KENNEBEC RIVER
ANADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT - 1998

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INTRODUCTION

This progress report covers the final year of the 12-year interim trap and truck program for American shad and alewives on the upper Kennebec River. This program was carried out by the Maine Department of Marine Resources (MDMR) as part of an agreement between the State of Maine fishery agencies and hydroelectric dam owners whose dams are located above the head-of-tide Edwards Dam in Augusta. This group of dam owners, known as the "Kennebec Hydro Developers Group [KHDG]," provided funds for the implementation of the state fishery agencies' fishery management plan (***Lower Kennebec River Anadromous Fish Restoration Plan and Inland Fisheries Management Overview, 1986***). The long-term goal of the plan is to restore American shad and alewives to their historical habitat above the Edwards Dam. The long-term objectives are:

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

The strategy developed to meet these objectives involves restoration planned in two phases. The first phase (January 1, 1986 through December 31, 1998) involved the initiation of restoration by means of trap and truck for alewives and shad to selected water bodies. As originally planned, the Edwards Dam (whose owner chose not to participate in the KHDG/State Agreement) was to be the primary site for capture of broodstock for this restoration program. Fish for the restoration were not obtained at the Edwards Dam until 1993 for several reasons. No facilities were available at this dam during 1987 and 1988. In 1989, an experimental fish pump was installed by the owner, but proved to be ineffective in capturing sufficient numbers of adult alewives for stocking in upriver lake systems. As a result, from 1987 through 1992, all the alewife broodstock stocked in the Phase I lakes (see Table 1) came from outside the Kennebec River (mostly from the Androscoggin River).

A dramatic shift in the source of alewife broodstock occurred in 1993 due to the increasing alewife returns in the Kennebec below the Edwards Dam and the sharp decline in the 1993 run of the Androscoggin donor stock of alewives. Alewife trapping was transferred completely to the Kennebec in 1993. Alewives were predominantly trapped by netting. The alewife broodstock source was split between the two rivers in 1994, but the bulk of the fish came from the Kennebec (93%), with most being trapped by the fish pump. The Kennebec was the only source of broodstock in 1995 and trapping was accomplished predominantly by fish pumping. In addition, the interim stocking goal of six alewives per acre was achieved in both 1994 and 1995.

Since 1996, MDMR obtained alewife broodstock exclusively from the Kennebec River at the Edwards Dam. In the last three years (1996-1998), the vast majority of alewives

trapped were taken by the fish pump. In addition, the Phase I alewife stocking goals for 1996 through 1998 were achieved.

MDMR has had surplus alewives (those in excess of the Phase I lakes stocking goal) available at Edwards since 1994. MDMR/KHDG-funded personnel have assisted in trapping, loading, and stocking alewives in other river drainages since 1994 and have continued every year through 1998, after meeting the annual Phase I stocking goals.

The issue of the future of the embattled, head-of-tide Edwards Dam was finally settled in 1998. The State of Maine took possession of the dam on January 1, 1999 as part of an agreement reached earlier in 1998 with the dam's previous owner, Edwards Manufacturing Company. The relicensing process of the Edwards Dam included several recent landmarks that contributed to the Edwards Manufacturing Company's decision to turn the dam over to the State of Maine. In the fall of 1997, FERC staff released their final basin-wide Environmental Impact Statement which recommended removal of the Edwards Dam. The Commission voted on this removal recommendation and approved it in December, 1997. In addition, Edwards' power contract with CMP expired December 31, 1998. Rather than fight 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.

The State of Maine will begin physical removal of the dam during the summer of 1999, allowing fish to pass upstream naturally some time in the latter part of summer. The breaching of the dam and resultant fish passage, coupled with the dewatering of the impoundment previously created by the dam, will allow the restoration of the above river segment to spawning and nursery areas for all anadromous fish species, including striped bass, rainbow smelt, shortnose sturgeon, and Atlantic sturgeon, which do not utilize conventional fish passage facilities. Dam removal will not be completed in time for the 1999 spring spawning runs of alewife and American shad; trap and truck operations will continue at Edwards this spring to ensure that alewives and shad trapped below the dam will be able to spawn above it.

Alewife collection for the spring of 1999 will be accomplished by trapping fish with the fish pump below Edwards. Based on past stocking and projected returns, there should be more than sufficient broodstock available at Augusta to complete the 1999 alewife stocking transfers to the Phase I lakes in the Kennebec River drainage.

Under Phase I of the plan, only those lakes which had approval for stocking by the Department of Inland Fisheries & Wildlife (MIF&W) were to be stocked with six alewives per surface acre. This amounted to 11 lakes (out of 21 to be stocked under Phase I), with 10 of these to be stocked commensurate with the initiation of the plan, requiring the stocking of 72,894 adult alewives. To date, MDMR has not stocked two of the three Phase I lakes in the Sevenmile Stream drainage -- Threemile Pond and Three-cornered Pond. Stocking at these ponds and Webber Pond was deferred to allow the Maine Department of Environmental Protection (MDEP) time to establish a

better, long-term water quality data base on these lakes. Webber Pond was stocked in 1997 at two alewives per acre and received four alewives per acre in 1998. Webber Pond will receive the normal Phase I stocking rate of six alewives per acre in 1999. Threemile Pond and Three-cornered Pond will be stocked at some time in the future, based on the level of success of the Webber Pond stocking.

In past years, American shad broodstock for transfers to the Kennebec River have been obtained from the Connecticut River in Massachusetts. Smaller numbers of shad have also been obtained from the Merrimack River in Massachusetts and the Narraguagus River in Maine. The objective for shad during Phase I is to pass 2,500+ adults a year at the Edwards Dam. If this objective can not be met, then additional shad will be obtained from other sources. Since 1987, fish passage for shad at the Augusta Dam has been nonexistent or ineffective. Although shad have been obtained from other sources, as previously noted, the numbers stocked have not approached the goal of 2,500. **Therefore, unless new sources become available, the goal for American shad is to stock 1,000 adult shad annually.**

In 1998, MDMR transferred 226 broodstock American shad from the Connecticut River to the Waldoboro shad hatchery for use as captive broodstock in the hatchery's tank spawning egg take program. No broodstock American shad were transferred from the Connecticut River directly to the Kennebec River in 1998. The number of shad transferred was limited by the mitigation policies of the Connecticut River Technical Advisory Committee. MDMR concentrated on providing broodstock for the hatchery's tank spawning effort as this was determined at earlier KHDG meetings to be the priority.

In 1998, MDMR acquired 178 additional shad broodstock from the CMP Cataract Fish Lift on the Saco River. These shad also were placed in the tank spawning system at the Waldoboro shad hatchery to further augment egg production for the Kennebec restoration effort.

American shad culture efforts were increased in 1997, with expansion of the culture facility funded by the Maine Outdoor Heritage Fund and the KHDG. The 1998 shad culture operational budget was funded by MDMR and KHDG. In 1998, MDMR stocked an estimated 1,348,937 American shad fry in the Kennebec River and an additional 571,720 fry in the Sebasticook River. In the fall, 36,377 fingerlings were released in the Kennebec River below Waterville. All shad fry and fingerlings were raised at the Medomak Hatchery in Waldoboro from either Connecticut River or Saco River eggs.

The interim plan for Atlantic salmon is to move whatever salmon become available at the Augusta Dam upriver. In 1998, fish pumping failed to trap any Atlantic salmon at Edwards Mill. Fish pump operation targeting salmon will continue at Edwards in the future with the approval of the Maine Atlantic Salmon Authority. No attempt will be made to seine or trap salmon at Bond Brook during high water temperatures, following recommendations of the Maine Atlantic Salmon Authority.

As granted in the KHDG/State Agreement, various studies and monitoring activities were undertaken. These included monitoring downstream emigration of juvenile and adult alewives and shad; monitoring growth rates of juvenile alewives by lake system; surveying lake outlet streams for obstacles to the successful downstream passage of alewives; and the identification and quantification of food organisms in the stomachs of juvenile smelt collected as part of the cooperative study between the MDIF&W, MDEP, and MDMR. The field and lab work portion of the Lake George Alewife Interaction Study is complete; a final interagency report is being written and is expected to be completed in 1999.

In 1998, MDMR tended weirs constructed to trap fish at the outlet streams of Pattee Pond and Nehumkeag Pond, on the Sebasticook River and Kennebec River drainages, respectively. This double weir project, which began in 1997, is designed to determine alewife emigration numbers and growth rates at the six alewives per acre and 12 alewives per acre stocking levels. MDMR is interested in comparing the quantity and size of young-of-the-year alewives produced at stocking densities higher than six alewives per acre to the quantity and size of young-of-the-year alewives produced at the current truck-stocking density of six alewives per acre. The stocking level of 12 alewives per acre was chosen as the initial point in comparing alternative stocking densities. MDMR will analyze the trapping and growth data obtained at the two lakes and report on the results of the study in the near future.

The following report summarizes activities and results related to American shad, alewife, and Atlantic salmon restoration which are being carried out in accordance with the KHDG/State Agreement and the 1986 fishery management plan.

METHODS: Alewife

In 1998, the Maine Department of Marine Resources [MDMR] utilized the Kennebec River as its source of broodstock alewives for the truck stocking program for Phase I lakes. The large number of broodstock alewives in the Kennebec River from 1993 through 1997, coupled with its positive effect on the efficiency of the Edwards Dam fish pump, encouraged MDMR to attempt to trap alewives from the Kennebec again in 1998.

Prior to the 1998 alewife run, MDMR and Edwards Manufacturing Company (i.e., Edwards Dam) agreed that the fish pump, which had been used for the purpose of trapping broodstock alewives at the site from 1994 through 1997, would be reinstalled and operated during the 1998 season. As in past years, the pump was positioned at the south side of the upper tailrace and was affixed to girders above. The 10-inch diameter pump intake pipe was fished in the same location as it was from 1994 - 1996 and most of the 1997 season. The intake was positioned in the eddy created by the concrete abutment located between the discharges from the two southern turbines in the upper powerhouse.

