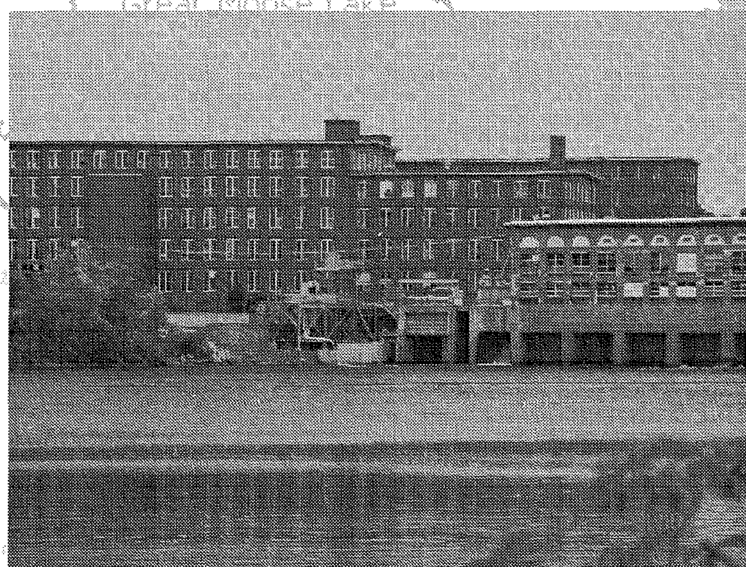
Kennebec River Anadromous Fish Restoration
Annual Progress Report - 2006



Lockwood Fishway

Prepared by:
Maine Department of Marine Resources
Stock Enhancement Division
#21 State House Station
Augusta, ME 04333-0021
(207) 624-6340

Maine Atlantic Salmon Commission
270 Lyons Road
Sidney, ME 04330
(207) 547-5326

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In 2006 the Kennebec River Restoration Program entered a new phase when upstream anadromous fish passage became operational at the Benton Falls, Burnham, and Lockwood hydropower projects (Fig. 1). The new fish lifts at Benton Falls and Burnham have made accessible nearly 100% of the riverine habitat and 43% of lacustrine habitat that was historically available to anadromous fishes in the Sebasticook River drainage, thereby allowing the Department of Marine Resources (DMR) to reduce stocking operations in the drainage. Fish returning to the Sebasticook River in 2006 were collected at the first dam (Fort Halifax) with the Transvac pump and sluiced into the headpond; in previous years, these fish had to be trucked upstream to spawning habitat. The new fish lift at Lockwood allowed DMR to capture fish imprinted on the Kennebec drainage and move them upriver for the first time since the inception of the Restoration Program.

On May 1, 2006, the interim fish pump was installed below the Fort Halifax Hydroelectric Project in Winslow, Maine. Trapping of alewives with the pump began on May 8. On May 13 rising river flows began effecting pump effectiveness and by May 18 the pump had to be shut down. On May 19 -24 high river flows did not permit pumping operations. On May 25 adequate numbers of alewives had returned to the tailrace and stocking operations resumed, however effectiveness remained depressed due to high tailwater levels river flows. On May 28, the pump developed a leak in the suction hose compromising the efficiency of the pump. On May 31, the fish pump experienced a mechanical breakdown and operations ceased. On June 2, 5, and 6 an additional 1,663 fish were hand bailed and carried up the embankment to the holding tank and were then counted into the hopper and sluiced into the headpond. River flows once again rose above fishable levels on 6 and efforts were ceased. The fish pump collected 45,297 alewives. The total mortality rate of adult alewives by DMR in 2006 was 0%. This was largely due to fish being stocked directly into the headpond and not transported by truck. Due to the mechanical failure of the fish pump, pumping mortality was higher than in years past. An accurate mortality count was not kept. Flashboards were installed at the Fort Halifax Project early in the alewife run in 2007. The sex ratio of randomly collected alewife samples was 1.4 males: 1.0 females (n=199). As predicted, fish lengths and weights decreased over time. The majority of adult alewives collected were age IV males (40.4%) and age V females (21.1%). Alewife harvest permits were issued to 15 commercial fishermen. At the time of this writing, of those permitted, 10 have reported combined landings of 3,946 bushels (1247 bushels in 2005).

The new fishlift at the Lockwood dam captured 4094 adult river herring. These fish were stocked into Wesserunset Lake (2,793) and Lovejoy Pond (146), Pleasant Pond – Gardiner (213).

Alewives were also hand bailed over the outlet dam to Webber Pond in Vassalboro, ME. On May 9, enough alewives had accumulated below the outlet dam to warrant hand bailing. A total of 18,589 alewives were captured over the course of 26 days at the base of the dam with dipnets and counted into Webber Pond. No alewife mortalities were recorded during this effort.

A total of 169 adult American shad broodstock were transferred to the Waldoboro hatchery from the Connecticut River. No attempt was made to capture broodstock from the Brunswick Fishway to augment hatchery broodstock in 2006.

Larval shad production in 2006 totaled 262,131. All were stocked in the Kennebec River below the Shawmut Project. On October 18 1,123, fingerlings were collected from the holding ponds and transported by Connecticut DEP to the City of Norwich, CT for its effectiveness study of the Occum Dam Downstream Bypass.

DMR personnel checked pond outlet dams from July through November. Water levels were generally higher than those encountered in previous years were and as a result, down stream passage was available during many of the inspections.

Bypass facilities were operating at all projects during all visits. The American Tissue Project, located on Cobbosseecontee Stream in Gardiner, re-installed intake grating in to prevent American eels from entering the turbine penstock. American Tissue also re-installed the plunge pool for out-migrant alewives. No dead eels or alewives were observed below the American Tissue Project in 2006.

DMR personnel conducted biweekly beach seine surveys at eight sites in the Kennebec River between Augusta and Waterville. A total of 47 seine hauls were made. A total of 136 juvenile alewives, 4,041 juvenile American shad and one American eel were captured. The catch/effort for juvenile shad was 84.19, compared to 92.53 in 2005.

DMR obtained data on upstream eel passage at six hydropower projects in the watershed. Passage at all locations was delayed because of extremely high runoff conditions. An estimated 47,755 eels passed Fort Halifax in 27 days; 552 passed Benton Falls in 57days; 4,597 passed Hydro-Kennebec in 38 days; 4,973 passed Burnham in 204 days; 1,863 passed American Tissue in 27 days; and 26 passed Anson in 49 days. In addition, FPL Energy reported passing none at Shawmut (late passage installation) and approximately 6,800 at Weston.

Interim downstream passage measures designed specifically for American eel were operational at two KHDG projects (Benton Falls and Burnham) and three other projects in the watershed (Anson, Abenaki, and American Tissue). At the remaining five KHDG projects interim downstream passage measures designed for anadromous species were operational. Quantitative effectiveness testing for the main stem projects will be initiated in 2007. Visual observations were made at two sites by MDMR in 2006, but no dead eels were observed. A small eel kill was reported by Essex Hydro Associates at the Benton Falls Project.

Considerable progress was made on Atlantic Salmon restoration in the Kennebec River in 2006. The first trapping facility on the Kennebec River was operational in May and captured the first Atlantic salmon on June 17. During the course of the trapping season a total of 15 adults were captured and transported to the Sandy River into appropriate holding, spawning and juvenile nursery habitat. Of the 15 adults captured seven were one sea-winter returns and eight were two sea-winter returns.

Habitat surveys were continued during the summer of 2006 as well. The Orbeton Stream survey, which was initiated in 2005, was completed in 2006 and additionally a survey was made of the South Branch of the Sandy River. Both surveys will be used to produce detailed Atlantic salmon habitat maps for management conservation purposes.

In the summer and fall of 2006, 30 sites were sampled with electrofishing gear in an effort to monitor the juvenile population. As a result of instream incubation and streamside incubation research, juveniles were released into the Sandy River and several of its tributaries. Most electrofishing results indicate that juveniles were present in most areas where they were released as either eggs or fry.

In addition to monitoring juveniles, spawning surveys were conducted to determine the number of returning adults to the Kennebec River and determine the locations of redds. Surveys were unsuccessful at locating any redds in the lower Kennebec River tributaries as well as the Sandy River. Unfortunately, high water and ice conditions hampered these efforts.

Some temperature monitoring effort was made in 2006. Loggers were placed in strategic locations to help identify release sites for adults and establish safe handling procedures as well as gaining additional information around the instream incubation sites.

Juvenile releases in 2006 were made as a result of two projects conducted in the Sandy River drainage. Approximately 6,500 non-feeding fry were released in late May from streamside incubators operated on Mill Brook. The fry were released at a single location in the mainstem of the Sandy River in Madrid. The streamside incubation project is part of a joint venture between the Maine Atlantic Salmon Commission and Trout Unlimited to investigate streamside incubation as a restoration tool for volunteers. Eggs were also planted in artificial redds in an effort to investigate the use of green and eyed eggs as a viable tool for salmon restoration. For this project, approximately 41,000 eggs were divided and buried in five locations. Alevin were produce at varying degrees at all five sites.

Introduction

The Kennebec River Restoration Program was initiated following the development of a Strategic Plan in 1985, an Operational Plan in 1986, and the signing of an Agreement in 1986 between the Department of Marine Resources (DMR) and the Kennebec Hydro Developers Group (KHDG). This Agreement provided a delay in fish passage requirements at seven hydropower facilities above Augusta in exchange for funds to initiate the restoration by means of trap-and-truck of alewife and American shad to selected upriver spawning and nursery habitat. In 1998, a new Agreement between state and federal fisheries agencies and the members of the KHDG was signed. The new Agreement provided for the removal of Edwards dam, included new timetables or triggers for fish passage at the seven hydropower facilities above Augusta, and provided additional funds to continue the restoration by trap-and-truck. A more detailed history of the restoration program, including management goals and objectives, is included in Appendix A.

In 2006, the Kennebec River Restoration Program entered a new phase when upstream anadromous fish passage became operational at the Benton Falls, Burnham, and Lockwood hydropower projects (Fig. 1). The new fish lifts at Benton Falls and Burnham have made accessible nearly 100% of the riverine habitat and 43% of lacustrine habitat that was historically available to anadromous fishes in the Sebasticook River drainage, thereby allowing the Department of Marine Resources (DMR) to reduce stocking operations in the drainage. Fish returning to the Sebasticook River in 2006 were collected at the first dam (Fort Halifax) with the Transvac pump and sluiced into the headpond; in previous years these fish had to be trucked upstream to spawning habitat. The new fish lift at Lockwood allowed DMR to capture fish imprinted on the Kennebec drainage and move them upriver for the first time since the inception of the Restoration Program.

1.0 Alewife Restoration Efforts

1.1 Overview

On May 1 2006, the interim fish pump was installed below the Fort Halifax Hydroelectric Project in Winslow, Maine. Stocking operations were delayed until May 8 when adequate numbers of alewives were available for pumping. On May 13 rising river flows began effecting pump effectiveness and by May 18 the pump had to be shut down. Pumping operations began again on May 25; however, effectiveness remained depressed due to high tailwater levels and river flows. On May 28 a series of pump failures began with a leak in the suction hose compromising the efficiency of the pump. On May 31 the combined pump failures reached a point that it could no longer be operated. The pump valves failed to seal and the vacuum vessel would dewater out the intake tube. At this time the seals would suddenly close and crush fish in the way. Fish parts were clearly visible in the clear lexan portion of the intake line where the pump was discharging the water back into the river instead of up into the holding tank.. Many fish were examined, wounds included chopped off heads and tails, fish cut completely in half, and many others with multiple strike marks which partially severed their bodies. As many fish appeared in parts and the pump was pumping many of these parts back into the river, it was impossible to keep a count of mortalities, however we estimate a mortality of a minimum of 800 fish for the season. On June 2, 5, and 6 fish were hand bailed and carried up the embankment to the holding tank and were then counted into the hopper and sluiced into the headpond. River flows once again rose above fishable levels on 6 and efforts ceased. As waters once again receded water temperatures increased to upwards of 22° C and fish densities never attained a point where further efforts were warranted.

Due to initially low spring flows, flashboards were installed within the first few days of the initiation of pumping efforts in 2006. FPL Energy has instituted new guidelines for operations personnel and biologists during the herring migration season that state spill over the crest of the dam is to be maintained until FPL Energy biologists safely remove any fish from the ledges to prevent stranding when spill is discontinued. Once the flashboards are installed, the headpond level is to be maintained 0.5 feet below the top of the boards. These procedures, coupled with relatively low spring flows, prevented spill over the crest of the dam onto the south ledges, thereby preventing alewives from ascending the ledges and possibly becoming stranded with the loss of spill.

Between May 8 and June 6, 2006, 46,960 alewives were collected with the fish pump. It operated for a total of 16 days (6 more than 2005, one fewer than in 2004) and an average 2,935 adult alewives (8,274 in 2005) were collected daily. The low number of fish collected in 2006 was due to a number of factors including environmental conditions causing variation in fish densities below the dam (e.g., high water and/or depressed water temperatures), and commercial fishing effort.

In 2006 the catch rate at Ft. Halifax wasn't necessarily representative of the run due to various environmental conditions. Historically (2000-2006), the mean date by which 50% of alewives have been collected is May 17. In 2006, the 50% date of alewife trapping was May 9 (Day 2 of pump operation). The 25% quartile was reached on May 9, the second day of pumping; the 75% quartile was reached on May 28 (Table 1).

Based on 12 years of data (1994-2005), the average peak date of alewife pumping is May 21. In 2006, the peak was on May 9 when 12,358 alewives were collected with the fish pump. The number of mortalities due to handling was very low in 2006. Overall trucking mortality was very low; 0 fish, in 2005 compared to 23 in 2005 for a trucking mortality rate of 0.00%. This is due to the reduced numbers of fish transported by truck due to fish passage facilities having been installed at Benton Falls and Burnham permitting us to simply count fish into the Ft. Halifax headpond and allowing the fish to swim freely to their natal spawning grounds.

1.2 Trap, Transport, and Release

DMR continued to utilize only Kennebec River adult alewife returns for release into Phase I restoration lakes (Figure 1) in 2006. Adult alewives were collected with a fish pump the Fort Halifax Project, and a fishlift at the Lockwood Project. The new fishlift at the Lockwood dam captured 4094 adult river herring. These fish were stocked into Wesserunset Lake (2,793) and Lovejoy Pond (146), Pleasant Pond – Gardiner (213) (Table 2). The fish pump at Fort Halifax was installed as temporary upstream fish passage in 2000 at the Fort Halifax Project.

The fish pump was configured and operated as in previous years. Briefly, the vacuum chamber and intake hoses were mounted on a platform above the turbine outlets, an 80-foot length of 10-inch diameter discharge pipe extended up the side of the powerhouse from the vacuum chamber to a receiving tank, and the intake pipe terminated in a three-foot long section of 10-inch diameter clear lexan. A chain hoist and ropes allowed the operator some adjustment in the intake apparatus.

The pump lifted and deposited alewives and water into a 2,270-gallon fiberglass receiving tank, measuring 9' x 7'6" x 4'6" deep, located at the top of the dam next to the powerhouse. Oxygen levels were maintained in the tank by a microporous delivery system. Supplemental water was supplied by an electric pump and two-inch hose that discharged onto the surface of the tank. Alewives were either caught in a dip net as they exited the discharge pipe or dip netted from the receiving tank. They were then counted into a hopper and sluiced into the headpond via a large PVC pipe or loaded into stocking tanks that had previously been filled with water pumped from the headpond. The sluce system included a plastic trough suspended in the holding tank where fish were counted into. The trough was fed by tank overflow water. The trough was sloped towards the exit pipe where there was an auxiliary water jet to force fish down the pipe. This system was simple and very effective. Special care was taken to insure that only alewives were dipped into the tanks or passed upstream. No carp, white catfish, or northern pike have been captured since the pump was employed at Fort Halifax in 2000. The stocking trucks are outfitted with pumps to circulate the water in the stocking tanks and with oxygen tanks and a porous pipe delivery system, that introduces approximately six liters of oxygen/minute-1. More complete descriptions of the fish pump, receiving tank, stocking tanks, stocking trucks, associated equipment, and fish handling protocols are provided in previous annual reports and are available from DMR upon request.

Phase I Restoration

In 2006, 4,228 brood stock river herring were stocked into 2 of the 12 upriver Phase I lakes in the Kennebec River watershed (Table 3). One thousand of these fish came from the Ft. Halifax pump and were transferred to Douglas Pond. The additional 3,152 river herring originated from the new fishlift at the Lockwood dam and were stocked into Wesserunset Lake (2,793) and Lovejoy Pond (146). Lockwood also supplied 213 River herring to Pleasant Pond in Gardiner on the Cobbosseecontee drainage, and 4,558 Blueback herring were dipped out of Cobbosseeconte Stream and stocked into Pleasant Pond in Gardiner (2,839) and the Androscoggin River (1719) bringing total truck transfers to 8,999. An additional 18,589 river herring were hand-dipped at Seven–Mile Stream and stocked into Webber Pond. Three-Mile and Three-cornered Pond were not stocked in 2006, however due to the high spring flows resulting in good passage adult river herring had adequate passage to migrate upstream from Webber Pond.

Forty five thousand, nine hundred and sixty adult river herring were pumped or bailed into the holding tank and counted into the hopper and sluiced into the headpond at Ft. Halifax. With the addition of two new fishlifts on the Sebasticook River, one at Benton Falls and one at Burnham, river herring, once counted into the Ft. Halifax headpond now have free passage into most of the phase one ponds including; Sebasticook Lake, Unity Pond, Pleasant Pond, Pattee Pond, Plymouth Pond and Burnham headpond.

In total, 18 alewife-stocking trips (18 tanks) were made to the upriver ponds in 2006, averaging 404 alewives per tank (Tables 4 & 5). This is a far lower average fish /tank ratio than in previous years. This is due to Lockwood now being our primary source or river herring for the trap and truck program. The greatest daily number of river herring captured at Lockwood was 643 on May 31.

Phase II Restoration

No Phase II lakes were stocked in 2006. DMR delayed stocking Great Moose Pond until improvements can be made in the down stream passage facility. The discharge of the downstream fish passage facility currently lands on ledge. A plunge pool needs to be constructed or the pipe needs to be extended before alewives are stocked in Great Moose Pond. DMR continued to focus its efforts on obtaining fish passage in the Pioneer and Waverly dams in Pittsfield.

Non-Phase I Transfers

In 2006, transfers from Lockwood to waters other than Phase I lakes totaled 213 river herring loaded, with 0 trucking mortalities (Table 6). The stocking of non-Phase I habitat with Kennebec river herring was far less than previous years due to the reduced number of river herring captured with the fish pump at Fort Halifax. Unusually high spring flows resulted in reduced catchability of alewives at the Fort Halifax project.

The non-Phase I transfers included two ponds within the Kennebec drainage and two ponds in other drainages. Non-Phase I transfers began on May 30, to Pleasant Pond in Gardiner in the Cobbosseecontee Drainage. Alewives transferred to waters other than the Phase I lakes represented 5.2% of the total number trapped at Lockwood.

1.3 Adult Alewife Biosamples

DMR personnel sampled 232 adult river herring at Fort Halifax. All samples were collected using the fish pump by dipping them out of the pump-receiving tank or by dipping them directly out of the river. Due to the presence of blueback herring in the Kennebec River, all samples were identified using the guidelines of Liem[1], which distinguishes the two species by body shape, size and position of the eye, and color of the peritoneum (i.e., lining of the gut cavity: alewives are white/silvery and bluebacks are charcoal). Once the fish were identified, they were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed, and a few scales were removed for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

Of the 232 fish collected, identified, and measured, 33 (14%) fish was identified as a blueback herring, thereby reducing the number of alewives sampled to 199. Of those 199, 42% were females and 58% were males.

On average, adult female alewives collected in 2006 were smaller than those collected in 2005. Adult females collected in 2006 were 5 mm shorter (mean = 273 mm) than in 2005 (mean = 278 mm) however, they were the same as those collected in 2004 (mean = 273). Additionally, those collected in 2006 were 2.9g heavier (mean = 187.5g) than in 2005 (mean = 184.6 g). Adult males collected in 2006 were 4 mm shorter in length (mean = 267 mm) than the 2005 samples (mean = 271 mm) and 6 mm shorter than those captured in 2004 (mean = 273mm). They averaged 1.8 g heavier (mean = 164.7g) in 2006 than in 2005 (mean =162.9g).

In 2006, there were minor differences in length and weight, both between sexes and over time. On average, females were longer (273 mm) than males (267 mm). In addition, females were heavier (187.5g) than males (164.7g). There was a decrease in both length (Figure 3) and weight (Figure 4) of adult alewife returns to the Sebasticook

River over time. Fish collected during the first sample on May 8 were longer and heavier (273.3 mm and 187.8 g) than fish collected during the last sample on June 2 (256.6 mm and 147.2 g).

Of the 199 alewives sampled, scales were collected from 70 fish. Most of the fish sampled were Age 4 (34.3%) males. 63.2% of all males were age 4. Age 5 (24.2%) and Age 4 females (21.4%) were the next most abundant age classes. 50% of all females sampled were age 5, 46.9% were age 4 (Table 7).

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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.

1.4 Commercial Alewife Harvest

In 2006, the Maine Department of Inland Fisheries and Wildlife (IFW) issued 15 permits to commercial fishermen for the harvest of alewives below Fort Halifax dam in Winslow (Figure 5). There was a 48-hour closure period on the commercial harvesting of alewives beginning at midnight Friday and lasting until midnight the following Sunday. A 150-foot closure area surrounded the intake of the fish pump. As of March 1 , 2007, only 11 permit holders had reported their landings for a total of 473,520 alewives (3,946 bushels) harvested, compared to 149,629 alewives (1,247 bushels) harvested in 2005. One crew accounted for the majority of the landings reported. The dramatic increase in commercial harvest was partially due to the high water levels reducing the capture efficiency of the fish pump as well as attracting fish to the ledge side of the dam making them much more susceptible to capture by commercial fish harvesting methods. In late may IF&W wardens enforced regulations regarding the definition of a dipnet utilized in the commercial river herring fishery. This enforcement action resulted in smaller gear in the fishery. Continued high flows and smaller gear lessened the potential harvest of river herring during the 2006 season. Harvest numbers would most likely have been higher had the enforcement action not taken place.

Year	# Reported	Bushel/Fish
2006	11 of 15	3946/473,520
2005	11 of 25	1247/149,629
2004	17 of 26	854/102,480
2003	13 of 30	1137/136,440

1.5 Anadromous fish passage monitoring

The first phase of anadromous fish restoration in the Kennebec River watershed, which included truck stocking of alewife and American shad to develop runs of imprinted fish, ended in 1999 when Edwards Dam was removed, and fish were able to migrate 17 miles upriver before encountering the next set of dams. A major event in the second phase of restoration occurred in 2006 when upstream anadromous fish passage (a fishlift) became operational at each of three hydropower projects (Lockwood, Benton Falls, and Burnham). Operation of the three fishlifts gives MDMR its first opportunity to evaluate the status of anadromous fish restoration in the Kennebec River watershed.

MDMR biologists made a number of assumptions when they estimated the number of adult alewife and American shad that would be produced by the waters above Augusta at full restoration and the spawning escapement required for a self-sustaining run. For example, production and spawning escapement numbers for American shad are based on data from the Connecticut River and for alewife are based on data from runs in small coastal Maine Rivers. For some species, like blueback herring and sea lamprey, there are no relevant data on production and escapement, and MDMR has made no estimates for the Kennebec River watershed. The assumptions and conclusions regarding production and escapement have implications for the management of any commercial or recreational fisheries that target these species. For example, MDMR has assumed that commercial harvest of 85% of an alewife run is sustainable (i.e. 15% escapement can maintain the run). This assumption is based on harvest data collected on coastal alewife runs in Maine, but may not be applicable to a run that may migrate more than 80 miles upriver to spawn.

When estimating design populations for fishways, MDMR has assumed an upstream passage efficiency of 90%. However, passage efficiency can range widely depending on the fish species, the type of fish passage, and the site-specific configuration of the dam and fishway. In addition, there is little information on passage efficiency of Alaskan steeppass and pool-and-chute fishways for non-salmonid anadromous species.

Objective: MDMR in cooperation with Benton Falls Associates/Essex Hydro Associates and Ridgewood initiated this project to evaluate the status of the Kennebec River Restoration Project, and assess assumptions made about anadromous fish restoration and passage effectiveness. Specific project objectives were to determine:

- the efficiency with which anadromous species pass upstream passage facilities;
- the progress of fish restoration and the accuracy of MDMR's fish production estimates;
- the time required for upstream migration of each species;
- the length of time that adults of each species remain in spawning habitat;
- the proportion of adults of each species that survive spawning; and
- the timing of closed periods that will best ensure a sustainable commercial alewife harvest.

