very different than in 1999, when the migration period was protracted. The size distribution of eels in 2000 was not the same as that in 1999. The 2000 distribution was bimodal with a major peak at 10.5-10.9 cm and a minor peak at 11.5-11.9 cm (Figure 4C); in 1999, the distribution was unimodal with a peak at 10.0-10.4 cm.

Late installation of the flashboards, leakage under the boards, and spill over the boards at **Lockwood** prevented timely installation of the passage and no eels were captured at this location. During the drawdown on July 7, DMR personnel inspected the base of the dam from the eastern shore to the Winslow/Waterville bridge looking for concentrations of stranded eels. They were found along this entire length of spillway, although it appeared that smaller eels were concentrated to the east and larger eels, along the canal wall.

At the **Shawmut** project, a total of 19 eels used the passage from June 29-30. These eels were not measured.

Discussion and Recommendations

The appropriate location of upstream passage for American eel has been determined for the Fort Halifax and Benton Falls projects. At Halifax, the passage should be placed on the southern side of the dam, against the retaining wall. The design developed by DMR probably can accommodate passage of 100,000 eels, but whether it can accommodate 500,000 is not certain. Leakage under the flashboards should be decreased to facilitate attraction of eels to the passage entrance. In addition, filling the small pool (approximately 5' x 5') below the resting area would eliminate stranding of eels. At Benton Falls, the passage should be placed on the eastern side of the dam, against the retaining wall. Leakage under the flashboards should be decreased to facilitate attraction of eels to the passage entrance.

In 2001, nighttime visual observations will be used at Burnham, Lockwood, Hydro Kennebec, Shawmut, and Weston to overcome difficulties in setting up passages.

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 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 the Fort Halifax Project, 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 on Twenty-five Mile Stream, approximately two miles downstream of Unity Pond. Twenty-five Mile Stream enters the Sebasticook River approximately 14 miles above the Benton Falls project.

Radio telemetry equipment was installed and calibrated at the two sites between August 14 and September 26. Three automated scanning receivers (Model SRX-400, Lotek Engineering, Newmarket, Ontario, CA) were deployed at Benton Falls and seven (same model, provided by FPLE) were deployed at Halifax to record the passage of radio-tagged eels. Three types of antennas (9-element Yagi, 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 (coaxial cable with distal 18" of insulation removed) were inserted inside braided nylon line or 1" 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 between.

At **Benton Falls**, one 6-element Yagi was used to monitor the turbine intake area and a second 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 undergoing repair during the entire study and was not monitored this year.

At **Fort Halifax**, a 9-element Yagi monitored an area from several hundred yards above the dam to the railroad bridge below; a 6-element Yagi monitored the headpond between the safety line and the dam; these antennas were attached to a single receiver via a switcher. A third 6-element Yagi scanned the water immediately below the spillway and 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. A final dropper was deployed in the bypass; however, current speeds through the bypass were so high that the probability of detecting a tag was about 33%.

Only downstream migrating female eels were used in this study because their large size ($\geq$400 mm) makes them particularly susceptible to turbine injury or mortality. Eels to be radio-tagged were removed from the weir and individually placed into a cooler containing a solution of Eugenol for five to ten 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 11 mm in diameter, 36 mm long, weighed 5.9 g in air and 2.6 g in water, and had a typical operation life of 100 days. The tags emitted a coded signal every five seconds at 149.480 MHz.

Eels were tagged and released on three dates (Table 2). On September 26, the eels were tagged at the weir site between 8:30-10:30AM and released at 5:45PM. On October 19, eels were tagged at the weir sites between 8:30-10:30AM and released at 11:30AM. On November 8, eels were transported in air from the weir to the University of Maine at Orono, held in well water for five hours, tagged, transported in air to Benton Falls, and released at 5:45PM; these eels were tagged as a demonstration during a workshop. Eels are able to obtain oxygen through their skin, and transport in air is preferable to transport in water if aeration cannot be provided.

Data from the scanning receivers usually were downloaded daily 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 10 feet at the Fort Halifax project and the weir site (HOBO data logging thermometer).

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), except for the period from September 16 to October 11. Because of low flow and concerns about out-migrating alewives, the eastern (upstream) turbine at Fort Halifax was not operated during the study period and the western turbine was only operated from September 29 to October 6, November 1 to 3, and on November 16. The large turbine at Benton Falls was undergoing repairs during the study period, and the small turbine was operated from September 27 to November 5.

Average daily water temperature in the river at Fort Halifax ranged from 16.8-7.3°C during the study period (September 26-November 16). During this same period, water temperature at the weir on Twenty-five Mile Stream ranged from 13.7-4.5°C. Rainfall during the study period occurred on October 18.

A total of 12 eels were tagged and released during the study (Table 2). Five eels (#16-20) were tagged on September 26 and released in the Benton Falls headpond, approximately 0.5 miles upstream of the dam, where the Rt. 139 bridge crosses the river. An additional five eels (#23-27) were tagged and released on October 19 from the public access area immediately below the Benton Falls Dam. The final two eels (#28-29) were tagged on November 8 and released in the Benton Falls headpond where eels #16-20 were released.

Of the seven eels released above Benton Falls, only one (14%) did not attempt to migrate downstream. This eel (#20) was detected just once near the intake approximately three hours after its release (Table 3). On October 11 and 26, DMR personnel attempted to locate the tag from a boat with a data logger/receiver and directional loop antenna. An intermittent signal was detected in the headpond on both occasions, but its location could not be determined with accuracy and recovery was not attempted. This eel is not discussed further.

The six remaining eels were detected at the Benton Falls Dam from 1.8-557 hours (0.1-23.2 days) after being released (Table 3). The time from release to arrival was not related to release date, i.e., eels tagged later in the season did not move faster. The time from arrival to passage ranged from 0.05-213.07 hours (0.001-8.88 days). Four eels (57%) passed through the small turbine, one (14%) used the bypass, and one (14%) passed over the gates or spillway. One of the eels (#29) passed through the turbine when it was not operating and was detected 11.51 hours later at Fort Halifax. DMR personnel attempted to locate the other three eels that had passed through the turbine when it was operating and had apparently not survived (#16, 18, and 19). Two tags were detected in deep water below the tailrace, but were not recovered.

The five eels released immediately below the Benton Falls Dam arrived at the Fort Halifax Project from 5.09-16.40 hours after being released (Table 4). Four of them (80%) passed the dam either via the Obermeyer gate or bypass; neither turbine was operating when these eels passed. The fifth eel (20%) remained near the Obermeyer and bypass for several days and moved upstream before contact was lost. Two of the eels (#26 and 27) covered the five miles between the dams in approximately five hours and passed the Halifax Dam within two hours of arrival. The other two eels (#24 and 25) took about twice as long to arrive and did not pass for about two days.

Three of the eels that were released above Benton Falls and successfully passed the dam (#17, 28, 29) were contacted at Fort Halifax. These eels arrived from 11.51-20.72 hours after passing Benton Falls and passed Halifax from 0.67-67.22 hours after arriving. Eel (#17) passed via the Obermeyer or bypass when the downstream turbine was operating; the other two passed when neither turbine was operating.

Near the two projects, migrating eels were mostly active at night (Tables 5 and 6). The number of contacts made during darkness ranged from 56-100%, and all but one of the eels (#29) passed during darkness. The higher number of daytime contacts at Fort Halifax may be an artifact of the antenna (9-element Yagi) and gain settings. Two eels moved during the day; eels #26 and 27 were released below Benton Falls at 11:30AM and were detected at Fort Halifax between 4 and 5PM.

Discussion and Recommendations
Four of seven eels above Benton Falls passed via the turbines (57%), one used the bypass (14%), one passed over the gates or spillway (14%), and one did not pass. Three of the eels that passed through the turbine were never detected at Fort Halifax, and were either killed, injured, or ceased migrating. One eel that passed when the turbine was not operating continued its migration. Before passing, eels were alternately detected in rapid succession by the antenna monitoring the intake and the antenna monitoring the headpond above the gates and spill. Some overlap in pickup between these two antennas occurred near the gate and pier in the middle of the dam, and eels were probably in this location (east of the east bypass entrance). Passage might be improved if the westernmost gate was opened at night.

Passage at Fort Halifax could not be evaluated in 2000 because the project was not generating during most of the study period. Eels did spend a considerable amount of time in the immediate vicinity of the turbine intakes, the bypass entrance, and the Obermeyer gate. In 2001, an antenna will be deployed in or near the Obermeyer gate to determine whether eels use the gate or the bypass.

ATLANTIC SALMON:
Atlantic salmon biologists from Maine's Atlantic Salmon Commission (ASC) requested DMR's assistance to transport adult Atlantic salmon from the Franklin co-op to the St. Croix River. On October 17 and 18, DMR personnel transported several hundred salmon to the St. Croix drainage near Calais for release into the wild. No mortalities were recorded for these six trips. Funds for the salmon transfers were taken from the DMR General Fund, not the Kennebec River Restoration Fund. No salmon were observed at the mouth of Bond Brook throughout the 2000 field season.

On July 3, 2000, the Atlantic Salmon Commission opened a new regional office in Sidney, ME and staffed the office with a Biologist I. Atlantic salmon population and habitat assessments and salmon management in Southern Maine rivers will be coordinated through this office. The geographical areas of responsibility for this regional office are the historical salmon rivers and streams from the lower Penobscot River, below the Veazie Dam, west to the New Hampshire border. Some of Maine's largest and most important rivers - the Androscoggin, Saco, Sheepscot, and Kennebec - are located within this region.

In 2000, due to limited time and personnel, Atlantic salmon assessments in the lower Kennebec River, from the head-of-tide to the Lockwood Dam in Waterville, were limited to redd counts. On December 3, spawning habitat in the mainstem was surveyed from the Lockwood Dam downstream to the Sidney boat launch. Approximately 30% of the mainstem spawning habitat was surveyed and three redds were found, indicating Atlantic salmon spawning activity. Furthermore, two redds in Messalonskee Stream were identified as those of Atlantic salmon. Of the other lower Kennebec River tributaries surveyed (Togus Stream, Sevenmile Stream, Bond Brook) between November 13 and November 17, Bond Brook contained the only other Atlantic salmon redd identified. In addition, on November 14, ASC personnel observed two Atlantic salmon - a male (grilse size) and a multi sea-winter female - in Bond Brook below the Rte. I-95 overpass.

Work plans for the 2001 field season include temperature monitoring in several of the larger lower river tributaries to determine suitability for in-stream rearing of juvenile salmon and the initiation of a full habitat survey of the mainstem lower Kennebec from the Lockwood Dam downstream to the head-of-tide in Sidney and all of the major tributaries for which habitat surveys have yet to be undertaken. Presence or absence of juvenile Atlantic salmon will be monitored in mid to late summer by electrofishing and redd counts will be undertaken in the fall to document spawning activity. It is anticipated that these efforts will be coordinated with the Department of Marine Resources, the Department of Inland Fisheries and Wildlife, and any stakeholder groups that wish to be involved.

TABLE 1. 2000 ALEWIFE STOCKING PLANS – PHASE I LAKES

Sebasticook River

PONDED AREA	LOCATION	RIVER SECTION	STOCKING GOAL[a]
Plymouth Pond	Plymouth	East Branch	2,880
Douglas Pond	Pittsfield	West Branch	3,150
Pattee Pond	Winslow	Main Stem	4,272
Pleasant Pond	Stetson	East Branch	4,608
Unity Pond	Unity	Main Stem	15,168
Sebasticook Lake	Newport	East Branch	25,728
Lovejoy Pond	Albion	Main Stem	1,944
Kennebec River			
Webber Pond	Vassalboro	Kennebec River	7,512
Wesserunsett Lake	Madison	Kennebec River	8,676
Three Mile Pond	China	Kennebec River	NS
Three Cornered Pond	Augusta	Kennebec River	NS
	TOTAL 2000 STOCKING GOAL:		**73,938**

a - Six adult alewives per lake surface acre
NS - These lakes have never been stocked

TABLE 2. HYDROELECTRIC FACILITIES MONITORED FOR DOWNSTREAM PASSAGE, 2000

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 3. 2000 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
Sebasticook Lake	4,288	25,728	26,172	9	102	6.1
Unity Pond	2,528	15,168	15,237	10	100	6.1
Plymouth Pond	480	2,880	2,925	2	102	6.1
Pleasant Pond (Stetson)	768	4,608	4,736	2	103	6.2
Douglas Pond	525	3,150	3,219	2	102	6.1
Pattee Pond	712	4,272	4,294	5	101	6.0
Wesserunsett Lake	1,446	8,676	8,691	4	100	6.1
Webber Pond	1,252	7,512	7,551	7	101	6.0
Lovejoy Pond	324	1,944	1,950	2	100	6.0
TOTALS:	**12,323**	**73,938**	**74,775**	**43**	**101**	**6.1**

a - Six alewives per lake surface acre

TABLE 4. 2000 ALEWIFE DISTRIBUTION BY TRIP IN KENNEBEC RIVER WATERSHED PHASE I LAKES

DATE	LOCATION[a]	NUMBER LOADED	NUMBER MORTS	NUMBER RELEASED
Stock Date	**Receiving**	**No. Loaded**	**No. Morts**	**No. Stocked**
5/4/00	Unity Pond	601	1	600
	Unity Pond	1,230	0	1,230
5/5/00	Unity Pond	1,100	0	1,100
	Unity Pond	2,665	0	2,665
	Webber Pond	602	0	602
5/6/00	Sebasticook Lake	3,019	0	3,019
	Sebasticook Lake	3,093	0	3,093
	Webber Pond	1,006	0	1,006
	Webber Pond	1,300	0	1,300
	Webber Pond	1,527	0	1,527
	Webber Pond	1,528	7	1,521
5/7/00	Lovejoy Pond	955	4	951
	Lovejoy Pond	1,000	1	999
	Pattee Pond	979	2	977
	Pattee Pond	1,005	2	1,003
	Sebasticook Lake	3,049	0	3,049
	Sebasticook Lake	3,054	7	3,047
	Unity Pond	1,517	1	1,516
	Unity Pond	1,656	0	1,656
	Webber Pond	1,295	0	1,295
5/8/00	Pattee Pond	425	0	425
5/9/00	Douglas Pond	1,603	1	1,602
	Sebasticook Lake	2,750	26	2,724
	Sebasticook Lake	3,188	32	3,156
	Unity Pond	800	0	800
	Unity Pond	1,685	0	1,685
5/10/00	Douglas Pond	1,618	1	1,617
	Wesserunsett Lake	3,042	1	3,041
5/12/00	Wesserunsett Lake	3,228	1	3,227
5/13/00	Sebasticook Lake	3,244	2	3,242
	Stetson Pond	1,629	0	1,629
	Webber Pond	300	0	300