Improvements to the pump system from 1994 -1997 were again utilized during the 1998 season. As in past years, a three-foot long section of transparent lexan, 10 inches in diameter, was affixed to the intake end of the pipe. The clear tip on the pipe was added to make the pump less obtrusive to the fish and thus, more effective. The intake end of the pipe, just above the lexan tip, was fastened in place with cable. Cable tension and the vertical position of the intake were maintained by adjusting a "come along" attached to the cable and a supporting davit attached to the concrete pier. The intake was also secured by several lines fastened to the concrete pier which helped prevent the intake pipe from jerking violently as the pump cycled between suction and discharge phases. This more static intake nozzle may have contributed to pump efficiency by scaring the fish less than the unstable arrangement used several years prior.

The pump lifted the alewives and water and deposited them into a fiberglass tank located at the top of the granite wall, just south of the upper tailrace. The receiving tank measured 9' x 7'6" x 4'6" deep. The tank floor was painted white to provide better visual contrast with the alewives and allow more accurate estimates of alewife numbers in the tank. Dipping alewives from this tank proved difficult until the alewife density was very high. Alewives were also removed by draining the tank, especially when fish density was low. Draining was accomplished by stopping the pump and removing a drain plug in the tank floor. A supplemental water supply, which was added to the pump holding tank during the 1994 season and utilized from 1994 -1997, was used again for the 1998 season. This water was supplied by an electric pump and discharged onto the surface of the holding tank water through a two-inch hose. This backup water supply was used to provide the alewives in the tank with fresh, oxygenated water, especially if the fish pump was shut down. When a sufficient number of alewives had been trapped in the absence of a stocking truck, the fish pump could be shut down. Fresh water to sustain the trapped fish was then provided with this auxiliary flow. This arrangement allowed

alewives to be stockpiled without fear of overcrowding or mortality of stored fish due to low DO levels.

During the 1998 season, the pump tank was usually drained only at the end of the day. During truck loading, alewives were intercepted before they entered the holding tank as they exited the pipe downstream of the pump. While standing on movable wooden decks laid over the top of the pump tank, MDMR personnel used dip nets to capture the alewives as they entered the tank. The head of the net was usually braced on a wooden plank against the force of the pumped water stream and the alewives were screened from the water as it flowed through the bag of the net. The bag of the dip net was allowed to float in the tank water to reduce stress on the alewives trapped in it. The dip net was exchanged for an empty one between pump cycles and the alewives in the loaded net were placed in the truck tank. Typically, one or two MDMR personnel manipulated the dip nets to catch the alewives, while another worker was handed the full nets, sorted the fish, and counted the alewives as they were released into the truck tanks. While loading the twin tank truck, two personnel were utilized counting and loading alewives on the truck. The second person was especially helpful for loading the front tank on the twin tanker as it is impossible to get the front of the truck close to the pump tank because of site configuration.

During the 1998 alewife run, MDMR also trapped a small number of alewives with dip nets below Edwards Mill. When netting alewives, MDMR personnel used dip nets hung with ¼" delta mesh netting. Alewives were dipped from the southern margin of the fast water in the upper powerhouse tailrace, just downstream from the pump intake area. When alewives were dip netted, 25-fish lots (or less) of fish were placed in five- gallon buckets half-filled with water. Buckets were immediately removed from the river bank as they were filled and hand carried to the base of the granite block wall at the south side of the upper tailrace. A rope, pulley, and davit affixed to the top of the wall were used to raise the alewives to the stocking truck level. Fish and water were poured into a five-gallon bucket attached to the rope strung over the pulley on the davit. The worker at the base of the wall then hoisted the pail, fish, and water hand-over-hand until it was within reach of the worker on the truck bed. The worker on the truck would then swing the bucket in, detach it from the rope, and place the alewives into the tank truck.

Prior to the seining or removal of alewives from the fish pump tank, the stocking trucks were filled with water from the headpond with the auxiliary water pump. Water was circulated in the stocking tanks with the truck-mounted pumps. Oxygen was introduced into the stocking tank water via a porous pipe arrangement. Water circulation and oxygen introduction continued as alewife loading progressed in order to provide a healthy, stable environment in the stocking tanks. Alewives were transported in two stocking trucks purchased with funds provided by the KHDG Agreement. A complete description of these trucks, associated equipment, and standard methods of operation is provided in our 1994 annual report, available from MDMR upon request.

Alewives were trucked from their loading site directly to the lake to be stocked and immediately released. The name, location, and programmed alewife stocking figures for each Phase I lake are summarized in Table 1. The location of each lake is illustrated by Figure 1.

Lake systems were sampled during the summer season to obtain young-of-the-year [YOY] alewives, the progeny of the spring 1998 stocking. The juvenile alewives were collected with beach seines fished from the shores of the lakes. Two beach seines were employed, one measuring 66' long x 6' deep, the other 40' long x 4' deep. Seines were constructed of ¼" or 1/8" delta mesh and were treated with a green dip to prevent rotting. When juvenile alewives were observed in the shallow littoral zone, on the surface, or near a lake outlet dam, a cast net or dip net was sometimes used to collect a sample. The cast net was constructed of multi-filament, ¼" bar mesh and was eight feet in diameter. Dip net frames varied in their dimensions, but were hung with either ¼" or 1/8" delta mesh netting.

All fish species collected were enumerated and released and a subsample of 10 fish measured for total length. Alewives were enumerated and a 50-fish sample measured to determine total length in millimeters.

Lake outlet streams were surveyed to determine the presence of obstacles to downstream passage of juvenile and adult postspawner alewives. The streams were traveled by boat or on foot. Obstructions to juvenile alewife migration were noted and their structure and location recorded. Beaver dams on the streams below Pattee, Plymouth, Pleasant, and Lovejoy Ponds are frequently encountered and in years when these dams are active, require regular attention during the late summer and fall to permit free emigration of postspawner and YOY alewives. A small hole opened in the dam in question usually allows downstream passage for several days, until it is repaired by the beavers. Ample rainfall and high stream flows in the late spring/early summer offered good downstream passage for a brief period of time. Typical low summer flows offered little for downstream passage until late fall rains finally provided somewhat better late season passage opportunities.

Downstream passage on the Sebasticook and Kennebec Rivers was monitored through the summer and fall. Hydroelectric facilities were visited routinely to assess any problems which downstream migrating juveniles might encounter. The condition and operation of downstream bypass facilities, magnitude and location of spilled water, number of turbines in operation, and the presence or absence of juvenile alewives at each facility were all noted. The dam sites and their locations are presented in Table 2, while locations of the dams are illustrated in Figure 1.

RESULTS & DISCUSSION: Alewife

In 1998, 73,148 broodstock alewives were stocked into nine upriver Phase I lakes in the Kennebec River drainage. These nine lakes are programmed for restoration as described in Phase I of the ***"Strategic Plan and Operational Plan for the***

TABLE 1. 1998 ALEWIFE STOCKING PLANS - PHASE I LAKES

Sebasticook River

Lake System	Location	River Section	# to be Stocked *
Douglas Pond	Pittsfield	West Branch	3,150
Pleasant Pond	Stetson	East Branch	4,608
Plymouth Pond	Plymouth	East Branch	2,880
Sebasticook Lake	Newport	East Branch	25,728
Lovejoy Pond	Albion	Main Stem	1,944
Pattee Pond	Winslow	Main Stem	4,272
Unity Pond	Unity	Main Stem	15,168

Kennebec River

Wesserunsett Lake	Madison	Kennebec River	8,676
Webber Pond	Vassalboro	Kennebec River	5,008 **
		TOTAL:	**71,434**

* Six adult alewives per lake surface acre.
** Four adult alewives per lake surface acre.

FIGURE 1:

Kennebec River Drainage

ANADROMOUS FISH RESTORATION PROGRAM

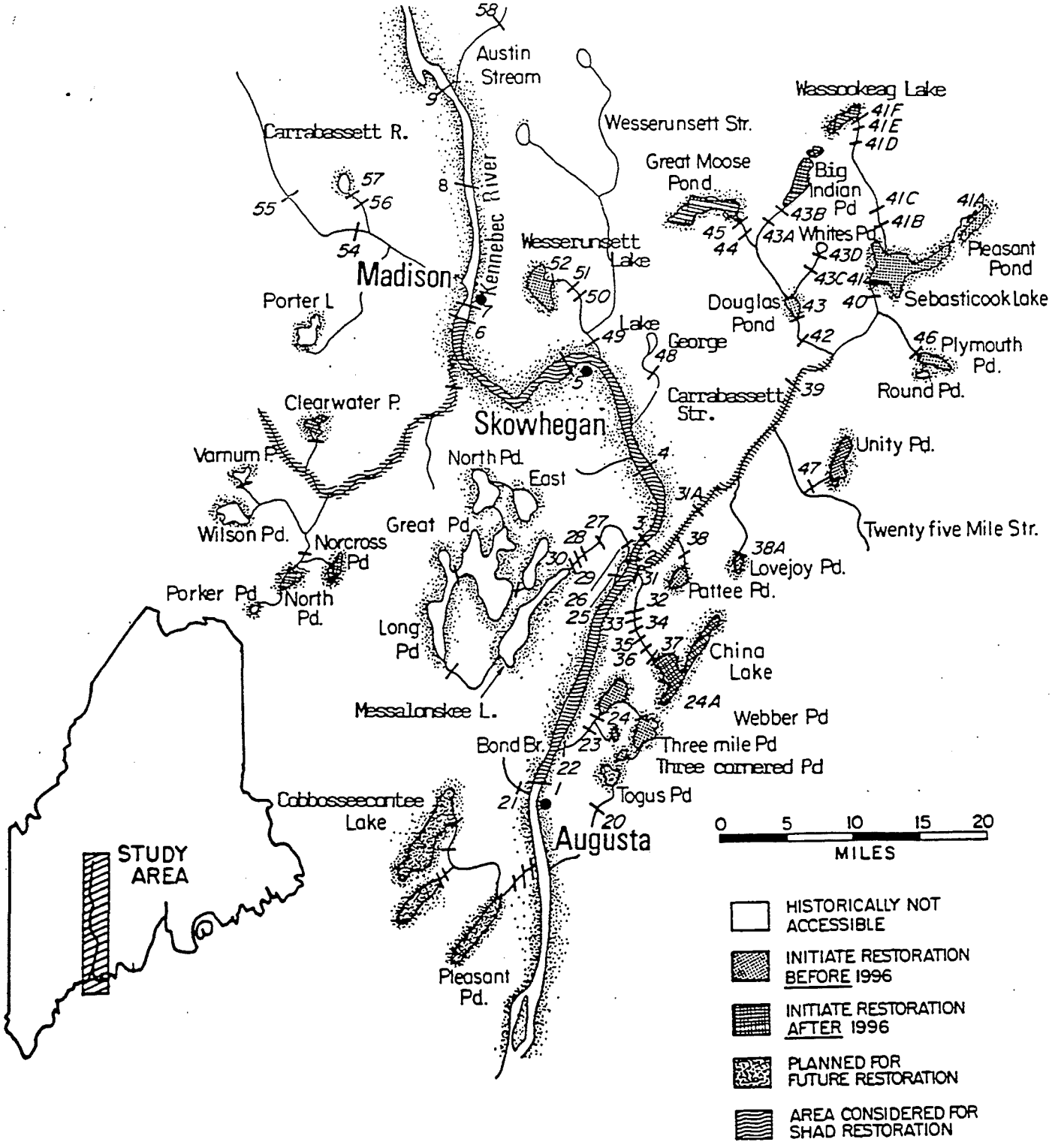


TABLE 2. HYDROELECTRIC FACILITIES MONITORED FOR DOWNSTREAM PASSAGE, 1998

Dam	FERC	#Body of Water	Town	Location (Fig. 1)
Waverly Avenue	#4293	West Branch Sebasticook River	Pittsfield	43
Pioneer	#8736	West Branch Sebasticook River	Pittsfield	42
Burnham	-----	Sebasticook River	Burnham	39
Benton Falls	#5073	Sebasticook River	Benton	31A
Fort Halifax	#2552	Sebasticook River	Winslow	31
Edwards Mill	#2389	Kennebec River	Augusta	1

Restoration of Shad and Alewives to the Kennebec River Above Augusta." In total, 12,323 acres of lake surface were stocked, usually to a density of approximately six alewives x acre^{-1}. The stocking density varied from the general Phase I goal of six alewives x acre^{-1} in only one of the Phase I lakes in 1998. Webber Pond was stocked at a density of four alewives x acre^{-1} in 1998. In 1997, alewife restoration was initiated in Webber Pond. The stocking rate was adjusted to two alewives x acre^{-1} for 1997 (the first year), with future stocking rates to increase in increments of two alewives x acre^{-1} per year up to the general goal of six alewives x acre^{-1} in 1999. With this plan, Webber was stocked at the rate of four alewives x acre^{-1} in 1998. Alewife stocking in the nine Phase I lakes is summarized in Table 3.

All nine of the lakes stocked in 1997 (seven on the Sebasticook River subdrainage and two on the Kennebec River drainage) have been stocked in previous years as part of the ongoing alewife restoration program in the Kennebec drainage. The most recent addition was Webber Pond in 1997. The addition of Webber Pond to the list of Phase I alewife restoration ponds increased surface acreage under production to the 12,323 acres in the Kennebec drainage currently being stocked.

The initial restoration of alewives in Webber Pond had been postponed for several years. MDMR had previously deferred stocking alewives into the Sevenmile Stream drainage (Webber, Threemile, and Three Cornered Ponds) for a number of years due to the ongoing work in water quality improvement by MDEP, local residents, lake associations, and the China Region Lake Alliance. In early 1995, MDMR, MDEP, and MDIF&W agreed that alewife restoration at six alewives x acre^{-1} would have no negative impact on water quality and may, in fact, have a positive long-term impact through phosphorus export from the lakes. However, a conservative plan was agreed upon which called for stocking in only Webber Pond initially. If all goes well at Webber, the other lakes will be stocked in future years.

MDMR, MDEP, and MDIF&W held a public meeting about alewife restoration in Webber Pond in March, 1995. Based on the results of that meeting, stocking in 1995 was deferred for several reasons. Some concern was expressed that any negative trend in water quality (perceived to be related to alewives or otherwise) might have a detrimental effect on securing funding for the new China Region Lake Alliance. In addition, some lakefront property owners remained skeptical about alewife introduction and the Webber Pond Lake Association submitted a letter asking MDMR not to stock alewives into Webber Pond.

MDMR held another public meeting on May 28, 1996 to further discuss the potential for alewife reintroduction into Webber Pond during the 1996 season. While there was no longer any opposition to alewife stocking by the CRLA or the Webber Pond Lake Association, Webber Pond residents present were split approximately 50/50 when a show of hands was requested. Based on the response from the public meeting, MDMR decided to postpone alewife reintroduction for one more year, until 1997. As noted previously, MDMR began alewife reintroduction at Webber Pond in a three-phased

TABLE 3. 1998 ALEWIFE STOCKING IN KENNEBEC RIVER DRAINAGE PHASE I LAKES

PONDED AREA	SURFACE ACREAGE	TARGET NUMBER TO BE STOCKED*	NUMBER STOCKED	NUMBER OF TRIPS	% OF TARGET # ACHIEVED	ALEWIVES PER ACRE
Douglas Pond	525	3,150	3,243	2	103	6.2
Lovejoy Pond	324	1,944	2,016	2	104	6.2
Pattee Pond	712	4,272	4,295	3	101	6.0
Pleasant Pond	768	4,608	4,912	3	107	6.4
Plymouth Pond	480	2,880	3,087	2	107	6.4
Sebasticook Lake	4,288	25,728	26,173	10	102	6.1
Unity Pond	2,528	15,168	15,313	6	101	6.1
Webber Pond**	1,252	5,008	5,241	2	105	4.2
Wesserunsett Lake	1,446	8,676	8,868	4	102	6.1
TOTALS:	**12,323**	**71,434**	**73,148**	**34**	**102**	**5.9**

* Six alewives per lake surface acre (unless otherwise specified).
** Four alewives per lake surface acre. Alewife reintroduction in Webber Pond commenced in 1997 at a reduced stocking rate of two alewives per acre for the first year. Four alewives per acre were stocked in 1998, and six alewives per acre are planned for 1999.

approach. Alewives were stocked at a rate of two alewives x acre^{-1} for the first year (1997), with future stocking rates to increase in increments of two alewives x acre^{-1} per year up to the general goal of six alewives x acre^{-1} for 1999. This approach was adopted to give local residents more of an opportunity to become accustomed to the seasonal presence of alewives in Webber Pond and to allow time to discuss any perceived problems prior to increasing the stocking density.

MDMR decided not to stock broodstock alewives in the Edwards Dam impoundment in 1998. Alewife releases into the impoundment in 1996 and 1997 (approximately 20,000 fish annually) and the subsequent behavior of these fish confirmed MDMR's belief that the vast majority of the alewives would home to the mouth of the Sebasticook River. Sightings of these fish in the Sebasticook below the Fort Halifax Dam and their absence in other areas, in both 1996 and 1997, laid the issue to rest. MDMR discontinued the release of alewives in the Edwards Dam impoundment in 1998.

Alewife stocking efficiency from Edwards Mill in 1998 was similar to that from 1994 - 1997. There was very little overlap between the alewife stocking in the Phase I lakes and the American shad broodstock transfers from the Connecticut River to the Waldoboro hatchery during the 1998 season. The shad transfers were largely completed prior to and after the alewife stocking to Kennebec drainage ponds, thus allowing the twin tank truck to be employed regularly for alewife transport. Alewife hauling tank densities in 1998 were somewhat higher than loading densities of the previous four years. Increased reliance on the twin tank truck probably contributed to the slightly higher densities transported in 1998. The heavy alewife run and availability of alewives at Edwards Dam during the peak of the run allowed high densities of fresh, lively alewives to be loaded into the tanks. This rapid loading precluded any degradation of the condition of the alewives by avoiding lengthy holding tank times.

YEAR	ALEWIVES STOCKED	# TRIPS	ALEWIVES X TRIP^{-1}
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

The 73,148 alewives stocked in the Sebasticook and Kennebec drainage Phase I lakes in 1998 nearly rivals the 74,165 stocked in 1997, the record year since the KHDG Agreement was implemented (Table 4). The 1998 alewife stocking total represents the fifth year in a row that all seven Sebasticook drainage restoration lakes were stocked to their target stocking density of six alewives x acre^{-1}. In addition, 1998 marked the second year of stocking in Webber Pond (currently up to four alewives x acre^{-1}) and the third year of stocking in Wesserunsett Lake. In total, only 34 alewife stocking trips were made to the upriver ponds. This trip count is much lower than the 41 trips required in 1997. The increased efficiency is probably due to the increased reliance on the twin tank truck and slightly higher alewife densities in all stocking tanks. All 41 trips

TABLE 4. KENNEBEC RIVER PHASE I LAKES ALEWIFE STOCKING SUMMARY (1985 - 1998)

Lake	Year													
	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985
Sebasticook Lake (4,288 acres)	26,173	25,835	25,913	25,934	25,911	17,281	2,853	21,030	11,166	24,966	14,850	12,099	8,478	3,567
Plymouth Pond (480 acres):	3,087	3,043	3,032	3,012	3,002	3,199	2,903	2,921	2,530	2,925	3,027	2,797	1,220	0
Pleasant Pond (768 acres):	4,912	4,669	4,718	4,628	4,789	2,224	3,546	4,689	3,475	4,614	2,648	2,688	0	0
Douglas Pond (525 acres):	3,243	3,251	3,349	3,229	3,333	3,504	3,188	3,150	2,959	3,257	3,099	2,286	525	0
Lovejoy Pond (324 acres):	2,016	2,042	2,045	2,000	2,008	699	1,952	1,976	2,077	1,741	2,055	1,949	0	0
Pattee Pond (712 acres):	4,295	8,556	4,366	4,316	4,315	4,450	4,287	4,327	3,919	4,363	3,393	4,031	0	0
Unity Pond (2,528 acres):	15,313	15,366	15,312	15,961	15,343	3,125	2,845	4,632	559	3,301	0	0	0	0
Webber Pond (1,252 acres):	5,241	2,548	0	0	0	0	0	0	0	0	0	0	0	0
Wesserunsett Lake (1,446 acre	8,868	8,855	8,706	0	0	0	0	0	0	0	0	0	0	0
Total:	73,148	74,165	67,441	59,080	58,701	34,482	21,574	42,725	26,685	45,167	29,072	25,850	10,223	3,567

originated at the Edwards Dam in Augusta as the Kennebec River was the sole source of alewife broodstock in 1998. It was not necessary to import alewife broodstock from outside the Kennebec to meet the goals of the program. The alewife stocking program in the Phase I lakes required eight days to complete, from May 13 to May 20, 1998. This represents another measure of the increased efficiency of the 1998 season, since the same stocking effort in 1997 required 10 days to complete. A chronological list of individual stocking trips to the nine Phase I lakes is presented in Table 5.