Methodology

Fish counts

The intent of this portion of the study was to identify and enumerate all upstream migrants at each of five sites on the Sebasticook River: an interim fish pump at the Fort Halifax Project, a fishlift at the Benton Falls Project, a fishlift at the Burnham Project, a pool-and-chute fishway at the Sebasticook Lake Dam, and either Twenty-Five Mile Stream, which drains Unity Pond, or the upper steeppass at Plymouth Pond (Figure 6). The fish pump and fishlifts provide passage along the major migratory corridor, while Twenty-Five Mile Stream and the fishways at Sebasticook Lake and Plymouth Pond provide access to the majority of alewife spawning habitat in the Sebasticook River watershed. The fishways at Sebasticook Lake Dam and Plymouth Pond Dam and also the fishway at Stetson Pond Dam and the Guilford Dam breach were MDMR-initiated projects that have been described in previous reports.

MDMR biologists were responsible for netting, identifying, and enumerating all fish, primarily alewives, that were captured by the Fort Halifax fish pump. At each of the other three passage facilities, an electronic fish counter (Smith-Root model SR-1601) was used to enumerate adult fish. Benton Falls Associates operated the Benton Falls fish counter, Ridgewood Associates operated the Burnham counter, and MDMR operated the counter at Sebasticook Lake. Because of equipment difficulties and high flows encountered, MDMR was unable to install a second fish counter in 2006.

All fish counter installations were similar, and consisted of an array of 16 counting tubes that were connected to the electronic counter. Each counting tube was made of a 20-inch long section of ¼-inch thick, 4-inch diameter, Schedule 40 PVC pipe. The inner wall of the pipe was fitted with three four-inch, stainless steel hose clamps set five inches apart; three slots were cut in each pipe to expose the bolt of the hose clamp. The 16 counting tubes were arranged in a 2x8 or 4x4 configurations in a wooden frame, and spaces between the counting tubes were filled with smaller diameter PVC pipe to exclude fish. Each of the three hose clamps in each of the 16 counting tubes was connected to the electronic fish counter via a Smith-Root tunnel junction box. The Sebasticook Lake counter was powered by a 12-volt battery, while AC power was available at the two hydropower sites. At Sebasticook Lake, the counting tubes were installed in the fishway exit, while at the Benton Falls Project and the Burnham Project the fish counter was installed in the exit flume of the fishlift, and a large funnel made of wood and plastic mesh was installed to guide fish towards the counting tubes.

Passive Integrated Transponder (PIT)-Tagging

MDMR intended to PIT tag a total of 300 alewives (100 per week for three weeks) at the Fort Halifax Project in 2006, and document their upstream migration with an antenna-receiver-datalogger array located at each of six sites: the Benton Falls fishlift, the Burnham fishlift, the entrance and exit of the Sebasticook Lake, the entrance of the lower Plymouth Pond fishway, and the exit of the upper Plymouth Pond fishway (Figure 6). MDMR biologists constructed, installed, and maintained arrays at all sites except the Burnham fishlift, where PIT equipment was not deployed in 2006.

Each antenna consisted of three windings of THHN 12-gauge cable inside a 2-ft x 3.5-ft rectangle constructed of 1-in diameter PVC electrical conduit, which was clamped to a wooded frame. At each hydropower project, the antenna frame was clamped to the fishlift frame where the hopper empties into the exit flume. At the other sites, the frame was bolted to the downstream face of the upper or lower chute of the fishway. After the antenna cable was attached to a datalogger-tuner unit (Oregon RFID half-duplex single reader) and a 12-V battery, the antenna was tuned. Batteries were replaced with recharged batteries every 3-4 days.

Fish to be PIT tagged were pumped from the Fort Halifax tailrace into a holding tank. Individual fish were netted from the tank, measured, and sex determined. A small incision (1/2 inch) was made on the right side of the fish with a scalpel, and a PIT tag (23 mm HDX glass encapsulated) inserted in the body cavity. The fish was then released into the headpond via a flume.

Observations and current measurements

MDMR biologists in cooperation with members of the Sebasticook River Watershed Association and students from Nakomis High School intended to make visual observations and current speed measurements (Swoffer flow meter model 2100) at the location of the channel restoration project on the East Branch Sebasticook River in Newport. This section of the river, located between the breached Guilford Dam and the Sebasticook Lake fishway, had been dredged and straightened by the Town of Newport in the 1980s to accommodate the rush of water produced during the annual fall drawdown of the lake to improve water quality. After construction of the Sebasticook Lake fishway and breaching of the Guilford Dam, the Town obtained funding to restore the original contour of the river, which occurred in 2003-2004.

Results

All capital equipment and most material for the project were ordered or purchased in 2006; however, a few items still need to be obtained. Four PIT-tag receiver/dataloggers were ordered. Construction, testing, and installation of all project equipment was completed in 2006. However, the first field season was not entirely successful, because of high freshwater discharge, passage difficulties at hydropower facilities, and problems with monitoring equipment.

Because of extremely high freshwater discharge during the fall and winter, the fishlift facilities on the Sebasticook River were not completed during 2005 as had been expected. The Burnham fishlift finally became operational on April 26, 2006 and the Benton Falls fishlift on April 28, 2006, approximately one week before the beginning of the anadromous fish migration season.

High freshwater discharge in the spring of 2006 and mechanical problems with the Fort Halifax fish pump further hindered the project. On May 8 a total of 10,882 alewives were passed with the Fort Halifax fish pump. Passage remained high for the next two days, and then declined quickly as freshwater discharge increased (Figure 7), and operational flows of the fishlifts were exceeded. Discharge began to decline at the end of May, but when it became possible to pump fish, an air leak was discovered in the Ft Halifax pump that reduced pump efficiency. During the entire season a total of 46, 960 alewives, only 14% of the escapement needed for accessible habitat, were passed into the Fort Halifax headpond.

MDMR installed fish-counting tubes at the Sebasticook Lake fishway on May 3, and installed the electronic counter and batteries on May 9. During the week of May 8, MDMR and staff from Benton Falls Associates determined that the electronic fish counts were inaccurate. MDMR made observations at the Benton Falls fishlift counting window, and found that most of the error occurred when a large fish, usually a smallmouth bass, attempted to pass through a fish counting tube. When this occurred, several thousand spurious counts would be recorded. Additional error occurred when long pieces of grass became caught on the counting tubes. MDMR biologists subsequently constructed a fish excluder screen, a wooden frame with 1-inch aluminum tubes installed vertically with 1-inch clear space (Figure 8), that was installed at Benton Falls on 5/18. The excluder allowed only narrow “alewife-shaped” fish to pass move upstream to the counting tubes. A similar excluder was constructed for the entrance of the Sebasticook Lake fishway, but could not be installed in May because of high water.

Prior to the start of the field season, MDMR staff constructed six PIT tag antennas, and bench-tested the antenna/receiver/datalogger arrays (the arrays for Sebasticook Lake and Plymouth Pond were purchased with other funds). A PIT antenna was installed at Benton Falls on 5/15; the remainder were installed between 5/25 and 6/2 after discharge began to drop.

The first alewives were passed at the Fort Halifax Dam on May 8 at 11 am. Five hours later fish were passed at the Benton Falls fish lift, and by the next morning they had reached the Burnham Dam. By the morning of May 11th, fish were passing over the fish ladder into Sebasticook Lake. Between 5/8 and 6/6 a total of 49,560 alewives were passed at the Fort Halifax Project, but most were passed during the first three days the fish pump was operated (Figure 9). Counts of alewives at the Benton Falls Project were incorrect, but the reason for the error was determined (large fish attempting to use counting tubes) and corrected by the installation of a fish screen, which will be used in the future. Between 5/9 and 5/18 a total of 22,666 alewives were passed at the Burnham Project (Figure 9). These counts are similar to expected counts (23,400) based on available spawning habitat below the project and 10% upstream passage efficiency. A total of 4620 fish were counted at the exit of the Sebasticook Lake fishway on 5/11 (Figure 9), but subsequent counts were obviously in error. A fish screen was constructed for this site, and will be used in the future.

On June 2, MDMR captured and PIT-tagged 50 alewives at the Fort Halifax Project, and released them into the headpond. We chose to tag 50 rather than 300 fish because water temperatures had risen and the alewife migration appeared to be ending. None of these fish were detected upstream, but discharge began to rise after the fish were tagged (Figure 9), and soon exceeded the operational flows of the upstream fishlifts.

Visual observations and flow measurements were not possible at the East Branch Sebasticook River channel restoration project for most of the migration season, because of high discharge during and after the migration season. MDMR was able to make flow measurements along one transect on July 11 when 3-4 inches of water were passing over the Sebasticook Lake Dam. Three flow measurements (feet per second), taken at each of three locations (west side, mid channel, east side), are shown below.

West	Middle	East
1.36	3.96	2.11
1.38	4.11	1.98
1.27	4.12	2.27

2.0 American Shad Restoration Methods

2.1 Adult Capture and Transport

The shad culture program initiated in 1991 was continued in 2006. The Kennebec River Shad Restoration Program began as a cooperative effort between the DMR, the KHDG, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development Project, the latter of which was created and administered by the local Time & Tide Resource Conservation and Development Organization. The hatchery is now privately owned and operated by Sam Chapman. It is located in the Town of Waldoboro and consists mainly of two 15-foot diameter adult spawning tanks, one 12-foot diameter adult spawning tank, and seven six-foot diameter larval rearing tanks. There are also three outdoor settling ponds formerly used for the production of shad fingerlings.

In 2006, the Merrimack River Technical Advisory Committee granted approval for DMR to transport up to 1,660 adult shad (60 for required fish health workup and the remainder for the hatchery and Androscoggin River) from the Merrimack River's Essex fish lift (operated by CHI) to the Waldoboro hatchery. Due to heavy rain and severe flooding acquisition of broodstock from the Merrimack River was not possible. In response, DMR obtained permission to collect broodstock from the Holyoke Fish lift on the Connecticut River. Transfer of adult shad broodstock from the Holyoke fish lift to the Waldoboro Shad Hatchery began on June 17. Only two trips were made as we received more heavy rain. By the time water levels dropped to allow operation of the fish lift the run was over. Of the 187 shad loaded at the Holyoke lift, 169 were released alive into the adult spawning tank, resulting in a hauling mortality of 9.6% (Table 8). Despite the extended trip hauling mortality decreased from 2005 level of 10.7 %. In order to improve egg production at the hatchery, Andrew Chapman accompanied DMR staff and hand-selected large healthy females as broodstock, as well as healthy males on one of the two trips. All shad were placed in a spawning tank and allowed to spawn over the next several weeks. The fertilized eggs were collected, disinfected, and placed in upwelling incubators. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp. On July 12, the 22 shad remaining were sacrificed for the required ME IF&W fish health assessment on shad broodstock from out of state.

No American shad were captured with the Fort Halifax fish pump in 2006. No adult shad were captured in the new Lockwood fish lift on the Main-stem Kennebec in Waterville in 2006 either. This was the lift's first year in operation and there are some operational issues including attraction water that need to be 0worked out. Although fish lifts are undoubtedly the most robust type of fishway their efficiency is still effected by high water. Due to the fishway attraction, water issues compounded by high river flows it is likely shad were not able to locate the fishway. Anglers reported capturing shad near the fishway.

2.2 Larval Culture and Transport

All adult shad transported to the hatchery were placed immediately into either one of the two 15-foot diameter spawning tanks. Shad were allowed to spawn "naturally," the eggs collected daily and placed into upwelling incubator jars, and reared to approximately 6-13 days old before being released. While in the hatchery, all larvae are marked with oxytetracycline ("OTC"), an antibiotic that leaves a mark on the otolith, or inner ear bone, when viewed under a microscope equipped with fluorescent light so that DMR can later distinguish adult returns as either hatchery or wild in origin. Otoliths from a 20-fish sample from each batch of fish were examined for OTC mark retention.

Larval shad are loaded into a stocking tank and released directly into the target river. At the hatchery, they are drained from their rearing tank directly into a four-foot diameter hauling tank that is affixed to the bed of a ¾-ton pickup truck. Approximately 12 liters/minute of oxygen are released into the approximately 150 gallons of hauling water via an air hose. Upon arrival at the stocking site, temperatures of the hauling water and river are assessed. If needed, river water is bucketed into the hauling water to gradually equilibrate the temperatures. Larval shad are then released into the river by draining the hauling tank through a hose attached to the bottom drain of the tank. Several five-gallon buckets of river water are poured through the tank to rinse any remaining larvae into the river. In 2006, no larval shad were intentionally released into the outdoor hatchery ponds for the production of fingerlings.

Between July 11 and July 25, an estimated 262,131 shad larvae were released just below the Shawmut Project on the Kennebec River (Table 9). The 2006 total of 262,131 larvae released into the Kennebec drainage is less than 2005 number (1,105,343), and is lower than average (Figure 10). The lower number of larval shad released in 2006 is attributed to the lower number of adult shad available to the hatchery.

No shad larvae were intentionally stocked into the three culture ponds at the hatchery in 2006; however, runoff from the upwelling incubators drains into these ponds and typically, some eggs/larvae are drawn out by the action of the incubators. Since the number of larvae escaping to the ponds is unknown, the ponds are monitored and the larvae/juveniles fed accordingly. On Oct 18, the first pond was beach seined and approximately 1,123 young fingerlings were transported by Connecticut DEP to the City of Norwich, CT for its effectiveness study of the Occum Dam Downstream Bypass. No shad fingerlings were released in 2006 (Figure 11). For a complete description of 2006 shad hatchery operations, refer to Appendix G, Waldoboro Shad Hatchery 2006 Annual Report.

Based on the results of over a decade of research in the successful American shad restoration of the Connecticut River, DMR biologists have estimated the production potential of shad in the Kennebec watershed. Table 10 shows the yearly natural production potential by river segment, adjusted for 10% mortality resulting from passage through each hydroelectric facility in the river reach, within the historical range of American shad.

In 2006, DMR personnel made few observations at the Fort Halifax tailrace for the presence of shad. Approximately thirty-three shad were observed in the Fort Halifax tailrace. Observations varied in duration as time allowed. Observations as high as 12 fish observed in 15 minutes were made.

2.3 Juvenile Assessment

Since all young-of-year shad released from the hatchery are marked with OTC (marks confirmed by DMR at time of stocking) , DMR is able to assess the relative contribution of hatchery-reared shad to the Kennebec River shad population. Starting in 2000, adult and young-of-year shad collected in the Kennebec were kept for OTC mark analysis. No adult shad were intentionally killed for this study. Young-of-year shad were collected during biweekly beach seine surveys (see FISH COMMUNITY ASSESSMENT in this report for complete details on capture sites and techniques). Otoliths were removed, cleaned in distilled water, and mounted in a thermoplastic resin. Lapping film (9, 3, and 1 micron grit) was used to grind each otolith to mid-saggital plane on one side; otoliths were then flipped over and ground to mid-saggital plane on the opposite side. A drop of Type FF, low fluorescing, immersion oil was placed on each ground otolith and then covered with a glass cover slip. Otoliths were then viewed under a compound microscope equipped with fluorescent light and a FITC filter set. With this microscope configuration, any fish marked with OTC would exhibit a glowing ring for the day that fish was marked. As of 2/24/2006 otoliths were successfully processed for 1379 juvenile shad collected collected in 2006. Of the 2174 shad only 80 individuals contained an OTC mark demonstrating hatchery origin contribution of 3.68% of our samples. In 2000, DMR began conducting similar beach seine surveys in the Kennebec River north of Augusta, upstream to Waterville/Winslow. Based on the information gathered during these surveys, DMR has begun to calculate a second Juvenile Abundance Index (JAI) for young-of-year shad for this newly reopened stretch of river (Table 11).

During the 2006 beach seine effort, 4,041 juvenile shad were captured at five different sites, with the highest number captured at Site 8C (1,584). This site is located approximately 2170 meters upstream from Augusta Memorial Bridge.

A JAI was calculated for juvenile shad captured in 2006 (Table 11). The index for all sites was.19 shad/seine haul. Of all the sites sampled in 2006, Site 8C had the highest comparative JAI of 264.0 shad/seine haul, followed closely by site 7 with 245.0 shad/seine haul. Depending on river flows, there is slack water or an eddy at Site 8C. Habitat suitability models indicate that larval shad prefer large eddies2, which may explain why younger shad are found there.

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

3.0 Status of Fish Passage

3.1 Upstream Passage

Sebasticook River – Fort Halifax

Per the KHDG Agreement and the Project License, FPL Energy was required to install a permanent upstream fish lift at Fort Halifax by May 1, 2003, or breach the dam in 2003. In 2002, FPL Energy proposed to decommission and partially breach the dam in order to provide upstream passage. FERC approved FPL Energy's Application to Surrender its license and partially breach the dam on January 23, 2004. A request for rehearing was filed by the Town of Winslow on February 19, 2004 and by Save our Sebasticook (SOS) on February 20, 2004. The requests were denied by FERC on May 6, 2004. SOS subsequently filed a petition for review of Final Agency Action with the U.S. Court of Appeals for the District of Columbia Circuit. The appeal to the D.C. Circuit Court of Appeals was subsequently dismissed.

The Maine Department of Environmental Protection issued an Order approving the breaching of the Fort Halifax dam on May 27, 2004. On August 16, 2004, SOS filed an appeal of DEP's action. The appeal was denied by the Board of Environmental Protection on February 22, 2005. S.O.S appealed the Board's decision to the Kennebec County Superior Court. The appeal filed by S.O.S. of the Board's decision approving the removal of Ft. Halifax Dam was dismissed in the Kennebec County Superior Court in August 2006. S.O.S subsequently appealed this decision to the Maine Supreme Court.

Sebasticook River –Benton

Upstream passage at the Benton Falls was required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and following installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the implementation of interim upstream passage measures at Fort Halifax dam and the construction of fishways at the Pleasant

Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport, and the removal of the Guilford dam in Newport. These projects were completed on June 13, 2003, triggering a June 14, 2004 date for fish passage to be operational.

Benton Falls submitted functional design drawings to FERC for a fish lift at the facility on January 3, 2005 and was subsequently approved by FERC on January 24, 2005. Fishway construction commenced mid summer 2005. Despite numerous flood events, unusually high water, and setbacks construction was completed in time for the 2006 river herring run. DMR, IFW, USFWS, and the Licensee have developed an agreement to incorporate a trapping and sorting facility in the Benton Falls fish passage facility. Functional design drawings were approved on May 7, 2006.

Sebasticook River –Burnham

Upstream passages at the Burnham dam was required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and following installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the implementation of interim upstream passage measures at Fort Halifax dam and the construction of fishways at the Pleasant Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport, and the removal of the Guilford dam in Newport. These projects were completed on June 13, 2003, triggering a June 14, 2004 date for fish passage to be operational.

The Burnham Project submitted its final design drawings to FERC on February 14, 2005. Construction began on the Burnham Fishlift early in the summer of 2005. Despite numerous flood events, unusually high water, and setbacks construction was completed in time for the 2006 river herring run.

Kennebec River – Lockwood

The Lower Kennebec River Comprehensive Hydropower Settlement Accord requires that the Licensee install a trap, lift, and transfer facility at the project's powerhouses. These facilities are to be operational by May 1, 2006. The Licensee submitted final design drawings to FERC on February 1, 2005. Construction commenced in early summer of 2005. Despite numerous flood events, unusually high water, and setbacks construction was completed in time for the 2006 river herring run. As with any new fishlift installation the first operational season is a "shakedown season" where issues are identified and corrected. The lockwood fishlift experienced some minor issues in 2006, including a cable length adjustment to correct a tracking issue and also attraction water issues due to debris plugging the attraction water trash rack. Attraction flow was operated at a rate less than prescribed (Personal Communication FPL Energy). No American shad were captured in the Lockwood fish lift in 2006. This is likely due to high river flows, depressed water temperature and reduced fishway attraction flows due to mechanical blockage. Additionally fishway attraction flow was masked by the higher than average volume of water in the river making it difficult for fish to locate the fishway.

3.2 Monitoring of Down stream Fish Passage at Phase I Lake Outlets

Starting in July, DMR personnel surveyed ten lake outlets regularly through November: Sebasticook Lake in Newport, Pleasant Pond in Stetson, Plymouth Pond in Plymouth, Wesserunsett Lake in Skowhegan, Unity Pond in Unity, Webber Pond in Vassalboro, Pattee Pond in Winslow, Threemile Pond in China, Corundal Lake in Corinna and Lovejoy Pond in Albion. The results are summarized in Table 12 and are briefly described below.

Sebasticook Lake outlet was checked on 22 days from July 13 through October 10th to ensure fishway operation. On four of the 22 visits, juvenile alewives were noted using the fishway as down stream passage. The lake drawdown after Labor Day eventually caused the fishway to dewater, but ample opportunity remained for down stream passage through the opened gates. .

Pleasant Pond in Stetson was visited 27 times from July 13 through October 19. Of those 27 visits, down stream passage was available 27 times. DMR personnel observed juvenile alewives above the dam passing down stream or in the river below on 11 different days.

Plymouth Pond was checked on 21 days from July 13 through October 19. Passage was available at Plymouth Pond on all visits, either through the fishway or over the crest of the dam. No juvenile alewives were observed at Plymouth Pond in 2006.

Wesserunsett Lake in Skowhegan was surveyed 22 times from July 13 through October 19 . Passage was available during all site visits at the upper dam. Passage at the lower dam was questionable at times. This will be investigated further in 2007.

Unity Pond has no outlet dam and has excellent down stream passage into the Twenty-five-Mile Stream on all but the driest of years. Unity Pond outlet was checked 19 times from July 13 through October 19 and passage was available during all visits. A sample of Juvenile alewives was collected on September 11th and on October 5.

Webber Pond, like Sebasticook Lake, also uses a fall drawdown for water quality improvement purposes and usually has sufficient water to allow passage over the spillway throughout the season. During the 31 visits to Webber Pond, (July 10-Nov.1) passage was available all 31 times. Alewives were observed on 5 occasions.

Pattee Pond has no outlet dam and in the past low water levels combined with a beaver dam obstruction during the summer and early fall made passage out of Pattee Pond difficult, if not impossible. 2006 had plenty of rain events in the fall which should have allowed more than adequate passage for out migrating juvenile alewives. Pattee Pond was visited 11 times and passage was available on all visits.
Three-mile Pond outlet was visited 15 times between July 25 and October 19. Three-mile does not have an outlet dam however, immediately down stream of the outlet the flow enters a wide shallow heavily shrubbed area where passage was questionable.

DMR personnel assessed down stream passage below this point to where the flow enters Webber Pond and found passage to be sufficient throughout the low summer water levels. DMR personnel also spent time clearing passage through the shrubbed area and will continue those efforts in 2007. Passage was sufficient for adult alewives to migrate up from Webber Pond in the spring and successfully spawn in Three-mile Pond during the high spring flows. During the fall rains in late October and November, down stream passage became readily available again and juvenile fish were documented leaving the system on 4 visits, samples were collected and beaver activity was monitored and passage was provided.

Generally, lake outlets were checked on the same schedule as hydropower facilities. Whenever possible, areas known to be past problems for out-migrant alewives and shad were inspected and debris/blockages removed.

3.3 Monitoring of Down stream Fish Passage at KHDG Hydropower Projects

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

"KHDG dam owners will conduct effectiveness studies of all newly constructed interim and permanent upstream and down stream 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."

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

To date, down stream passage effectiveness studies have been conducted at Benton Falls (1995) and Fort Halifax (1997). In addition, qualitative assessments are being recorded at the interim down stream passage facilities at Lockwood and Shawmut. At Hydro-Kennebec, Plans for a new interim down stream passage were approved on April 2, 2006 and construction authorization was granted on June 9, 2006. The downstream passage consists of a floating 10 ft deep, angled, fish guidance boom located in the powerhouse forbay. This boom directs migrants to a 4' x 8' ft deep gated surface bypass with a max flow of 320 CFS and discharges migrants into a plunge pool which then dumps into the projects tailrace. At the Burnham Project, permanent down stream passage was installed ahead of schedule. Ridgewood Renewable Power is currently working on a downstream bypass efficiency study plan.

Down stream passage at hydropower facilities located on the Sebasticook and Kennebec Rivers were monitored through the summer and fall of 2006. Facilities were visited routinely to assess any problems that down stream migrating juveniles might encounter. The condition and operation of down stream bypass facilities, magnitude and location of spilled water, number of turbines in operation, and presence or absence of juvenile alewives were noted at each site. The dams and their locations are presented in Table 13; locations were illustrated earlier in Figure 1.

The Fort Halifax Project in Winslow is operated by FPL Energy and is the lowermost dam on the Sebasticook River. FPL Energy installed permanent down stream bypass facilities during the summer and fall of 1993; it 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 down stream bypass. The down stream side of the opening was fitted with a metal trough with an open top to carry water and fish down close to the tailrace elevation. A 12-foot deep metal punch plate trash rack overlay was installed to aid in excluding alewives from the turbine forebays. This configuration and operational regime was approved by the FERC Order issued on September 30, 1996 and was utilized again during the 2006 season.