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5/14/00	Plymouth Pond	1,615	2	1,613
	Unity Pond	1,742	1	1,741
5/15/00	Pattee Pond	760	0	760
	Plymouth Pond	1,312	0	1,312
	Unity Pond	2,244	0	2,244
	Wesserunsett Lake	1,376	0	1,376
5/16/00	Sebasticook Lake	1,616	0	1,616
	Sebasticook Lake	3,229	3	3,226
	Stetson Pond	3,109	2	3,107
	Wesserunsett Lake	1,049	2	1,047
5/17/00	Pattee Pond	1,130	1	1,129
Total Fish:		**74,875**	**100**	**74,775**
Total Days:	**13**			
Total Trips:	**43**			

a - Within a date, locations are in order by which they were stocked

TABLE 5. ALEWIFE TRAPPING AND DISTRIBUTION FROM FORT HALIFAX, SEBASTICOOK RIVER - 2000

	# OF ALEWIVES[a]					TRUCKING		
DATE	**DIPPED**	**PUMPED**	**PUMP MORTALITIES**	**BIOLOGICAL SAMPLES**	**RELEASED ABOVE DAM**	**LOADED**	**MORTALITIES**	**RELEASED**
May 4	0	1,976	95	50	0	1,831	1	1,830
5	1,100	3,582	315	0	0	4,367	0	4,367
6	6,300	10,180	7	0	5,000[b]	11,473	7	11,466
7	3,375	13,578	18	50	2,375[b]	14,510	17	14,493
8	0	526	101	0	0	425	0	425
9	0	10,057	31	0	0	10,026	59	9,967
10	0	5,838	NA	0	0	5,838	4	5,834
11	0	0	0	0	0	0	0	0
12	0	3,859	12	50	569	3,228	1	3,227
13	0	6,924	51	0	0	6,873	3	6,870
14	0	4,307	12	50	0	4,245	5	4,240
15	0	5,732	40	0	0	5,692	0	5,692
16	0	11,725	105	0	0	11,620	10	11,610
17	0	7,843	182	0	1,187	6,474	3	6,471
18	0	8,494	27	0	493	7,974	4	7,970
19	0	6,452	65	50	0	6,337	3	6,334
20	0	6,522	35	0	883	5,604	1	5,603
21	0	2,606	81	0	459	2,066	1	2,065
22	0	3,418	76	0	108	3,234	3	3,231
23	0	5,137	67	0	998	4,072	4	4,068
24	0	5,141	NA	50	0	5,091	50	5,041
May 31	0	2,357	10	50	0	2,297	0	2,297
June 9	0	2,487	NA	0	0	2,487	2	2,485
June 15	50	0	0	50	0	0	0	0
TOTALS:	**10,825**	**128,741**	**1,330[c]**	**400**	**12,072**	**125,764**	**178[d]**	**125,586**

a - Includes all alewives released, not just Phase I ponds
b- Fish that were collected with dip net
c - Represents a 1.03% pump mortality
d - Represents a 0.14% trucking mortality

TABLE 6. DISPOSITION OF KENNEBEC RIVER ALEWIVES DISTRIBUTED IN LOCATIONS OTHER THAN PHASE I LAKES – 2000

DRAINAGE	DATE	LOCATION	NUMBER LOADED	MORTALITIES	NUMBER RELEASED
KENNEBEC RIVER:	5/10/00	Pleasant Pond	1,178	2	1,176
	5/13/00	Pleasant Pond	1,700	1	1,699
	5/14/00	Pleasant Pond	888	2	886
	5/16/00	Pleasant Pond	756	0	756
	5/17/00	Martin Stream	505	1	504
	5/18/00	Kennebec River (Augusta)	1,371	0	1,371
	5/20/00	Center Pond	451	0	451
	5/20/00	Sewell Pond	586	0	586
	5/20/00	Whiskeag Creek	1,003	1	1,002
	5/21/00	Adams Pond	540	0	540
	5/23/00	Martin Stream	505	2	503
	6/9/00	Nehumkeag Pond	2,487	2	2,485
TOTAL:			**11,970**	**11**	**11,959**
ANDROSCOGGIN:	5/16/00	Sabattus Pond	1,861	3	1,858
	5/17/00	Sabattus Pond	3,086	0	3,086
	5/17/00	Taylor Pond	752	0	752
	5/17/00	Taylor Pond	1,001	1	1,000
	5/18/00	Sabattus River	2,051	1	2,050
	5/18/00	Taylor Pond	1,518	0	1,518
	5/19/00	Bog Brook	690	0	690
	5/19/00	Loon Pond	415	0	415
	5/19/00	Lower Range Pond	875	0	875
	5/19/00	Lower Range Pond	875	2	873
	5/19/00	Marshall Pond	612	0	612
	5/19/00	Sutherland Pond	315	0	315
	5/19/00	Taylor Pond	531	0	531
TOTAL:			**14,582**	**7**	**14,575**
SHEEPSCOT:	5/20/00	Sherman Lake	1,002	0	1,002
	5/31/00	Branch Pond	1,007	0	1,007
	5/31/00	Branch Pond	1,033	0	1,033
	5/31/00	Savade Pond	257	0	257
TOTAL:			**3,299**	**0**	**3,299**

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EASTERN:	5/23/00	Dresden Bog	1,008	2	1006
	5/23/00	Dresden Bog	1,018	0	1,018
TOTAL:			**2,026**	**2**	**2,024**
CATHANCE:	5/24/00	Bradley Pond	501	1	500
TOTAL:			**501**	**1**	**500**
PRESUMPSCOT:	5/24/00	Highland Lake	856	0	856
	5/24/00	Highland Lake	3,020	3	3,017
TOTAL:			**3,876**	**3**	**3,873**
BAGADUCE:	5/24/00	Pierce Pond	714	46	668
TOTAL:			**714**	**46**	**668**
ST. GEORGE:	5/18/00	Sennebec Lake	3,034	3	3,031
	5/20/00	Seventree Pond	503	0	503
	5/21/00	South Pond	1,014	1	1,013
	5/23/00	Crawford Pond	1,543	0	1,543
TOTAL:			**6,094**	**4**	**6,090**
PEMAQUID:	5/19/00	Pemaquid River	2,024	1	2,023
	5/20/00	Duckpuddle Pond	1,011	0	1,011
TOTAL:			**3,035**	**1**	**3,034**
ROYAL:	5/21/00	Runaround Pond	512	0	512
	5/22/00	Royal River (Elm St. Bridge)	3,234	3	3,231
TOTAL:			**3,746**	**3**	**3,743**
GRAND TOTAL:			**49,843**	**78**	**49,765**

TABLE 7. TRANSFERS OF AMERICAN SHAD BROODSTOCK, 2000

RIVER:	TRAPPING SITE:	DATE:	RECEIVING:	NO. LOADED:	NO. MORTS:	NO. IN
KENNEBEC:	Fort Halifax	6/1/00	Hatchery	3	0	3
		6/12/00	Hatchery	2	0	2
		6/13/00	Hatchery	5	0	5
		6/15/00	Hatchery	3	0	3
		6/21/00	Hatchery	7	0	7
		6/22/00	Hatchery	5	0	5
TOTAL:				**25**	**0**	**25**
SACO:	Cataract Lift	6/12/00	Hatchery	81	1	80
		6/30/00	Hatchery	41	0	41
		7/21/00	Hatchery	22	0	22
TOTAL:				**144**	**1**	**143**
CONNECTICUT:	Holyoke Lift	5/11/00	CT River, NH	257	1	256
		5/25/00	CT River, NH	250	2	248
		5/26/00	CT River, NH	250	3	247
		6/3/00	CT River, NH	250	14	236
TOTAL (in-basin transfers)[a]:				**1,007**	**20**	**987**
		6/4/00	Hatchery	61	1	60
		6/15/00	Hatchery	64	5	59
		6/16/00	Hatchery	64	5	59
		6/19/00	Hatchery	20	3	17
		6/23/00	Hatchery	59	5	54
		6/26/00	Hatchery	34	7	27
TOTAL (transfers to hatchery):				**302**	**26[b]**	**276**
TOTAL NUMBER TRANSPORTED TO HATCHERY:						**444**

a - Required by CT River Shad TAC b - 8.6% trucking mortality

TABLE 8. LARVAL AMERICAN SHAD RELEASES, 2000

RIVER:	DATE:	RELEASE POINT:	TOTAL RELEASED:
KENNEBEC:	6/23/00	Fort Halifax Park	438,231
	6/23/00	Fort Halifax Park	354,502
	6/27/00	Mill Island Park	246,770
	6/30/00	Below Shawmut	420,231
	7/17/00	Below Shawmut	291,608
	7/18/00	Mill Island Park	397,542
	7/27/00	Fairfield boat ramp	179,574
	7/27/00	Fairfield boat ramp	207,356
	7/24/00	Below Shawmut	539,410
	8/4/00	Below Shawmut	271,503
TOTAL:			**3,346,727**
SEBASTICOOK:	7/3/00	Below Burnham	109,395
	7/17/00	Below Burnham	390,609
TOTAL:			**500,004**
ANDROSCOGGIN:	7/10/00	Auburn boat launch	529,558
TOTAL:			**529,558**
SACO:	7/10/00	Saco	259,090
TOTAL:			**259,090**
MEDOMAK:	8/14/00	Below Rt. 1 bridge	145,894
TOTAL:			**145,894**
GRAND TOTAL:			**4,781,273**

TABLE 9. AMERICAN SHAD FALL FINGERLING RELEASES, 2000

RIVER:	DATE:	RELEASE POINT:	NO. LOADED:	NO. MORTS:	NO. RELEASED:
KENNEBEC:	9/18/00	Augusta boat ramp	4,450	10	4,440
	9/18/00	Augusta boat ramp	12,000	22	11,978
	9/18/00	Augusta boat ramp	10,900	15	10,885
	10/5/00	Augusta boat ramp	335	10	295
TOTAL:			**27,685**	**57***	**27,598**

*Trucking Mortality Rate=0.21%

TABLE 10. DOWNSTREAM PASSAGE OBSERVATIONS AT LAKE OUTLETS, 2000

DATE	SEBASTICOOK LAKE	PLYMOUTH POND	UNITY POND	PLEASANT POND	WEBBER POND	WESSERUNSETT LAKE
7/14	X	X		X^{laj}		X
8/7	X	S^{j}		O		
8/18	X	S^{l}		X^{lj}		X
8/29	X			O		X
9/11					X	
9/14	X^{laj}	O^{j}	X	X^{l}	X	
9/25	X	O		O		O
9/26			O			
10/5	O	O	X^{laj}	O	X	O
10/17	X	O		O		O
Total Visits	**8**	**7**	**3**	**8**	**3**	**6**

X = Downstream passage available
O = No downstream passage available
= Not surveyed on this day
* = Dead alosids present below outlet
l = Live alosids present below outlet
a = Juvenile alosids using downstream passage facilities
A = Adult alewives using downstream passage facilities
j = Juvenile alosids above outlet
S = Downstream passage available only over dam spillway

TABLE 11. DOWNSTREAM PASSAGE OBSEVATIONS AT HYDROELECTRIC FACILITIES, 2000

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly	Hydro Kennebec	Lockwood
7/3		X	X				
7/13	X	X	X			X	X
7/14				X	X[s]		
7/17	X	X					X
7/19	X						
7/21						X	
7/23		X	X				
7/25						X	
7/26	X	X	X	O	X		
8/7	X	X	X	X[a]	X	X	X
8/17	X	X	X	X	X		X
8/18				X[a]	X		
8/22		X	X[a]				
8/24			X				
8/29				X	X		
8/30		X	X				
9/14	X	X	X[a]		X		
9/19			X*				
9/20	X	X	X[a]*				
9/21			X[a]				
9/25				X	X		
9/26	X[a]	X	X				
9/28	X	X[a]	X*				X
10/5	X[f]	X	X			X	X
10/17				X	X		
10/19		X[a]*	X				
10/20	X	X	X				
11/1	X	X	X	X	X		X
Total Visits	**13**	**17**	**19**	**9**	**10**	**5**	**7**

X = Downstream passage available
O = No downstream passage available
= Not surveyed on this day
* = Dead alosids present in tailrace
a = Juvenile alosids using downstream passage facilities
A = Adult alewives using downstream passage facilities
f = Juvenile alosids in turbine forebay
s = Downstream passage available only over dam spillway

TABLE 12. ANADROMOUS AND MAJOR SPORTFISH CAPTURED IN THE KENNEBEC RIVER, 2000

SITE 1	
Alewife	38
American shad	1
LM bass	36
SM bass	25
TOTAL	**100**

SITE 2	
Alewife	2
LM bass	2
SM bass	216
TOTAL	**220**

SITE 2A	
LM bass	11
SM bass	72
TOTAL	**83**

SITE 2B	
LM bass	16
SM bass	89
TOTAL	**105**

SITE 3	
Alewife	255
Alosid sp.p.[1]	50
American shad	6
LM bass	23
SM bass	57
TOTAL	**391**

SITE 4	
Alosid sp.p.[1]	1
Blueback herring	1
LM bass	2
SM bass	41
TOTAL	**45**

SITE 5	
Alewife	24
Alosid sp.p.[1]	3
American shad	16
LM bass	4
SM bass	35
TOTAL	**82**

SITE 6	
Alewife	1
Alosid sp.p.[1]	17
LM bass	7
SM bass	13
Smelt	1
Striped bass[1]	6
TOTAL	**45**

SITE 7	
Alosid sp.p.[1]	178
American shad	412
LM bass	1
SM bass	7
TOTAL	**598**

SITE 8A	
Alewife	102
American shad	1
LM bass	3
SM bass	11
Striped bass[1]	3
TOTAL	**120**

SITE 8B	
American shad	1
LM bass	13
SM bass	35
Striped bass[1]	1
TOTAL	**50**

GRAND TOTAL 1,839

TOTAL BY SPECIES	
Alewife	422
Alosid sp.p.[1]	249
American shad	437
LM bass	118
SM bass	601
Smelt	1
Striped bass[1]	10