Table 6 is a summary of the 1998 alewife trapping at Edwards Dam. Figure 2 shows the daily trapping data in chart form. During the 1998 season, 108,790 alewives were trapped at the Edwards Dam. Of these, 108,437 were captured by the fish pump and 353 were dip netted. The 108,790 alewives trapped include 73,148 stocked in the nine Phase I lakes; 7,825 stocked in Kennebec drainage lakes other than Phase I lakes; 22,258 stocked in other river drainages; 2,000 given to CMP; 2,495 released below the Edwards Dam; 317 placed in the MDMR aquarium; 450 biological samples; and 158 fish pump and 139 trucking mortalities. The 139 alewives lost while trucking represent a 0.13% mortality of the 103,737 total alewives loaded.

Operation of the fish pump commenced on May 12, and 11 alewives were captured while testing the system. Alewife transfers to the Phase I lakes commenced with three loads hauled on May 13 and accelerated on May 14 and 15 when 11,661 and 11,980 alewives were trapped, respectively. Alewife trapping peaked on May 18 and 19, when 16,311 and 16,114 alewives were trapped. River temperatures were in the 16.5 - 17.5°C range on these two days.

Stocking in Phase I lakes was completed on May 20, after three loads were transported to Wesserunsett Lake, Plymouth, and Pattee Ponds. Stocking of other drainages, which had commenced to a limited degree during the stocking of the Phase I lakes, was completed between May 20 and 27 (see Table 7). Alewife trapping with the fish pump ended on May 27, while very limited numbers of alewives were collected with dip nets after this date (200 for biological samples and 153 for MDMR's aquarium).

In 1998, transfers from the Edwards Dam trapping site to waters other than the Phase I lakes totaled 32,410 alewives loaded, with 32,400 stocked and 10 mortalities (Table 7). Alewives transferred to waters other than the Phase I lakes represented 30% of the total number of alewives trapped at Augusta. Alewives were transferred to lakes in the Kennebec drainage other than Phase I lakes, the MDMR aquarium, and other river drainages, including the Cathance, Eastern, Sheepscot, Marsh, Pemaquid, Royal, St. George, and Presumpscot. Alewives stocked in the Kennebec drainage represented approximately 75% of the total number of alewives trapped at Augusta, while alewives transferred to waters outside the Kennebec drainage represented 25% of the total (see Figure 3).

The efficiency of trapping at Edwards Dam in 1998 was comparable to the previous seasons from 1996-1994. The peak day of pumping in 1998 on May 18 was

TABLE 5. 1998 ALEWIFE STOCKING BY TRIP IN KENNEBEC RIVER DRAINAGE PHASE I LAKES

DATE	LOCATION	NUMBER LOADED	NUMBER MORTS	NUMBER STOCKED
05/13/98	Sebasticook Lake	1,606	1	1,605
	Lovejoy Pond	1,000	0	1,000
	Pleasant Pond/Stetson	1,606	0	1,606
05/14/98	Lovejoy Pond	1,016	0	1,016
	Douglas Pond	1,604	0	1,604
	Pleasant Pond/Stetson	1,643	0	1,643
	Unity Pond	1,030	28	1,002
	Unity Pond	3,276	1	3,275
	Sebasticook Lake	3,042	0	3,042
05/15/98	Wesserunsett Lake	1,666	12	1,654
	Sebasticook Lake	3,218	0	3,218
	Unity Pond	3,212	0	3,212
	Unity Pond	1,179	9	1,170
	Plymouth Pond	1,051	0	1,051
05/16/98	Sebasticook Lake	1,624	1	1,623
	Sebasticook Lake	1,684	0	1,684
	Sebasticook Lake	1,512	1	1,511
05/17/98	Sebasticook Lake	3,037	3	3,034
	Sebasticook Lake	3,772	2	3,770
05/18/98	Douglas Pond	1,664	25	1,639
	Pleasant Pond/Stetson	1,666	3	1,663
	Sebasticook Lake	3,448	0	3,448
	Wesserunsett Lake	1,654	1	1,653
	Wesserunsett Lake	3,319	3	3,316
	Unity Pond	3,360	2	3,358
05/19/98	Pattee Pond	1,529	22	1,507
	Pattee Pond	1,610	0	1,610
	Webber Pond	1,739	0	1,739
	Sebasticook Lake	3,238	0	3,238
	Unity Pond	3,299	3	3,296
	Webber Pond	3,510	8	3,502
05/20/98	Wesserunsett Lake	2,246	1	2,245
	Plymouth Pond	2,036	0	2,036
	Pattee Pond	1,181	3	1,178
TOTAL FISH:		**73,277**	**129**	**73,148**

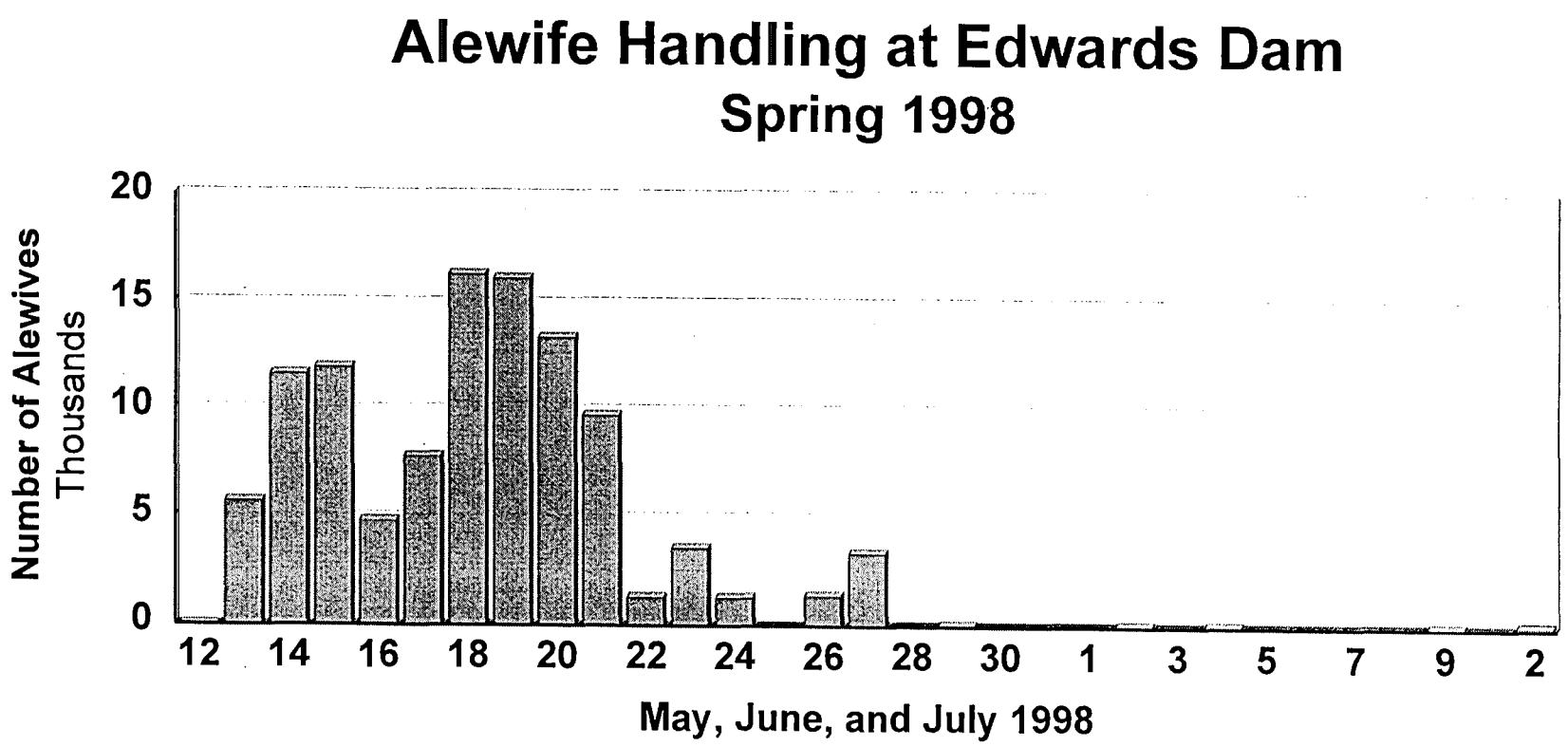
TOTAL DAYS: 8
TOTAL TRIPS: 34

TABLE 6. ALEWIFE TRAPPING AND STOCKING FROM EDWARDS DAM, KENNEBEC RIVER - 1998

	# of Alewives*			Trucking					
Date	Pumped	Seined/Dipped	Pump Mortalities	Loaded	Mortalities	Stocked	Biological Samples	Released Below Dam	Given to CMP
May 12	11	0	0	0	0	0	0	11	
13	5,717	0	0	5,223	1	5,222	0	494	
14	11,661	0	0	11,661	29	11,582	50	0	
15	11,980	0	0	11,980	21	11,959	0	0	
16	4,820	0	0	4,820	2	4,818	0	0	
17	7,776	0	0	7,726	5	7,721	50	0	
18	16,311	0	0	16,102	35	16,067	0	209	
19	16,114	0	0	15,414	33	15,381	0	700	
20	13,392	0	6	13,247	10	13,237	50	89	
21	9,733	0	152	7,377	1	7,276	0	204	2,000
22	1,303	0	0	1,303	1	1,302	0	0	
23	3,576	0	0	3,526	0	3,526	50	0	
24	1,307	0	0	1,307	1	1,306	0	0	
25	***	0	0	0	0	0	0	0	
26	1,382	0	0	544	0	544	50	788	
27	3,354	0	0	3,354	0	3,354	0	0	
28	***	0	0	0	0	0	0	0	
29	***	50	0	0	0	0	50	0	
30	***	0	0	0	0	0	0	0	
31	***	0	0	0	0	0	0	0	
June 1	***	0	0	0	0	0	0	0	
2	***	50	0	0	0	0	50	0	
3	***	0	0	0	0	0	0	0	
4	***	50	0	0	0	0	50	0	
5	***	0	0	0	0	0	0	0	
6	***	0	0	0	0	0	0	0	
7	***	0	0	0	0	0	0	0	
8	***	0	0	0	0	0	0	0	
9	***	50	0	0	0	0	50	0	
July 2	***	153	0	153	0	153	0	0	
TOTALS:	**108,437**	**353**	**158**	**103,737**	**139****	**103,448**	**450**	**2,495**	**2,000**

* Includes alewives that were stocked in the Kennebec River drainage and other river drainages.
** Represents 0.13% trucking mortality.
*** Pump not operated on this day.