DMR made five visits to the Fort Halifax dam in 2005. All visits found the down stream bypass open and functioning. Observations of the down stream bypass operation were made from the south shore when access to the powerhouse was not available.

The Benton Falls Project is equipped with permanent down stream 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. During the 2006 season the weirs above both the large and small turbine were open.

DMR personnel made 26 visits to make observations of down stream passage capabilities at Benton Falls in 2006. Due to past problems of debris blocking down stream passage via the bypass, DMR made a more concerted effort to observe this area in 2006. The bypass entrance was open and the facility appeared to be operating properly during each of the site visits and problems associated with debris from the headpond plugging the entrance were not observed. Juvenile alewives were observed in the Benton Falls headpond on August 3 .

DMR personnel made 17 visits to the Burnham Project in 2006. All inspections found the down stream bypass entrance open and operating according to interim passage requirements. Juvenile alewives were observed during 2 site visits.

Down stream passage through the bypass was available during each of the 13 site visits to the Pioneer dam in Pittsfield. No overlays had been placed on the intake racks at the project. No juvenile alewives were observed using the down stream passage facilities on any visit.

DMR visited the Waverly Avenue dam on 7 occasions during the 2006 season. Down stream passage was available at the site on all occasions. Problems encountered during the 2006 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, causing down stream migrants to be attracted away from the bypass during low flow conditions. Second, the bypass itself frequently collected debris and lost its effectiveness with this fouling. No overlay was installed on the intake racks in 2006.

DMR visited both the Lockwood and Hydro-Kennebec dams as often as possible in 2006. Both of these projects are located on the Kennebec River and must pass all down stream migrant alewives from the Wesserunsett Lake alewife restoration effort. Additionally, all of the larval shad, released into the Kennebec River are released above both Lockwood and Hydro-Kennebec. In 2006 there were also 15 adult Atlantic Salmon transferred from the Lockwood fishway to the sandy river a tributary of the Kennebec. These adults also had to navigate Lockwood and Hydro-Kennebec facilities on there return trip to the ocean after spawning. During the 2006 season, interim down stream passage at Lockwood was made available through the power canal trash sluice, which is located near the turbine trash racks.

3.4 Cobbosseecontee Stream Fish Passage

The Department of Marine Resources is in the process of developing a Diadromous Fish Restoration Plan for the Cobbosseecontee Stream watershed. Presently, the draft is being reviewed within the Department, after which it will be forwarded to IF&W and the Atlantic Salmon Commission (ASC) for review. Several consecutive years of fish kills involving out-migrating alewives and American eels have prompted the DMR to begin to focus on these important fisheries. Both DMR and the USFWS have approved interim plans for down stream fish passage in the form of a flashboard notch and plunge pool. At the current stocking density in Pleasant Pond (the only waterbody in the watershed presently stocked with adult alewives) and resulting alewife offspring production, this bypass method has been successful the past four seasons.

In 2006 the plunge pool was reinstalled as well as the punch plate, (extending from the bottom to within eight feet of the surface), at the American Tissue Project on

Cobbosseecontee Stream. No evidence of eel entrainment was noted during multiple site visits in the 2006. In conjunction with the punch plate, the deep gate was opened and appeared to successfully pass eels. Alewives appeared to use the plunge pool successfully as none were noted dead or injured below the project site.

4.0 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 in the mid-1800s. The benefits of dam removal are already being realized with anecdotal reports of enhanced recreational angling opportunities and results, as well as an increase in available spawning and nursery habitat for native anadromous fish species. For example, evidence of American shad spawning has occurred as far upriver as Winslow. In addition, both striped bass and sturgeon are now observed in Winslow. There are also increased observations of wildlife species benefiting from this newly opened river stretch. DMR staff have observed bald eagles, osprey, great blue heron, several species of ducks and Canada geese, as well as various species of aquatic furbearers, including mink and river otter, and even a harbor seal, utilizing this free-flowing segment of the Kennebec.

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

Sampling Sites

In June 2000, Kennebec River Project personnel surveyed the 17-mile stretch of the Kennebec River from the Fort Halifax and Lockwood dams down stream to the former Edwards dam site. The objective of the survey was to locate potential sampling sites for the deployment of beach seines and other sampling gear for fish community assessment purposes. Several factors led to the selection (or non-selection) of the sampling sites, including depth; areas of strong currents; and obstructions such as ledges, logs, and boulders, which render potential sites unsuitable for seining and fyke net deployment. Generally, sites with even, regular bottoms were chosen. Originally, a total of eight sites were sampled biweekly between Waterville and Augusta from June/July (immediately following alewife/shad stocking) until November.

Biological Sampling Procedures

Depending on river flow, either a 17-foot or a 19-foot johnboat equipped with a jet drive was used to access all of the sampling sites. At sites where water depth exceeded the ability to wade, the johnboat was used to deploy an 8' x 150' x 3/8" delta mesh net with an 8' x 8' x 8' x ¼" delta mesh bag seine. The bag was used to better capture and, more importantly, retain the items sampled by eliminating the gap between the net and river bottom at the vertex of the seine as it was hauled. The beach seine was flaked onto the bow of the boat. After landing at the survey site, a crewmember would debark and hold one end of the beach seine. The boat would then be backed out into the river and continue until approximately 2/3 of the net had been deployed. At this point, the boat would back towards shore. As the boat reached wading depth, a crewmember would debark, taking the other end of the net to shore where the haul would be completed.

In order to best understand the structure of the fish community present, every species of fish -diadromous and resident - was examined. Total number of fish caught was assessed, as was number per species. Total length was assessed to the nearest millimeter for up to 100 diadromous fish per species and up to 10 per resident species. If American shad were captured (Figure 12) a random sample was placed on ice and brought back to the DMR office in Hallowell for otolith work (see Section 3.0 of this report).

Data Analysis

Seining surveys for the 2006 season commenced on July 18. The sampling sites consisted of the same sites as those of late 2002.

A total of 47 seine hauls were made during the community assessment survey on the Kennebec River upstream of the site of the former Edwards dam. A total of 5,440 fish representing 17 species were captured and identified. Of those, total length was assessed for 2,042 fish. Fish of questionable identity were placed on ice for later identification. For a breakdown of diadromous fish captured by site, refer to Table 14.

5.0 American eel

5.1 Upstream eel passage in the Kennebec River watershed

Introduction

Juvenile eels migrate into Maine's coastal waters in the spring. Some juveniles remain in estuarine habitat, but many attempt to migrate to growth habitat in inland waters. Natural and man-made obstacles, such as hydropower dams, may prevent or delay the upstream migration. The Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan for American Eel, adopted in 2000, calls for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and 3) providing adequate upstream passage and escapement into inland waters of elvers and eels. Migration of eels past dams and other obstacles must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

Beginning in 1998, DMR has conducted field studies or consulted with hydropower owners to determine where upstream eel passage should be located at 10 hydropower projects in the lower Kennebec Basin. Pursuant to the Lower Kennebec River Comprehensive Hydropower Settlement Accord, DMR and the Kennebec Hydro-Developers Group (KHDG) conducted a study at each of seven KHDG facilities (Figure 6) to determine where juvenile eels pass or attempt to pass upstream at each of the hydropower facilities. Upstream eel passage has been installed at five of these projects on the basis of the study. Installation of passage at the Lockwood Project, scheduled for 2006, was delayed because of extremely high freshwater discharge. One more year of observation is required at the Burnham Project to determine whether eels are using the fishlift for upstream passage or whether a separate eel facility is needed. In addition, upstream eel passage was provided at two non-KHDG hydropower facilities in 2006. Passage was installed at the Anson Project as required by the project license and at the American Tissue Project on a voluntary basis (Figure 6). Because of changes to the Abenaki spillway, an additional year of study is required to determine the locations of upstream eel passage. At six of the 10 projects, DMR obtained data on upstream eel passage (timing, magnitude, and length distribution).

Methods

"Permanent" upstream eel passage is installed each spring and removed each fall by project owners to prevent damage from high flows and ice. Target operational dates for upstream eel passage on the Kennebec River are June 1 to September 15; however, installation may be delayed by high flows and removal may be expedited if heavy fall rains are forecast.

Migrating eels were collected in traps at the upstream end of permanent or interim upstream eel passage facilities at each of six hydropower projects. DMR enumerated all eels that were passed upstream, and collected length and weight information on subsamples. In general, the passages were operated seven days per week, and were tended at least twice per week. If the number of eels captured at a project was less than 70, all eels were counted and total weight recorded. If catches exceeded 70, all eels were weighed and the number estimated from subsamples. Eels were released above each dam into the headpond after measurements were taken. Slight modifications to this methodology were made at the Hydro-Kennebec Project to allow DMR and Brookfield Power to assess the internal efficiency of the eel upstream passageway.

Results and discussion

Upstream eel passage at all locations was delayed in 2006 due to extremely high freshwater discharge on the Sebasticook River and the mainstem Kennebec River. From mid-May through the beginning of July the discharge was well above median, 75, and 95 percentile for daily steamflow based on 75 years of record on the Sebasticook and 19 years on the Kennebec (Figure 7).

FPL Energy installed a new aluminum eel passage at the Ft. Halifax Project in 2006, because the wooden one has badly deteriorated. The new passage became operational about three weeks later than usual due to high flows. It operated for 27 days between 7/28 and 8/30, and passed an estimated 43,755 eels (Table 6). All the eels moved upstream in the first month of operation (Figure 13), a pattern that has occurred in most years. Eels ranged from 85-227 mm total length (TL). The length distribution of eels at Fort Halifax has been fairly consistent during the nine years of passage with the exception of 2004 and 2005 (Figure 14) when a large number of eels greater than 150 mm were passed.

The passage at the Benton Falls Project became operational at the end of June. It operated for 57 days until 8/30 and passed 522 eels, the second lowest to date (Table 6). Migration was somewhat protracted and most eels passed the site in the first 50 days of operation (Figure 15). Eels using the passage ranged from 103-253 mm TL and were larger than in previous year (Figure 16).

A portable eel passage was installed in the third bay from the west shore at the Burnham Project in 2006. It passed 4,943 eels in 20 days of operations between 7/19 and 8/30 (Table 6; Figure 17). These eels ranged from 98-240 mm TL, and the length distribution was similar to previous years (Figure18). Eels also utilized the upstream anadromous fishlift on a few occasions, but they were counted and no biological samples were taken.

Eel passage at the Hydro-Kennebec Project was operational for 38 days between 7/17 and 9/5 (Table 6). During this period a total of 4,597 eels used the passage to migrate upstream, although more than 90% of the eel movement occurred during a 30 day period (Figure 19). Eels ranged from 85-227 mm TL, and the size distribution was similar to previous years (Figure 20).

FPL Energy reported that because of high flows, the eel passage at the Shawmut Project was installed late in the season in 2006 and no eels were passed at the project. They also reported that an estimated 6,800 eels, ranging from 97 mm to 296 mm, were passed at the Weston Project in 2006 (Table 6).

An interim passage was installed at the American Tissue Project, the second dam on Cobbosseecontee Stream (Figure 6) in late summer. The first dam does not have fish passage; however, in the past DMR has documented that some eels are able to ascend this dam by climbing the corner created by the retaining wall and south end of the dam. The passage operated for 27 days and passed 1,863 eels, which ranged from 84-185 mm TL (Table 6).

Permanent upstream eel was installed at the Anson Project in 2006 on the east side of the spillway. A total of 26 eels, ranging from 114 to 185 mm TL, were passed in 49 days of operation (Table 6).

5.2 Downstream eel passage in the Kennebec River watershed

Introduction

Adult eels, known as silver eels, migrate in late summer and fall from Maine's inland waters to the sea to spawn. The Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan for American Eel, adopted in 2000, calls for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and

3) providing adequate escapement to the ocean of prespawning adult eels. Migration of eels past dams and other obstacles must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

Results and Discussion

Downstream eel passage in the Kennebec watershed probably was facilitated in 2006, because of high discharge from 9/10-9/25 and from 10/11-10/31. During both of these periods the discharge exceeded the 95 percentile based on 20 years of record for the USGS gauge on the Kennebec River at North Sidney and on 66 years of record for the gauge on the Sebasticook River (Figure 7).

In 2006, interim downstream passage measures designed specifically for American eel were operational at two KHDG projects (Benton Falls and Burnham) and three other projects in the watershed (Anson, Abenaki, and American Tissue). These measures include full-depth screening (one-inch clear space or one-inch punch plate) of the turbine intakes and bypass flows through surface or bottom opening gates. At the remaining five KHDG projects interim downstream passage measures designed for anadromous species were operational. These measures include surface screening of the turbine intakes and bypass flows through surface opening gates.

No quantitative assessment of the downstream passage measures has been conducted at any site to date. However, FPL Energy has proposed to use radio telemetry to study the effectiveness of the interim measures for passing American eels downstream at the Lockwood, Shawmut, and Weston projects. This study will be initiated in 2007. In addition, Brookfield Power has proposed to use sonar (DIDSON) in 2007 to study the effectiveness of a newly constructed downstream bypass at the Hydro-Kennebec Project for passing American eel. Finally, Madison Paper Company will be conducting quantitative effectiveness testing for American eel at the Anson and Abenaki projects in the near future.

Qualitative assessment of two of the downstream passage measures was conducted in 2006 prior to the increase in freshwater discharge. DMR made visual surveys of the Weston Project tailrace on 9/7, 9/13, and 10/4 and of the Shawmut project tailrace on 9/7 and 9/20, but did not observe any dead eels.

One reported incident of eel mortality occurred in 2006. On October 13, Essex Hydro Associates contacted DMR to report that eels were migrating during the day, and that some had become impinged on the overlay at Benton Falls. This event corresponded to a rapid increase in discharge (Figure 7). The company reported that it had begun reducing generation and opening gates to decrease impingement. Over the next few days, Essex Hydro Associates worked closely with DMR to find a generation level and gate settings that could be maintained without killing eels. A total of 65 eels were killed during a 6-day period, although most (53) were killed during the first 24-hours, primarily during the day.

6.0 Atlantic Salmon

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

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

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

The Maine Atlantic Salmon Commission (MASC formerly the MASA as of 1999) developed an interim 5-year restoration plan for the Kennebec River in the winter of 2006 (Appendix E). The restoration plan continues the two-phase plan adopted in 1997 and outlines in detail how reintroductions of salmon will take place while encouraging wild spawning along with various options and program needs.

6.1 ATLANTIC SALMON RESTORATION

In 2006, field activities conducted by the Maine Atlantic Salmon Commission staff consisted of the following: adult translocation from the Lockwood Fishlift, juvenile salmon population assessments, spawning surveys, habitat assessments, temperature monitoring, streamside and instream incubation and juvenile releases.

Lockwood fishlift

The construction of the fishlift at the Lockwood Dam on the mainstem Kennebec River in Waterville, Maine was completed in the spring of 2006. The fishlift was operational for the majority of the year between May and November, except during periods of extreme high flows and warm river temperatures. MASC staff transported all captured adult Atlantic salmon to the Sandy River.

A total of 15 adult Atlantic salmon were captured and transported to the Sandy River, and all were released alive. Of the 15 salmon transported to the Sandy River seven were one sea-winter (grilse) returns and eight were two sea-winter returns. The two sea-winter returns were composed of three females and five males. Grilse are primarily males however positive identification is impossible during the trapping season. A breakdown of the age, origin, and sex of the captured fish are outlined in Table 16.

In addition, river specific trap and truck protocols were developed to guide transportation activities and ensure safe handling (Appendix F).

6.2 ATLANTIC SALMON POPULATION MONITORING

Juvenile Atlantic Salmon Assessments

Methods

The MASC staff from the Sidney Regional Office sampled four sites in two tributaries below Waterville-Winslow (Bond brook, Togus stream) to determine the presence or absence of juvenile Atlantic salmon. Additionally, 26 sites were sampled in the Sandy River drainage to assess survival and growth of fry released from streamside and instream incubators in 2004, 2005 and 2006. All sites were evaluated using a single pass electrofishing assessment method except for 18 sites in the Sandy River drainage where a multiple-run removal method was used. All Atlantic salmon captured were sampled for length and weight. A small proportion of the captured Atlantic salmon parr also had a small sample of scales removed for age determination. All salmon were released alive.

Results and Discussion

No Atlantic salmon were found in Bond Brook or Togus Stream. Population estimates for the multiple-run removals in the Sandy River drainage will be generated by MASC during the winter of 2007.

Spawning Surveys

Methods

A single redd count was undertaken by foot on both Bond Brook and Togus Stream. In addition, 11 redd count surveys were completed in the Sandy River drainage to evaluate the spawning success of the adult Atlantic salmon transported to the Sandy river from the Lockwood fishlift. No survey was completed on Messalonskee Stream or the mainstem Kennebec River due to extremely high water.

Results and Discussion

In general two surveys, one early and one late in the spawning season, are conducted to generate a final redd count. This is primarily due to the distortion of redds over time by high flows and the potential for late spawning. In 2006, due to extremely high flows, only a single survey was completed on Bond Brook and Togus Stream. We were unable to document any redds in either of these lower Kennebec River tributaries and no redds were documented in the Sandy River drainage

6.3 ATLANTIC SALMON HABITAT ASSESSMENT

Habitat Surveys

Methods

The MASC continued ongoing habitat surveys on tributaries of the Kennebec River to identify and quantify adult salmon habitat and juvenile rearing habitat in the basin. The survey conducted on Orbeton Stream, a large tributary to the Sandy River in Madrid, in 2005 was completed in 2006. Orbeton Stream was surveyed from below the Reed's Mills Road Bridge in Madrid to its confluence with the Sandy River. This survey covered over three miles of riverine habitat. The South Branch of the Sandy River was also surveyed in its entirety, from its origins in the foothills of Jackson and Blueberry mountains in Township 6 to its confluence with the Sandy River in Phillips. The South Branch survey covered nearly eight miles of riverine habitat.

Results and Discussion

The quantity of salmon habitat surveyed in 2006 is currently being evaluated and will be added to the current habitat data during the winter of 2007.

Temperature Monitoring

Methods

Data loggers were deployed and set to record once every hour in the Sandy River and in the mainstem Kennebec River. Eight loggers were deployed in the Sandy River drainage to aid analysis of our ongoing instream and streamside incubation projects and 2006 fry stocking, and to establish baseline data for Temple stream, a Sandy River tributary in Farmington. Four temperature loggers, three in the Sandy River drainage and one in the mainstem Kennebec River were used to evaluate appropriate locations for adult Atlantic salmon releases from the Lockwood fishlift. At the end of summer, the data from all loggers, except the three loggers placed to record instream incubation temperatures, were downloaded and archived into an electronic database. The two data loggers in the mainstem Sandy River were located just above and just below the confluence of the South branch of the Sandy River in Phillips. In the South Branch of the Sandy River, one logger was located just above the Route 4 crossing in Phillips. The two loggers in Temple Stream were located in Temple and Farmington.

Results and Discussion

The Sandy River temperature data collected will be analyzed in conjunction with instream incubator fry production and future parr densities if necessary. A copy of the entire temperature dataset can be obtained by contacting the MASC.

Research

The MASC continued a research project to test the feasibility of streamside incubation as a method for Atlantic salmon restoration during the winter of 2005-2006. The project was initiated in 2004-2005 with the signing of a memorandum of understanding with the Kennebec Valley Chapter of Trout Unlimited, creating a 3-year partnership with the goal of further evaluating streamside incubation as a restoration tool. In 2005-2006 15,000 eyed (38% development) Atlantic salmon eggs were incubated on a small tributary to the Sandy River in Avon. The resultant fry were then stocked into the Sandy River in Madrid.

The MASC undertook various instream incubation projects between the fall of 2003 and 2005, specifically aimed at developing a restoration plan with little or no hatchery dependence. The projects achieved varying levels of success but indicated that eyed eggs can be transported to the Sandy River, buried in the gravel and expected to produce juveniles. An additional project was undertaken during the winter of 2005-2006, to explore survival of green eggs (freshly fertilized) transported to and buried in the Sandy River. . For the purposes of this study two treatments, eggs fertilized streamside and eggs fertilized at the hatchery and transported in jugs were compared with eyed eggs plants. Overall, of the incubators that produced alevin (non-feeding fry), we observed an average of 41% for eyed egg treatments and 26 % and 27% for the streamside and hatchery fertilized treatments (Appendix D).

6.4 ATLANTIC SALMON JUVENILE RELEASES

Two age classes of salmon have been introduced into the Sandy River in the past four years, (Table 17). The releases have been eggs, as a result of instream incubation research and fry, as a result of the streamside incubation project. Most releases were in the mainstem of the Sandy River above Avon, however some releases have been in tributaries such as Orbeton Stream, Warm Brook and Avon Valley Brook.

Tables

Table 1. Summary of Alewife Trapping by Quartile and Peak Alewife Trapping

Year	Capture site	25%	50%	75%	Peak date	Number Stocked (peak day)
2006	Winslow	9-May	9-May	28-May	9-May	12,358
2005	Winslow	18-May	21-May	3-Jun	18-May	15,272
2004	Winslow	13-May	18-May	24-May	13-May	16,752
2003	Winslow	21-May	27-May	30-May	21-May	15,467
2002	Winslow	11-May	20-May	23-May	20-May	15,867
2001	Winslow	12-May	14-May	16-May	14-May	18,896
2000	Winslow	9-May	15-May	19-May	7-May	13,578
	Average	13-May	17-May	24-May		24-Apr

Table 2. Lockwood Fishway River Herring Disposition

DATE	SOURCE	DESTINATION	NUMBER STOCKED
5/23/2006	LOCKWOOD	WESSERUNSETT LAKE	113
5/18/2006	LOCKWOOD	WESSERUNSETT LAKE	291
5/22/2006	LOCKWOOD	WESSERUNSETT LAKE	257
5/24/2006	LOCKWOOD	WESSERUNSETT LAKE	205
5/25/2006	LOCKWOOD	WESSERUNSETT LAKE	269
5/26/2006	LOCKWOOD	WESSERUNSETT LAKE	128
5/29/2006	LOCKWOOD	LOVEJOY POND	146
5/30/2006	LOCKWOOD	PLEASANT/RICHMOND	180
5/31/2006	LOCKWOOD	WESSERUNSETT LAKE	643
6/1/2006	LOCKWOOD	WESSERUNSETT LAKE	119
6/2/2006	LOCKWOOD	PLEASANT/RICHMOND	33
6/16/2006	LOCKWOOD	WESSERUNSETT LAKE	300
6/22/2006	LOCKWOOD	WESSERUNSETT LAKE	468
		TOTAL	3152

Table 3. Alewife Stocking & Distribution, Phase I and II Lakes, 2006

Ponded Area	Location	Surface Acres	River Section	Stocking Goal[1]	Actual Stocked 2006	No. of Trips	% of Target Number Achieved	Alewives per Acre
Corundel Lake	Corinna	225	Sebasticook, E. Branch	2,000	0	1	0%	0.0
Douglas Pond	Pittsfield	525	Sebasticook, W. Branch	18,375*	1000	1	5%	1.9
Lovejoy Pond	Albion	324	Sebasticook, mainstem	1,944	146	1	8%	0.5
Halifax Headpond	Winslow	---	Sebasticook, mainstem	---	45960	---	---	---
Pattee Pond	Winslow	712	Sebasticook, mainstem	4,272	***	0	---	---
Pleasant Pond	Stetson	768	Sebasticook, E. Branch	4,608	***	0	---	---
Plymouth Pond	Plymouth	480	Sebasticook, E. Branch	2,880	***	0	---	---
Burnham Headpond	Pittsfield	600	Sebasticook, E Branch	30,000*	***	0	---	---
Sebasticook Lake	Newport	4,288	Sebasticook, E. Branch	25,728	***	0	---	---
Unity Pond	Unity	2,528	Sebasticook, mainstem	15,168	***	0	---	---
Big Indian Pond[2]	St. Albans	990	Sebasticook, W. Branch	5,940	0	---	---	---
Little Indian Pond[2]	St. Albans	145	Sebasticook, W. Branch	870	0	---	---	---
Great Moose Lake[2]	Hartland	3,584	Sebasticook, W. Branch	21,504	0	---	---	---
Threemile Pond	China	1,077	Kennebec River	6,462	0[3]	---	---	---
Webber Pond	Vassalboro	1,252	Kennebec River	7512*	18,589	40+	247%	14.8
Wesserunsett Lake	Madison	1,446	Kennebec River	8,676	3082	11	36%	2.1
Totals:		**18,944**		**127,675[4]**	**68,777**	**14**		

[1] Six adult alewives per lake surface acre unless noted with an *

[2] Phase II lakes

[3] Fish have free passage from Webber Pond

[4] Does not include Phase II lakes

*** Fish passage available from Fort Halifax Headpond

Table 4. Alewife Distribution by Trip, Kennebec River Watershed Phase I Lakes, 2006

Date	Location	No Loaded	No. Mortalities	No. Released
5/8/2006	SEBASTICOOK-FORT HALIFAX HDP			10882
5/9/2006	SEBASTICOOK-FORT HALIFAX HDP			12358
5/9/2006	WEBBER POND-VASSALBORO			152
5/10/2006	SEBASTICOOK-FORT HALIFAX HDP			6162
5/11/2006	SEBASTICOOK-FORT HALIFAX HDP			929
5/11/2006	WEBBER POND-VASSALBORO			507
5/12/2006	SEBASTICOOK-FORT HALIFAX HDP			119
5/12/2006	WEBBER POND-VASSALBORO			529
5/15/2006	SEBASTICOOK-FORT HALIFAX HDP			536
5/15/2006	WEBBER POND-VASSALBORO			1100
5/15/2006	WEBBER POND-VASSALBORO			724
5/16/2006	WEBBER POND-VASSALBORO			114
5/17/2006	SEBASTICOOK-FORT HALIFAX HDP			629
5/18/2006	SEBASTICOOK-FORT HALIFAX HDP			687
5/18/2006	WEBBER POND-VASSALBORO			307
5/18/2006	WESSERUNSETT LAKE	291	0	291
5/19/2006	SEBASTICOOK-FORT HALIFAX HDP			300
5/19/2006	WEBBER POND-VASSALBORO			216
5/22/2006	WEBBER POND-VASSALBORO			951
5/22/2006	WEBBER POND-VASSALBORO			1459
5/22/2006	WESSERUNSETT LAKE	257	0	257
5/23/2006	WEBBER POND-VASSALBORO			905
5/23/2006	WEBBER POND-VASSALBORO			332
5/23/2006	WESSERUNSETT LAKE	113	0	113
5/24/2006	WEBBER POND-VASSALBORO			1051
5/24/2006	WEBBER POND-VASSALBORO			1459
5/24/2006	WESSERUNSETT LAKE	205	0	205
5/25/2006	SEBASTICOOK-FORT HALIFAX HDP			799
5/25/2006	WEBBER POND-VASSALBORO			832
5/25/2006	WEBBER POND-VASSALBORO			879
5/25/2006	WESSERUNSETT LAKE	269	0	269
5/26/2006	SEBASTICOOK-FORT HALIFAX HDP			823
5/26/2006	WEBBER POND-VASSALBORO			636
5/26/2006	WEBBER POND-VASSALBORO			471
5/26/2006	WESSERUNSETT LAKE	128	0	128
5/27/2006	SEBASTICOOK-FORT HALIFAX HDP			304
5/27/2006	WEBBER POND-VASSALBORO			833
5/27/2006	WEBBER POND-VASSALBORO			553
5/28/2006	SEBASTICOOK-FORT HALIFAX HDP			3163
5/28/2006	WEBBER POND-VASSALBORO			692
5/29/2006	LOVEJOY POND	146	0	146
5/29/2006	SEBASTICOOK-FORT HALIFAX HDP			3027
5/29/2006	WEBBER POND-VASSALBORO			131
5/29/2006	WEBBER POND-VASSALBORO			304
5/29/2006	WEBBER POND-VASSALBORO			643
5/30/2006***	DOUGLAS POND	1000	0	1000
5/30/2006	PLEASANT/RICHMOND	180	0	180

Table 4. Alewife Distribution by Trip, Kennebec River Watershed Phase I Lakes, 2006 Cont.