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

TABLE 13. SUMMARY OF UPSTREAM EEL MIGRATION DURING 2000 AND 1999 FIELD SEASONS

	2000		1999	
Project	Operation dates	Number of eels passed	Operation dates	Number of eels passed
Fort Halifax	6/21-7/28; 8/15-8/22	81,628	6/4-9/15	551,262
Benton Falls	6/29-7/28; 8/14-8/24	37,207	6/22-9/16	14,335
Hydro Kennebec	6/27-7/28; 8/14-8/24	6,462	7/5-9/16	683
Shawmut	6/29-6/30	19	-	-

TABLE 14. SUMMARY OF THE TAG AND RELEASE DATE, SIZE OF TAGGED EELS, AND RELEASE LOCATION FOR THE 2000 TELEMETRY FIELD SEASON

Date tagged and released	Tag number	Eel total length (mm)	Release location
9/26	16	852	Benton Falls headpond, Rt 139 bridge
9/26	17	890	Benton Falls headpond, Rt 139 bridge
9/26	18	920	Benton Falls headpond, Rt 139 bridge
9/26	19	842	Benton Falls headpond, Rt 139 bridge
9/26	20	958	Benton Falls tailrace
10/19	23	846	Benton Falls tailrace
10/19	24	852	Benton Falls tailrace
10/19	25	876	Benton Falls tailrace
10/19	26	894	Benton Falls tailrace
10/19	27	795	Benton Falls tailrace
11/8	28	750	Benton Falls headpond, Rt 139 bridge
11/8	29	666	Benton Falls headpond, Rt 139 bridge

TABLE 15. TIME OF RELEASE, ARRIVAL, AND PASSAGE FOR RADIO-TAGGED SILVER EELS AT THE BENTON FALLS PROJECT DURING THE 2000 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
16	9/26	1745	09/27	2217	10/6	1922	28.5	213.07	Turbine
17	9/26	1745	10/01	0236	10/1	239	104.9	0.05	Bypass
18	9/26	1745	10/19	2247	10/19	2327	557.0	0.66	Turbine
19	9/26	1745	9/26	2353	9/26	2358	6.1	0.08	Turbine
20	9/26	1745	9/26	2059	NA	NA	3.2	NA	Didn't pass
28	11/8	1745	11/8	1930	11/9	0505	1.8	9.58	Spill
29	11/8	1745	11/12	1953	11/15	2213	98.1	74.34	Turbine

TABLE 16. TIME OF RELEASE, ARRIVAL, AND PASSAGE FOR RADIO-TAGGED SILVER EELS AT THE FORT HALIFAX PROJECT DURING THE 2000 FIELD SEASON

	Release or pass BF Dam		Arrival at dam		Passage at dam				
Tag	Date	Time	Date	Time	Date	Time	Release to arrival (hr)	Arrival to passage (hr)	Route
17	10/1	0239	10/1	2153	10/2	1933	19.23	21.66	Gate/bypass
23	10/19	1130	10/20	354	NA	NA	16.40	NA	Didn't pass
24	10/19	1130	10/20	133	10/21	1913	14.05	41.67	Gate/bypass
25	10/19	1130	10/20	059	10/22	105	13.49	48.11	Gate/bypass
26	10/19	1130	10/19	1635	10/19	1808	5.09	1.56	Gate/bypass
27	10/19	1130	10/19	1725	10/19	1828	5.93	1.05	Gate/bypass
28	11/9	0505	11/10	149	11/12	2102	20.72	67.22	Gate/bypass
29	11/15	2213	11/16	944	11/16	1024	11.51	0.03	Gate/bypass

TABLE 17. 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
16	342	514	0	14	1	92%
17	5	0	2	0	0	100%
18	21	17	0	0	2	100%
19	14	4	0	0	1	100%
20	1					100%
28	53	80	0	8	0	100%
29	55	42	0	7	7	100%

TABLE 18. TOTAL NUMBER OF CONTACTS AND NIGHTTIME CONTACTS MADE WITH RADIO-TAGGED SILVER EELS AT THE FORT HALIFAX PROJECT DURING THE 2000 FIELD SEASON (9 UR = headpond to RR bridge; 6 UR = headpond near intakes; E IN = east (upstream) turbine intake; W IN = west (downstream) turbine intake; N OUT = north draft tube; S OUT = south draft tube; 6 DR = below spillway and above and below Obermeyer gate)

	Number of contacts							Contacts
Tag	9 UR	6 UR	E IN	W IN	N OUT	S OUT	6 DR	during darkness
17	814	0	1	4	29	0	95	64%
23	7,413	2	189	1,216	0	0	138	72%
24	1,290	2	0	75	0	0	61	63%
25	3,141	3	0	0	5	1,685	115	75%
26	258	1	5	217	0	0	18	81%
27	197	0	8	21	0	0	70	100%
28	7,872	3,128	14,862	17	15	552	196	56%
29	2,991	211	0	13	1	0	73	41%