Figure 2.



108,437 alewives were pumped and 353 were dipped (seasonal total = 108,790).
Peak Day = 16,311 (May 18).

TABLE 7. DISPOSITION OF KENNEBEC RIVER ALEWIVES STOCKED IN LOCATIONS OTHER THAN PHASE I LAKES - 1998

	DATE	LOCATION	NUMBER LOADED	MORTALITIES	NUMBER STOCKED
KENNEBEC RIVER:	05/13/98	Pleasant Pond/Gardiner	1,011	0	1,011
	05/15/98	Pleasant Pond/Gardiner	1,654	0	1,654
	05/17/98	Pleasant Pond/Gardiner	917	0	917
	05/18/98	Pleasant Pond/Gardiner	991	1	990
			4,573	**1**	**4,572**
	05/20/98	Nehumkeag Pond	782	0	782
	05/20/98	Nehumkeag Pond	1,306	1	1,305
			2,088	**1**	**2,087**
	05/24/98	Sewell Pond	678	1	677
	05/19/98	Center Pond	489	0	489
Total			**7,828**	**3**	**7,825**
CATHANCE RIVER:	05/24/98	Bradley Pond	629	0	629
EASTERN RIVER:	05/23/98	Dresden Bog	804	0	804
	05/23/98	Dresden Bog	1,364	0	1,364
			2,168	**0**	**2,168**
SHEEPSCOT RIVER:	05/21/98	Clary Lake	3,150	1	3,149
	05/21/98	Adams Pond	535	0	535
			3,685	**1**	**3,684**
MARSH RIVER:	05/23/98	Sherman Lake	1,358	0	1,358
PEMAQUID RIVER:	05/21/98	Pemaquid River/Bristol Mills	2,109	0	2,109
	05/21/98	Pemaquid Pond	1,048	0	1,048
	05/20/98	Duckpuddle Pond	1,018	4	1,014

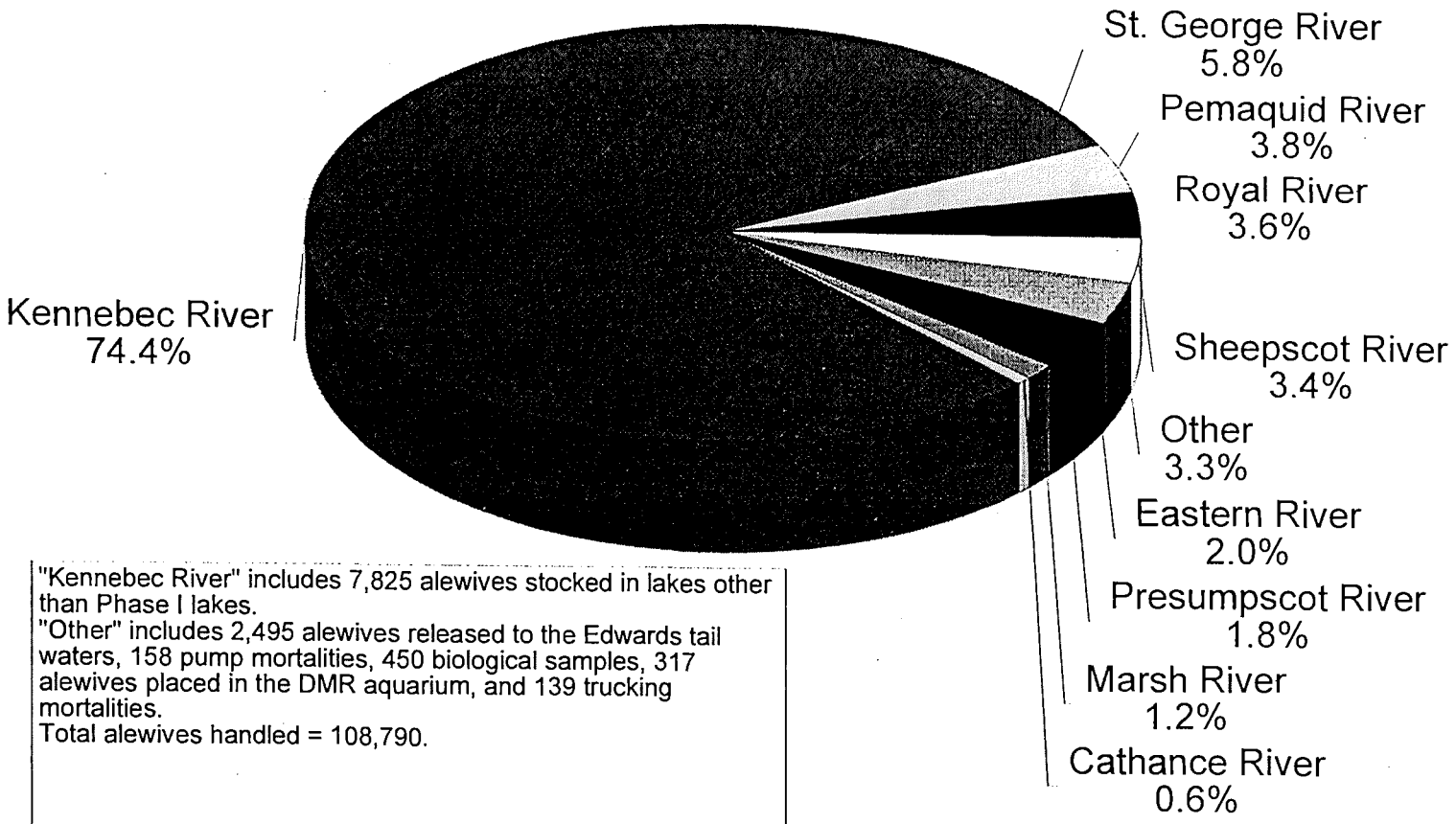
TABLE 7. DISPOSITION OF KENNEBEC RIVER ALEWIVES STOCKED IN LOCATIONS OTHER THAN PHASE I LAKES - 1998

	DATE	LOCATION	NUMBER LOADED	MORTALITIES	NUMBER STOCKED
			4,175	**4**	**4,171**
ROYAL RIVER:	05/26/98	Runaround Pond	544	0	544
	05/27/98	Royal River/Elm St. Headpond	3,354	0	3,354
			3,898	**0**	**3,898**
ST. GEORGE RIVER:	05/20/98	Crawford Pond	1,504	0	1,504
	05/22/98	South Pond	1,139	1	1,138
	05/21/98	Seventree Pond	535	0	535
	05/20/98	Sennebec Lake	3,174	1	3,173
			6,352	**2**	**6,350**
PRESUMPSCOT RIVER:	05/21/98	Highland Lake	2,000*	0	2,000
DMR AQUARIUM:	05/22/98	Aquarium	164	0	164
	07/02/98	Aquarium	153	0	153
			317	**0**	**317**
GRAND TOTAL:			**32,410**	**10**	**32,400**

* Transported by CMP

Figure 3.

Stocking Location of Alewives Trapped at Edwards Mill - 1998



"Kennebec River" includes 7,825 alewives stocked in lakes other than Phase I lakes.
"Other" includes 2,495 alewives released to the Edwards tail waters, 158 pump mortalities, 450 biological samples, 317 alewives placed in the DMR aquarium, and 139 trucking mortalities.
Total alewives handled = 108,790.

significantly lower than previous peak days in 1997 and 1996. However, the high volumes pumped on the peak days in 1996-1997 were due to continuous pump operation to support the short duration, heavily loaded truck trips to the Edwards Dam headpond. Similar highs probably could have been attained in 1998 if the pump had been operated continuously at the peak of the alewife run.

YEAR	PEAK TRAPPING DAY
1998	16,311 alewives
1997	21,756
1996	22,205
1995	10,634
1994	13,050

In 1998, the pump operated on 15 days and trapped alewives on all 15 of these days. Over 3,000 alewives were pumped on 11 days; over 5,000 on eight days; and over 10,000 on five days (Table 6, Figure 2).

The most stocking trips completed to the Phase I ponds in one day was six. These six trip days occurred on May 14, 18, and 19. On May 20, eight stocking trips were completed: three to Phase I lakes and an additional five trips to other waters.

Based on experience gained during alewife trapping at Edwards in previous years, MDMR developed a standard operating procedure for using the fish pump in an efficient manner. Since the majority of shad transfers in 1998 did not occur at the same time alewife stocking was underway, there were usually five KHDG Project personnel available to work on alewife trapping and transport. While two crew members traveled with each of the two stocking trucks, the fifth worker usually remained at Edwards to coordinate pump operations.

Based on the pump's alewife trapping rate and the time trucks were due back at the site, the MDMR staffer could perform rough calculations to determine the number of alewives already in the pump tank and the number likely to be pumped into the tank prior to a truck's return. If too many alewives were likely to be trapped prior to a truck's return, the pump could be stopped by an Edwards employee. A maximum of approximately 2,500 alewives could be stockpiled in the pump tank. A supplemental circulating water supply (added during the 1994 season) allowed alewives to be held in the tank when the pump was switched off. If the single tanker was due to return first, a whole load of alewives (1,500 to 1,800) could be stockpiled in the pump tank. If the twin tanker or both trucks were due to return, the maximum stockpile of alewives (2,500) could be held. Ideally, these fish would be trapped immediately preceding the arrival of the truck to allow the alewives to be held in the tank for a minimum amount of time. As the loading of the double tank truck commenced, the pump would be restarted and additional alewives would be trapped to finish the load. This operational mode allowed loading to be as efficient as possible without sacrificing the quality of the alewives.