Date	Location	No Loaded	No. Mortalities	No. Released
5/30/2006	SEBASTICOOK-FORT HALIFAX HDP			1521
5/30/2006	WEBBER POND-VASSALBORO			487
5/30/2006	WEBBER POND-VASSALBORO			344
5/31/2006	SEBASTICOOK-FORT HALIFAX HDP			850
5/31/2006	WEBBER POND-VASSALBORO			242
5/31/2006	WEBBER POND-VASSALBORO			212
5/31/2006	WESSERUNSETT LAKE	643	0	643
6/1/2006	SEBASTICOOK-FORT HALIFAX HDP			1208
6/1/2006	WEBBER POND-VASSALBORO			248
6/1/2006	WESSERUNSETT LAKE	119	0	119
6/2/2006	PLEASANT/RICHMOND	33	0	33
6/2/2006	SEBASTICOOK-FORT HALIFAX HDP			767
6/2/2006	WEBBER POND-VASSALBORO			180
6/2/2006	WEBBER POND-VASSALBORO			119
6/3/2006	WEBBER POND-VASSALBORO			512
6/4/2006	WEBBER POND-VASSALBORO			116
6/4/2006**	WESSERUNSETT LAKE	289	0	289
6/5/2006	SEBASTICOOK-FORT HALIFAX HDP			849
6/5/2006	WEBBER POND-VASSALBORO			56
6/6/2006	SEBASTICOOK-FORT HALIFAX HDP			47
6/7/2006	WEBBER POND-VASSALBORO			60
6/9/2006	WEBBER POND-VASSALBORO			122
6/13/2006	PLEASANT/RICHMOND	1007	0	1007
6/13/2006	PLEASANT/RICHMOND	1018	0	1018
6/14/2006	PLEASANT/RICHMOND	814	0	814
6/15/2006	WEBBER POND-VASSALBORO			88
6/16/2006	WEBBER POND-VASSALBORO			23
6/16/2006	WESSERUNSETT LAKE	300	0	300
6/22/2006	WESSERUNSETT LAKE	468	0	468
Total # Fish:*		**4441**	**0**	**68990**
Total # Days:	**33**			

* Does not include Pleasant Pond/ Richmond trips on 6/13,14. These trips originated from Cobbosseecontee Stream.

** Fish source Androscoggin River

*** Fish source Ft. Halifax

All other from Lockwood Fishway

Table 5. Summary of Alewife Truck-Stocked into Phase I Habitat

Year	No. released	No. of trips/tanks	No. Alewives per trip/tank
2006**	**68,990**	**15/15**	**296/296**
2005*	75547	38/55	1988/1400
2004*	121,733	62/89	1963/1368
2003*	91,088	58/67	1570/1360
2002	81,067	38	2,133
2001	77,168	41	1,882
2000	74,775	43	1,739
1999	71,857	36	1,996
1998	73,148	34	2,151
1997	74,165	41	1,809
1996	67,441	41	1,645
1995	59,080	34	1,738
1994	58,701	36	1,631
1993	36,503	28	1,303
1992	23,579	31	761

* Includes Corundel Lake and Burnham Headpond

Note: 1992-2002 numbers per trip only

** Most fish from Sebasticook River stocked into Fort Halifax Headpond. Passage available to most of phase I habitat. Trucking activity occurred mostly from Lockwood fishway.

Table 6. Disposition of Kennebec River Alewives Distributed in Locations Other Than Phase I Lakes, 2006

Drainage	Date	Location	Number Loaded	Number Mortalities	Number Released
Bagaduce		Pierce Pond	**0**	**0**	**0**
Kennebec	30-May	Pleasant Pond (Cobbossee Stream)	180	0	180
	2-Jun	Pleasant Pond (Cobbossee Stream)	33	0	33
		Nehumkeag Pond	0	0	0
		Total:	**213**	**0**	**213**
Pemaquid		Pemaquid Pond	0		0
		Pemaquid River	0		0
		Total:	**0**		**0**
Seal Cove		Seal Cove Pond-MDI	**0**		**0**
Sebasticook		White's Pond	0		0
		White's Pond	0		0
		Martin Stream	0		0
		Total:	**0**	**0**	**0**
Union		Lower Patten Pond	0	0	0
		Total:	**0**	**0**	**0**
Webber Pond		Webber Pond – Bremen	0	**0**	0
Mill Brook		Great Pond-Franklin-Taunton Bay	**0**		**0**
		Total Fish:	**213**	**0**	**213**

Table 7. Age Distribution of Adult Alewives Collected at Fort Halifax, 2006

Sample Date	Age II		Age III		Age IV		Age V		Age VI		Mean Age	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
8-May	0	0	0	0	5	3	4	3	1	0	4.6	4.5
17-May	0	0	0	0	5	5	1	5	0	0	4.2	4.5
26-May	0	0	0	0	3	3	1	6	2	1	4.8	4.8
30-May	0	0	0	0	8	3	2	2	0	0	4.2	4.4
2-Jun	0	0	1	0	3	1	2	0	0	0	4.2	4.0
Σ=	**0**	**0**	**1**	**0**	**24**	**15**	**10**	**16**	**3**	**1**	4.4	4.6
% By Sex	**0**	**0**	**2.6**	**0**	**63.2**	**46.9**	**26.3**	**50.0**	**7.9**	**3.1**		
% of Total	**0**	**0**	**1.4**	**0**	**34.3**	**21.4**	**14.3**	**24.2**	**4.3**	**1.4**		

Table 8. Transfers of American Shad Broodstock to Waldoboro Hatchery, 2006

Source	Trapping Site	Date	Number Loaded	Number Mortalities	Number In Hatchery
Connecticut River	Holyoke Lift	17-Jun-05	108	5	103
		19-Jun-05	79	13	66
	Total		**187**	**18**	**169**

[1] Represents a 9.6% trucking mortality

Table 9. Larval American Shad Releases, 2006

Receiving Location	Date Stocked	No. Stocked
Kennebec River, downstream of Shawmut Project	7/11/2005	54,900
Kennebec River, downstream of Shawmut Project	7/14/2005	184,790
Kennebec River, downstream of Shawmut Project	7/25/2005	22,441
TOTAL:		**262,131**

Table 10. American Shad Annual Production Numbers - Kennebec River Watershed above Augusta[1]

River Segment	Habitat Units (100 sq. yd.)	Potential Shad Production[2]	Potential Shad Production With 10% Down stream Mortality[3, 4]
Sandy River above Madison Electric dam, Madison	36,370	83,650	44,455 (5)
Kennebec River above Weston dam, Skowhegan	55,869	128,498	75,877 (4)
Kennebec River from Shawmut dam, Fairfield to Weston dam	61,252	140,879	92,431 (3)
Kennebec River from Hydro Kennebec dam, Waterville to Shawmut dam	25,314	58,221	42,443 (2)
Kennebec River from Augusta to Lockwood dam, Waterville	63,066	145,053	130,547 (1)
Sebasticook River above Burnham	22,986	52,867	34,686 (3)
Sebasticook River from Benton Falls to Burnham dam, Burnham	20,847	47,948	34,954 (2)
Sebasticook River from Fort Halifax dam, Winslow to Benton Falls, Benton	14,199	32,658	26,453 (1)
Total Kennebec	**205,501**	**472,651**	**341,298**
Total Sebasticook	**58,032**	**133,473**	**96,093**
Total, Kennebec watershed above Augusta	**263,533**	**689,774**	**481,846**

[1] Based on 10% down stream mortality at each hydroelectric dam
[2] Based on estimates derived from Connecticut shad restoration efforts of 2.3 adult shad per Habitat Unit
[3] 10% mortality estimates based on a theoretical efficiency goal
[4] Number in parentheses represents the total dams from that area down stream

Table 11. Juvenile Abundance Index (JAI) for American Shad in the Kennebec River above Augusta

Site	2001	2002	2003	2004	2005	2006
1	0.00	0.88	0.00	0.00	0.00	0.00
2	0.00	0.63	14.20	80.60	334.00	55.67
3	0.38	0.50	0.00	0.00	0.00	2.67
4	0.00	0.00	0.00	0.00	0.00	0.00
5	63.25	0.22	0.50	4.40	0.00	0.00
7	87.75	0.00	0.00	0.00	5.80	245.00
8A[1]	19.88	12.67	---	---	---	---
8B	0.00	0.13	43.17	1.60	0.00	106.17
8C[2]	---	382.80	61.50	43.00	400.40	264.00
Mean # of Shad/Seine Hall	21.89	0.97/31.69/ 30.80[3]	15.26	15.43	90.27	85.98
Geometric Mean # of Shad/Seine Hall	0.32	1.01	0.64	0.73	1.43	1.06

[1] Due to bridge construction, Site 8A was abandoned in August 2002.

[2] Site 8C was created as a result of Site 8A being abandoned. JAI based on six trips.

[3] First number includes sites 8A, 8B, second number includes sites 8B,8C, third number includes all.

Table 12. Downstream Passage Observations of Juvenile Alewives at Lake Outlets in Sebasticook and Upper Kennebec Watersheds, 2006

Date	Sebasticook Lake	Plymouth Pond	Unity Pond	Pleasant Pond	Pattee Pond	Webber Pond	Threemile Pond	Wesserunsett Lake	Corundal Lake	Lovejoy Pond
10-Jul						O				
13-Jul	O	O	O	O	O			O		O
14-Jul			O			OA				
17-Jul	O	O		O		O		O		
21-Jul	O	O		O		O		OB		
24-Jul	O	O		O		O		OB		
25-Jul						O	O			
26-Jul	OU	O	O	O		O		OB		
2-Aug	O	O		OA		O		O		
3-Aug						O				
4-Aug					O					
7-Aug	OU	O	O	OA		O				
8-Aug	O	O		OA						
9-Aug	OU	O	O	OA	O	O				
11-Aug	OU			OA				O		
12-Aug	O									
14-Aug						O	O			
17-Aug		O		O		O	O			
18-Aug	O		O	O				O		
21-Aug	O		O	O		O		OU		
28-Aug						O		O		
1-Sep						O	O			
7-Sep	O			OA						
8-Sep	O		O	OU						
11-Sep	O	O	OU	OU	O	O	O			
12-Sep	O		O	OA	O			OU		
13-Sep		O	O	OA		O		O		
14-Sep		O		O	O	O		O		
15-Sep							O			

Table 12. Downstream Passage Observations of Juvenile Alewives at Lake Outlets in Sebasticook and Upper Kennebec Watersheds, 2006 cont.

Date	Sebasticook Lake	Plymouth Pond	Unity Pond	Pleasant Pond	Pattee Pond	Webber Pond	Threemile Pond	Wesserunsett Lake	Corrundal Lake	Lovejoy Pond
20-Sep						O				
21-Sep	O	O	O	O		O	O	O		
25-Sep	O		O	O		OU	O	O		
26-Sep	O	O	O	OA	O	OU		O		
29-Sep	OA	O	O		O	O	OA	O		
2-Oct		O	O	O	O	O	OU	O		
3-Oct						O	OU			
5-Oct			OU		O		O			
10-Oct	O	O		O	O	O	O	O		
11-Oct		O	O	O		OU		O		
13-Oct		O		O			OA	O		
19-Oct		O	O	O		O	O	O		
22-Oct						OA				
1-Nov						O				

O = Downstream passage available at time of survey

X = Downstream passage not available at time of survey

= Not surveyed on this day

[U] = Juvenile alosids passing downstream

[A] = Juvenile alosids above outlet

[B] = Live alosids present below outlet

[D] = Dead alosids present below outlet

Table 13. Downstream Passage Observations at Hydroelectric Facilities, 2006

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly
7/10/2006			O		
7/13/2006		O			O
7/17/2006			O	O	O
7/21/2006		O		O	
7/24/2006		O		O	O
7/26/2006			O		O
8/2/2006		O	O	O	
8/3/2006		OH		O	
8/5/2006			OH		
8/7/2006			O		
8/8/2006		O			
8/9/2006				O	
8/11/2006		O	O		
8/12/2006		O			
8/17/2006			O	O	O
8/18/2006	O	O			
8/21/2006	O	O	O		O
8/28/2006	O	O	O		
8/31/2006					
9/7/2006		O		O	
9/11/2006		O			
9/12/2006	O	O		O	
9/13/2006		O	O		
9/14/2006		O		O	O
9/21/2006		O			
9/25/2006		O	O		
9/26/2006		O	O	O	
9/29/2006		O			
10/2/2006		O			
10/5/2006	O	O			
10/6/2006			O		
10/10/2006		O	OH	O	
10/11/2006		O			
10/13/2006		O	O		
10/19/2006		O			
10/20/2006			O	O	O
Totals	**5**	**26**	**17**	**13**	**7**

Table 14. Diadromous Fish Captured in the Kennebec River above the Edwards Dam Site, 2006

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8B	Site 8C
Alewife	0	0	136	0	0	0	0	0
American Eel		0	0	1		0	0	0
American Shad	0	334	16	0	0	1470	637	1584
Blueback Herring	0	0	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	0	0
Site Totals	**0**	**334**	**152**	**1**	**0**	**1,470**	**637**	**1,584**
Grand Total All Sites	**4,178**							
Total By Species								
Alewife	**136**							
American Eel	**1**							
American Shad	**4,041**							
Blueback Herring	**0**							
Striped Bass	**0**							

Table 15. Upstream eel passage at hydropower projects in the Kennebec River watershed, 1999-2006.

Project	Year	Startup date	Shutdown date	Operating days	Eels passed
American Tissue	2006*	8/2	9/1	27	1,863
Anson	2006*	7/14	8/31	49	26
Benton Falls	1999**	6/22	9/16	61	14,013
	2000**	6/30	9/15	44	37,987
	2001*	6/6	8/24	55	229,536
	2002	6/18	9/13	53	22,437
	2003	6/26	9/2	15	6,421
	2004	7/15	8/12	29	2,409
	2005	7/13	8/29	38	469
	2006	6/30	8/30	57	522
Burnham	2001	7/5		1	301
	2005	7/26	8/12	14	742
	2006	7/19	8/30	20	4,943
Fort Halifax	1999**	6/4	9/15	80	473,273
	2000*	6/19	8/29	59	71,879
	2001	5/26	8/24	89	223,184
	2002	6/10	9/13	75	56,376
	2003	6/11	9/11	50	154,624
	2004	6/28	9/1	40	67,217
	2005	6/28	8/29	44	7,818
	2006	7/28	8/30	27	43,755
Hydro-Kennebec	2001	7/5	8/15	2	431
	2002**	8/20	9/5	2	66
	2003	7/10	8/29	26	4,733
	2004*	7/14	8/13	28	7,929
	2005	7/8	8/26	50	2,979
	2006	7/17	9/5	38	4,597
Shawmut	2003*	6/9	9/22		917
	2004	7/9	8/30		4,521
	2005	7/5	9/2		3,718
	2006	8/7	9/12		0
Weston	2004***	6/21	8/27		2,113
	2005*	6/13	9/15		758
	2006	7/12	9/13		6,800

Table 16. Adult Atlantic Salmon Captured at the Lockwood Fishlift and Transported to the Sandy River, 2006.

Date	Age *	Sex	Origin

17-Jun	1SW	grilse	W
17-Jun	1SW	grilse	H
17-Jun	1SW	grilse	W
20-Jun	2SW	female	H
24-Jun	2SW	male	H
24-Jun	2SW	male	H
26-Jun	1SW	grilse	H
27-Jun	1SW	grilse	H
27-Jun	1SW	grilse	W
27-Jun	2SW	male	W
28-Jun	2SW	male	H
2-Jul	2SW	female	W
2-Jul	1SW	grilse	H
9-Jul	2SW	male	H
11-Oct	2SW	female	H

* 1SW denotes a one sea-winter fish, and 2SW denotes a two sea-winter fish

Table 17. Two age classes of Atlantic salmon released over three years into the Sandy River Drainage.

Year	Fry	Eggs
2003	39,000	
2004	55,000	12,000
2005	30,000	18,000
2006	6,500	41,800
Total	130,500	71,800

Figures

Figure 1. Kennebec River Restoration Study Area

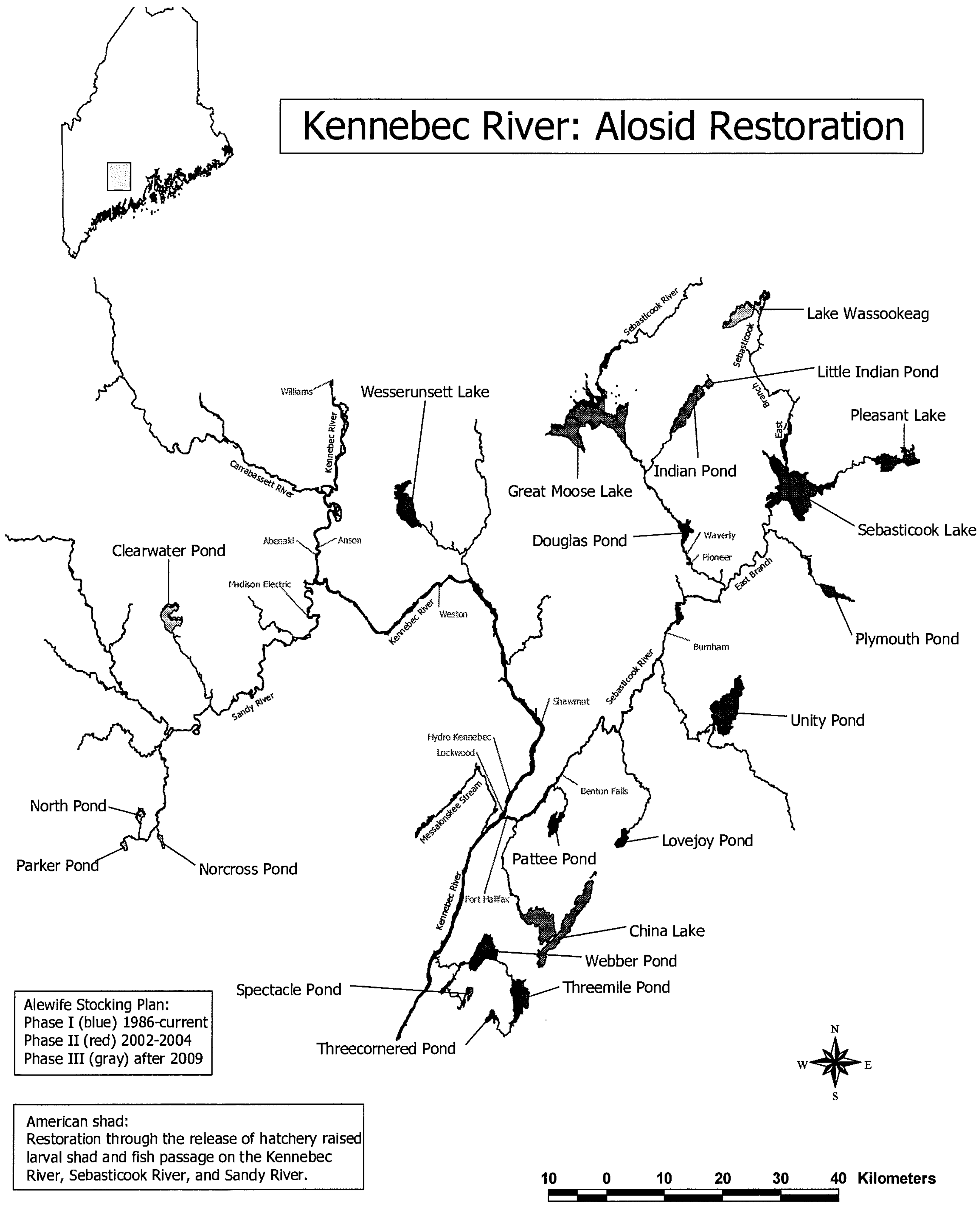


Figure 2. Adult Alewife Biosamples - Male vs. Female Captured at Fort Halifax, 2006