FIGURE 1. KENNEBEC RIVER DRAINAGE - PHASE I LAKES

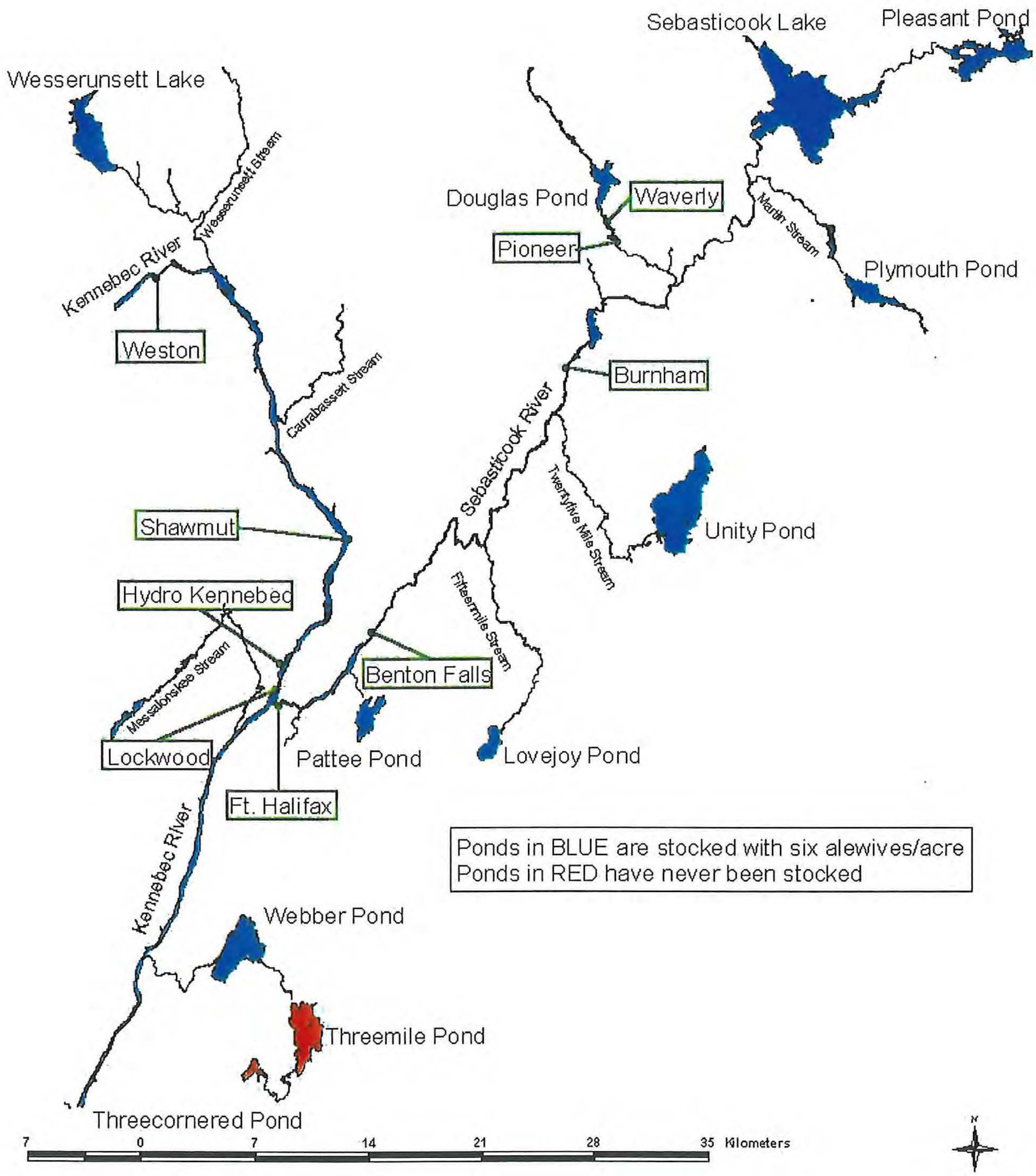


FIGURE 2. ALEWIVES HANDLED AT FORT HALIFAX, 2000

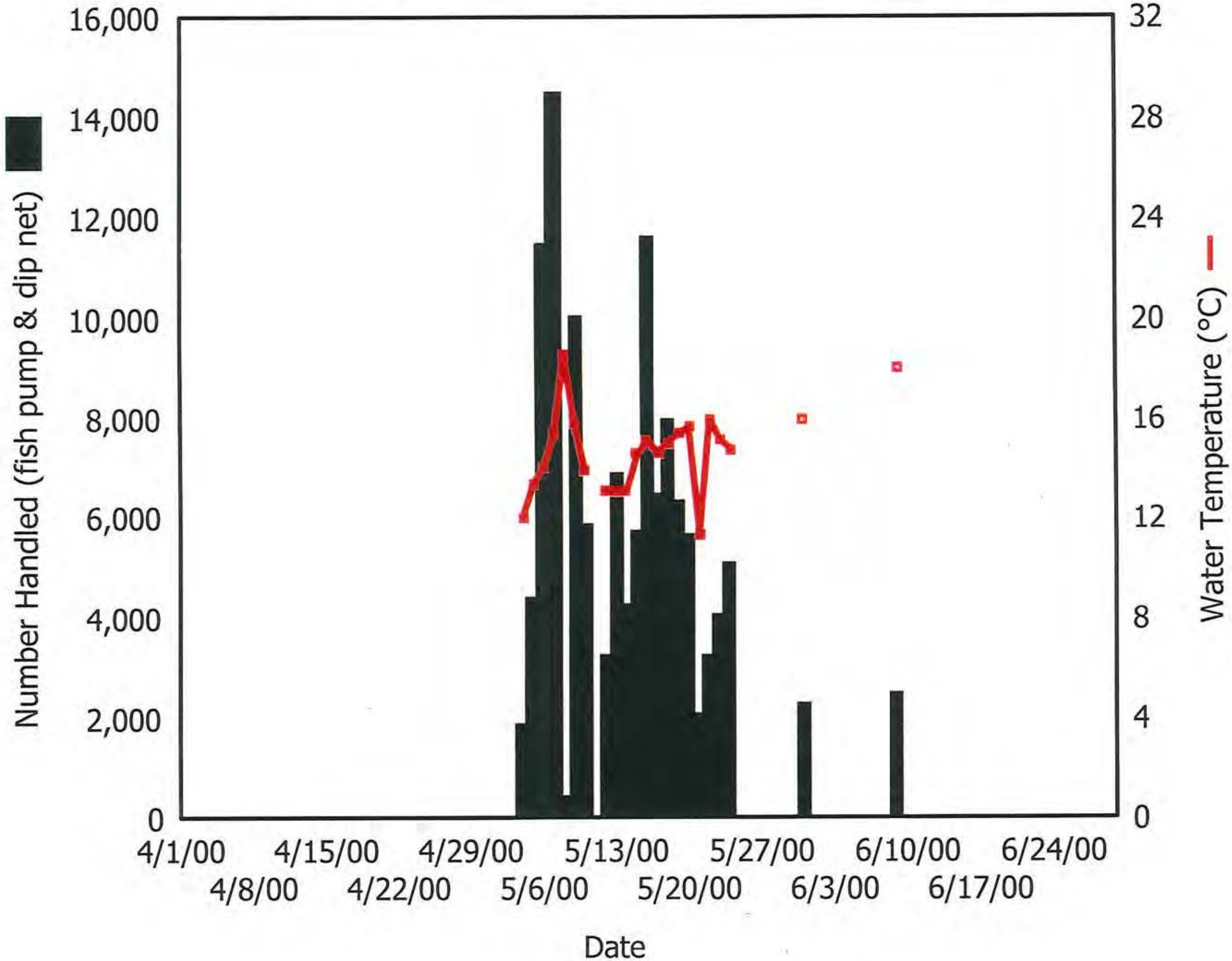


FIGURE 3. SEX RATIO OF ADULT ALEWIVES CAPTURED AT FORT HALIFAX, 2000

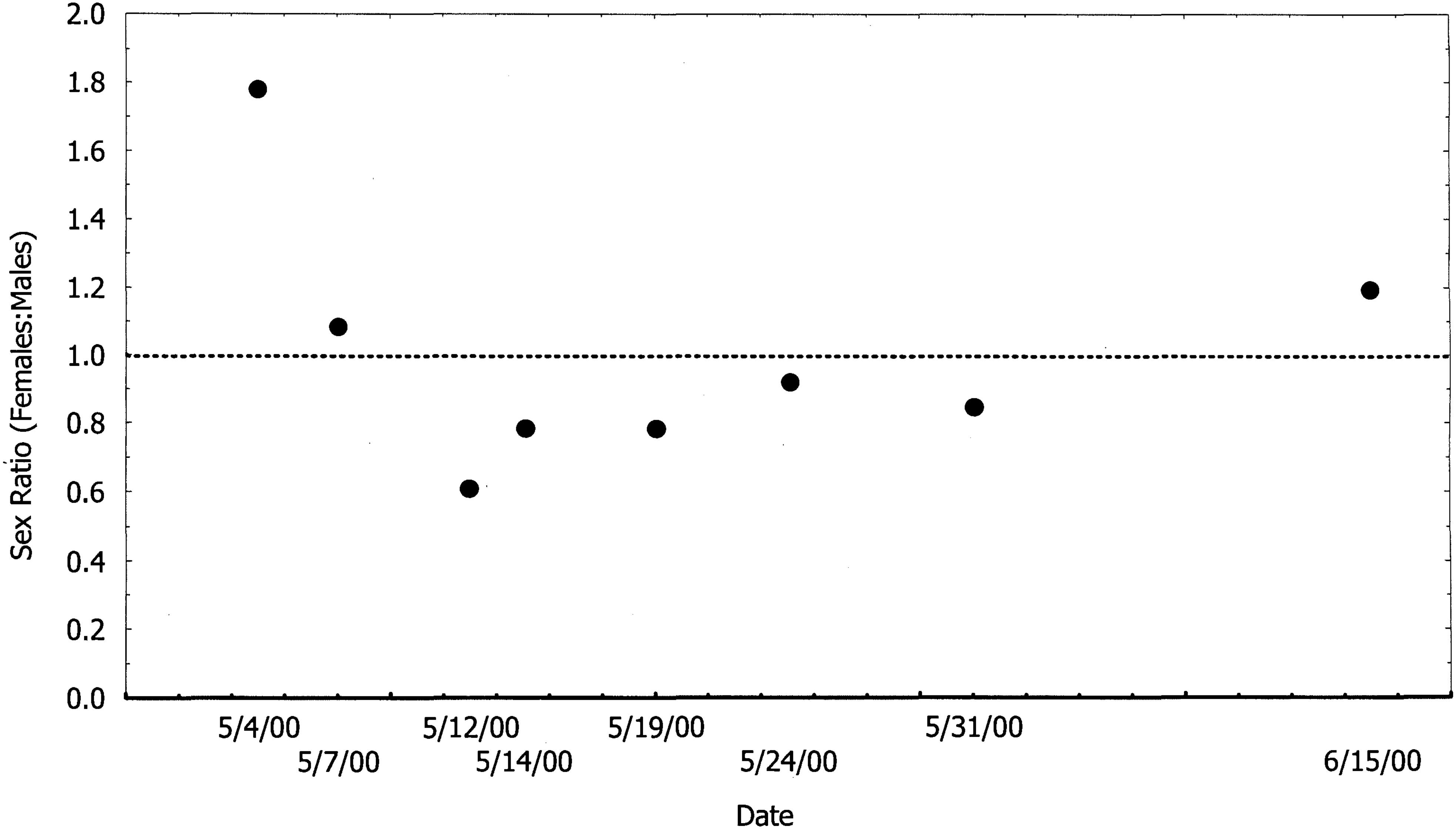


FIGURE 4. LENGTH OF ADULT ALEWIVES COLLECTED AT FORT HALIFAX, 2000

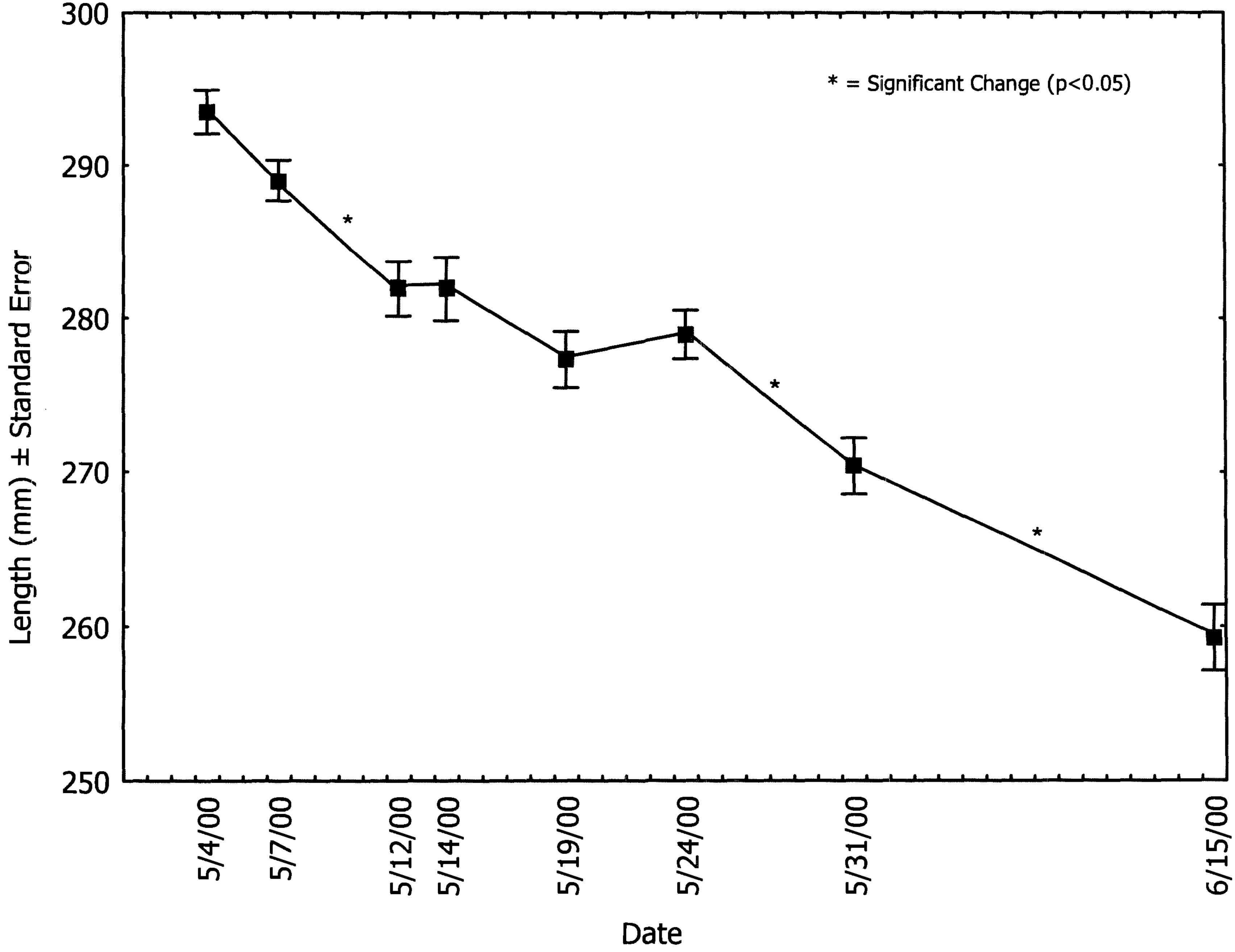


FIGURE 5. WEIGHT OF ADULT ALEWIVES CAPTURED AT FORT HALIFAX, 2000

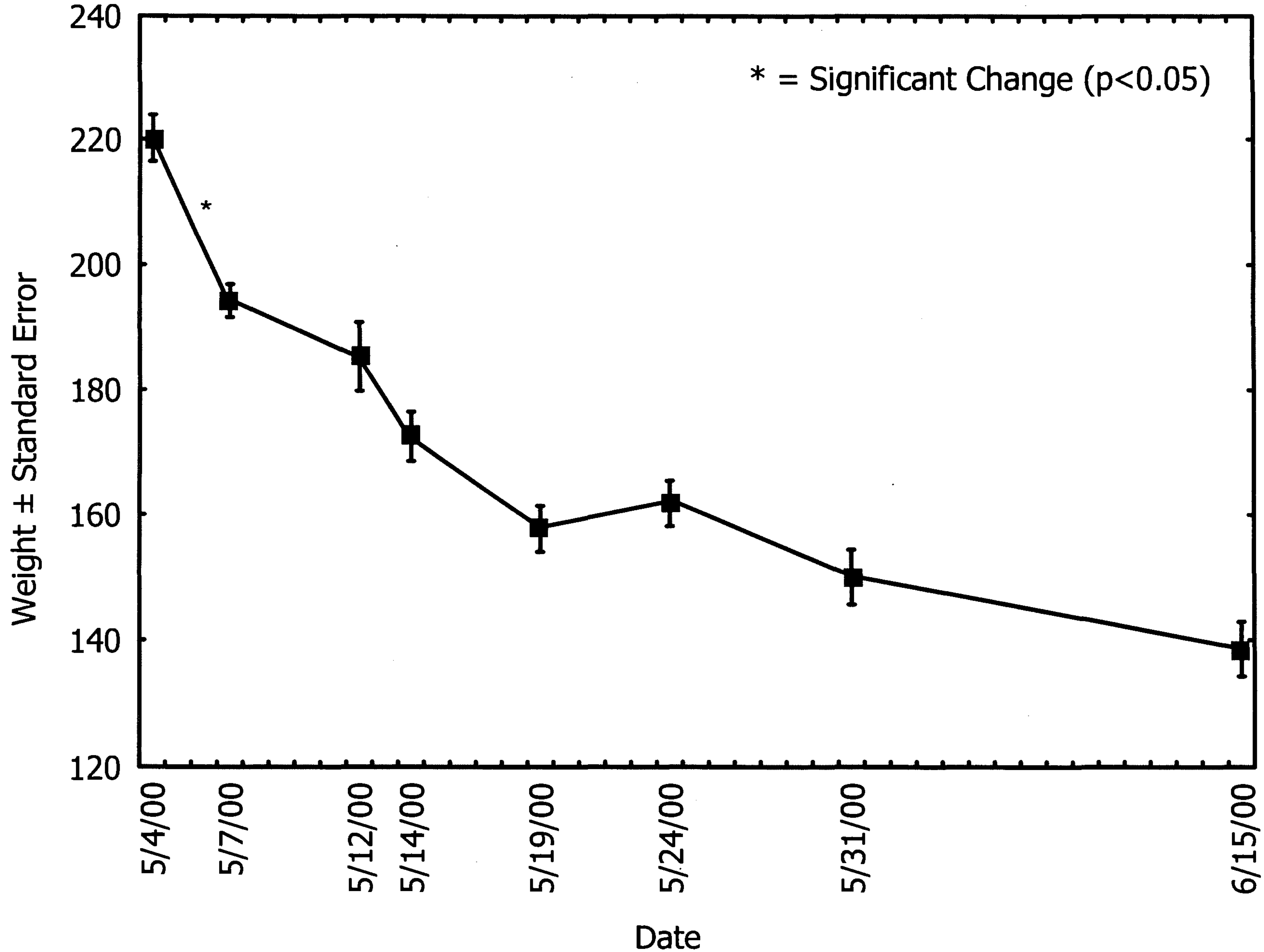


FIGURE 6. NUMBER OF AMERICAN SHAD LARVE RELEASED IN THE KENNEBEC DRAINAGE