Because of efficient loading, they spent less time in the truck tanks at the loading site, which also helped minimize trucking mortalities.

Loaded trucks were immediately dispatched from Edwards to the stocking site. Three remaining crew members were usually adequate to complete loading even the double tanker. This immediate and staggered departure method allowed tankers to return from the lakes to Edwards at alternating intervals and prevented waiting in line to load the next batch of alewives, contributing to more efficient trucking overall. If trucks did overlap at Augusta, the waiting crew helped in loading the first tanker and accelerated its departure.

The configuration of the hauling tank system and the operational procedure used by the MDMR/KHDG crew were very important in hauling the large loads of alewives. The porous pipe/oxygen delivery system first fitted to the trucks in 1992 for American shad hauling was used extensively during the 1998 alewife trucking operations. This system consisted of porous polyethylene pipes four feet long, fastened to the tank floors and connected to lexan-ball type flow meters downstream of the welding type regulators attached to the oxygen tank. This porous pipe produced finer diameter bubbles and used less volume of oxygen than prior systems. These fine bubble, porous pipes are used on the Susquehanna River shad hauling trucks to increase dissolved oxygen levels.

One of the double tanker tanks was fitted with Bio-Weve diffuser, which was also used during the 1995 -1997 seasons. This experimental application continued to work about as well as the porous polyethylene tubing for delivering oxygen, but may be more durable. Flexible, porous, rubber tubing was also used during the 1998 trucking season. It appeared to perform comparably to the porous polyethylene and Bio-Weve diffusers, but is much less costly and more durable. Evaluation of this product and new diffusers will continue in future seasons.

After truck tanks were filled with river water, the circulation pumps were operated prior to loading the first alewives. Dissolved oxygen levels in the tank water were monitored during loading and while on the road by using remote probes in the tanks connected to a meter in the truck cabs. During the loading process, the flow of oxygen into the tank water was increased as alewife density increased. With the remote monitoring of the DO level in the tank water, oxygen input could be adjusted to keep the tank DO within acceptable limits, usually above 6mg/l, and below saturation at the current temperature. Monitoring during loading and transport indicated that the oxygen input was more than adequate to maintain tank DOs and keep pace with alewife oxygen demand at the fish densities and average temperatures experienced in 1998.

The maximum alewife density hauled to the lakes during the 1998 season was 1,926 alewives/1,000 gallons of water per tank. This new high was achieved as part of the largest load of alewives transported in the twin tank truck (3,772 alewives), with only two hauling mortalities (one hour on the road, plus loading time). If necessary, it may

be possible in future years to experiment with even heavier loads on the longer trips to the upriver lakes. Significant mortalities may occur at some theoretical density, with the time spent collecting the alewife mortalities decreasing the overall efficiency of the operation. Few problems were experienced with the KHDG Project tank trucks during the 1998 stocking season.

Preliminary data for the **1998 commercial alewife harvest** has been collected from only four of the dozen permitted dip net harvesters who fish below the Augusta Dam. Reported catch for 1998 was in the range of 20,880 to 21,480 alewives, using the figure of 120 alewives per bushel to convert bushels to number of fish. Fishermen failing to report landings data on their Kennebec alewife harvest forfeit the opportunity to obtain the special harvesting permit required to legally participate in the fishery the following season. Reporting may not be complete, but serious, repeat fishermen must report a figure to preserve their place in the fishery. Additional landings data may be received prior to the start of the 1999 season and will be reported.

During the summer and fall of 1998, young-of-the-year alewives were captured in seven of the nine Phase I restoration lakes stocked with adults (Table 8). No juvenile alewives were captured in Douglas Pond or Lovejoy Pond in 1998. Juvenile alewives were captured in 16 of the 78 seine hauls made in 1998. Dip nets contributed three samples in three attempts, while cast nets added one sample in five attempts completed. The one fyke net set completed in 1998 produced a sample of young-of-the-year alewives at Webber Pond. Electrofishing by boat contributed another two samples from the three days on which it was attempted. In total, 585 young-of-the-year alewives were measured over the course of the 1998 season (see Table 8).

A weir was used throughout the summer and fall of 1998 to monitor young-of-the-year alewife emigration from Pattee Pond. Large numbers of YOY alewives were trapped and sampled at Pattee Pond in 1998, but the data is still under analysis and was not available at the time of publication. There is no data presented in Table 8 for Pattee Pond due to the pending analysis. Alewife young-of-the-year emigration from Pattee Pond was monitored with a weir and a fyke net during the 1996 season at a stocking density of six alewives x $acre^{-1}$. The number of young-of-the-year alewives emigrating from Pattee Pond at the six alewives x $acre^{-1}$ stocking rate (1996 and 1998) will be compared to the number emigrating from the pond at the 12 alewives x $acre^{-1}$ stocking rate of 1997.

The study also includes another lake in the Kennebec drainage, Nehumkeag Pond, which is not included in the list of Phase I lakes currently under restoration. Nehumkeag Pond is being stocked with the same two stocking densities in alternate years with Pattee Pond to serve as a control with respect to any effects related to the specific lake or year. Further information on this study will be made available as the data analysis is completed.

TABLE 8. JUVENILE ALEWIFE SAMPLES FROM PHASE I LAKES - 1998

Lake	Stocking Density	# of Seine Hauls	# of Cast Net Attempts	# of Dip Net Attempts	# of Fyke Net Sets	# of Days Electrofished	# of Juveniles	Mean Total Length (mm)
Douglas Pond	6.2	0/0	0/0	0/0	0/0	0/1	0	
Lovejoy Pond	6.2	0/0	0/0	0/0	0/0	0/0	0	
Pattee Pond	6.0	2/7	0/0	0/0	*	0/0	*	*
Pleasant Pond	6.4	0/2	0/2	1/1	0/0	1/1	100	63
Plymouth Pond	6.4	0/0	1/2	1/1	0/0	0/0	101	88
Sebasticook Lake	6.1	5/33	0/0	0/0	0/0	0/0	50	106
Unity Pond	6.1	6/8	0/1	1/1	0/0	0/0	200	91
Webber Pond	4.2	1/7	0/0	0/0	1/1	1/1	34	72
Wesserunsett Lake	6.1	2/21	0/0	0/0	0/0	0/0	100	43
TOTALS:		**16/78**	**1/5**	**3/3**	**1/1**	**2/3**	**585**	

Notes:
Stocking density is adult alewives/lake surface acre.
# of seine hauls is the # of hauls producing alewives/total # of hauls (seasonal total).
# of cast net attempts is the # of throws producing alewives/total # of throws (seasonal total).
# of dip net attempts is the # of dips producing alewives/total # of dips (seasonal total).
# of fyke net sets is the # of sets producing alewives/total # of sets (seasonal total).
# of juveniles is the total # of juveniles measured (seasonal total).
* Pattee Pond outlet was monitored with a weir for the entire 1998 season.

The **Fort Halifax Project** in Winslow is operated by the Central Maine Power Company and is the lowermost dam on the Sebasticook River. Permanent downstream bypass facilities were installed by CMP during the summer and fall of 1993. The permanent bypass uses the same trash sluice opening that was used in past years for the interim facility. The old trash sluice was refitted with a weir gate to control depth of flow at the entrance of the downstream bypass. The downstream side of the opening was fitted with a metal trough with an open top to carry water and fish down close to the tailrace elevation. A 12-foot deep metal punch plate trash rack overlay was installed to aide in excluding alewives from the turbine forebays. This downstream bypass configuration and operational regime was approved by a FERC order issued on September 30, 1996 and was utilized again during the 1998 season.

MDMR made only two complete visits to the Fort Halifax Dam in 1998, on July 23 and October 21. The downstream bypass was open and operational on both of these visits (see Table 9). MDMR personnel observed construction at the site for installation of a minimum flow gate during the July 23 visit. Turbine operation was curtailed for a period of time over the summer while the headpond was partially dewatered until this project was completed. Downstream passage for fish was available via an alternative route through an open hatch in the turbine pit while the normal downstream bypass was dewatered due to the drawdown.

MDMR personnel made more frequent visits to the Fort Halifax Project over the course of the summer and fall, but because access to the facility is not permitted without CMP staff present, observations were made from the Route 201 bridge just downstream of the project. Water flow through the bypass could be observed, but little else could be noted from this location. MDMR and CMP staff tried to coordinate visits at the site to make downstream passage observations, but this alignment of schedules proved to be cumbersome on a regular basis. An alternative arrangement will be explored for the 1999 season so that observations can be made on a more regular basis.

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

MDMR personnel observed the Benton Falls downstream passage during 10 visits in 1998, beginning June 5 and ending October 21. The bypass was open and operating during all of the site visits except June 5, as it had not yet been opened for the season. American shad fry were stocked in the river reach above the Benton Falls Project during the summer of 1998, as they were in 1996 and 1997. MDMR personnel looked

TABLE 9. DOWNSTREAM PASSAGE OBSERVATIONS AT HYDROELECTRIC FACILITIES - SEBASTICOOK RIVER, 1998

Date	Ft. Halifax	Benton Falls	Burnham	Pioneer	Waverly
6/05		O	X	O	X
6/16			X	X	X
7/01		X	X	X	X
7/06		X	X	X	X
7/23	X	X	X	X	X
8/11		X	X	X	X
8/24			X	X	X
8/28			X	X	
8/31		X	X	X	X
9/16		X	X	X	
9/29		X			
10/05		X	X	X	X
10/21	X	X	X	X	X
Total Number Site Visits:	**2**	**10**	**12**	**12**	**10**

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

for young-of-the-year alosids at Benton Falls during each visit, but were not able to observe any during the 1998 season, anywhere at the site.

MDMR first visited the **Burnham Dam** on June 5 in 1998. Prior to this visit, the flashboard closest to the intake structure had already been notched down below the other flashboards. This modification allowed surface spill from the headpond over the crest of the spillway and so provided some opportunity for interim downstream passage. This type of controlled spill for downstream passage has been utilized in past years at the Burnham Dam.