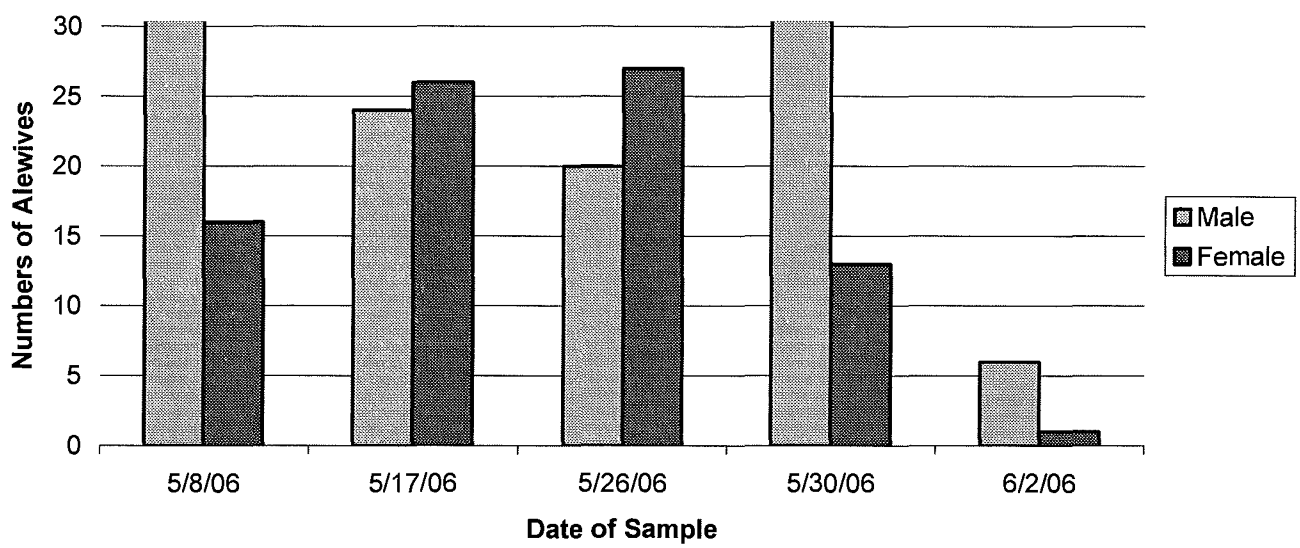


Figure 3. Average Lengths of Adult Alewife Biosamples, 2006

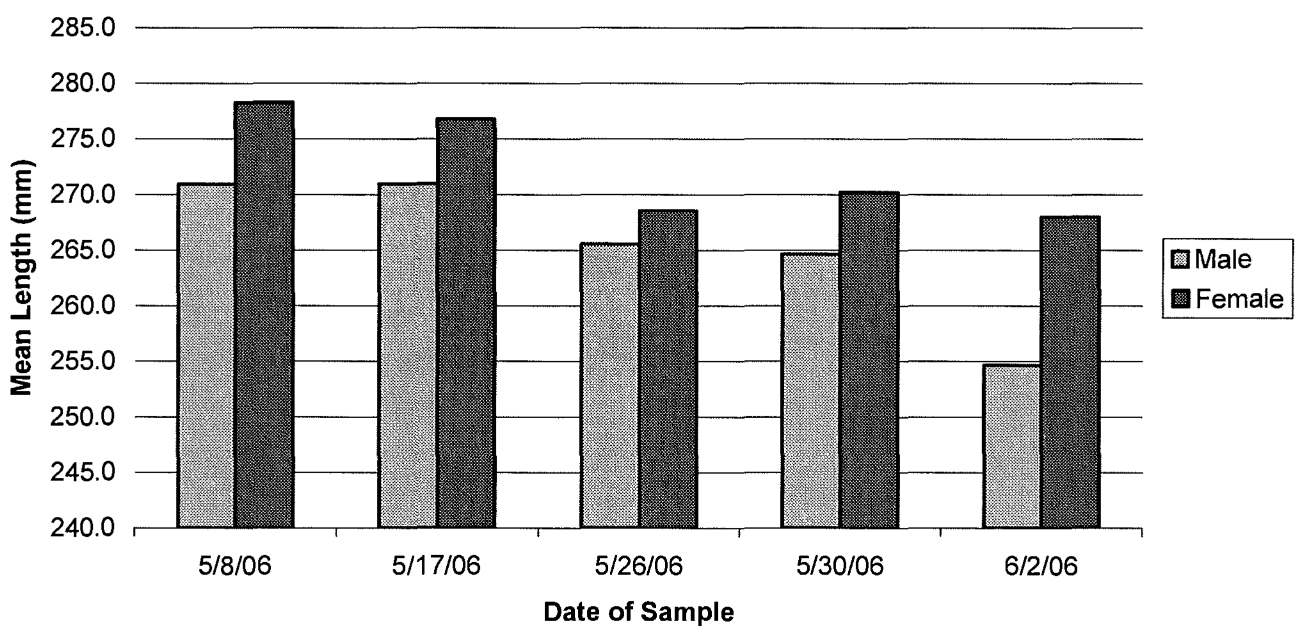


Figure 4. Average Weights of Adult Alewife Biosamples, 2006

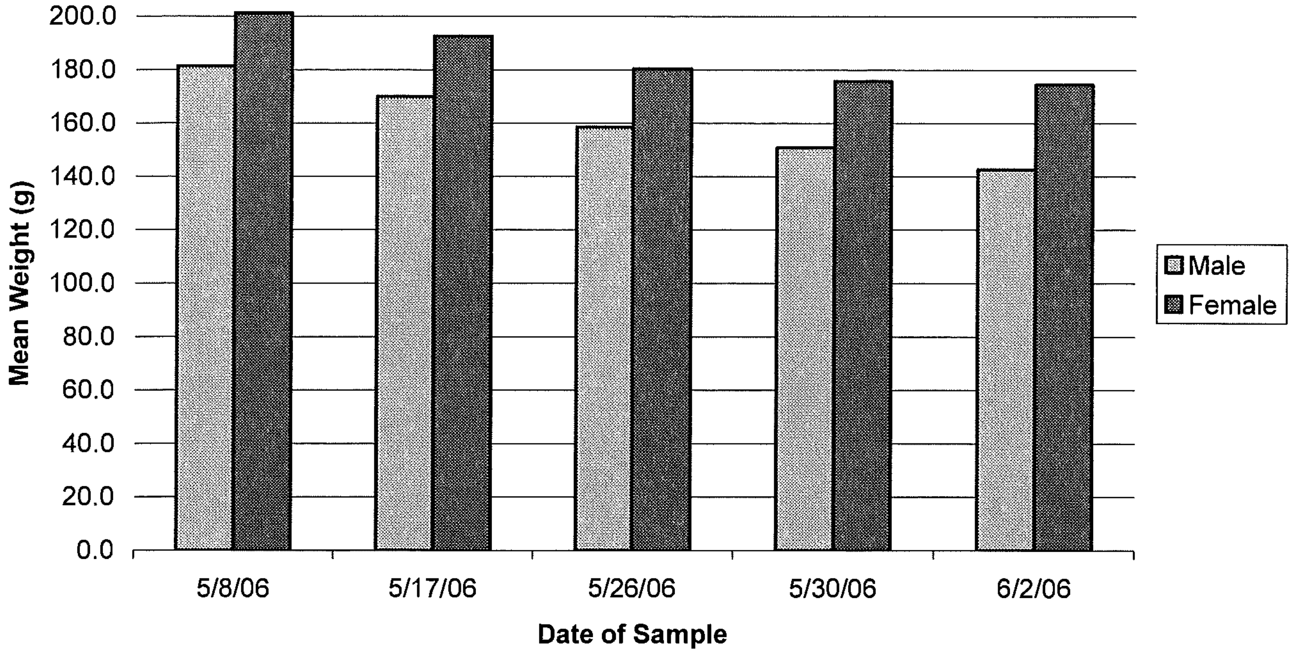


Figure 5. Commercial Alewife Harvest

Figure 6. Location of hydropower projects and fishways within the Kennebec River watershed.

KHDG hydropower projects indicated by star (*), hydropower projects that have been removed by two stars (**), other hydropower projects by plus (+), and nonhydropower dams have no symbol.

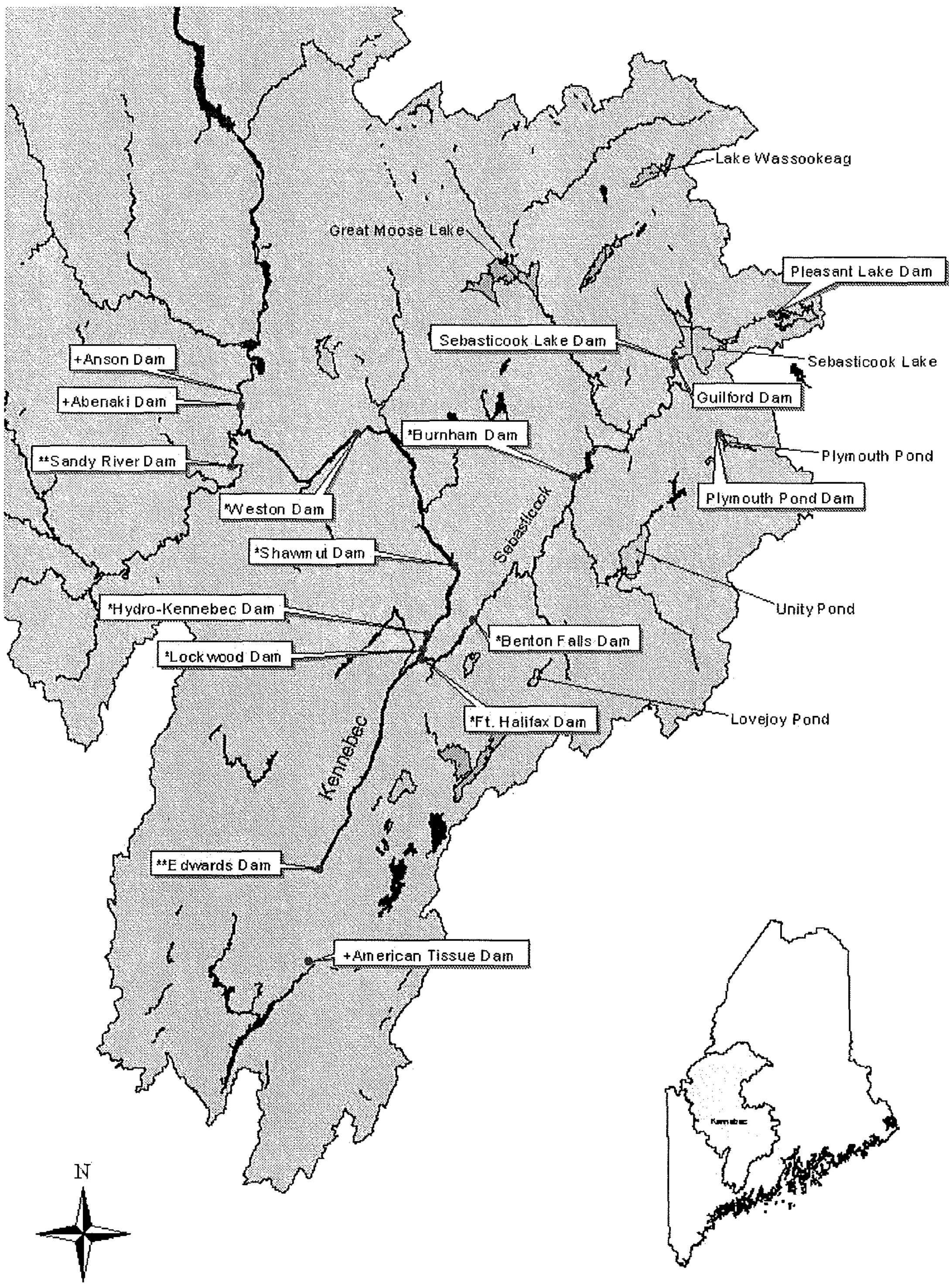
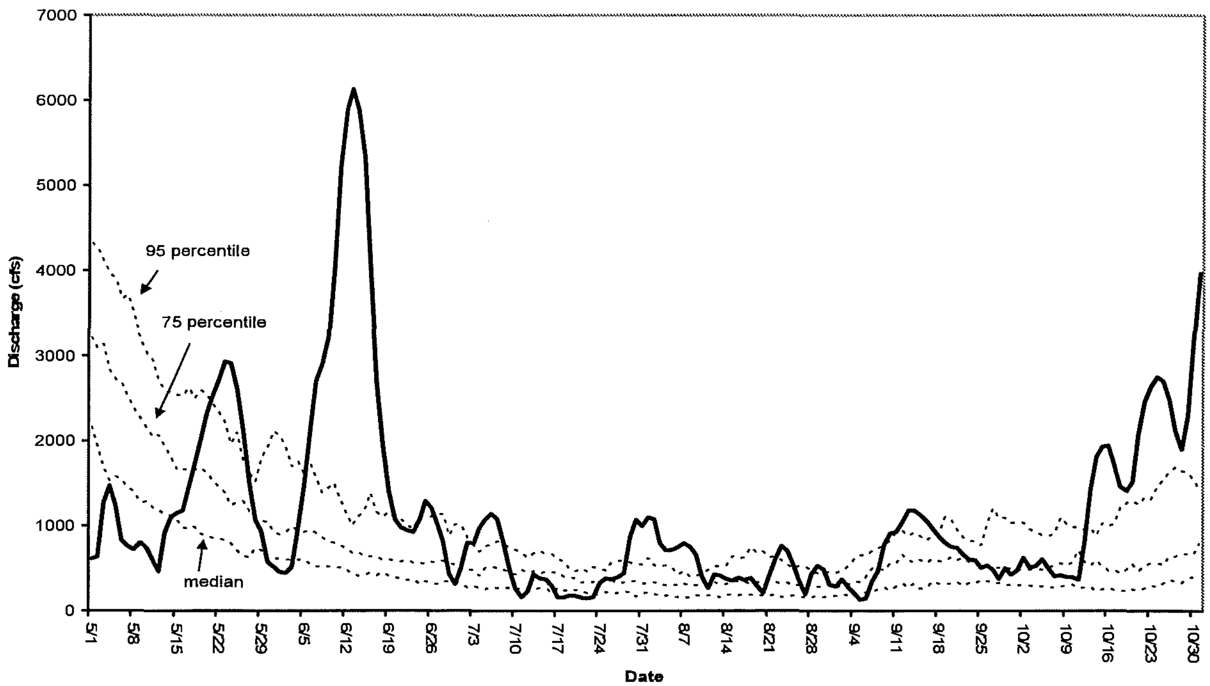


Figure 7. Provisional streamflow on the Sebasticook River (upper panel) and the Kennebec River (lower panel).



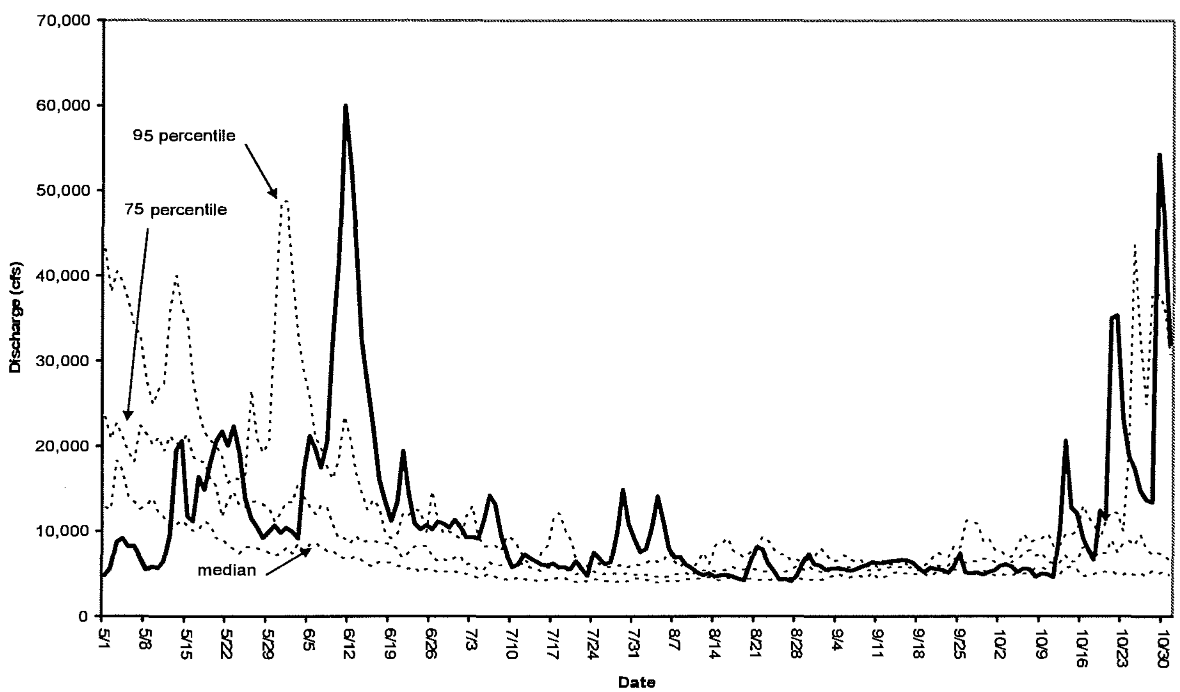


Figure 8. Fish screen that passes alewives but excludes larger fish that was installed at the Benton Falls Project. A similar screen was made for the Sebasticook Lake fishway. During normal operation, alewives swim through the screen and then through the counting tubes. At the end of the day, the counter is turned off, several tubes lifted, and other species identified, counted, and passed upstream.

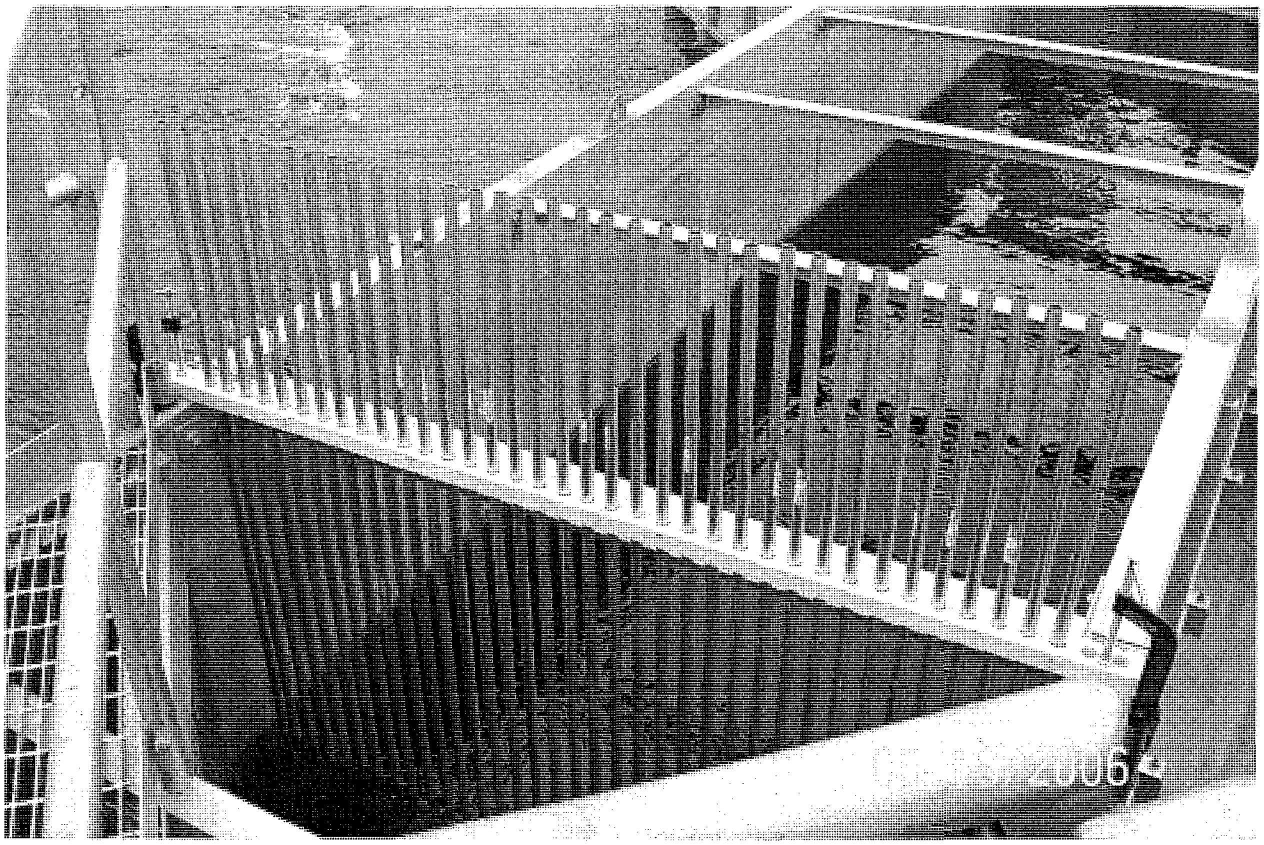


Figure 9. Number of alewives passed at the Fort Halifax Project, Burnham Project, and Sebasticook Lake fishway and provisional daily discharge measured at USGS gage 01049000 near Pittsfield, Maine, during the 2006 migration season.

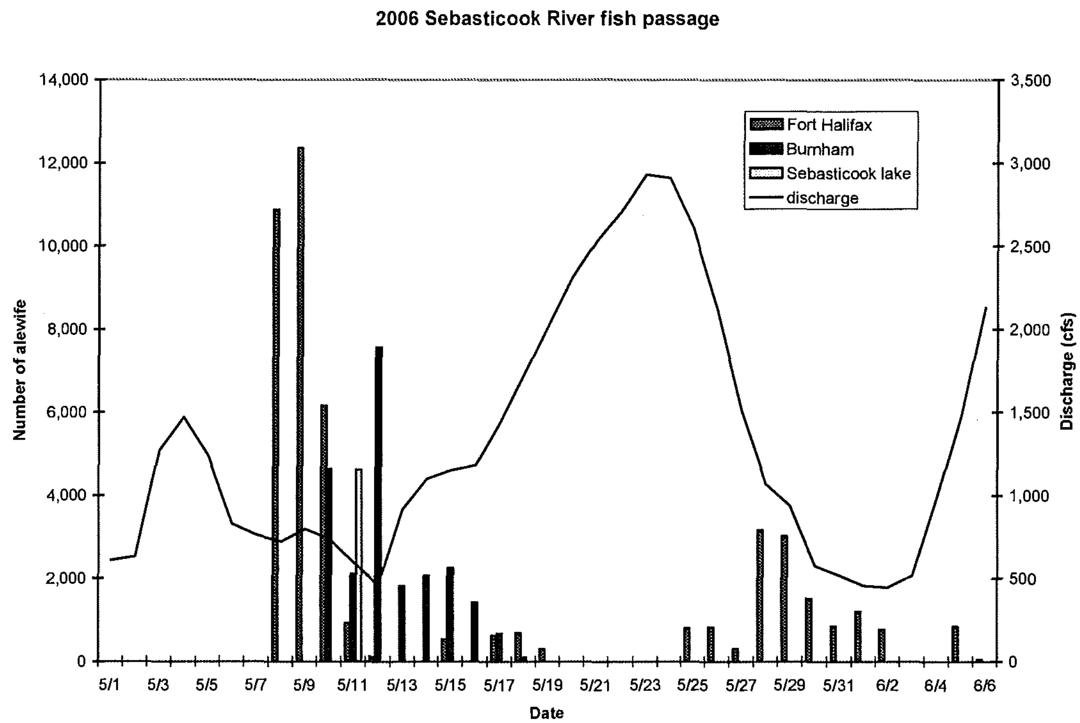


Figure 10. American Shad Larvae Released in the Kennebec Drainage, 1992-2006

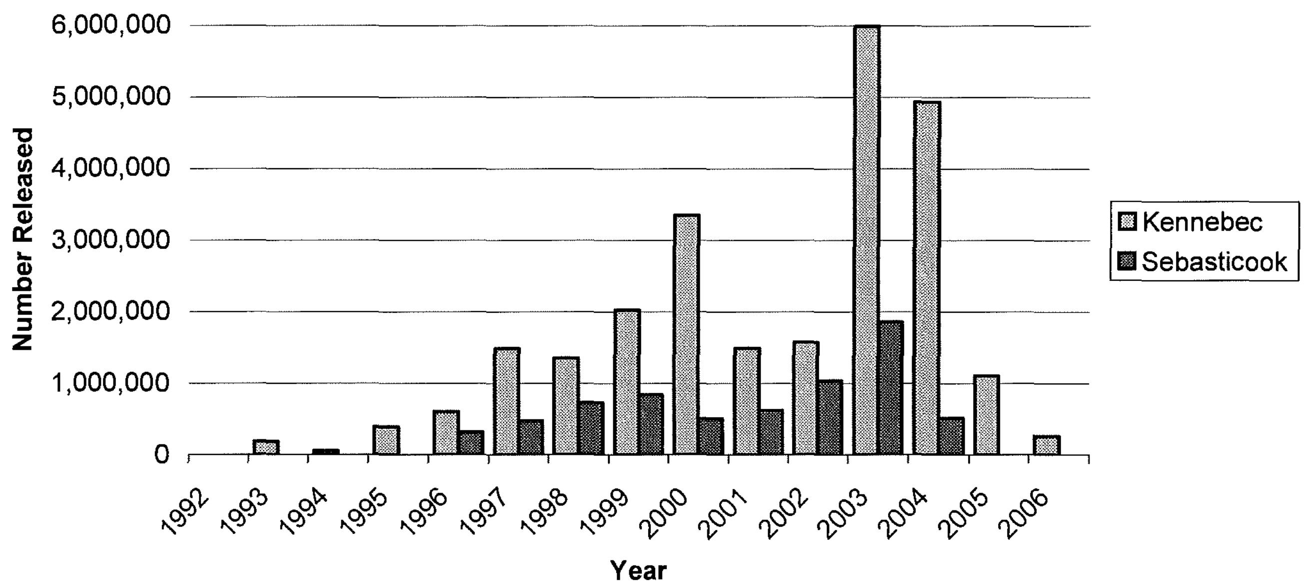


Figure 11. Number of American Shad Fingerlings Released into the Kennebec and/or Medomak Rivers 1992-2006

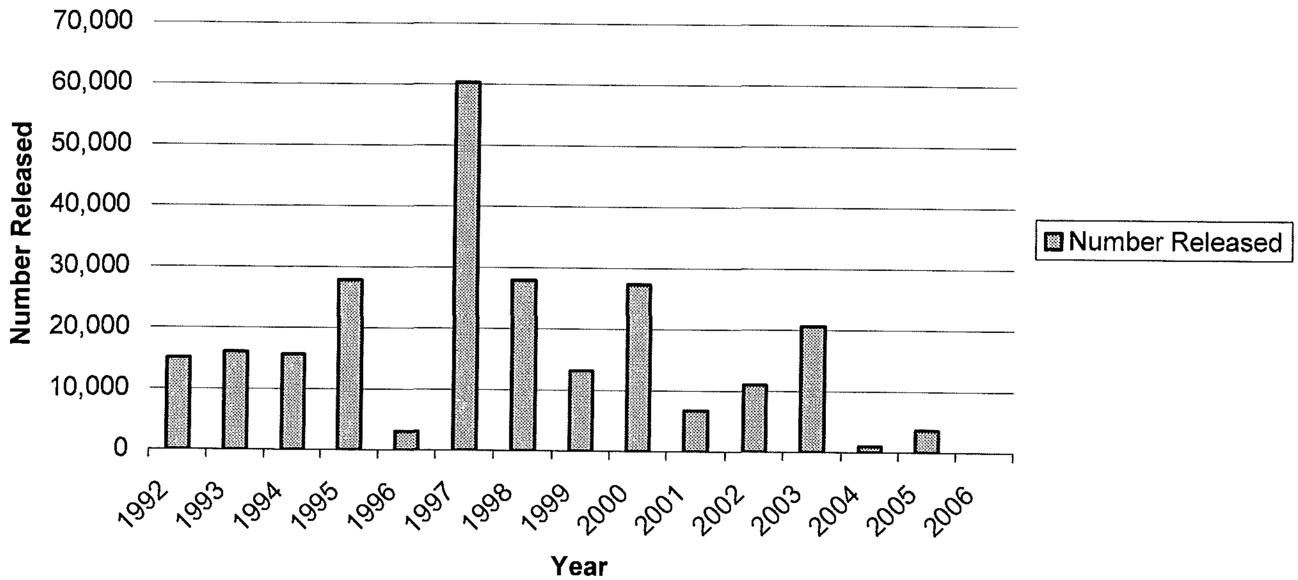


Figure 12. Shad Sample from Community Assessment Study, 2004

Figure 13. Eel passage at the Ft. Halifax Project during the 2006 field season.