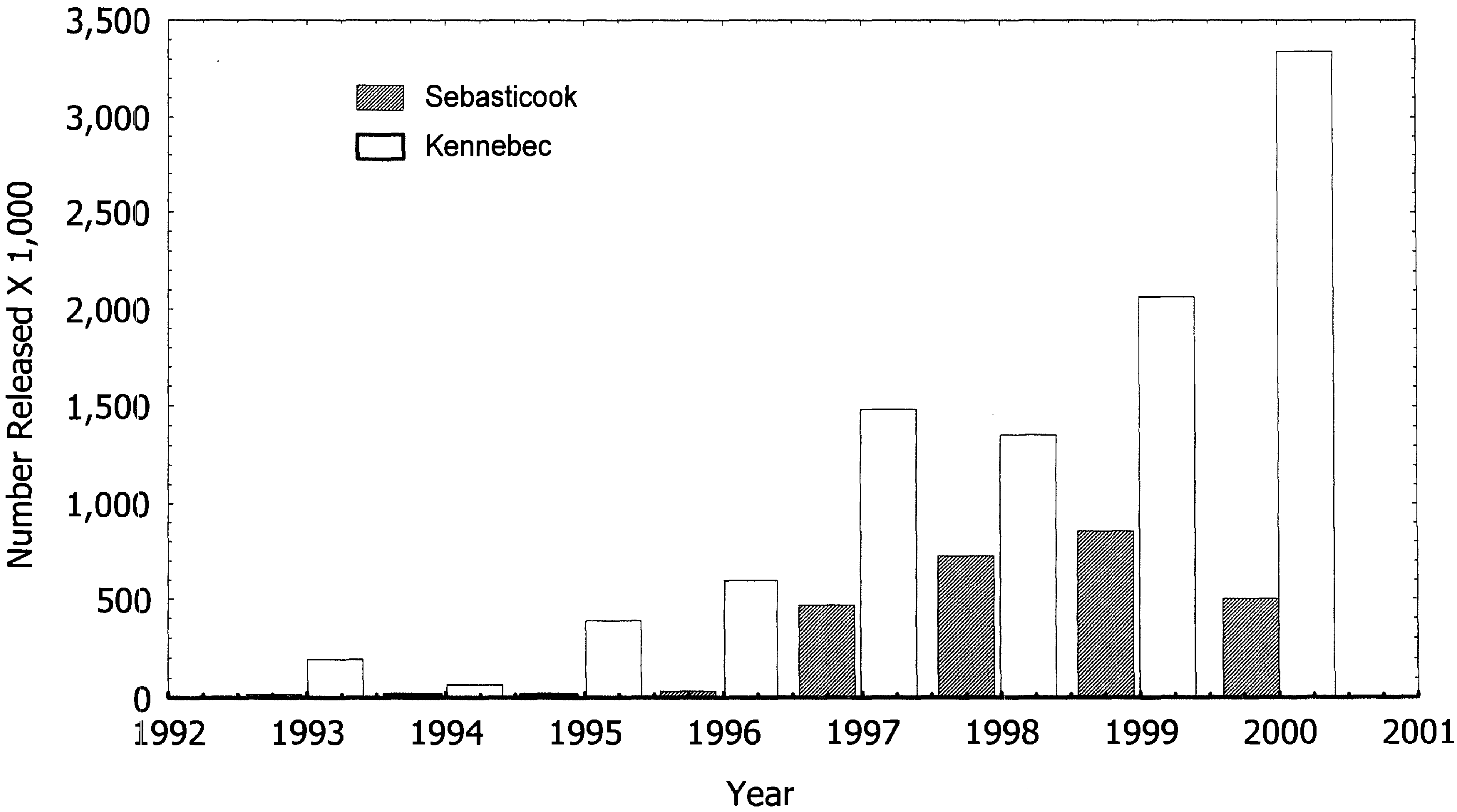


FIGURE 7. NUMBER OF AMERICAN SHAD FINGERLINGS RELEASED IN THE KENNEBEC RIVER

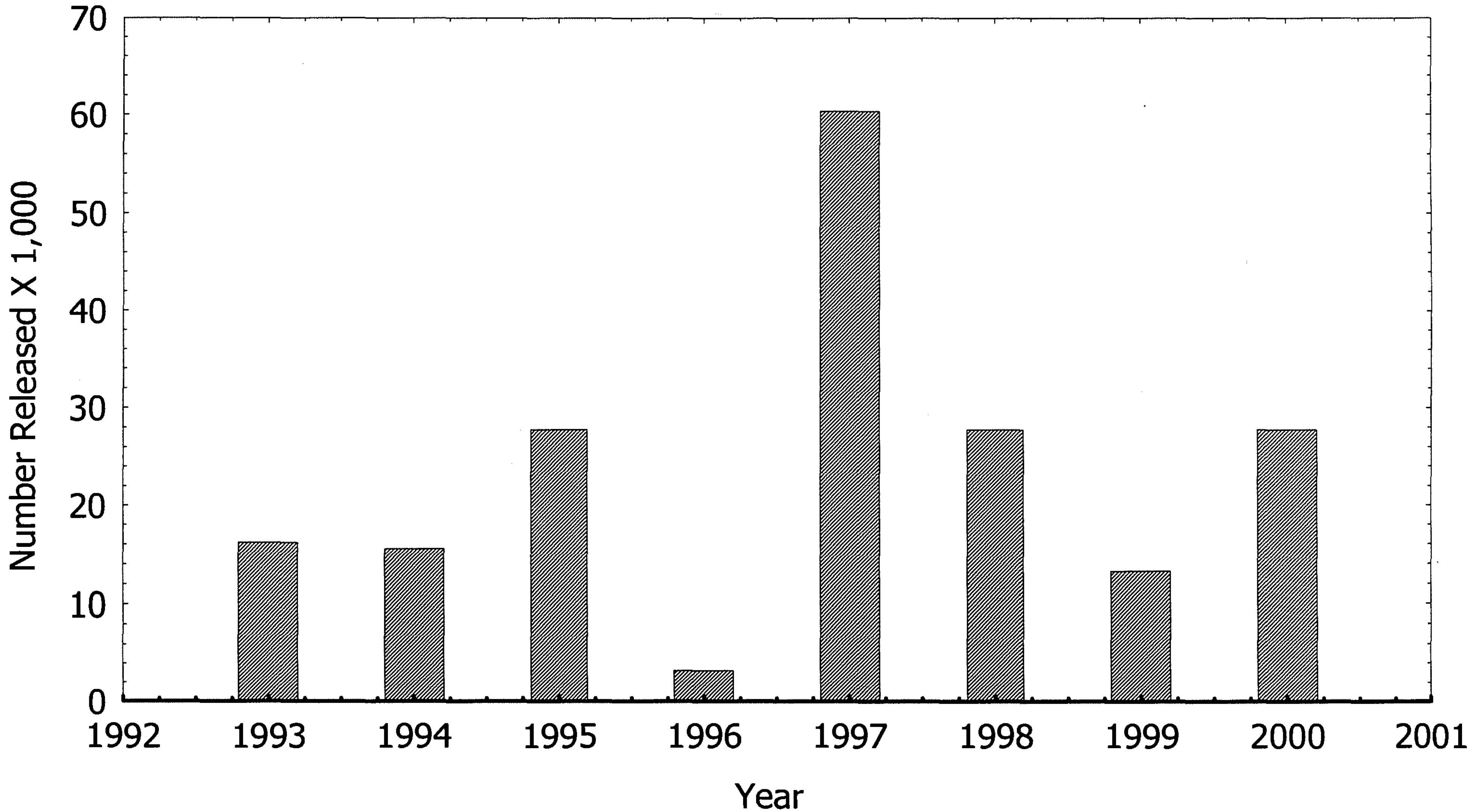


FIGURE 8. SEBASTICOOK RIVER, NON-HYDRO DAMS

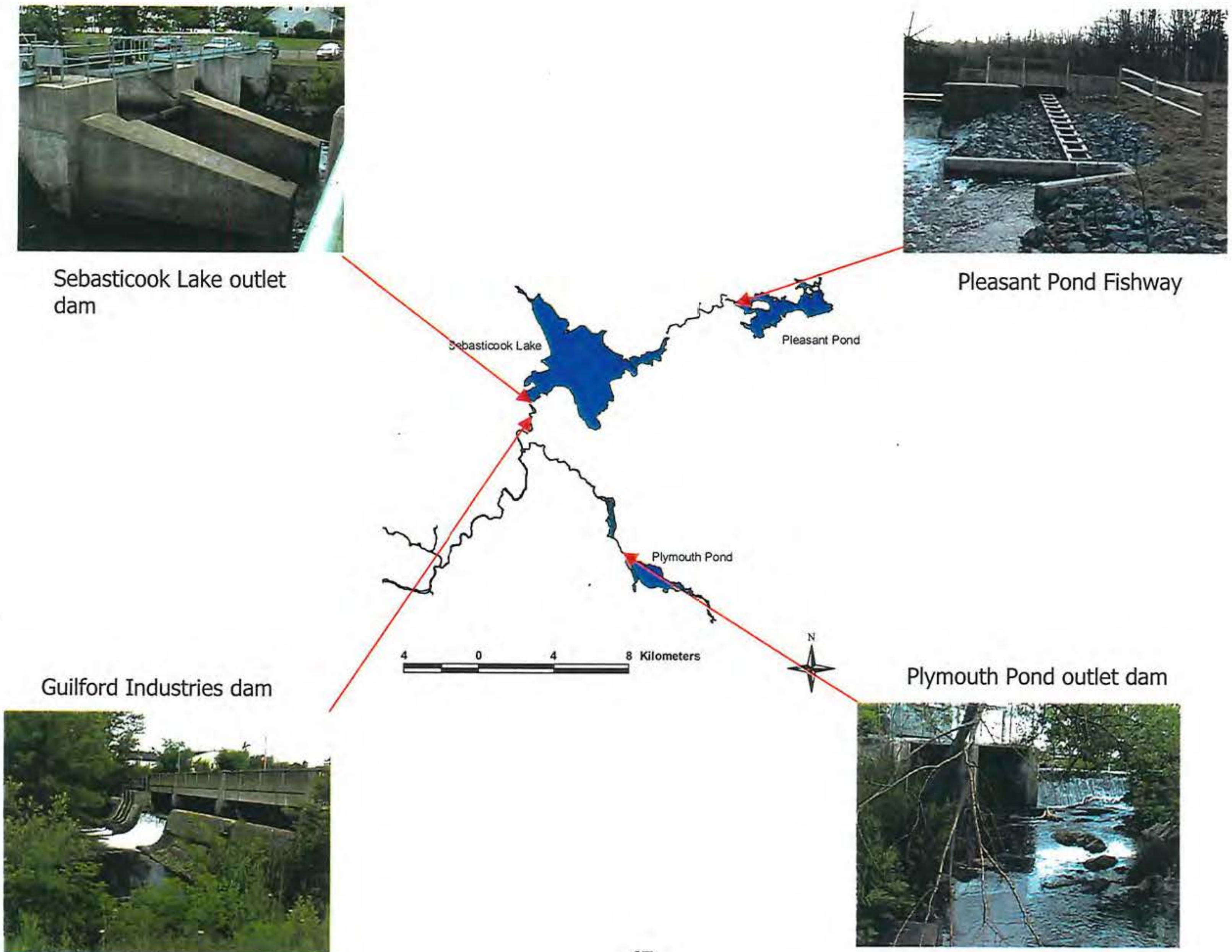


FIGURE 9. KENNEBEC RIVER FISH COMMUNITY ASSESSMENT SAMPLE SITES

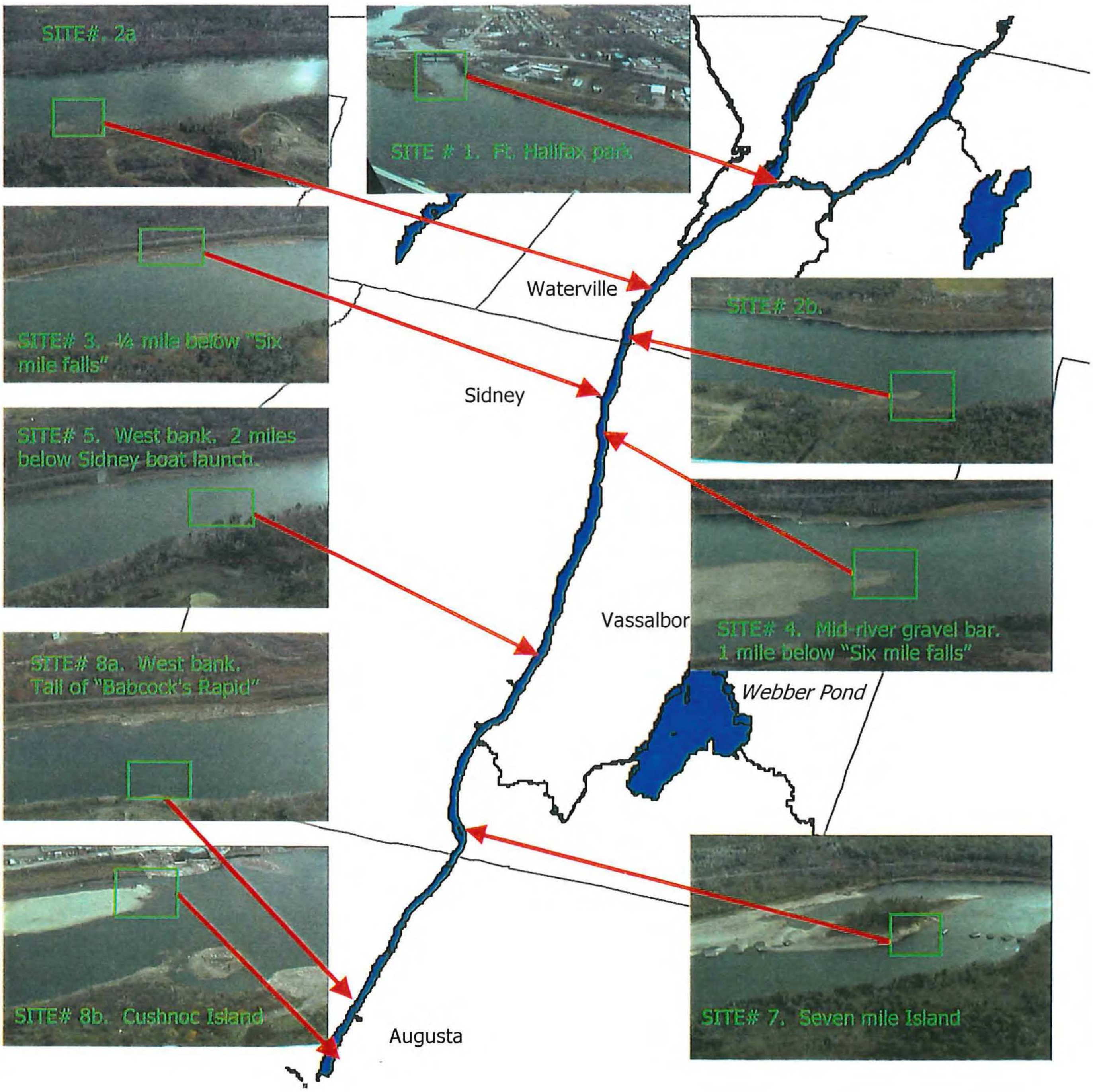


Figure 10. Upstream passage of American eel during the 2000 field season at the (A) Fort Halifax Project, (B) Benton Falls Project, and (C) Hydro Kennebec Project