MDMR visited the Burnham Dam on 12 days in 1998. Some level of controlled spill was available as an interim downstream bypass during all 12 visits. However, during the September 16 visit, the volume of water flowing through the interim bypass was very small due to a low headpond level. Low bypass flows at Burnham are due to variations in headpond levels since the crest of the notched flashboard comprising the temporary bypass is at a fixed height. This flow may lack the volume needed to attract emigrating alewives and prevent them from being entrained in the project pen stock. Alewife entrainment has been a concern at this site with higher bypass flows.

After the January, 1998 KHDG/State joint meeting, Burnham's owner, CHI, agreed to upgrade interim downstream passage prior to the issuance of the new FERC license. Consultation between CHI, MDMR, and USF&WS resulted in a plan for the installation of an improved downstream facility: the new bypass entrance would be a surface weir-type, drop box to be located in the face of the trash racks. This collection area would be attached to a pipe to transfer the downstream migrants down near the tail water elevation. In addition, the existing trash racks would be screened with a metal punch plate overlay similar to the one in use at Fort Halifax. The overlay would serve to aide in physically excluding fish from the wide-spaced trash rack and thus prevent their entrainment into the pen stock.

MDMR observed the new overlay in place on the trash racks during its October 21 visit; no other bypass construction had been observed prior to that date. MDMR hopes that the new bypass facility can be completed before the peak of the downstream migration, which will occur in the late summer/early fall of 1999. MDMR did not observe any alewives at the Burnham Project using the controlled spill for downstream passage during any of its 12 visits.

In 1998, downstream passage at the **Pioneer Dam** in Pittsfield consisted of passage over the stop log weir crest of the downstream bypass (located near the trash racks, with its associated concrete work and wood bypass trough) or passage via intermittent spills over the crest of the spillway. Pioneer's owner, Chris Anthony, has made some attempt to comply with the requirement to reduce trash rack spacing to one inch from June 15 to November 30. The metal mesh overlay, which was hung over the project racks in past years and utilized for the 1998 season, does have a small, clear space which would probably physically exclude alewives from passing through it. However,

the overlay does not fit securely and oftentimes has gaps present. The biggest problem with the mesh overlay is that it clogs very rapidly when a turbine is operational; water then flows under the six-foot depth of the overlay and alewives are likely to be drawn in the same direction. Cleaning of the overlay appears to be another major shortcoming of the materials and design used.

Of the 12 site visits conducted by MDMR in 1998, three observations indicated that downstream passage through the bypass may have been compromised by ill-fitting or fouled trash rack overlays. On June 5, no overlay was present on the trash racks. On August 24, only half the trash rack was fitted with the fine mesh overlay; on October 24, it was fouled with debris, rendering it ineffective. Fortunately, a shallow spill (two inches) over the spillway provided some opportunity for downstream passage during the October 24 visit. MDMR did not observe YOY alewives at the site, nor were any observed using the downstream bypass at Pioneer during the 1998 season.

In 1998, as in previous years, there continued to be several chronic problems at the Pioneer site which will need to be resolved. First, the overlay should be improved so that it can be operable, cleanable, and maintainable if the turbine(s) are to be run during the migration season. As an alternative, the unit(s) may be shut down throughout the passage season. Second, maintaining adequate water flow through the bypass is still a problem. The bypass was built with a very shallow floor, compared to normal pond elevation with no flashboards. Furthermore, it is usually stop logged to further restrict bypass flow. Increased flow through the bypass, routine checks to adjust its flow, and regular debris removal would improve current conditions. The project owner has requested that he be allowed to install flashboards at this site, which would provide deeper bypass flows given its current elevation. However, the practice of placing stop logs in the bypass to reduce its flow would continue to have a detrimental effect on passage, even with the added pond height.

MDMR visited the **Waverly Avenue Dam** on 10 days during the 1998 season. All 10 visits revealed some type of downstream passage available at the site (see Table 9). MDMR personnel observed that the headpond had been drawn down prior to the October 5 visit. The construction crew informed MDMR that repairs were FERC mandated and the site would be back in operation in approximately one week.

Problems encountered during the 1998 season at Waverly Avenue were similar to those of previous seasons. First, gate leakage at the stop log bays on the far side of the spillway remained a problem; this leakage causes downstream migrants to be attracted away from the bypass during low flow conditions. Second, the bypass itself frequently collects debris and loses its effectiveness with this fouling. Third, the deflector at the terminus of the bypass (which was installed to direct the plunging bypass flow away from the draft tube of the turbine) was not functioning properly and the flow was, in part, striking the draft tube. These problems need to be addressed to bring the bypass up to its maximum level of performance. Hopefully, the repairs that were undertaken in October, 1998 will address some of these problem issues.

MDMR personnel did not observe YOY alewives at Waverly Avenue during the 1998 season. Alewives were neither observed in the headpond nor passing downstream.

MDMR visited both the **Lockwood** and **Hydro-Kennebec** Dams whenever possible in 1998. Both of these projects are located on the Kennebec River and must pass all downstream migrant alewives from the Wesserunsett Lake alewife stocking effort. During the 1998 season, interim downstream passage at Lockwood was made available over the crest of a trash sluice which is located near the turbine trash racks. No interim downstream bypass was available at the Hydro-Kennebec Project other than passage through the two large turbines. No post spawner or YOY alewives were observed at either site by MDMR personnel. More regular visits will be attempted during the summer and fall of 1999.

During the spring, summer, and fall of 1998, MDMR personnel made observations on a regular basis at the downstream passage at **Edwards Mill** on the Kennebec River. Adult and YOY alosids frequently were observed in the forebay near the downstream bypass. Adult alewives were observed in the forebay during the early part of the summer. No adult American shad were observed attempting to move downstream through Edwards since none were stocked in the river above the dam during 1998.

Young-of-the-year alewives were frequently observed using the downstream bypass at the site over the course of the summer and fall. Young-of-the-year American shad, the result of fry stocking in the Sebasticook or Kennebec River above Edwards, were sighted frequently in the project's "#7 & #8" forebay, which feeds the downstream bypass. No YOY shad were collected during the 1998 season, although several YOY alewife samples were collected. These results should not be construed as indicative of the level of shad present at the site. Although alewives were far more common, especially at the peak of their downstream migration, the amount of YOY shad was quite high and sampling efforts should have been more effective. A regular YOY shad sampling plan and new sampling techniques at Edwards Dam will be incorporated for the 1999 season.

METHODS: American Shad

This section has been compressed. If you require a complete **"METHODS"** section, please refer to any other KHDG report from 1987-1994. Adult shad from Saco and Connecticut River facilities were taken to the Waldoboro hatchery for experimental spawning studies and egg take. The 1998 season included transferring adult prespawner shad from the Hadley Falls Lift to the Connecticut River above the Vernon Dam to meet the mitigation requirements of the Connecticut River Technical Advisory Committee. No broodstock shad from the Connecticut River were stocked in the Edwards impoundment during the 1998 hauling season.

During the 1998 field season, the Edwards Dam #7 and #8 turbine forebay was sampled to obtain information on the abundance of juvenile shad. Sampling in 1998 was accomplished with the use of dip nets, fly rods, cast nets, and shad scoop nets.

With all four types of sampling gear, fish collected were identified by species and shad were enumerated and sampled/measured for total length.

RESULTS & DISCUSSION: American shad

A fish health inspection was performed on the Connecticut River shad stock in the spring of 1998. A 150-fish sample of adult American shad was collected at the Holyoke fish lift on April 29, 1998. Kidney, spleen and gill samples were taken in accordance with the AFS Fish Health Blue Book Procedures and returned to the Maine Department of Inland Fisheries & Wildlife in Augusta, Maine. Samples were processed for the detection of bacterial and viral fish pathogens and found to be free of those pathogens of concern to the State of Maine. These procedures are necessary to comply with state law concerning importation of live fish and eggs into Maine waters.

Adult Transfers -

No broodstock American shad were transferred directly to the Kennebec River from the Hadley Fish Lift in 1998. However, two trips were made to obtain broodstock for the Waldoboro hatchery on May 17 and 21. Of the 226 shad loaded at the Hadley Lift, 152 were released alive in the experimental egg take tank, resulting in a hauling mortality of 33%. Broodstock shad for tank spawning were also obtained from CMP's Cataract Lift on the Saco River. On May 29, June 2, 10, and 11, and July 14 and 16, a total of 179 shad were transported to the Waldoboro hatchery. Only one mortality was recorded during these transfers (see Table 10).

As in past years, the Connecticut River Technical Advisory Committee required MDMR to transport shad upriver on the Connecticut as mitigation for the shad that MDMR gill nets (for egg take) in the Holyoke impoundment and as mitigation for the shad that MDMR transports to the Waldoboro hatchery. Four shad transport trips were made upriver on the Connecticut, from Holyoke to the Vernon Dam headpond at West Chesterfield, New Hampshire. These trips resulted in a total of 1000 adults stocked in West Chesterfield, with 40 mortalities recorded during these trips.

The remote DO probe mounted on the tank truck in 1992 was again used for the 1998 stocking season and was connected to a Model 57 YSI DO meter located in the truck's cab. This system provided constant monitoring of DO levels while the fish were loaded and also allowed levels to be maintained while on the road. The commercial anti-foam agent (NO FOAM) was used again during the 1998 shad hauling season.

Juvenile Sampling -

Several failed attempts were made to sample shad fingerlings in the #7 & #8 turbine forebays at Edwards Dam; fingerlings were observed on several visits. Behavioral differences in shad and alewives make it possible to distinguish between the two as they school in the forebay. Random samples taken with the shad scoop net invariably produced hundreds of alewives and no shad; the same occurred with the dip net and the cast net. The "fly rod" (a fine maple sapling with 6-pound monofilament and a #14 hare's ear) was stolen from the site early in the season and was not replaced.