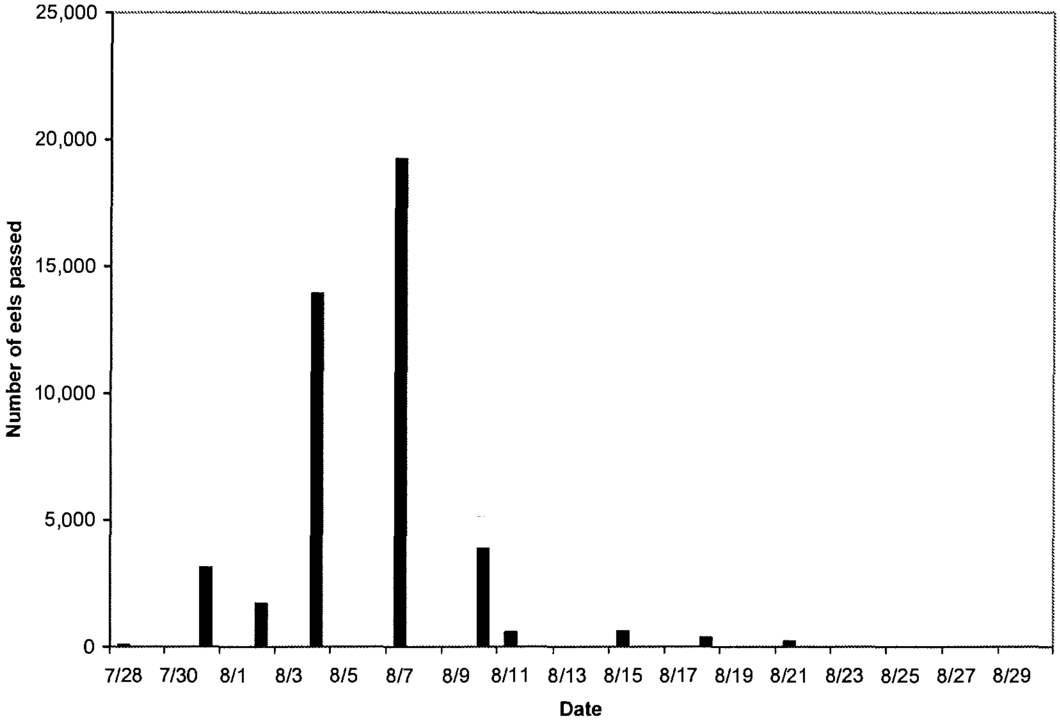


Figure 14. Box plots of total length of eels passed at the Ft. Halifax Project, 1998-2006.

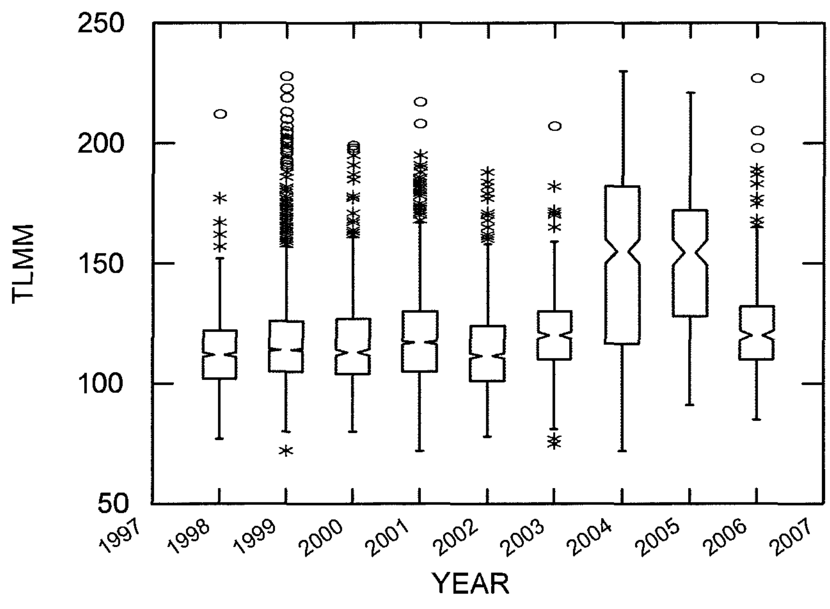


Figure 15. Eel passage at the Benton Falls Project during the 2006 season.

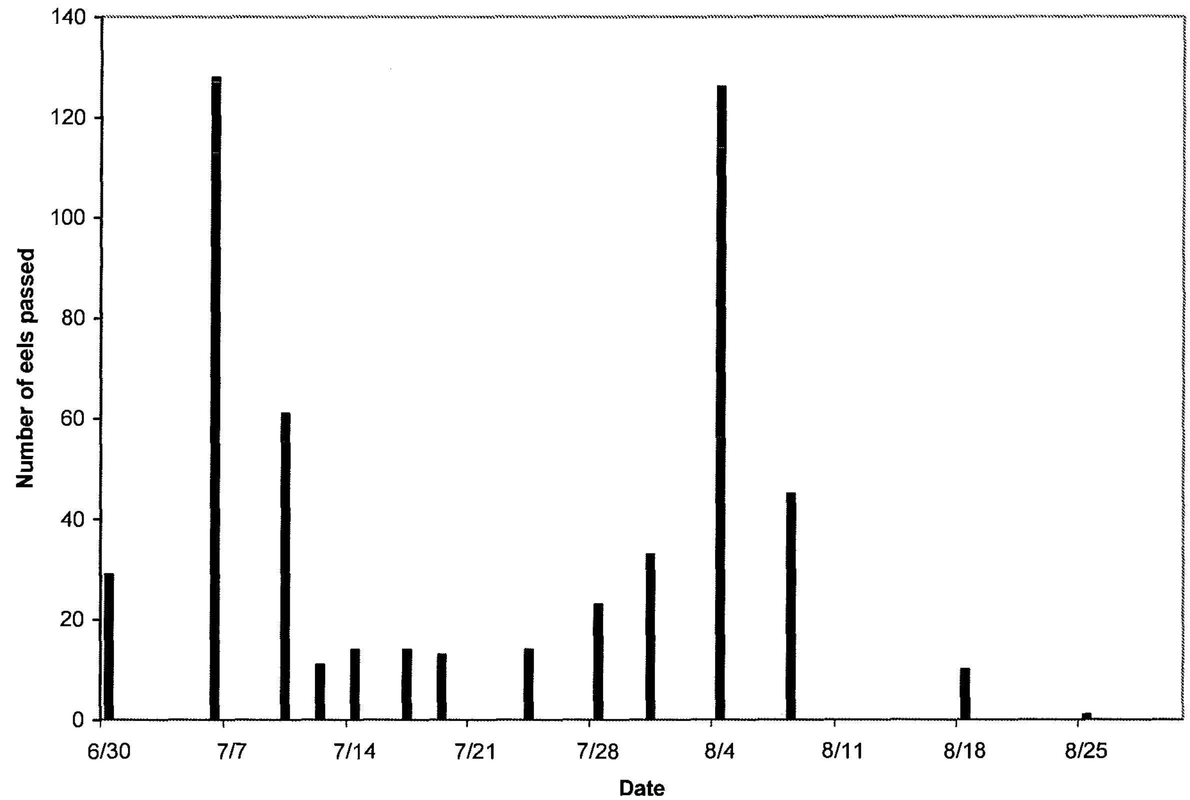


Figure 16. Box plots of total length of eels passed at the Benton Falls Project, 1999-2006.

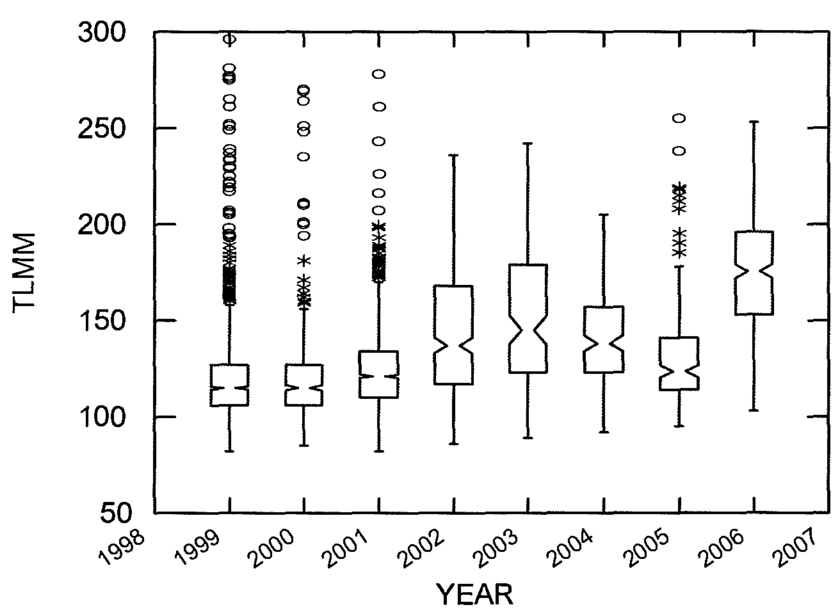


Figure 17. Eel passage at the Burnham Project during the 2006 season.

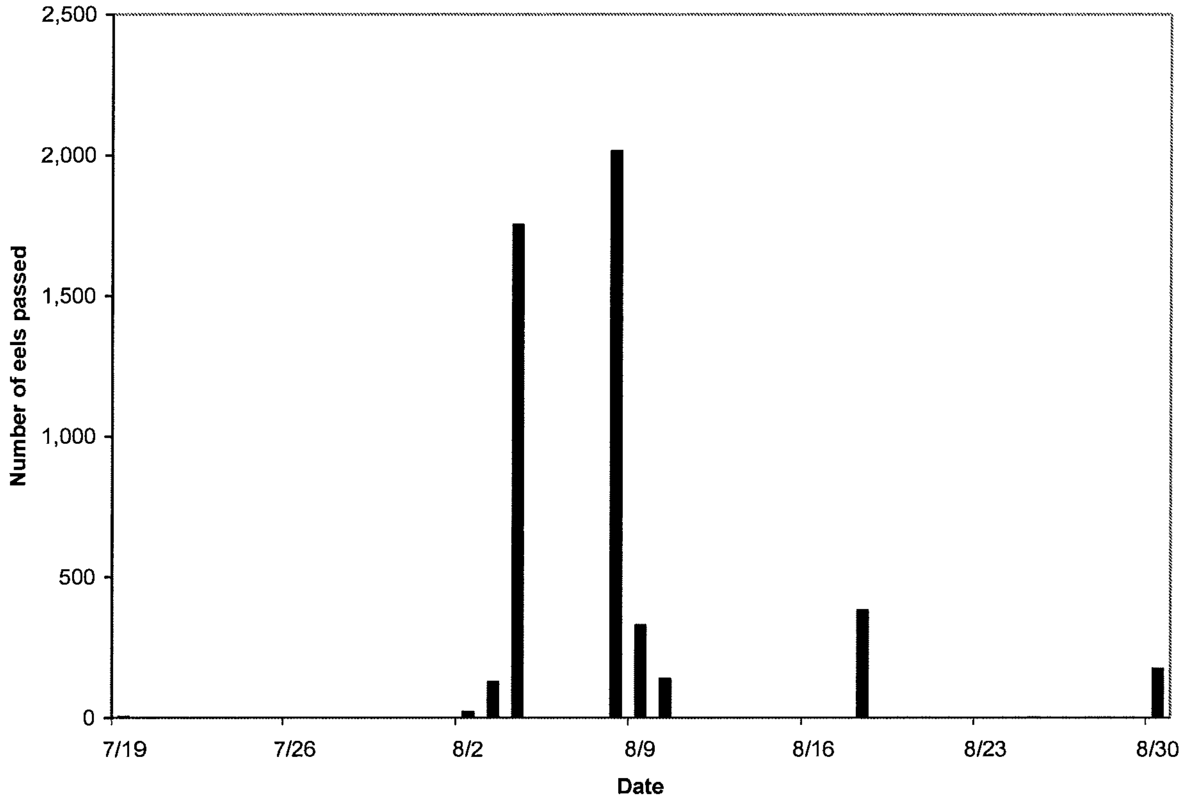


Figure 18. Box plots of total length of eels passed at the Burnham Project.

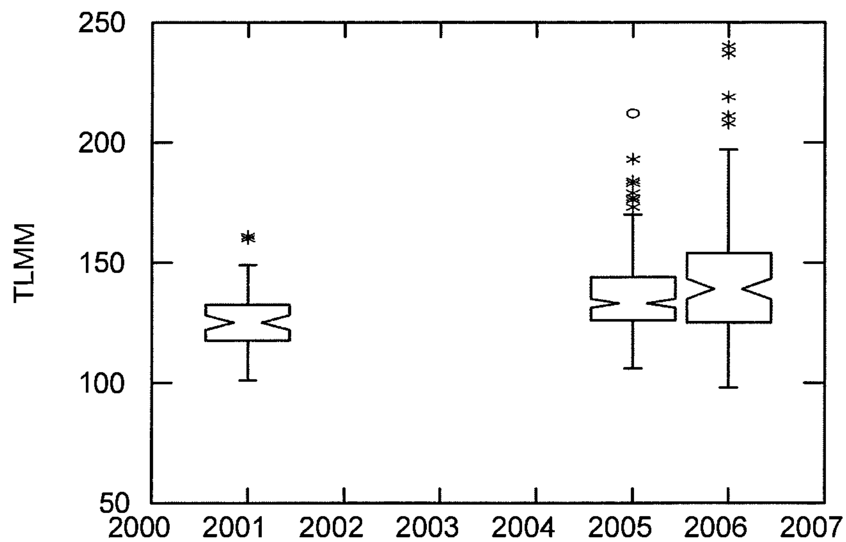


Figure 19. Eel passage at the Hydro-Kennebec Project during the 2006 season.

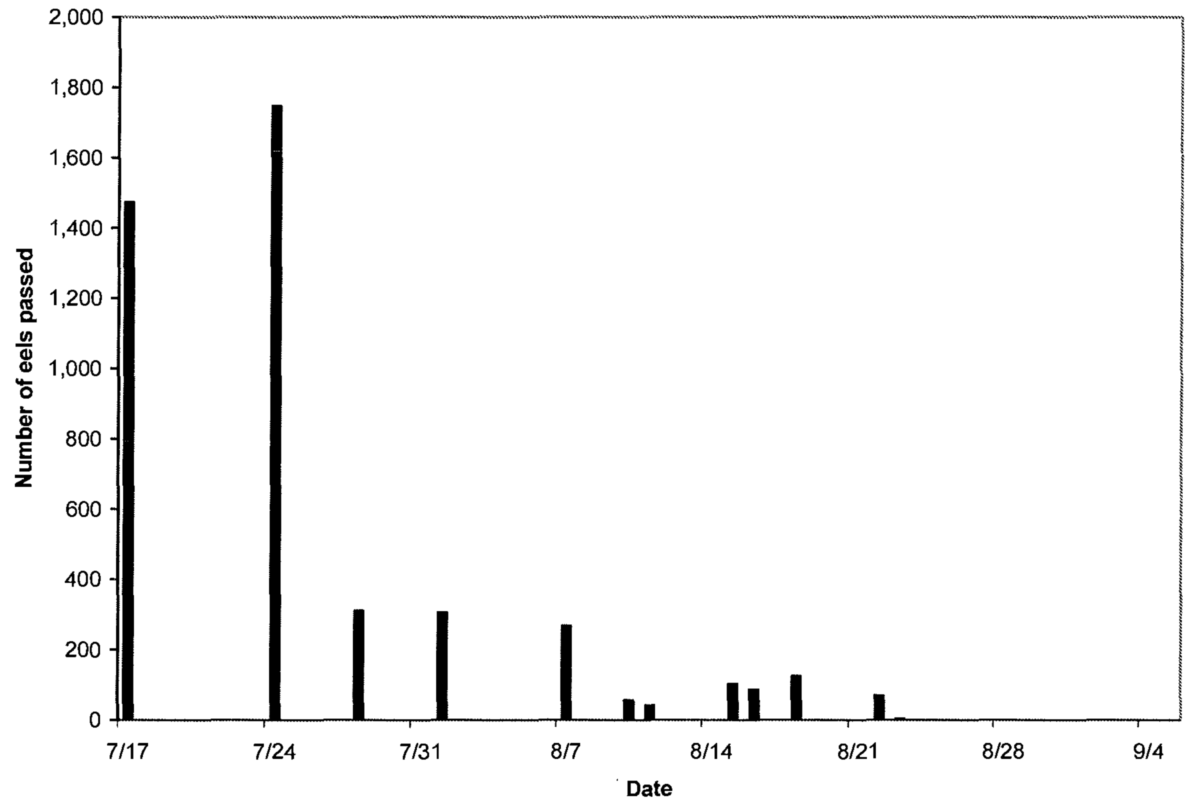
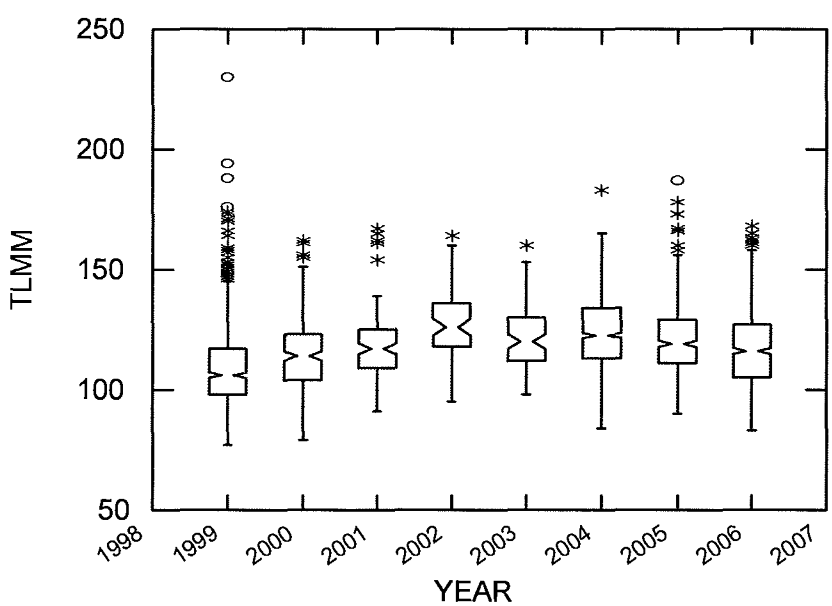


Figure 20. Box plots of total length of eels passed at the Hydro-Kennebec Project, 1999-2006.



Appendices

APPENDIX A - History of Management Plan

Diadromous Fish Restoration on the Kennebec River

(The information contained in the following sections is intended as an overview of the history of diadromous fish restoration in the Kennebec River watershed.)

1.1 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 1986, the Maine Department of Marine Resources (DMR) developed *"The Strategic and Operational Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta."* The goal of this plan was:

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

To meet this goal, the following objectives were developed:

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

Coincidentally with the creation of this plan, the Kennebec Hydro Developers Group (KHDG) was created and a new *Operational Plan for the Restoration of Shad and Alewives to the*

Kennebec River was implemented in 1986. This plan became the first "Agreement" between the KHDG and DMR. While its goals and objectives were the same as those of 1985, it allowed dam owners upstream of Edwards dam to delay the installation of fish passage in exchange for funding a trap, truck, and release program to move adult alewives and shad into upstream habitat.

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

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

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

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

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

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

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

1.2 Implementation of the Management Plan (1986-2001)

The strategy developed to meet the objectives of alosine restoration was planned in two phases. Phase I (January 1, 1986 through December 31, 2001) involved restoration by means of trap and truck of alewives and shad for release into spawning and nursery habitat. Phase II (January 1, 2002 through December 31, 2010), which is currently ongoing, involves providing upstream and down stream 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, for several reasons, fish for the restoration were not obtained at Edwards until 1993. No capture facilities were available during 1987 and 1988;

in 1989, an experimental fish pump was installed by the owner, but proved to be ineffective in capturing sufficient numbers for release in upriver spawning habitat. As a result, from 1987 through 1992, all the alewife broodstock stocked in Phase I lakes (see Table 1 for a list of these lakes) came primarily from the Androscoggin River.

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

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 2003, a record number of alewives were captured at Fort Halifax and released into 44 ponds throughout Maine, including all Phase I ponds that DMR was permitted and chose to stock.

The Edwards dam issue was settled in 1998. The State of Maine took possession of the dam on January 1, 1999 as part of an agreement reached with the dam's previous owner, Edwards Manufacturing Company. The relicensing process of Edwards dam included several landmarks that contributed to the company's decision to turn the dam over to the state. In the fall of 1997, the Federal Energy Regulatory Commission (FERC) released a basin-wide Environmental Impact Statement, which recommended removal of the Edwards dam. The FERC voted on this removal recommendation and ordered it in December 1997. In addition, Edwards' power contract with FPL Energy expired December 31, 1998. Rather than participate in a protracted legal battle, Edwards Manufacturing chose to negotiate with and turn the dam over to the State of Maine, allowing its ultimate removal by the state.

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

On June 25, 1999, DMR, in cooperation with the Maine Department of Inland Fisheries & Wildlife (IFW), installed a barrier on Sevenmile Brook 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. The barrier was installed May 3, 2003 and IFW was responsible for its cleaning and maintenance.

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 is slated to be used for the trapping and trucking of adults for release upstream through 2004.

Under Phase I of the restoration plan, only those lakes approved by IFW were to be stocked with six alewives per surface acre. Of the 11 impoundments listed under Phase I, only eight were stocked at the beginning of the program in 1987; Wesserunsett Lake was stocked beginning in 1996. Restoration at the remaining two Phase I impoundments, Threemile Pond and Three-cornered Pond, both in the Sevenmile Brook drainage, was delayed due to their marginal to poor water quality. In 2001, alewives were released into Threemile at a reduced rate of two alewives $acre^{-1}$; however, this was increased in 2002 to six $acre^{-1}$. Restoration at the ten remaining impoundments was contingent upon the outcome of a cooperative research project sponsored by DMR, the Maine Department of Environmental Protection (DEP), and IFW to assess the interactions of alewives with resident smelt and salmonids. In June 1997, IFW 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 DEP time to establish a better long-term water quality database on this pond. In fact, DMR deferred stocking alewives into the whole Sevenmile Brook drainage (Webber, Threemile, and Three-cornered Ponds) for a number of years due to the ongoing work in water quality improvement by DEP, local residents, lake associations, and the China Region Lake Alliance. In early 1995, DMR, DEP, and IFW 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 initially stocking only Webber Pond. Webber was stocked in 1997 with two alewives per acre, followed by four alewives per acre in 1998, and starting in 1999, six per acre annually. As previously mentioned, DMR implemented a conservative stocking plan at Threemile Pond in 2001 when alewives were released at a density of two alewives acre^{-1}.