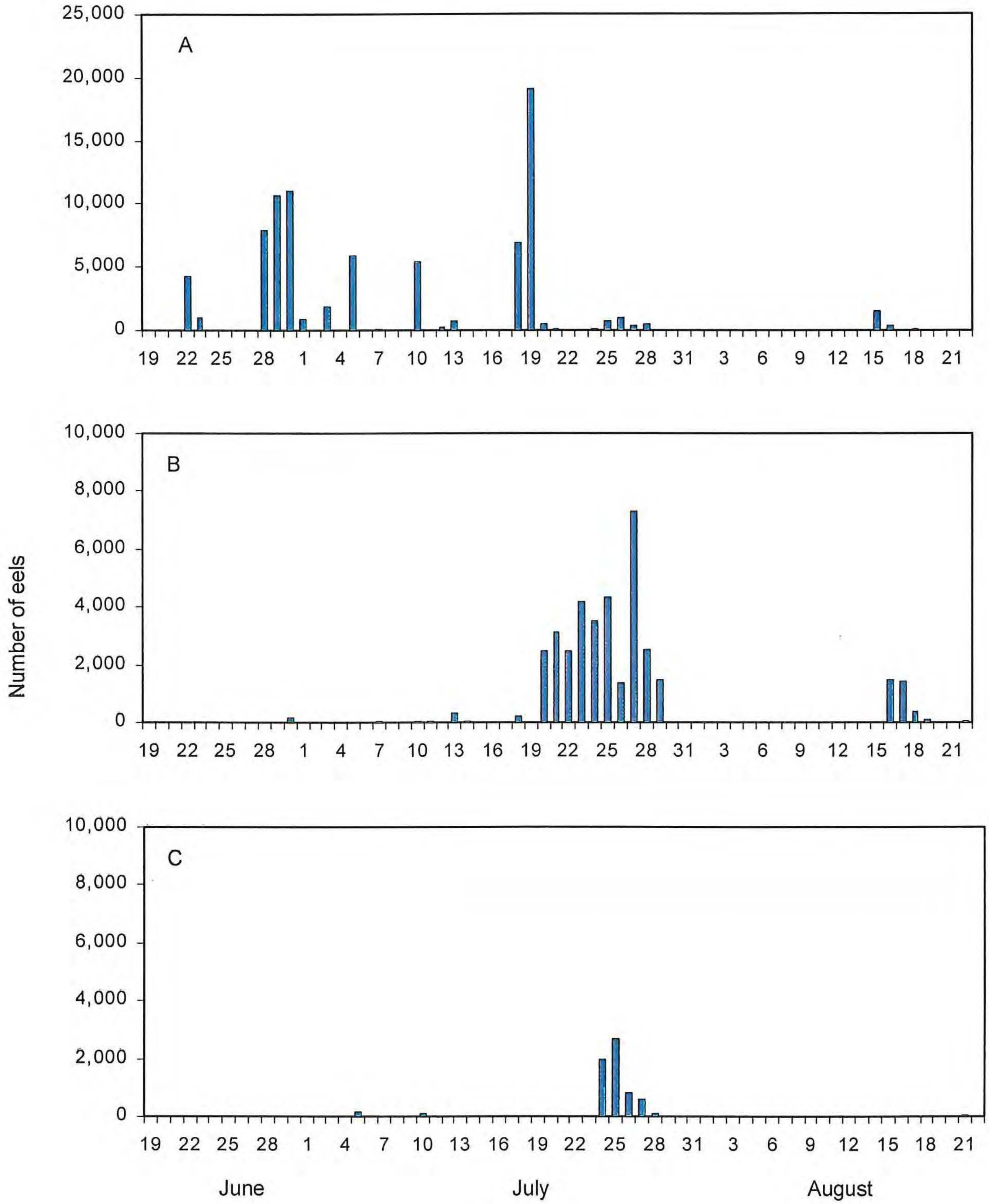
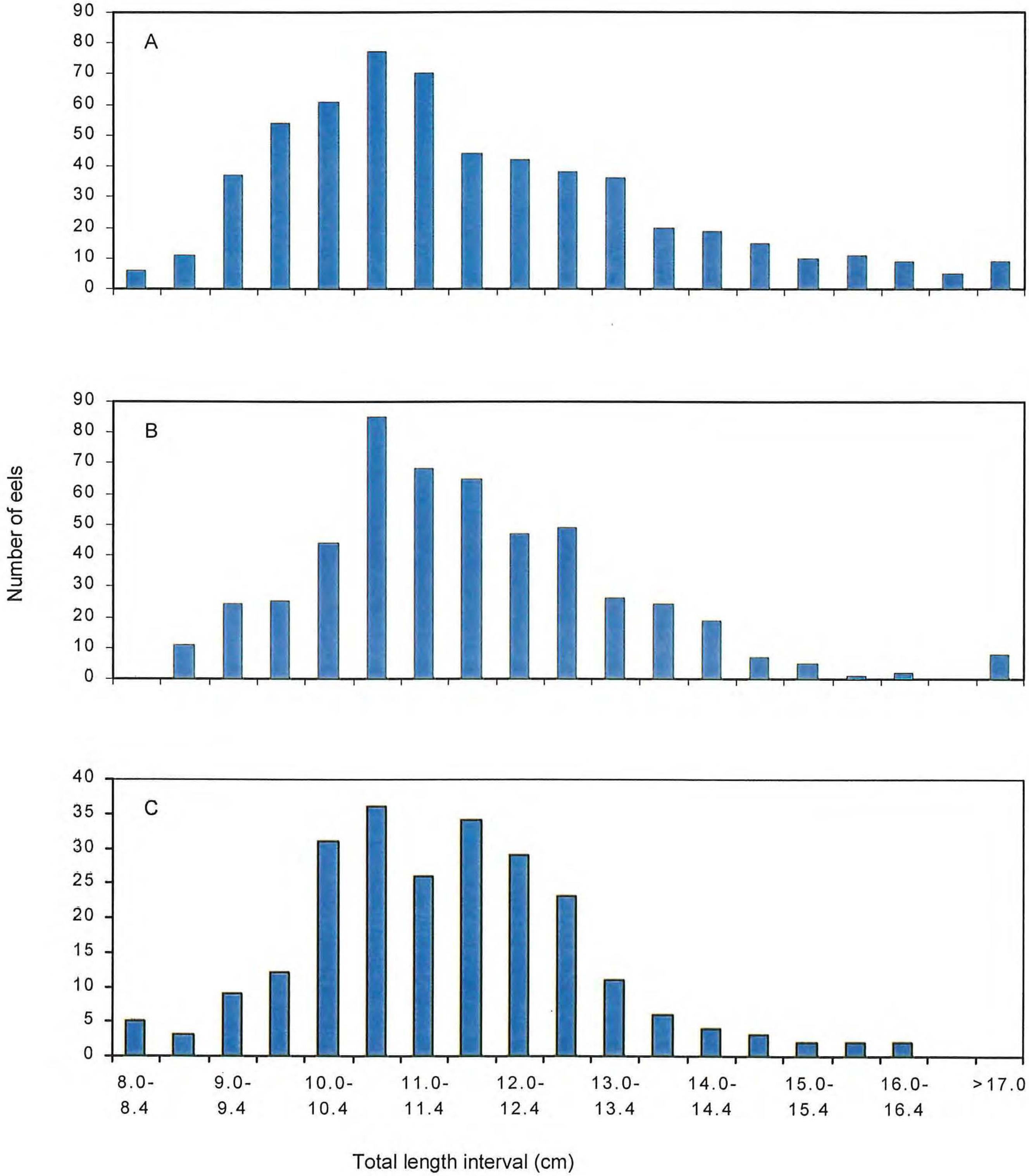
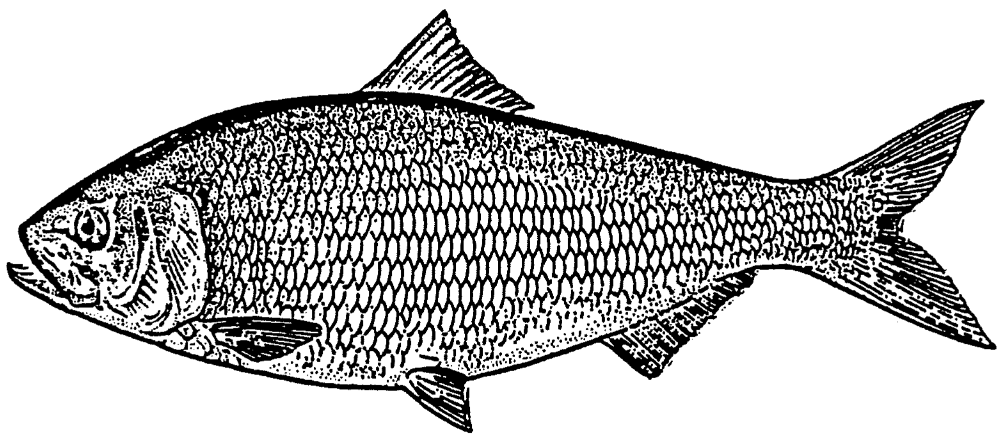


Figure 11. Length distribution of upstream migrating American eel during the 2000 field season at the (A) Ft. Halifax Project, (B) Benton Falls Project, and (C) Hydro-Kennebec Project.



APPENIDX A – Shad Hatchery Report

WALDOBORO SHAD HATCHERY



2000

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. The technology was adopted from the Susquehanna River Van Dyke Shad Hatchery and proved to be very sound and reliable. The Waldoboro Hatchery has successfully operated from 1992 to 2000 and during that period provided 13,295,073 fry for distribution by the DMR.

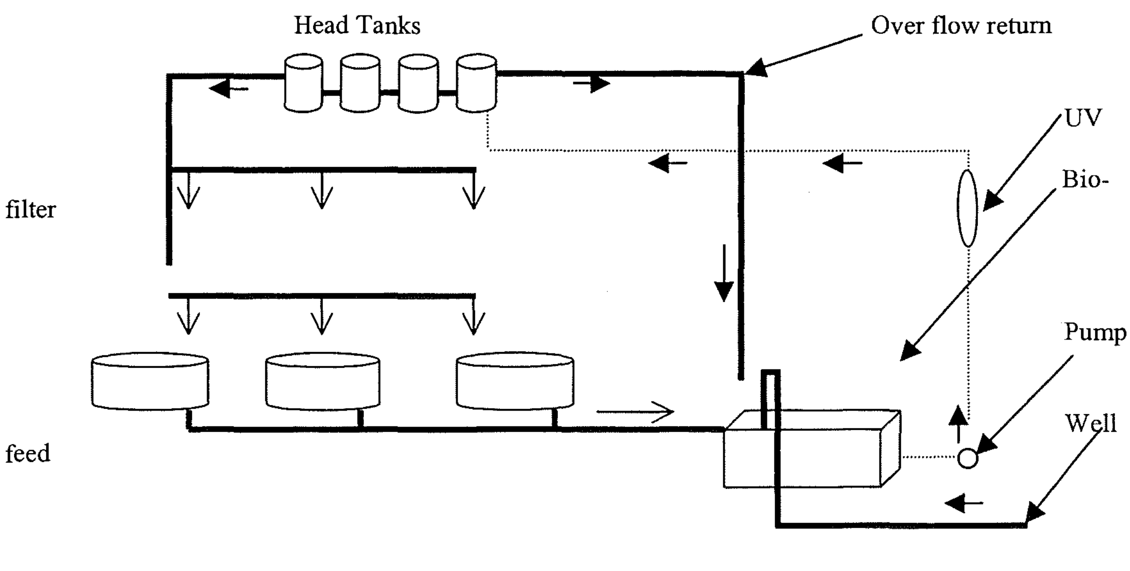
In 1997, the Maine Department of Marine Resources' Stock Enhancement Division (DMR-SED) received funds from The Maine Outdoor Heritage Fund to increase production capacity and implement new in-house technology for obtaining eggs from adult shad held in a spawning tank system at the Waldoboro Hatchery. These funds, administered through the Time and Tide Resource Conservation Area Council, allowed a complete renovation of the Waldoboro Hatchery and the installation of a recirculating spawning system. This new tank spawning system increased total egg availability and boosted hatchery production from an annual average of 600,000 to 2,700,000 during the 1997 season. In 1998, this system produced 3,660,739 shad eggs.

In 1999, the DMR-SED received another grant from The Maine Outdoor Heritage Fund and matched it with money from the Kennebec River Restoration Fund in order to create space to add two more tank-spawning systems for increased shad egg production at the hatchery. The first system was installed in time for the 1999 season and the second was installed at the end of that season, when funds became available. With the addition of one more spawning system in 1999, the number of eggs produced was increased to 4,142,122. In 2000, after the second system was installed, the total number of eggs produced increased to 6,917,407. These eggs, in combination with 3,314,882 from the Connecticut River egg take, resulted in the stocking of 4,781,273 shad fry in 2000.

The additional two tank-spawning systems, coupled with a year's experience in their operation, has provided an increased production of eggs and the new capability of maintaining Saco River shad as a river specific spawning group.

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 a UV sterilizer before entering the head tank. The tank is built on a shelf close to the ceiling in order to provide water pressure and 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. Shad fry are held in the tanks 10-20 days after hatching and need to be fed. Brine shrimp are the main shad fry diet and a system to conveniently feed all the tanks is needed. Two fiberglass 125-gallon, conical bottom tanks were set up to provide 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 shad 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 that are 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 per minute of new water. 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 watts of immersion heaters was an undersized 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 spawning tank enters the bio-filter tank through a 3" pipe tee that is drilled full of ¼" holes and acts as a muffler in slowing down the water velocity and evenly diffusing water currents. Knitted polyethylene bags of ½ mm mesh are tied onto both legs of the water muffler to collect the eggs released by the adult shad. The bags are changed each morning and the collected eggs placed in incubators.

TANK SPAWNING SYSTEM

2000 OPERATION:

The system was operated in the manner 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.

Having the additional two 15' diameter tank spawning systems allowed a separation of the Connecticut and Saco River origin shad at the hatchery. This enabled hatchery personnel to observe a difference in survival rates between the two populations. In 2000, it was clear that the handling during capture was a major factor in the survival of the broodstock shad after they were introduced into the hatchery tank spawning systems. The Saco River shad arrived in very good condition, exhibiting minimal scale loss and very little of the bruising/open sores that often develop from the capture and transport process. The Connecticut River shad arrived at the hatchery in a battered and bruised condition, with many open lesions about their bodies. Survival to the end of the spawning season of the Saco River shad was 85 out of 144 (58%), while survival of the Connecticut River shad was 7 out of 222 (3.2%).

The ME-IF&W Fish Health Laboratory was asked to examine the spawning tank mortalities of 2000. The state pathologist determined that the same bacteria as in 1999, vibrio and pseudomonas, were present. Also as in 1999, the infections in the shad were attributed to open lesions being a pathway for bacterial invasion. Despite being kept in well water while at the hatchery, large numbers of glochidia were found on the gills of the Connecticut River shad in the hatchery in 2000. This indicates that massive mortality due to glochidia on the shad gills in 1999 may be attributed to the glochidia infecting the shad in the Connecticut River and not coming from the hatchery water, as thought at that time. Due to a better understanding of the spawning tank operation in 2000, the rate of broodstock mortality was reduced, allowing for an increased egg production from CT River shad.

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, which would be lessened if the small eggs were removed. From 1998-2000, 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.

The viability of eggs >2mm in the first six deliveries from the CT River egg take averaged 60.2%. Because of this generally low viability, it was decided to try using a 0.45% saline solution in the fertilization process. Instead of the typical filtered river water, 0.45% irrigation saline was added to the egg and sperm mixture to initiate sperm motility. When this technique was employed on the second to last batch of eggs of the season, it resulted in viability of 91%. The last batch of eggs was also fertilized using a 0.45% saline solution, as well as being hardened and shipped in a 0.45% saline solution. The viability of the last batch of eggs was 74%.

ENUMERATION OF CULTURE TANK MORTALITY

During the 2000 hatchery season, the waste that is routinely siphoned from the bottom of the culture tanks was sampled to determine larval mortality after hatching and up to the point 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 time interval varies from one batch of larvae to the next. When a tank was cleaned, the bottom waste from one culture tank was siphoned into several plastic buckets and diluted to 15 liters in each bucket. The contents of a bucket were suspended by mixing with an open hand. While a bucket was being mixed, three 10 ml samples were removed and emptied into three individual petri dishes. The live and dead larvae were counted separately, but both were counted as mortality. An average of the three samples, live and dead, was determined as larvae per milliliter. The number of mortalities per bucket was estimated by multiplying the average of the three samples by 15,000. Finally, total mortality was estimated as the sum of the means of all the buckets.

When a culture tank standpipe screen was changed, its outside was rinsed into a bucket and the same method that was used to determine mortality from tank bottom waste was used to determine the number of dead larvae removed from the screen. Note sheets on the individual bucket and tank counts were not kept and that data is not available.

HATCHERY PRODUCTION SUMMARY FOR 2000

Normandeau Egg Take:

A total of 73.725 liters of eggs taken from netted Connecticut River shad were received at the hatchery. These 73.725 liters represented a total of 3,314,882 shad eggs, 656,250 of which were <2mm and 2,658,616 >2mm. As noted previously, eggs <2mm are generally unviable, immature eggs. The eggs >2mm had an average viability of 59.1% that produced 1,677,928 fry at hatch. Due to the volume of eggs handled and the limited number of culture tanks at the Waldoboro Hatchery, the Normandeau egg take fry were combined with other Connecticut River fry produced at the hatchery. It is not possible to give an unambiguous number of fry produced from the Normandeau eggs (Table 1).