In 2003, DMR continued to transfer American shad from out-of-basin to the Waldoboro Shad Hatchery for use as captive broodstock in the tank-spawning program. However, beginning in 2001, DMR collected broodstock from the Merrimack River rather than the Connecticut River because of its increased run size over the past few years and its closer proximity to Maine[3]. In both 2000 and 2001, DMR transferred broodstock from the Kennebec River to the shad hatchery. In 2002, a total of 50 shad were captured near the confluence of the Kennebec and Sebasticook Rivers, although only four females were transported to the hatchery (at the time of the shad capture, the hatchery was already near capacity with shad).

[3] Shad restoration efforts in other rivers, such as the Susquehanna, have shown fry releases to be more successful than fingerling or adult releases. Therefore, no broodstock American shad have been transferred from out-of-basin (the Connecticut River was the primary source in past years) directly to the Kennebec River since 1997. Rather, DMR has concentrated on providing broodstock for the hatchery's tank spawning effort.

American shad fry production increased in 1997 with the Maine Outdoor Heritage and KHDG-funded expansion of the hatchery facility. The 2000 shad culture operational budget was funded by the DMR and Kennebec River Restoration Fund. DMR released more larval shad (2.6 million into the Kennebec watershed) in 2003 than in previous years. All larval shad raised at the hatchery were marked with oxytetracycline prior to release.

APPENDIX B - Proposed 2007 Trap & Truck Budget

Job 1. Trap and Sort Alewives

Transfer of broodstock alewives via Transvac pump at the Ft. Halifax facility will begin in May and conclude in June. About 90% of the alewife habitat that has been stocked in past years is in the Sebasticook drainage, which means that the majority of returning adult alewives will home to the Sebasticook River. Alewives returning to the Sebasticook River will be collected with the Transvac pump and then released into the Ft. Halifax headpond to continue upstream. Therefore, trucking operations will be greatly reduced from the Ft. Halifax facility with nearly all Phase I habitat in the Sebasticook River drainage accessible to the alewives with the new fish passages installed.

Job 2. Trap/Sort and Truck Alewives/American shad

Transfer of broodstock alewives via tank truck will begin in May and conclude in July. Alewives and American shad returning to the mainstem Kennebec will be captured at the fishlift facility installed by FPL Energy/Constellation Energy at the Lockwood hydroelectric facility. Alewives returning to Lockwood will be used to stock Wesserunsett Lake in Skowhegan as well as Douglas Pond on the Sebasticook drainage. Excess fish from the Lockwood facility will also be used to stock out of basin as time permits. The fishlift will deposit captured fish in a holding tank where undesirable species will be removed and returned to the river below the dam. Alewives will be sorted into receiving tanks with discharge pipes to be loaded into stocking trucks. American shad captured at the Lockwood fishlift will be loaded into a stocking truck and trucked to the Hydro-Kennebec headpond to saturate available habitat above that facility.

.**Job 2. Trap and Truck of American Shad**

Transfer of broodstock American shad via tank truck will begin in May and conclude in July. DMR expects to transfer about 400-600 shad broodstock to the shad hatchery from the Merrimack River and or Connecticut Rivers. These fish will spawn naturally in tanks at the hatchery. For a complete description of shad hatchery operations see attached report.

Job 3. Transportation of American Shad Larvae

DMR will load, transport, and release shad larvae produced at the hatchery. As the larvae reach 7 to 21 days old, they will be 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-Year American Shad and Alewives

DMR will continue to sample young-of-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, and adult broodstock. Sampling will occur between July and early November 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.

Job 5. Assessment of Downstream Passage of American Shad and Alewives

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

DMR will visit hydroelectric dams, as well as non-hydro 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 alosine emigration.

Job 6. Studies of the Fish Assemblage of the Kennebec River

DMR will continue to collect data on the fish community at several locations in the Kennebec River between Merrymeeting Bay and Winslow. In addition, habitat data including DO, substrate type, water temperature and depth, flow, and measurements of bank stability and vegetation will be collected. This effort will continue in 2007.

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

2007 Budget

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$ 29,174.84	$ 44,920.75	$ 40,777.38	$ 33,319.31	$ 148,192.28
Operations/Maintenance	$ 3,179.55	$ 11,330.78	$ 7,257.75	$ 3,179.55	$ 24,947.63
Materials/Supplies	$ 240.72	$ 995.17	$ 617.95	$ 240.72	$ 2,094.56
TOTALS	$ 32,595.11	$ 57,246.70	$ 48,653.07	$ 36,739.58	**$ 175,234.47**

APPENDIX C--Proposed 2007 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

Proposed 2007 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

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

Job 2. Produce Geographic Information System Coverages.
Using the habitat information collected above, MASC staff will produce Geographic Information System (GIS) coverages to display the location and estimate the amount of salmon habitat types available in the surveyed streams. Coverages produced from the 2001- 2006 habitat surveys will also give us the ability to display redd locations and areas of critical importance to salmon in the lower mainstem and tributaries.

Job 3. Assess Current Atlantic Salmon Populations in the Kennebec River and Tributaries.
The MASC staff will continue to electrofish various waters including Togus stream and Bond Brook to 1) add to the historical database for Togus Stream and Bond Brook and document successful spawning and 2) assess other tributaries identified as having salmon habitat for presence/absence of salmon or to establish baseline fish species composition information.

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

In addition, spawning surveys will be conducted on portions of the Sandy River in an effort to document successful spawning of translocated adult salmon.

Job 4. Continue Trap and Transport Operations at The Lockwood Project Fishlift
The MASC in 2007 will continue to document adult returns and allow wild adult Atlantic salmon spawning in the Sandy River by assisting FPL Energy with trapping and transport of all captured salmon.

Job 5. Instream Incubation
MASC staff will continue testing instream egg incubation in the Sandy River drainage. Incubating Atlantic salmon eggs remotely in the Sandy River will provide MASC with the following information and benefits: 1) can eggs be used as a large scale reintroduction tool 2) if egg can be successfully used, is it a viable tool for volunteers 3) cost effectiveness for establishing a volunteer group instream incubation program.

Job 6. Annual Report and Recommendations
The MASC staff will produce an annual report with recommendations for future salmon efforts in the Kennebec River and its tributaries. These recommendations will be based on available habitat, current populations status, and estimated salmon production potential in the waters currently accessible to salmon.

Job 7. Implimenting a Telemetry Study of Adult Salmon
The MASC will initiate a multi-year telemetry study of adults transported to the Sandy River to evaluate trap and transport operations as well as gain insight into behavior of adult salmon in the Sandy River.

Job 8. Public Outreach
The MASC staff will participate in meetings, forums, round-tables, etc. as necessary to appraise public and private groups of MASC activities within the Kennebec River drainage. This will include interpretation, explanation, and promotion of MASC programs, policies, and concerns to the public, private organizations, stakeholders, and the media in the Kennebec River watershed.

	Q1	Q2	Q3	Q4	Totals
Personal Services	$2,849.00	$3,560.00	$9,258.00	$9,258.00	$24,925.00
Materials/Supplies	$3,144.00	$3,144.00	$1,000.00	$500.00	$7,788.00
Operations/Maintenance	$1,165.00	$2,583.00	$2,583.00	$1,969.00	$8,300.00
Capital	$ -	$ -	$ -	$ -	$0.00
Totals:	$7,158.00	$9,287.00	$12,841.00	$11,727.00	$41,013.00

APPENDIX D—2005/2006 Instream Incubation Report

(by Paul Christman and Dan Mccaw)

2005/2006 Instream Incubation Report

(by Paul Christman and Dan Mccaw)

Background/Introduction

The 2004/2005 Instream Incubation Report put forth the idea that failure to incubate green eggs successfully may have been the result of handling stress during egg transport. It is likely the incubation trays caused egg mortality by allowing vibrations and movement of the eggs during transport. Two ways to potentially reduce this handling stress are; 1) transport eggs in water inside insulated gallon jugs after fertilization and place eggs into incubation trays just before they are planted into the gravel. Transporting egg in large jugs is a common method used in the hatchery industry for moving green eggs. 2) transport eggs and milt separately and fertilize just prior to deposition.

We planted green eggs during the winter of 2005/2006 using these two different handling regimes together with a group of eyed eggs as controls. Because we have been successful incubating with eyed eggs in the past the intent is to use the eyed egg groups to control for site problems. One group was fertilized at the hatchery and transported in gallon jugs and another group transported as gametes and fertilized streamside. The eyed eggs were placed in incubators at the hatchery and transported to five sites in the Sandy River drainage

Methods

The same incubators were used from the 2004/2005 instream incubation project. The incubator designs were from Donaghy and Verspoor (2000). They consist of small aluminum trays that fit into a wire rack. The trays were 140mm X 125mm X 10mm and perforated with 6mm holes. Each wire rack, held eight trays. Previous to loading the eggs, a wire basket with a hinged lid was buried approximately 30cm deep in the gravel to receive the wire frame.

The same three sites in the Sandy River drainage used in 2004/2005 were also used in 2005/2006 with the addition of two sites. Incubators were paired in each location for comparative performance between handling techniques. One incubator was placed at each of the five site and filled with eyed eggs as a control for site.

In November 2005, both groups of green eggs were transported to the Sandy River drainage and buried in the gravel. One group of green eggs was transported in water inside insulated gallon jugs immediately after fertilization and loaded into instream incubators prior to burial. Egg counts derived from photos taken prior to burial indicated between 2,968 and 3,622 eggs were placed into each incubator.

The other green egg group was transported as unfertilized eggs and milt according to handling and fertilization protocols developed by John W. Fletcher (Branch Chief Northeast Fishery Center U.S. Fish and Wildlife Service, personal communication July, 18, 2005). Eggs and milt taken from salmon were place in oxygen filled plastic bags and transported on ice packs in coolers to the incubation sites. Upon arrival to the river, eggs and milt were combined, treated with an iodine solution and then loaded into incubators. Egg counts derived from photos taken prior to burial indicated between 3,241 and 7,793 eggs were placed into each incubator.

In February 2006, when eggs at Green Lake National Fish Hatchery had eyed, (approximately 39% development) five incubators were loaded with 1000 egg each(500 eggs in each of the bottom two trays), transported to five sites in the Sandy River drainage and deposited in the previously buried wire baskets.

All incubators were left in place until mid June 2006 to allow fry escapement. Incubators were removed from the gravel and individual egg trays were photographed to derive dead egg counts. Green Lake National Fish Hatchery reported a 29% egg loss during incubation prior to eyed eggs being transported to the Sandy River. This 29% egg loss was added to our counts for the eyed egg control incubators.

RESULTS

Egg counts were made from photos of all trays and were compared to the number of eggs placed into each incubator tray. Counts from photos indicate that most incubators produced alevin. The only exceptions are four green egg incubators from two sites. These were the first incubators removed from the gravel and given the great number of undeveloped eggs no counts were made and it was assumed to be a complete loss. When the trays were opened for photos, massive amounts of sand and silt clogged the undeveloped dead eggs, and many dead eggs were covered in a mat of white fungus. It is unknown whether the fungus or sediment caused the egg mortality.

The streamside fertilized (SSF) group showed between 20% and 29% alevin escapement from the three remaining incubators. The hatchery fertilized (HF) group had 12% to 40% alevin escapement for these three remaining incubators. The best performance was the eyed egg control group that achieved 24% to 66% alevin escapement (Figure 1.). One observation was noted when the incubators were being removed from the gravel. While most incubators remained near 30cm deep in the streambed, one of the control incubators seems to have been buried deeper due to deposition of gravel. It was approximately 60cm below the streambed surface. It was the best performing incubator with 66% alevin escapement.

All sites were averaged by treatment and can be seen in Figure 2.

Figure 1. Instream incubator performance with two treatments and eyed egg controls. (Eyed=eyed eggs, SSF=streamside fertilized green eggs and HF=hatchery fertilized green eggs.)

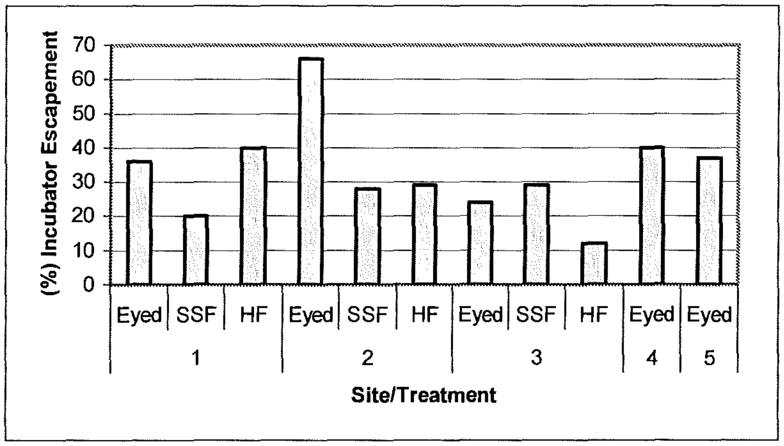
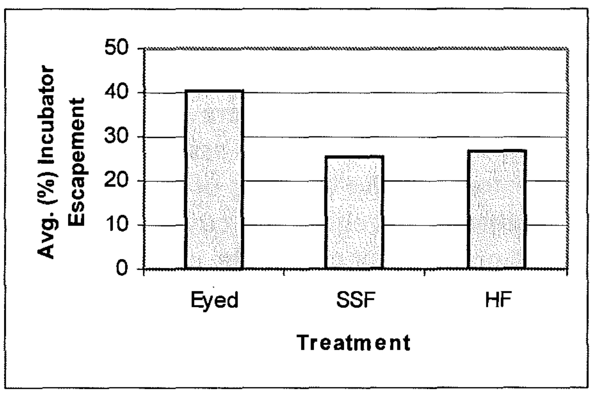


Figure 2. Average treatment performance for all incubators that had alevin escapement.



Discussion

Overall, the performance of these incubators was very encouraging. Achieving 40% alevin escapement with at least one green egg instream incubator indicates that we can successfully incubate green eggs in the Sandy River drainage. It is likely we were causing mortality by transporting fertilized green eggs in the incubators. The hatchery fertilized group was nearly equal with the streamside fertilized group with overall alevin escapement being 27% and 26% respectively.

The performance between the green eggs and eyed eggs is also noteworthy. Alevin escapement from the eyed egg control group was consistently higher than the green egg groups, as it had been in all previous incubation experiments. One potential factor could be the density of eggs in the green egg treatments compared to the eyed egg group. Our green egg treatments were loaded with 2,900 to 7,700 eggs compared to our eyed egg treatments, which had only 1,000 eggs. It has been documented that artificially elevated densities of eggs can have an effect on survival due to fungus (Tabachek et al. 1993, Barlaup and Moen 2001). It may be possible to achieve greater alevin escapement from green eggs by using lower egg densities. This would be consistent with other research that showed no survival difference between plants of green and eyed salmonid eggs (Kelly-Quinn et al. 1993, Barlaup and Moen 2001). It is also worth noting that research on Atlantic salmon redd structure indicates that a female will normally deposit 500 to 1000 eggs in several pockets of each redd (Barlaup and Moen 2001). It seems likely that reducing the number of eggs in contact with each other will decrease mortality due to fungus.

As for the logistics of using either of the green egg treatments, it was slightly easier to use the hatchery fertilized group because all fertilization and iodine treatments were done at the hatchery and not on site.

Overall the burying of the wire cages that hold the incubators is a laborious, time-consuming task, especially when considering that high flows can displace these cages, and only a few thousand eggs can be placed inside each incubator. In addition, when planting eyed egg incubators into the gravel in February, there is often a large amount of ice covering the river, which makes chipping a hole directly over the previously buried wire cage extremely difficult, and makes excavating a new hole impossible. It would be advantageous to find a new method of burying fertilized eggs that would require no wire cages to be pre-buried. A method that uses no incubator with trays that are prone to capturing sediment and take additional time to load, increasing handling stress. We need a method of planting fertilized eggs that can be done quickly. Planting eggs quickly would not only lower handling stress on the eggs but would also allow many small batches of eggs to be planted in many locations, lowering egg densities and decreasing the potential amount of mortality caused by fungus. We have the ability to incubate green and eyed eggs in the gravel. However, we need a new method to bury these eggs so that volunteers can do it quickly and cheaply on a restoration scale.

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APPENDIX E— Kennebec River Atlantic Salmon Interim Restoration Plan 2006-2011

Kennebec River Atlantic Salmon Interim Restoration Plan 2006-2011

Current Status of Atlantic Salmon Restoration Program

BACKGROUND

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

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

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

CURRENT PROGRAM STATUS

- The Sidney field office of the Maine Atlantic Salmon Commission (MASC) was established in 2000 to work on central/southern Maine salmon rivers, including the Kennebec River. This office currently has a staff of one fulltime biologist, one fulltime biology specialist and a 9-month conservation aide. The conservation aide is the only staff member with a salary paid from Kennebec River dedicated funds. This position is funded until 2010.
- To date the MASC has documented juvenile salmon habitat in several Kennebec River tributaries, including the Sandy and Sebasticook rivers and Bond Brook, Togus and Cobbosseecontee streams as well as the mainstem Kennebec River. MASC has begun small releases of juveniles in the Sandy River and worked with

stakeholders to gain upstream and downstream passage at the Anson, Abenaki, and Sandy River projects.

- Two agreements govern the timing of upstream and downstream fish passage construction and operation in the Kennebec River drainage. The Lower Kennebec River Comprehensive Hydropower Settlement Accord (1998) covers upstream and downstream passage at the Lockwood, Hydro-Kennebec, Shawmut, and Weston projects on the mainstem and at Ft. Halifax, Benton Falls, and Burnham on the Sebasticook River whereas the 2002 Offer of Settlement with Madison Paper, Inc. (MPI) provides for passage at their Anson and Abenaki projects.
- Plans are currently underway by Kennebec River stakeholders to remove the Sandy River Project hydro dam in 2006. The dam, owned and operated by Madison Electric Works, is the only dam on the mainstem Sandy River.
- MASC staff has also begun the planning process to move adult salmon upstream into the Sandy River as part of interim passage when the first capture facility at Lockwood becomes operational in the spring of 2006. .
- MASC has also begun exploring possible egg sources appropriate for restoration of Kennebec River salmon.

Current Atlantic Salmon Population Status

- The number of adults returning to the Kennebec River is unknown due to the lack of a fish trapping facility. Using anecdotal angler catches of Atlantic salmon in the Kennebec River (Table 1.) and returns to the Androscoggin River (Table 2.) MASC expects the number of salmon captured at the Lockwood Project will not exceed 25 adult fish in 2006.
- The origin of adult returns to the Kennebec River is also unknown. Tagged salmon caught by anglers in the Kennebec River and analysis of scale samples taken from Androscoggin River returns to the Brunswick trap suggest that the majority of adult salmon in the Kennebec River are strays from the Penobscot River smolt stocking program.
- Two tributaries (Togus Stream, Bond Brook) located below the old Edwards Dam site, have had documented adult returns and juvenile salmon. Monitoring over the past five years by MASC biologists seems to indicate that both populations are very small. Both tributaries are currently within the Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon listed as endangered under the federal Endangered Species Act (ESA).
- From 2003-2005 three small cohorts of salmon have been introduced into the Sandy River in an effort to gain insight into habitat quality (Table 3). All three cohorts have been monitored through population assessments. Very few adult returns are expected from these plantings.
- In addition, small numbers of juveniles are introduced throughout the watershed annually by the Fish Friends Program. No monitoring has been done on these smaller introductions.

Estimated Units of Atlantic Salmon Habitat

- Based on Foye et al. (1969) and recent surveys conducted by MASC personal there is over 132,000 metric units ($100m^2$) of juvenile Atlantic salmon habitat distributed through the Kennebec River watershed. Table 4 summarizes the amount and distribution in the watershed.

Estimate of Potential Adult Returns

- Table 4 summarizes the estimated juveniles and potential adult returns for the Kennebec River according to habitat figures. The assumptions made to derive figures are listed in the table.

Angling Potential

- Anglers caught Atlantic salmon in the Kennebec River before Edwards Dam removal (Table 1).
- Since the removal of Edwards Dam approximately 15 miles of riverine habitat is available for adults below the first dam. This section would likely be considered the primary Atlantic salmon angling water.
- Boat anglers could access the river at several boat launches between Waterville and Augusta. There is foot access for wading in the vicinity of Fort Halifax in Winslow and at various other access points requiring landowner permission.
- The Kennebec River is also readily accessible to a large human population in those counties either wholly or partially within 50 miles of Waterville and Augusta (Table 5). These counties make up over 72% of Maine's population.

Five-Year Restoration Goal

PURPOSE

The primary purpose for the restoration of the Kennebec River Atlantic salmon run is to fulfill MASC's mandate to restore Atlantic salmon for the benefit of the people of Maine. The restoration of the Kennebec River depends, in part, on fish passage at hydropower facilities, quantity and quality of juvenile and adult salmon habitat, and the availability of resources to the agency. Since the construction of Edwards Dam in 1837 salmon have not had access to juvenile habitat in headwater tributaries. However, fish passage has and will continue to improve dramatically. The removal of Edwards Dam, the pending removal of Madison Electric Dam and the construction of a fish lift and capture facility at the Lockwood Project in Waterville will allow access for returning adults to spawning and juvenile habitat. Habitat surveys from 2001 to 2005 and small releases of fry have confirmed the habitat in the Sandy River is capable and extensive enough to support an abundant juvenile Atlantic salmon population. In addition, the Kennebec River could yield a tremendous Atlantic salmon fishery. As mentioned above, the Kennebec River has approximately 15 miles of river between Waterville and Augusta that would be considered the primary angling water. Much of this section has angling potential for drift boat and wade fishing. Habitat surveys have identified numerous Atlantic salmon holding and resting pools and shallow water valuable for angling. Also, with 72% of Maine's population within 50 miles of this stretch of river, its access for anglers is unsurpassed in the state.

Restoration of the Kennebec offer opportunities to build on Maine's Atlantic salmon restoration program on the Penobscot River. The Kennebec River is similar to the Penobscot River in that it also has over 100,000 units of Atlantic salmon habitat. Smolts, parr, and fry are released annually in the Penobscot River to supplement wild reproduction, with assessment keyed on adult returns by cohort. On the Kennebec, the ASC sees a unique opportunity to experiment in a habitat rich system for the benefit of both rivers. For example, implementing new and creative management techniques and assessing alternate enhancement strategies, such as streamside and instream incubation, can be done without risking or complicating current management.

GEOGRAPHICAL RANGE OF PLAN

The five-year Atlantic salmon restoration goal for the Kennebec River encompasses all historical Atlantic salmon habitat from the old Edwards Dam site in Augusta up to the Anson and Abenaki projects in Madison. In addition, initial habitat assessments will begin on the Carrabassett River.

IMPLEMENTATION OF PLAN

To aid in accomplishing the objective outline below a work plan had been developed (Appendix A). The intent is for the work plan to annually be updated to reflect new information and changes that may occur during the life span of the plan. The Interim Restoration plan is not intended to restrict efforts but to act as a guide allowing for adaptive management.

OBJECTIVES

SEVENMILE BROOK

- As a result of the Edwards Dam removal this small tributary is now accessible for Atlantic salmon. It has a small amount of Atlantic salmon habitat and will continue to be monitored through redd surveys, when possible, in the event salmon should re-colonize.

Messalonskee Stream

- Similar to Cobbosseecontee Stream, this tributary does not have passage at the several dams found within the lower reaches of the stream. The small amount of habitat presently available will be monitored through electrofishing and redd counts in the event salmon should attempt to re-colonize.

SEBASTICOOK RIVER

Passage

- All Atlantic salmon will be passed upstream in the Sebasticook as passage facilities become operational. Efficiency/effectiveness of passage/trapping facilities will be evaluated upon completion. The MASC will need to coordinate with Department of Marine Resource and Inland

Fisheries and Wildlife to sort at passage facilities in this watershed as they become operational.

- If resources become available juveniles could be release into this drainage.
- Monitoring juvenile production and adult spawning will begin when adults have passage

Mainstem Kennebec River Below Waterville

- Since the removal of the Edwards Dam this section of river is open to Atlantic salmon. Monitoring through electrofishing and redd counts when possible will take place.
- Behavior, migratory timing and routes as well as capture efficiency/effectiveness of passage/trapping facilities of returning adults, out-migrating kelts, and smolts will be evaluated.
- This sections will primarily be considered a corridor for migration.

Mainstem Kennebec River Between Waterville and Madison

- The quality and quantity of juvenile and adult holding habitat in this section is largely unknown. As upstream passage is obtained and resources become available habitat quantity and quality will be assessed. Habitat assessment need not be by survey – could involve satellite imagery or GIS modeling.
- With passage, this river section will primarily be a corridor for migration. However, in the event that juvenile habitat is documented, it may be considered for juvenile introductions.
- Downstream passage of both kelts and smolts should be evaluated for passage efficiency/effectiveness as well as to establish behavior, migratory timing and routes

VARIOUS TRIBUTARIES BETWEEN WATERVILLE AND SKOWHEGAN

- Several small tributaries identified as having salmon habitat enter the mainstem of the Kennebec River between Waterville and Skowhegan. Their potential for restoration as well as passage is unknown. Habitat data will be collected either by survey, satellite or GIS modeling.