Waldoboro Hatchery Tank Spawning System:

Saco River Shad - 15' MOHF tank (Fall 1999)

A total of 144 Saco River adult shad were delivered to the hatchery for tank spawning in three shipments: June 12 (81), June 30 (41), and July 22 (22). During the time the Saco River broodstock were in the hatchery system, they produced 42.059 liters of eggs. This volume represented a total of 3,040,910 eggs: 1,037,775 <2mm and 2,003,135 >2mm. The eggs <2mm are considered unviable and were thus discarded. The eggs >2mm had an average viability of 83.48% that produced 1,685,908 fry at hatch. These fry were cultured in segregated tanks from shad of other river origins. After enumerating culture tank losses, 1,572,517 fry were stocked (Table 2).

Kennebec River Shad – 12' MOHF tank (1997)

A total of 25 Kennebec River adult shad were delivered to the hatchery between June 1 and June 22. They were delivered in several trips: June 1 (3), June 12 (2), June 13 (5), June 15 (3), June 20 (7), and June 22 (5). On June 23, Connecticut River adult shad were added to the Kennebec River shad being held at the hatchery. While segregated, the Kennebec River shad produced 5.294 liters of eggs, representing 356,364 eggs. From June 10 to June 16, six batches of eggs were collected. They were measured and found to be 112 to 130 eggs per 10". Those eggs that ranged from 112 to 119 eggs per 10" were just barely retained on a 2mm sieve and upon examination, were determined to be developing, but still immature eggs. Since these eggs are dribbled out of the adult shad as they swim around in the tanks and are not a part of any spawning process, their role in determining overall egg viability is disregarded. Another source of <2mm immature eggs, from the females that die during the spawning process, are observed dropping from the females when they are removed from the tank. These eggs are always <2mm and immature. The eggs produced in these six batches amounted to 71,026 eggs and 19.9% of the total produced.

From June 17 to June 23, five batches of eggs were produced from spawning activity and contained viable eggs >2mm, varying in size from 84 to 92 eggs per 10"; unviable eggs <2mm measured 130+ eggs per 10". These five batches were used to determine overall viability of the Kennebec River shad broodstock. In total, these five batches resulted in 198,188 eggs >2mm, which had an average viability of 86.2% and produced 178,871 fry. Additionally, 87,150<2mm eggs were produced, but were deemed unviable and discarded. Due to the volume of eggs handled and the limited number of culture tanks in the Waldoboro Hatchery, the Kennebec River fry were combined with Connecticut River fry produced at the hatchery. While it is not possible to give an unambiguous number of fry stocked from the Kennebec River eggs, the tank batch they were combined with may be traced to the river of stocking (Table 3).

Connecticut/ Kennebec River Mixed Broodstock - 15' tank (NFWF funds, 1999)

A total of 222 live Connecticut River shad were combined with 22 Kennebec River shad and produced 59.005 liters of eggs. This volume represents a total of 4,914,272 eggs, 2,476,248 >2mm and 2,438,024 <2mm. The eggs >2mm had an average viability of 66.6% that produced 1,827,311 fry at hatching. The eggs <2mm were unviable and discarded. Due to the volume of eggs handled, the limited number of culture tanks, and the desire to maintain pure tanks of Saco fry, the Normandeau egg take fry were combined with Kennebec River and other Connecticut River fry produced at the hatchery. It is not possible to give an unambiguous number of fry stocked from the Connecticut River source eggs produced in the Waldoboro Hatchery spawning systems (Table 4).

Fry Stocking Summary:

Kennebec & Sebasticook Rivers	3,846,731
Saco River	259,090
Androscoggin River	529,558
Medomak River	145,545*

*The observed number stocked does not match this figure

POND CULTURE

No shad fry were intentionally removed and stocked into the ponds for rearing. The fall fingerlings produced are the result of either fry escaping from the hatchery culture tanks or from live fry caught when mortalities were enumerated in the waste sampling buckets.

The fry culture tanks have a 500-micron nylon screen that fits tightly over the tank standpipe in order to prevent the fry from escaping down the drains. Even so, there have been and continue to be, numbers of fry that get through the screening and make it into the drains and ponds. Sometimes when the standpipe screens are changed, a few larvae escape into the drains.

The mortality enumeration process counted both the dead and live larvae removed. Sometimes it was possible to return to a fry tank "some" of the larvae that could be observed swimming near the surface of the water in the enumeration buckets. Sometimes it was not possible to remove and return any of the larvae to a culture tank. There was no counting done of the fry returned to a tank or those left in with the dead and dumped into Pond #1. The numbers generated during the enumeration process were not kept, so it is not possible to provide an estimate of fry added to the ponds.

RECOMMENDATIONS FOR 2001

1. The positive role of Ca, Na, and Mg ions in the fertilization process has been demonstrated in other fish species. General water hardness may play a role in fertilization success, embryo development, and as a stress mitigator in older fish. When NaCl was used in the fertilization water of net egg take eggs in 2000, a much higher viability was attained. In 2001, all net egg take eggs should be fertilized in a 0.45% NaCl-CaCl, 50-50 solution. The exact proportions are not critical. The eggs should then be processed as they normally are and shipped in regular (unsalted) filtered river water. The NaCl-CaCl saline solution can be prepared from industrial grade salts ahead of time in convenient handling volumes and will add negligible cost to the operation in either time or money.

2. The DMR-SED transport crew should be given the license to pick and choose high quality adult shad for transport and the fish lift operation staff should be informed of this.

3. Strategies for obtaining shad broodstock for the hatchery tank spawning systems should be worked out ahead of time and be in place in time to put adult shad in the spawning systems as early as possible. Adult pathology sampling should be performed on the first 60 shad at the Holyoke fish lift. Adult shad should be provided to the hatchery before in-system stocking is accomplished.

TABLE 1. Connecticut River Net Egg Take Data

Date	Incubator	Mls eggs	Eggs/10"	Eggs/liter	Total eggs	% Viability	# Fry hatch
31-May	A	7500>2mm	74	29,063	217,962	67	146,035
		250<2mm	130+	150,000	37,500	0	0
1-Jun	B	7650>2mm	78	32,547	248,984	83	205,910
		450<2mm	130+	150,000	67,500	0	0
	C	7500>2mm	78	32,547	244,102	83	201,872
2-Jun	D	9000>2mm	82	39,378	354,402	40	141,406
		550<2mm	130+	150,000	82,500	0	0
3-Jun	E	8800>2mm	80	36,611	322,176	74	238,410
		400<2mm	130+	150,000	60,000	0	0
5-Jun	F	5500>2mm	85	43,521	239,365	23	54,096
		475<2mm	130+	150,000	71,250	0	0
	G	5500>2mm	85	43,521	239,365	23	54,096
6-Jun	H	4700>2mm	76	31,090	146,123	75	109,592
		350<2mm	130+	150,000	52,500	0	0
	I	4700	76	31,090	146,123	75	109,592
10-Jun	J	5100>2mm	88	48,912	249,451	91[1]	227,000
		400<2mm	130+	150,000	60,000	0	0
11-Jun	K[3]	3400>2mm	101	73,695	250,563	74[2]	185,417
	L[3]	1500<2mm	130+	150,000	225,000	2[2]	4,500
						μ = 59[4]	**Σ = 1,677,928**

[1] 0.045% NaCl used at fertilization
[2] 0.45% NaCl used at fertilization, hardening, and shipping
[3] K and L were shipped as one batch of eggs, but sieved and incubated separately
[4] Mean viability of eggs >2mm

TABLE 2. **Saco River Egg and Fry Production**

Date	# Adult Shad	Incubator	Mls eggs	Eggs/10"[1]	Eggs/liter[1]	Total eggs	% Viability	# Fry hatch
12-Jun	81							
13-Jun	81	1	132	105	83,402	11,009	0	0
			160	130	150,000	24,000	0	0
14-Jun	81		175	130	150,000	26,250	0	0
	81		10	130	150,000	150	0	0
16-Jun	79		15	130	150,000	225	0	0
	79		10	130	150,000	150	0	0
18-Jun	78	2	800	94	60,039	48,031	95	45,629
	78		45	130	150,000	6,750	0	0
19-Jun	78	3	650	91	53,724	34,921	78	27,238
20-Jun	74	4	1,550	90	52,286	81,043	84	68,076
	74		405	130	150,000	60,750	0	0
21-Jun	73	5	345	98	66,896	23,079	93	21,463
	73		22	130	150,000	3,300	0	0
22-Jun	71	6	1,000	90	52,286	52,286	86	44,966
	71		422	130	150,000	63,300	0	0
23-Jun	70	7	1,750	88	48,912	85,596	91	77,892
	70		56	130	150,000	8,400	0	0
24-Jun	70	8	1,790	86	44,647	79,919	0	0
	70		52	130	150,000	7,800	0	0
25-Jun	70	9	1,755	89	50,897	89,324	92	82,178
	70		77	130	150,000	11,550	0	0
26-Jun	70	10	2,055	86	44,647	91,750	93	85,328
	70		71	130	150,000	10,650	0	0
27-Jun	70	11	845	96	63,570	53,717	58	31,156
	70		125	130	150,000	18,750	0	0
29-Jun	69	12	1,850	94	60,039	111,072	85	94,411
	69		250	130	150,000	37,500	0	0
30-Jun	69	13	1,125	94	60,039	67,544	90	60,790
	69		210	130	150,000	31,500	0	0
30-Jun	110					0		0
1-Jul	110	14	4,650	92	55,217	256,759	80	205,407
	110		750	130	150,000	112,500	0	0
2-Jul	110	15	1,650	93	57,569	94,988	72	68,391
	110		375	130	150,000	56,250	0	0
3-Jul	110	16	1,690	96	63,570	107,433	78	83,798
	110		150	130	150,000	22,500	0	0
6-Jul	107	17	1,800	93	57,569	103,624	63	65,283
	107		340	130	150,000	51,000	0	0
7-Jul	106	18	400	97	65,436	26,174	97	25,389
	106		150	130	150,000	22,500	0	0
9-Jul	103	19	900	92	55,217	49,695	83	41,247
	103		45	130	150,000	6,750	0	0
11-Jul	103	20	1,505	90	52,286	78,690	96	75,542
	103		125	130	150,000	18,750	0	0
12-Jul	103	21	315	89	50,897	16,032	88	14,108
	103		30	130	150,000	4,500	0	0

TABLE 2 (CONTD) Saco River Egg and Fry Production

Date	# Adult Shad	Incubator	Mls eggs	Eggs/10"[1]	Eggs/liter[1]	Total eggs	% Viability	# Fry hatch
13-Jul	102	22	800	91	53,724	42,979	87	37,392
15-Jul	101	23	1,190	95	61,770	73,506	92	67,626
	101		52	130	150,000	7,800	0	0
16-Jul	101	24	114	109	93,362	10,643	52	5,534
			171	130	150,000	25,650	0	0
17-Jul	101	25	106	101	73,695	7,812	0	0
			34	130	150,000	5,100	0	0
18-Jul	99	26	1,030	97	65,436	67,399	88	59,311
	99		56	130	150,000	8,400	0	0
19-Jul	98	27	400	95	61,770	24,708	95	23,473
	98		16	130	150,000	2,400	0	0
21-Jul	98	28	350	99	69,404	24,291	91	22,105
	98		44	130	150,000	6,600	0	0
22-Jul	97		32	106	86,093	2,754	0	0
	97		242	130	150,000	36,300	0	0
22-Jul	119					0		0
23-Jul	119	29	1,365	99	69,157	94,736	73	69,157
	119		400	130	150,000	60,000	0	0
24-Jul	119	30	345	101	73,695	25,425	81	20,594
	119		125	130	150,000	18,750	0	0
25-Jul	116		320	130	150,000	48,000	0	0
26-Jul	115	31	150	105	83,402	12,510	68	8,507
	115		250	130	150,000	37,500	0	0
27-Jul	114	32	375	105	83,402	31,275	94	29,399
	114		250	130	150,000	37,500	0	0
29-Jul	101	33	295	102	75,976	22,412	79	17,705
	101		44	130	150,000	6,600	0	0
31-Jul	92		425	130	150,000	63,750	0	0
2-Aug	85	ADULTS RELEASED TO DMR-SED					0	0
							μ = 83.4[2]	**Σ = 1,579,095**

[1] Entries of 130 eggs/10" and 150,000 eggs / liter indicate eggs that are <2mm

[2] Mean viability of eggs >2mm

TABLE 3. Kennebec River Shad Egg Production

Date	# Adult shad	Incubator	Mls eggs	Eggs/10"[1]	Eggs/liter	Total eggs	% Viability	# Fry hatch
1-Jun	3							
10-Jun	2							
11-Jun	2		13	130	150,000	1,950	0	0
12-Jun	4		45	130	150,000	6,750	0	0
14-Jun	9		80	119	~120000	9,600	0	0
15-Jun	12		180	130	150,000	9,600	0	0
16-Jun	12		100	130	150,000	15,000	0	0
	12		100	112	99,761	9,976	0	0
17-Jun	12		5	130	150,000	750	0	0
		k1	1,400	84	42,433	62,206	95	59,096
18-Jun	11		37	130	150,000	4,050	0	0
19-Jun	10							
20-Jun	9							
	9	k2	350	92	55,217	19,326	61	11,789
20-Jun	16		20	130	150,000	3,000	0	0
21-Jun	16							
		k3	890	84	42,433	37,765	98	37,010
22-Jun	13		15	130	150,000	2,250	0	0
		k4	450	89	50,897	22,904	85	19,468
22-Jun	18	k5	367	130	150,000	55,050	0	0
23-Jun	18							
		k6	1,100	89	50,897	55,987	92	51,508
23-Jun			88	130	150,000	13,200	0	0
	CONNECTICUT RIVER SHAD ADDED----NOW A MIXED BROODSTOCK							
							μ = 86.2[2]	**Σ = 178,871**