SANDY RIVER

Given the quantity and quality of documented juvenile and spawning habitat present, the Sandy River offers the best opportunity to initiate a restoration program in the Kennebec River drainage.

Interim Upstream Passage to the Sandy River

The MASC will work with owners of hyro-projects to capture adult Atlantic salmon at either Lockwood or other capture facilities to transport adults to the Sandy River. In order to promote river specific stock returning adults will be allowed to spawn naturally. However, if sufficient numbers of adults return, and/or a broodstock management plan can be developed that will reinforce and support river specific adaptations, adults could be removed to develop a river specific broodstock source for additional supplementation.

Initiate Sandy River Juvenile Introductions

It is unlikely that the small numbers of adult Atlantic salmon anticipated to return to the Kennebec River are sufficient to establish a population. It is important to supplement and boost the population, not only to have as diverse a genetic pool as possible, but also to have annual returns in large enough numbers so that adults can find one another and successfully spawn. As the population grows juvenile introductions will be reevaluated, adjusted and/or suspended.

- By 2008 provide at least 500,000 Atlantic salmon eggs/fry for distribution into the Sandy River basin. This target number will utilize about 25% of the documented habitat.
- By 2011 provide at least 1,000,000 Atlantic salmon eggs/fry for distribution into the Sandy River basin. This target number will utilize about 50% of the documented habitat in the Sandy River.

Broodstock

Currently there is no broodstock source for the Sandy River. Ultimately a reliable egg source will need to be established to ensure continuing restoration beyond this plan if needed. Several potential sources for supplementation have been identified.

Passage Upstream and Downstream

- Smolt passage will need to be evaluated for effectiveness, timing and insight into migratory behavior along the migratory routes in the non-obstructed portions of the Kennebec River including the Sandy River.
- Adults released in the Sandy River should be evaluated to determine trap and truck interim passage effectiveness, behavior and spawning effectiveness.

Tributary Passage Status

- The Sandy River has many large tributaries potentially capable of sustaining Atlantic salmon. In addition to assessing the quantity and quality of habitat in each tributary they should be surveyed for dams. As the need and opportunity arises passage should be obtained through installation of fishways, rock ramps or removals.

Habitat Surveys

- Quantitative habitat surveys have been conducted on the entire mainstem of the Sandy River and partially on one tributary. Given the size of many of its tributaries, they should be surveyed or modeled for quantity and quality of habitat as soon as time and resources allow.

- When fry/egg releases reach 200,000, including estimated wild reproduction, smolt trapping/tracking should be initiated to enhance our understanding of habitat quality, production potential and population size.

CARRABASSETT RIVER

Even though the Carrabassett River will take a prominent roll in the next stage of Kennebec River restoration, activities will need to be initiated within the time frame of this plan. Currently passage agreements are in place that will give adults access to the Carrabassett River and the mainstem of the Kennebec River up to Solon. The Carrabassett historically supported its own population of salmon.

- Within the next five years habitat surveys will be conducted in the Carrabassett River drainage to determine access points, habitat quantity and quality, passage status and potential obstructions.
- Issues associated with restoration should be identified.

Current Challenges and Issues

- Inadequate resources to initiate, monitor and evaluate restoration program.
- Insufficient juvenile salmon available for stocking.
- Potential conflicts with other fishery management programs (e.g. brown trout, smallmouth bass).
- Unknown status of downstream passage
- Spread of invasive exotic fish species
- Inadequate upstream passage on the mainstem Kennebec River.
- Current passage triggers in Kennebec River are dependent on Shad returns. If shad triggers cannot be met another species would need to be used.
- Incidental take by anglers
- Inadequate Atlantic salmon habitat information
- Lack of volunteers/stakeholders.
- Barriers on tributaries

FIVE YEAR PROGRAM REQUIREMENTS

Resources needed to achieve program requirements will primarily come from dedicated resources to the Kennebec and newly acquired resources. No current program will be sacrificed to initiate this plan.

1. One additional full time fisheries scientist. As recommended in the Maine Atlantic Salmon Commission's 10-year Strategic Plan the Sidney office needs a dedicated Biologist II to coordinate and evaluate management and research programs.
2. Current funding, to support the interim trap and tuck operation and restoration efforts including the Sidney office conservation aide, from the KHDG agreement

will come to an end in 2010. New funds will need to be obtained to continue these efforts and secure this state position.

3. State and/or federal funding should be acquired at a level to match 50:50 any hydro-project funding dedicated to the Kennebec River. This funding will be used to support restoration and research needs.
4. The need for hatchery assistance is anticipated. Currently both Craig Brook National Fish Hatchery and Green Lake National Fish Hatchery are dedicated to other restoration programs. If hatchery assistance is going to come from either one of these facilities it would need to expand to allocate space for the Kennebec River. It is possible if funding can be obtained to contract with a private hatchery to produce sufficient juveniles and/or hold adults to produce eggs or for direct release into the Sandy River.
5. Numerous grant opportunities exist that will need to be taken advantage of to implement research needed in the Kennebec River in addition to the resources outlined above.

Table 1 Angler catch in the Kennebec River reported in E.T. Baum 1997.
K=kill and R=released

Year	K	R	Year	K	R	Year	K	R
1936-1963	0	0	1974	4	0	1985	0	0
1964	0	0	1975	2	0	1986	0	0
1965	2	0	1976	0	0	1987	4	0
1966	0	0	1977	0	0	1988	2	0
1967	0	0	1978	0	0	1989	2	0
1968	0	0	1979	6	0	1990	46	60
1969	0	0	1980	4	0	1991	4	0
1970	0	0	1981	14	0	1992	0	0
1971	0	0	1982	24	0	1993	2	10
1972	0	0	1983	18	0	1994	0	1
1973	0	0	1984	1	0	1995	No Kill	0

Table 2. Adult Atlantic salmon trapped at Brunswick

Year	Adults
1995	16
1996	39
1997	1
1998	4
1999	5
2000	6
2001	6
2002	2
2003	5
2004	11
2005	10

Table 3. Two age classes of Atlantic salmon released over three years into the Sandy River Drainage.

Year	Fry	Eggs
2003	39,000	
2004	55,000	12,000
2005	30,000	18,000
Total	124,000	30,000

Table 4 Summary of juvenile habitat, potential smolt production and adult escapement. Habitat units (unit=100m^2) derived from Foye et al. 1969 and MASC surveys. Smolt estimates are for 2 and 3 smolts produced for each habitat unit. Target escapements are based on the amount of habitat, egg deposition of 240 eggs/unit, sex ratio of 50:50 and 7200 eggs for each female.

River Reach	**Square Yards**	**Square Meters**	**Units**	**2.0 Smolts/unit**	**3.0 Smolts/Unit**	**Target Escapement**
Kennebec River: Harris dam to The Forks	305,000	255,019	2,552	5,104	7,656	170
Kennebec River: The Forks to Wyman Lake	2,200,000	1,839,480	18,395	36,790	55,184	1,226
Dead River	2,963,700	2,478,031	24,780	49,561	74,341	1,652
Austin Stream	82,138	68,678	687	1,374	2,060	46
Kennebec River: Wyman Lake to Solon	1,173,000	980,777	9,808	19,616	29,423	654
Kennebec River: Solon to Madison	1,760,000	1,471,584	14,716	29,432	44,148	981
Carrabassett River	1,985,980	1,660,532	16,605	33,211	49,816	1,107
Kennebec River: Madison to Skowhegan	117,000	97,827	978	1,957	2,935	65
Sandy River*	2,186,589	1,828,267	18,283	36,566	54,849	1,219
Kennebec River: Skowhegan to Shawmut	291,532	243,758	2,438	4,875	7,313	163
Wesserunsett Stream	457,626	382,634	3,826	7,653	11,479	255
Carrabassett Stream	43,266	36,176	362	724	1,085	24
Martin Stream	64,202	53,681	537	1,074	1,610	36
Kennebec River: Shawmut to Waterville	na	na	na	na	na	na
Kennebec River: Waterville to Augusta**	1,604,811	1,341,826	13,418	26836	40,254	895
Sebasticook River (East Branch)	52,799	44,147	441	883	1,324	29
Sebasticook River to Old Power Dam, in Burnham	263,999	220,737	2,207	4,415	6,622	147
Twenty-Five Mile Stream**	46,165	38,600	386	772	1,158	26
Pattee Pond	5,866	4,905	49	98	147	3
China Lake Outlet**	71,520	59,800	598	1,196	1,794	40
Messalonskee Stream***	24,278	20,331	203	406	609	14
Seven Mile Brook**	12,080	10,100	101	202	303	7
Bond Brook**	20,930	17,500	175	350	525	12
Kennebec River: Augusta to Merrymeeting Bay	na	na	na	na	na	na
Cobbosseecontee Stream***	20,451	17,100	171	342	513	11
Togus Stream**	45,448	38,000	380	760	1,140	25
Eastern River	2,932	2,932	29	59	88	2
Total	**15,801,312**	**13,212,421**	**132,126**	**264,251**	**396,377**	**8,808.38**

*Incomplete habitat data collected by MASC.

**Habitat data collected by MASC

***Habitat data collected by MASC between Kennebec mainstem and first barrier.

Table 5. Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates 2004.

County	Population
Androscoggin	107,022
Cumberland	273,505
Franklin	29,736
Kennebec	120,645
Knox	41,008
Lincoln	35,236
Oxford	56,614
Penobscot	148,196
Sagadahock	36,927
Somerset	51,584
Waldo	38,392
Total	**938,865**
Maine's population	**1,317,253**

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APPENDIX F— Atlantic Salmon Trap Operating and Fish-Handling Protocols

Lower Kennebec River

ATLANTIC SALMON TRAP OPERATING AND FISH-HANDLING PROTOCOLS LOWER KENNEBEC RIVER

LOCKWOOD PROJECT (FERC NO. 2574)

Merimil Limited Partnership holds the FERC license for the Lockwood Project. FPL Energy Maine Hydro LLC (FPLE) operates the Lockwood Project, including the Project's fish passage facilities. In cooperation with the Maine Atlantic Salmon Commission (MASC), FPLE is responsible for operating the passage facility and enumerating all Atlantic salmon utilizing this facility. The primary objectives of this Atlantic salmon trapping operation are to enumerate the spawning stock, collect biological data, and transportation of spawning stock to designated areas.

The field season of 2006 will be the initial year of operation for the interim fish lift facility. The trap operating procedures and Atlantic salmon handling protocols identified below may be revised pending facility debugging and experience gained while operating the fish lift and the handling Atlantic salmon during the fish lift's initial year of operation

The following trap operating procedures and Atlantic salmon handling protocols will be applied at the Lockwood facility:

I. Facilities Operating Procedures

A. **Trapping/Counting Season:** See Chapter 1, Section I.A. under General Guidelines for Trapping Operations.

B. **Frequency of Trap Tending/Counting and Data Transfer:** See Chapter 1, Sections I.B. and I.E. under General Guidelines for Trapping Operations.

C. **Safety:** Integrate FPLE safety standards into MASC protocols.

D. **Personnel Authorized to Tend Traps:** See Chapter 1, Section I.D. under General Guidelines for Trapping Operations.

E. **Captured Aquaculture salmon:** See Chapter 1, Section I.F. under General Guidelines for Trapping Operations.

II. Fish handling procedures:

A. **Biological Sampling:** See Chapter 1, Section II.A. under General Guidelines for Trapping Operations.

B. **Marking**: See Chapter 1, Section II.B. under General Guidelines for Trapping Operations

C. **Water temperature considerations**:

1. ***Biological sampling*:** The Lockwood facility has a holding tank specifically designed for Atlantic salmon. Water in this tank may be cooled by the addition of ice kept in a freezer on the premises. When river water temperatures exceed 22°C, tank water will be cooled with ice so that the tank temperature is not more than 3°C less than the ambient river temperature. If tank water can be cooled to 22°C or less following these guidelines, then the ASC standard biological sampling protocols will be followed. If tank water cannot be cooled to below 22°C following these guidelines, then limited biological sampling will be conducted at the discretion of the crew leader.

2. ***Broodstock collections:*** Currently, there are no plans to procure Atlantic salmon for broodstock from this facility.

3. ***Trap and Transport Guidelines*:** The principle release locality will be the Sandy River subdrainage which typically runs several degrees cooler than the mainstem Kennebec River, and has several thousand units of juvenile rearing habitat and adult spawning and holding habitat. In order to minimize stress in Atlantic salmon during transport, a general rule is to maintain water temperature differentials between holding areas and receiving waters to within 3°C. This procedure allows Atlantic salmon an opportunity to acclimate to temperature changes slowly, and helps reduce stress due to thermal shock. Fish transported from the Lockwood fish lift could experience four areas of differing water temperatures: mainstem Kennebec River, holding tank, transport tank, and Sandy River. Atlantic salmon should be allowed ample time to acclimate to each phase of temperature change prior to moving them to the next location

4. Atlantic salmon will not to be trucked when recipient water temperatures exceed 22°C (72°F). In this circumstance, Atlantic salmon will be released below the Lockwood facility into the tailrace.

III. Classification and Disposition of captured Atlantic salmon and other Species:

A. WILD-ORIGIN **(AS DETERMINED BY FIN CONDITION): SEE CHAPTER 1, SECTION III.A. UNDER GENERAL GUIDELINES FOR TRAPPING OPERATIONS.**

Hatchery-origin from intentional smolt or parr releases: See Chapter 1, Section III.B. under General Guidelines for Trapping Operations.

Hatchery-origin returns to non-natal rivers (strays): See Chapter 1, Section III.C. under General Guidelines for Trapping Operations.

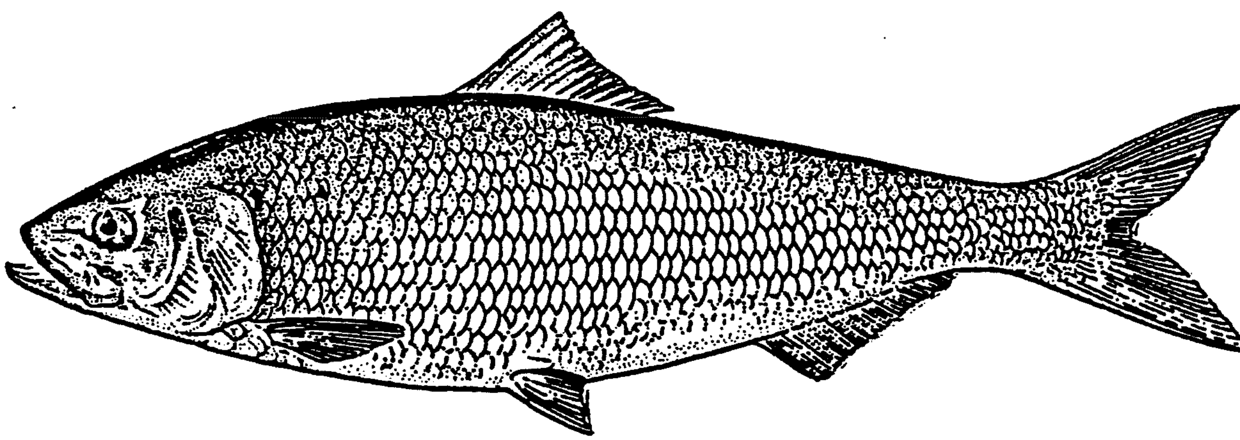
Farm fish escapees: See Chapter 1, Section III.D. under General Guidelines for trapping Operations.

Other Species: Sections 5.2 and 5.3 of FPLE's Fish Passage Facilities Operations and Effectiveness Study Plan, dated January 30, 2006, details the handling and disposition non-target and undesirable species, respectively.

Mortalities related to trapping operations: See Chapter 1, Section III.F. under General Guidelines for Trapping Operations.

APPENDIX G—2006 Shad Hatchery Report

WALDOBORO SHAD HATCHERY



2006

Carolyn, Samuel and Andrew Chapman

ANNUAL REPORT

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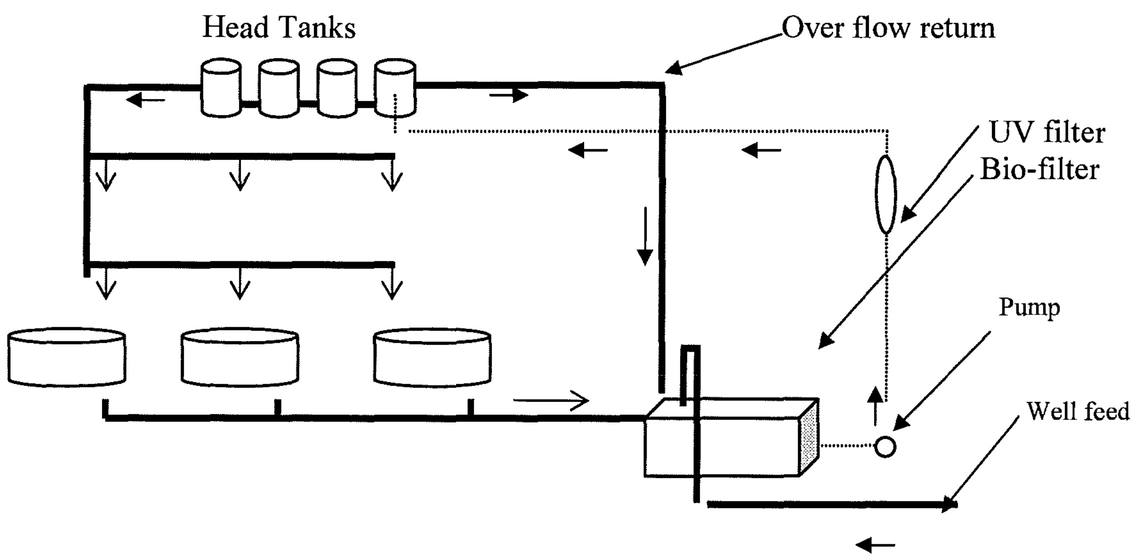
INTRODUCTION

In 1992, the Time and Tide Resource Conservation and Development Area Council, in cooperation with and financed by the Maine Department of Marine Resources, established a pilot shad hatchery in the town of Waldoboro, Maine. This operation was run in an 18' x 19' aluminum shed that had no running water or sanitary facilities. Water for the hatchery's operation was piped in from an artesian well overflow 325' from the site. Technology developed at the Susquehanna River Van Dyke Shad Hatchery proved to be very sound and reliable and was adopted for use at the Waldoboro Shad Hatchery. The Waldoboro Hatchery has successfully operated from 1992 to 2003 and during that period, provided 28,551,156 fry for distribution by the DMR.

BASIC HATCHERY CULTURE SYSTEM

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



DETAILED SYSTEM INFORMATION

Water coming into the building goes through a 50-micron filter and UV sterilizer before entering the head tank. The tank is built on a shelf close to the ceiling to provide water pressure and some height for the pipes above the culture tanks. Excess flow to the head tanks is allowed to return to a bio-filter recirculation tank where it is mixed with new water coming into the building, heated, aerated, and pumped back up into the head tanks. Seven 6' diameter x 3' deep fiberglass tanks were constructed locally and are positioned under the pipe system in a floor plan that allows easy access for culture and cleaning. Plastic upwelling incubators sit on tables beside the tanks. Newly hatched fry swim up to the top of the incubators and are automatically drained into the fry culture tanks; they are held in the tanks 5-7 days after hatching. Brine shrimp are the primary fry diet and a system to conveniently provide feed to all the tanks is required. Four fiberglass 125-gallon, conical bottom tanks were set up to supply the hatched brine shrimp for the fry. Two 250-gallon fiberglass tank holds a day's supply of brine shrimp and is connected to two systems of pipes, valves, and timers that automatically feed a plentiful diet of newly hatched shrimp over a 22-hour period to all the culture tanks at once. The fiberglass tanks used to culture the fry are 6' in diameter and 3' deep, with a slight slope to the center drain. This drain is a threaded 2" fitting that is designed to accept a 2" standpipe, which in turn maintains the tank water level. All water flow out of the fry culture tanks is filtered and piped into the outflow end of the head tank bio-filter recirculation system. If a water crisis should develop, the larval culture tanks can be put into a temporary recirculation loop through the bio-filter tank with no stress to the fish in the tanks.

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

TANK SPAWNING SETUP

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

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

TANK SPAWNING SYSTEM

2006 OPERATION:

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

QUALITY OF BROODSTOCK:

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

During the 2006 season, the acquisition of broodstock from the Merrimack River was severely hampered by heavy rain and subsequent flooding at the fish lift in Lawrence. The MEDMR-SED obtained permission to collect broodstock from the Holyoke Fish lift on the Connecticut River and on June 17-19 delivered 169 adults to the Spawning tanks at the hatchery. More rain and increased water levels prevented getting more. These shad were in poor physical shape, exhibiting scale loss and heavy bruising. They did not survive well and the ripe females were reluctant to produce eggs in the disease situation that existed in the spawning tanks. On July12, the 22 surviving shad were sacrificed for the required ME IF&W fish health assessment on shad broodstock from out of state. This survival rate of 13% over 23-26 days was the worst since the beginning of the tank spawning effort at the hatchery in 1997.

EGG VIABILITY

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

ENUMERATION OF CULTURE TANK MORTALITY

During the hatchery season, waste that is routinely siphoned from the bottom of the culture tanks is sampled to determine larval mortality after hatching and up to the time of stocking. Individual tanks were/are not cleaned daily. It takes several days for detritus to develop and show on a tank bottom; there-fore, the cleaning time interval varies from one batch of larvae to the next. When a tank is cleaned, the bottom waste is siphoned into several plastic buckets and diluted to 15 liters per bucket; the contents are suspended by mixing with an open hand. While a bucket is being mixed, three 10-ml samples are removed and emptied into three individual petri dishes. The live and dead larvae are counted separately, but both are counted as mortality. An average of the three samples, including live and dead larvae, are determined as larvae mortality per milliliter. The number of mortalities per bucket is estimated by multiplying the average of the three samples by 15,000. Finally, total mortality is estimated as the sum of the means of all the buckets. Mortalities were determined for all batches of cultured shad and are listed as "Fry discarded" in the data table 1.

The number of fry discarded increases with amount of time they are maintained in the hatchery system.

HATCHERY PRODUCTION SUMMARY FOR 2006

Waldoboro Hatchery Tank Spawning System:

Connecticut River Shad

A total of 169 Connecticut River shad were delivered to the Waldoboro Shad Hatchery between June 17 and June 19. While in the hatchery system the Connecticut fish produced a total of 7.77 liters of eggs >2mm, equaling 539,058 eggs with an average viability of 74.6%. During culture, 128,900 dead and alive shad fry were siphoned with waste from the bottom of the tanks and discarded into waste treatment ponds. On July 12, 22 end-of season Connecticut River shad were sacrificed and checked for disease. A total of 262,131 fry were stocked in the Kennebec River, between June 26 and July 9.

Fry Stocking Summary:

The following list of dates, names, locations, and numbers of fry are the American shad fry released back into Maine waters during the 2006 season:

Date	Egg location	Stocking location	# Fry stocked
7/11/06	Connecticut	Shawmut- Kennebec	54,900
7/14/06	Connecticut	Shawmut- Kennebec	184,790
7/25/06	Connecticut	Shawmut- Kennebec	22,441

POND CULTURE

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

As of September 27, no fall fingerlings had been removed from hatchery ponds.

RECOMMENDATIONS FOR 2007

Dr. Russell Danner who heads the ME IF&W Fish Health Laboratory and oversees the fish permits for fish stocking in the state of Maine has offered to prescribe an antibiotic for treating the broodstock adult shad during transport and for additional use if a disease event should develop in the spawning system at the Waldoboro Shad Hatchery.

A prayer requesting less rain during the early shad run in the Merrimack River in 2007.

Table 1. 2006 Connecticut River Egg + Fry Production

Date	Source	Fry tank	Incubator	Total egg volume mls	Egg>2mm volume mls	Eggs/10"	Eggs/L	#Egg >2mm	% viability	viable eggs	Fry start	Fry discard	Fry stock	Date stock	Stock loc.
21-Jun	Ct. River	3	1	3500	2000	100	71507	143014	52	74367	26-Jun				
22		3	2	1800	1600	99	69404	111046	86	95500	26-Jun	114967	54900	7/11/2006	Shawmut
23 - 26		NO EGGS													
27		2	3	450	300	99	69404	20821	71	14783	1-Jul				
28		NO EGGS													
29		2	4	2275	2075	97	65436	135780	71	96404	4-Jul				
30		NO EGGS													
1-Jul		2	5	1350	1300	99	69404	90225	90	81203	5-Jul	6600	184790	7/14/2006	Shawmut
2-8 July		NO EGGS													
9		1	6	625	500	99	69404	38172	78	29774	13-Jul	7333	22441	7/25/2006	Shawmut
10-12 July		NO EGGS													
				10000	7775	98.8		539058	74.6	392031		128900	262131		