[1] Entries of 130 eggs/10" and 150,000 eggs / liter indicate eggs that are <2mm

[2] Mean viability of eggs >2mm

TABLE 4. Connecticut and Kennebec River Mixed Egg Production

Date	# Adult shad	Incubator	Mls eggs	Eggs/10"[1]	Eggs/liter	Total eggs	% Viability	# Fry hatch
4-Jun	59							
5-Jun	49	1	75	87	47,017	3,526	0	0
			60	130	150,000	9,000	0	0
6-Jun	49		100	130	150,000	15,000	0	0
7-Jun	49	2	1,050	88	48,912	51,358	38	19,516
8-Jun	46	3	650	93	57,569	37,420	39	14,594
			300	130	150,000	45,000	0	0
9-Jun	45		710	130	150,000	106,500	0	0
10-Jun	45	4	650	88	48,912	31,792	31	9,856
			112	130	150,000	16,800	0	0
11-Jun	42	5	85	98	66,896	5,686	0	0
			110	130	150,000	16,500	0	0
12-Jun	40	6	950	98	66,896	63,551	63	39,783
			1,260	130	150,000	189,000	0	0
13-Jun	39	7	900	94	60,039	54,035	30	16,211
			467	130	150,000	67,050	0	0
14-Jun	38		122	130	150,000	18,300	0	0
15-Jun	102							0
16-Jun	157		475	130	150,000	71,250	0	0
17-Jun	150		127	93	57,569	7,311	0	0
			2,550	130	150,000	37,500	0	0
18-Jun	139	8	200	106	86,093	17,219	0	0
			335	130	150,000	50,250	0	0
19-Jun	151	9	1,840	98	66,896	123,089	44	54,159
			750	130	150,000	112,500	0	0
20-Jun	140	10	225	95	61,770	13,898	19	2,641
			575	130	150,000	86,250	0	0
21-Jun	133	11	150	98	66,896	10,034	0	0
			350	130	150,000	52,500	0	0
22-Jun	124	12	1,750	95	61,770	108,098	66	71,345
			720	130	150,000	108,000	0	0
23-Jun	109	13	1,100	97	65,436	71,980	34	24,473
			1,057	130	150,000	158,550	0	0
24-Jun	95	14	2,365	90	52,286	123,656	71	87,796
			900	130	150,000	135,000	0	0
25-Jun	88	15	5,190	91	53,724	278,828	86	239,792
			820	130	150,000	123,000	0	0
26-Jun	109	16	5,260	88	48,912	257,277	88	226,404
			820	130	150,000	123,000	0	0
27-Jun	106	17	3,900	92	55,217	215,346	93	200,272
			190	100	71,507	13,586	0	0
			807	130	150,000	121,077	0	0

TABLE 4 (CONTD) Connecticut and Kennebec River Mixed Egg Production

Date	# Adult shad	Incubator	Mls eggs	Eggs/10"[1]	Eggs/liter	Total eggs	% Viability	# Fry hatch
28-Jun	104	18	4,575	95	61,770	282,598	75	211,949
			1,012	130	150,000	151,800	0	0
29-Jun	119	19	880	96	63,570	55,942	74	41,397
			875	130	150,000	131,250	0	0
30-Jun	108	20	2,200	97	65,436	143,959	80	115,167
			500	130	150,000	75,000	0	0
1-Jul	100	21	2,280	94	60,039	136,888	88	120,461
			160	130	150,000	24,000	0	0
2-Jul	88	22	1,225	94	60,039	73,547	80	58,838
			150	130	150,000	22,500	0	0
3-Jul	84	23	370	98	66,896	24,752	80	19,802
			250	130	150,000	37,500	0	0
5-Jul	74	24	1,350	93	57,569	77,718	79	61,397
			325	130	150,000	48,750	0	0
6-Jul	71	25	500	98	66,896	33,448	95	31,776
			39	130	150,000	5,850	0	0
7-Jul	69	26	750	94	60,039	54,029	94	50,787
			42	130	150,000	6,300	0	0
9-Jul	66	27	400	94	60,039	24,016	54	12,969
			260	130	150,000	39,000	0	0
10-Jul	66	28	600	97	65,436	39,261	94	36,905
			315	130	150,000	47,250	0	0
14-Jul	24	29	1,090	97	65,436	71,325	82	58,487
			190	130	150,000	28,500	0	0
19-Jul	10							0
25-Jul	?	30	14	99	69,404	971	55	534
			92	130	150,000	13,800	0	0
26-Jul	?		39	130	150,000	5,850	0	0
27-Jul	7							
							μ =66.6[2]	**Σ = 1,827,311**

[1] Entries of 130 eggs/10" and 150,000 eggs / liter indicate eggs that are <2mm
[2] Mean viability of eggs >2mm

TABLE 5. 2000 Shad Fry Stocking Data

Date Stocked	Tank	Source	Incubators	# Fry hatch	% Survival after hatch	# Stocked	Range of Stock Age	Receiving Site
23-Jun	1	CT	A	146,035				
			B	205,910				
			C	201,872				
				553,817	79.1	438,231	13-18	Kennebec
23-Jun	2	CT	D	141,406				
			E	238,410				
			F	54,096				
			G	54,096				
				488,008	72.6	354,502	9-14	Kennebec
27-Jun	3	CT	H	109,592				
			I	109,592				
			1	0				
			2	19,516				
			3	14,594				
				253,294	97.4	246,770	10-14	Kennebec
30-Jun	4	CT	J	227,000				
			K	185,417				
			L	4,500				
			4	9,856				
			5	0				
			6	39,783				
			7	16,211				
				482,767	87	420,231	8-14	Kennebec
3-Jul	5	CT-K	K1	59,096				
			K2	11,789				
			K5	0				
			8	0				
			9	54,159				
			10	2,614				
			11	0				
				127,658	85.6	109,395	9-12	Sebasticook
10-Jul	6	S	1	0				
			2	45,629				
			3	27,238				
			4	68,076				
			5	21,463				
			6	44,966				
			7	77,892				
				285,264	90.8	259,090	9-17	Saco

TABLE 5 (CONTD) 2000 Shad Fry Stocking Data

Date Stocked	Tank	Source	Incubators	# Fry hatch	% Survival after hatch	# Stocked	Range of Stock Age	Receiving Site
10-Jul	2-a	CT-K	K3	37,010				
			K4	19,468				
			K6	51,508				
			12	94,411				
			13	60,790				
			14	205,407				
			15	68,391				
				536,985	99.6	529,558	7, -16	Androscoggin
17-Jul	1-a	S	8	0				
			9	82,178				
			10	85,328				
			11	31,156				
			12	94,411				
				293,073	99.5	291,608	9, -18	Kennebec
17-Jul	3-a, 16, 17	CT-K	16	226,404				
			17	200,272				
				426,676	91.5	390,609	12, -15	Sebasticook
18-Jul	5-a	S	13	60,790				
			14	205,407				
			15	68,391				
			16	83,798				
				418,386	95	397,542	6-13	Kennebec
24-Jul	4-a	CT-K	18	211,949				
			19	41,397				
			20	115,167				
			21	120,461				
			22	58,838				
			23	19,802				
				567,614	95.6	539,410	14-20	Kennebec
27-Jul	6-a	CT-K	24	61,397				
			25	31,776				
			26	50,787				
			27	12,969				
			28	36,905				
				193,834	96.8	179,574	7-16	Kennebec
27-Jul	2-b	S	17	65,283				
			18	25,389				
			19	41,247				
			20	75,542				
			21	14,108				
				221,569	93.5	207,356	6-16	Kennebec

TABLE 5 (CONTD) 2000 Shad Fry Stocking Data

Date Stocked	Tank	Source	Incubators	# Fry hatch	% Survival after hatch	# Stocked	Range of Stock Age	Receiving Site
4-Aug	1-b	S, 22-28	22	37,392				
		CT-K, 29	23	67,626				
			24	5,534				
			25	0				
			26	59,311				
			27	23,473				
			28	22,105				
			29	58,487				
				273,928	99.1	271,503	5-19	Kennebec
14-Aug	2-c	S, 29-33	29	69,157				
		CT-K30	30	20,594				
			31	8,507				
			32	29,399				
			33	17,705				
			CT-K30	534				
				145,896	99.7	145,894	11-17	Medomak
				$\sum$ = 4,877,432	**μ = 92.1**	**$\sum$ = 4,781,273**		

APPENDIX B – Proposed 2000 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. The Edwards Dam was successfully removed in 1999, which will allow alewives to freely migrate to the first dam on the Sebasticook River at Fort Halifax. The majority of the alewives should home to the Sebasticook River because over 90% of alewife habitat that has been stocked is in this drainage.

Alewives will be trapped using the Transvac fish pump and storage tank that were employed 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/load alewives in the tank trucks. DMR personnel will transport 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 2000 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 2000 can be split into four different types, based upon the origin and destination of the shad:

1) It is likely DMR will be requested to transport shad within the Connecticut River system during 2000. In recent years, the Connecticut River Technical Advisory Committee has required DMR to transport shad from the Holyoke Dam to stocking sites in the Connecticut drainage as mitigation for allowing DMR contractors to net adult shad and take eggs in the river above Holyoke, as well as transfer shad from the Holyoke fish lift back to Maine. Requirements for DMR in 1999 included transporting a minimum of 1,000 shad above the Vernon Dam. It is expected that the same or similar conditions will be in place for the 2000 season. In that event, DMR will be required to transport a minimum of 1,000 shad upriver to support the egg take program from the Connecticut River. Additional shad transport upriver on the Connecticut may be required depending upon the number of shad DMR is able to truck back to Maine (see **2**).

2) DMR's first priority in 2000 will be to obtain adult shad broodstock at the Fort Halifax Dam. The dam's owner, Florida Power and Light (FPL) 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 Waldoboro Shad Hatchery. Lengths, scales, and otoliths will be collected from all adult mortalities occurring at Fort Halifax, during transport, and/or at the hatchery.

3) DMR will transport American shad broodstock from the Holyoke fish lift to the DMR-funded shad hatchery in Waldoboro, ME. These shad are placed in large circular tanks where they spawn over the course of several weeks; the fertilized eggs are collected, hatched, and the fry placed in rearing tanks. The tank spawning facility was expanded in 1999 from one to three tanks. The facility now has the capability of holding river specific broodstock separately.

4) DMR will transport American shad broodstock from the Cataract fish lift on the Saco River to the DMR-funded shad hatchery in Waldoboro, ME. These shad will also be utilized in tank spawning, as outlined in **3** above. The Saco shad are normally collected as the run picks up in June, supplementing the Connecticut River shad already at the hatchery. The later-run Saco fish are available at a time when the contribution to egg production of the spawned-out or dead Connecticut River fish is waning. In addition, the Saco River fish are typically in better condition, both at the fish lift and upon their arrival at the hatchery. Their superior condition should translate to lower delayed mortality, especially for the heavily laden females. Light loads will be used to transport Saco shad since few fish are available per day and the lower hauling densities help reduce transfer and delayed mortalities at the hatchery. It is expected that the minimum need for broodstock from all three sources is 400-500 gravid adults.

Job 3. Transportation of American Shad Fry and Fall Fingerlings.

Fry:
DMR will load, transport, and release shad fry produced at the Waldoboro Shad Hatchery. As the fry 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. With the proposed expansion of tank spawning operations, DMR hopes to have significantly more fry to release from the hatchery in 2000.

Fall Fingerlings:
Fall fingerling shad will be grown out in the hatchery rearing ponds by the contractor until October. DMR will seine, load, transport, and release the fingerlings produced at the Waldoboro hatchery. They will be seined from the rearing ponds by fishing a fine mesh beach seine through each pond several times. Fingerlings will be removed from the seine with dip nets and loaded into the transport tanks on the stocking trucks for transfer to the release sites. In 2000, maximum fingerling production will be approximately 60,000 fish, requiring six to eight trips to transfer and stock them in the appropriate habitat.

Job 4. Assessment of Young-of-the-Year American Shad and Alewives.
DMR will sample young-of-the-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with fry, fall fingerlings, and/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-the-year alewives in all lakes or ponds in the Sebasticook and Kennebec drainages that were stocked with broodstock alewives. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, dip or cast netting, or sampling downstream migrants at hydroelectric sites and lake outlet dams.

Job 5. Assessment of Downstream Passage of American Shad and Alewives.
DMR will survey the outlet streams of lakes and ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the post spawner adult and young-of-the-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 the hydroelectric dams, as well as other dams, located below shad and alewife stocking sites 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. We will continue this sampling effort to collect more data on the current fish assemblage through the year 2000.

Sampling methods will include fyke netting, electrofishing, minnow trapping, trawling, and beach seining. Overnight fyke net sets and electrofishing will be used to collect primary samples. Samples from deep-water areas may be supplemented by otter trawling. Beach seines and baited minnow traps will be used to collect additional samples of YOY and juvenile fishes. Samples will be collected biweekly from all sites.

Job 7. Temporary Fish Weir on Sevenmile Stream.
DMR will install and maintain a temporary fish weir on Sevenmile Stream until the Maine Department of Inland Fisheries and Wildlife installs a permanent fish barrier and counting station. Once these 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 2000.

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
Wesserunsettt Lake	1,446	8,676
Great Moose Lake	3,584	21,504

(CALENDAR YEAR)

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$20,234.48	$35,379.20	$35,463.34	$ 21,129.98	$112,207.00
Materials/Supplies	$ 5,639.00	$ 1,272.00	$ 618.00	$ 1,365.00	$ 8,894.00
Operations/Maintenance	$ 6,442.76	$ 7,478.08	$ 4,178.08	$ 2,173.08	$ 20,272.00
State Indirect Cost (2%)	$ 665.00	$ 821.00	$ 805.00	$ 536.00	$ 2,827.00
Capital					
TOTALS:	$32,981.24	$44,950.28	$41,064.42	$ 25,204.06	$144,200.00

APPENDIX C – 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. This 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/load alewives in the tank trucks. DMR personnel will transport 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 on 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 Fort Halifax 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 Fort Halifax, during transport, and/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 the run picks up in June. Light loads will be used to transport the Saco shad, since few fish are available per day and the lower hauling densities help to reduce transfer and delayed mortalities 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 400-500 gravid adults.

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-the-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, and/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-the-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 and lake outlet dams.

Job 5. Assessment of Downstream Passage of American Shad and Alewives.
DMR will survey the outlet streams of lakes and ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the post spawner adult and young-of-the-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 the hydroelectric dams, as well as other dams, located below shad and alewife stocking sites 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, depth, and flow; and made measurements of bank stability and vegetation. These efforts 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 methods may need to be employed to capture adult fish. 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 Stream.
DMR will install and maintain a temporary fish weir on Sevenmile stream until the Maine Department of Inland Fisheries and Wildlife installs a permanent fish barrier and counting station. Once they 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
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Unity Pond	2,528	15,168
Webber Pond	1,252	7,512
Wesserunsett Lake	1,446	8,676
Great Moose Lake	3,584	21,504

	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**