TABLE 10. TRANSFERS OF AMERICAN SHAD BROODSTOCK TO THE WALDOBORO SHAD HATCHERY, 1998

Date	River of Origin	Trapping Site	# Transported	# Morts	# Placed in Spawning Tank
05/17/98	Connecticut River	Holyoke Lift	136	61	75
05/21/98	Connecticut River	Holyoke Lift	90	13	77
TOTAL:			**226**	**74**	**152**
05/29/98	Saco River	Cataract Lift	27	0	27
06/02/98	Saco River	Cataract Lift	13	0	13
06/10/98	Saco River	Cataract Lift	56	1	55
06/11/98	Saco River	Cataract Lift	22	0	22
07/14/98	Saco River	Cataract Lift	20	0	20
07/16/98	Saco River	Cataract Lift	42	0	42
TOTAL:			**180**	**1**	**179**

After egg collection operations were concluded for the season, the surviving spent broodstock shad were released. On 8/14/98, the 50 Saco origin shad remaining in the spawning tank were tagged and released in the tidal waters of the Saco River below the Cataract Dam.

Shad Culture -
The experimental shad culture program initiated in 1991 was continued in 1998. The shad restoration program on the Medomak River is a cooperative program between the Maine Department of Marine Resources (MDMR), the Kennebec Hydro Developers Group, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development Project, the latter of which was created and administered by the local Time & Tide Resource Conservation and Development Organization.

On the evenings of May 26-31 and June 1-6, 1998, a total of 3,185,622 eggs were taken from ripe and running females in the Connecticut River. These eggs were obtained and transported by Normandeau Associates to the hatching facility located in Waldoboro, Maine. The eggs were disinfected and then placed in four custom-built upwelling egg incubators where they remained until hatchout. Of the 3.1 million eggs taken, an estimated 1,548,703 hatched (48.6%). After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp.

On May 17 and 21, MDMR personnel successfully transferred 152 (roughly 50/50 male:female) prespawner, adult American shad from the Holyoke Fish Lift on the Connecticut River to the Waldoboro hatchery for experimental tank spawning (see Table 10). These shad were placed in a spawning tank at the hatchery and allowed to spawn over the next several weeks. The fertilized eggs were collected, disinfected, and placed in upwelling incubators, as described above.

On May 29, June 2 and 10, and July 11, 14, and 16, MDMR personnel successfully transferred 179 (roughly 50/50 male:female) prespawner, adult American shad from the Cataract Lift on Maine's Saco River to the Waldoboro hatchery for experimental tank spawning (see Table 10). Over half the fry produced were released in the Saco River. Three stocking trips were made to the Saco to release these shad fry, on July 7, and August 4 and 18. In 1998, a total of 503,730 fry were released below Bar Mills on the Saco. The remainder of the Saco origin fry were released in the Kennebec and Sebasticook Rivers.

On June 24-26 and August 21, an estimated 1,348,937 shad fry ranging from 14-23 days old were released into the Kennebec River at the Waterville and Sidney boat launches (see Table 11). On June 26, July 24, and August 12, a total of 725,420 shad fry were released into the Sebasticook River just downstream of the Burnham Dam (see Table 11). Historical shad fry stocking in the Kennebec and Sebasticook Rivers is presented in Figure 4.

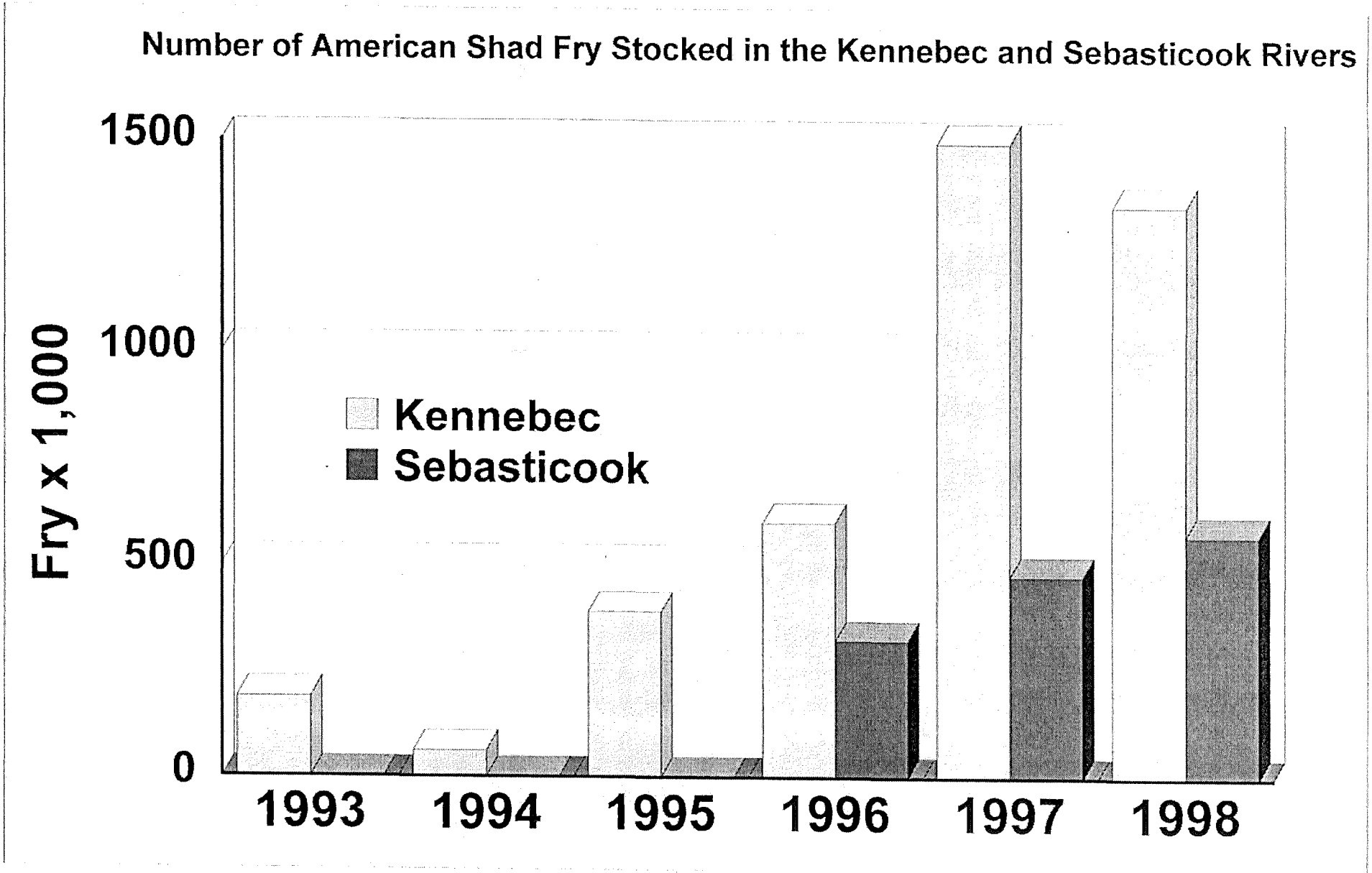
MDMR's decision to stock a portion of the shad fry available in 1998 into the Sebasticook River was based on several factors: MDMR sought to ensure that returning adult shad could be collected and used for future tank spawning egg take at the hatchery. Using broodstock collected from the Kennebec is preferred over continuing to collect broodstock from out-of-state. Fry stocked in 1998 will return in 2003 as five-year-old spawners. Fry stocked below Lockwood and Fort Halifax will not

TABLE 11. AMERICAN SHAD FRY RELEASES IN THE KENNEBEC AND SEBASTICOOK RIVERS, 1998

			STOCKING LOCATION	
RIVER	DATE	# LOADED AT HATCHERY*	TOWN	ACCESS POINT
Kennebec	06/24/98	303,795	Waterville	Boat Launch
	06/24/98	156,214	Waterville	Boat Launch
	06/25/98	387,881	Waterville	Boat Launch
	06/26/98	430,824	Sidney	Boat Launch
	08/21/98	70,223	Waterville	Boat Launch
		1,348,937		
Sebasticook	06/26/98	546,720	Pittsfield	Burnham Dam Tailwaters
	07/24/98	25,000	Pittsfield	Burnham Dam Tailwaters
	08/12/98	153,700	Pittsfield	Burnham Dam Tailwaters
		725,420		

* Estimated number of shad fry on day of loading. This estimate is subject to correction in final shad hatchery report.

Figure 4.


Number of American Shad Fry Stocked in the Kennebec and Sebasticook Rivers
Fry x 1,000
1500
1000
500
0
Kennebec
Sebasticook
1993
1994
1995
1996
1997
1998

have the same strong urge to pass back up over these dams as would fry stocked and imprinted with a more upriver stretch above one of these barriers. Trapping shad in a fish passage at one of these dams will be a more effective means of acquiring live, healthy broodstock than gill netting or attempting to trap shad in the open segment of the Kennebec River below Waterville.

MDMR viewed the Sebasticook River as the logical choice to receive some of the shad fry in 1998 rather than the Kennebec above Lockwood Dam for two reasons, both related to fish passage. First, MDMR believes that an upstream fish passage and trapping facility must certainly be built at Fort Halifax to support the burgeoning alewife restoration program on the Sebasticook River. Assuming such passage at Fort Halifax, the site becomes a natural place to trap returning broodstock shad imprinted with an upriver segment to fuel the hatchery egg take effort. Second, the lower hydroelectric dams on the Sebasticook River, Benton Falls and Fort Halifax, have installed permanent downstream passage facilities and have conducted site studies relevant to alewife downstream passage. MDMR believes stocking shad fry on the Sebasticook above these dams is a more reasonable action than stocking fry above Lockwood or Hydro-Kennebec, both of which currently have no downstream passage. Furthermore, MDMR did not want to stock all fry available in 1998 in one river segment. Since there were 2,729,930 fry available for release in 1998, MDMR sought to distribute them in two river segments so as not to "put all our eggs [fry] in one basket" and on the chance of some type of lethal condition occurring in the "one" segment, lose a major portion of the whole year's fry production.

Finally, MDMR chose that section of the Sebasticook below Burnham and above Benton Falls to receive the shad fry due to the large amount of quality habitat available in this long river segment; MDMR believes this area is highly productive and conducive to good shad growth.

The remaining fry were stocked into the three culture ponds at the hatchery and raised until fall. On October 15, 16 and 20, 27,907 fall fingerlings 2-6" in length were released in the Kennebec impoundment above the Edwards Dam, at the Waterville and Sidney boat launches. American shad fall fingerling releases in 1998 are presented in Table 12. The history of shad fall fingerling stocking in the Kennebec is represented in Figure 5.

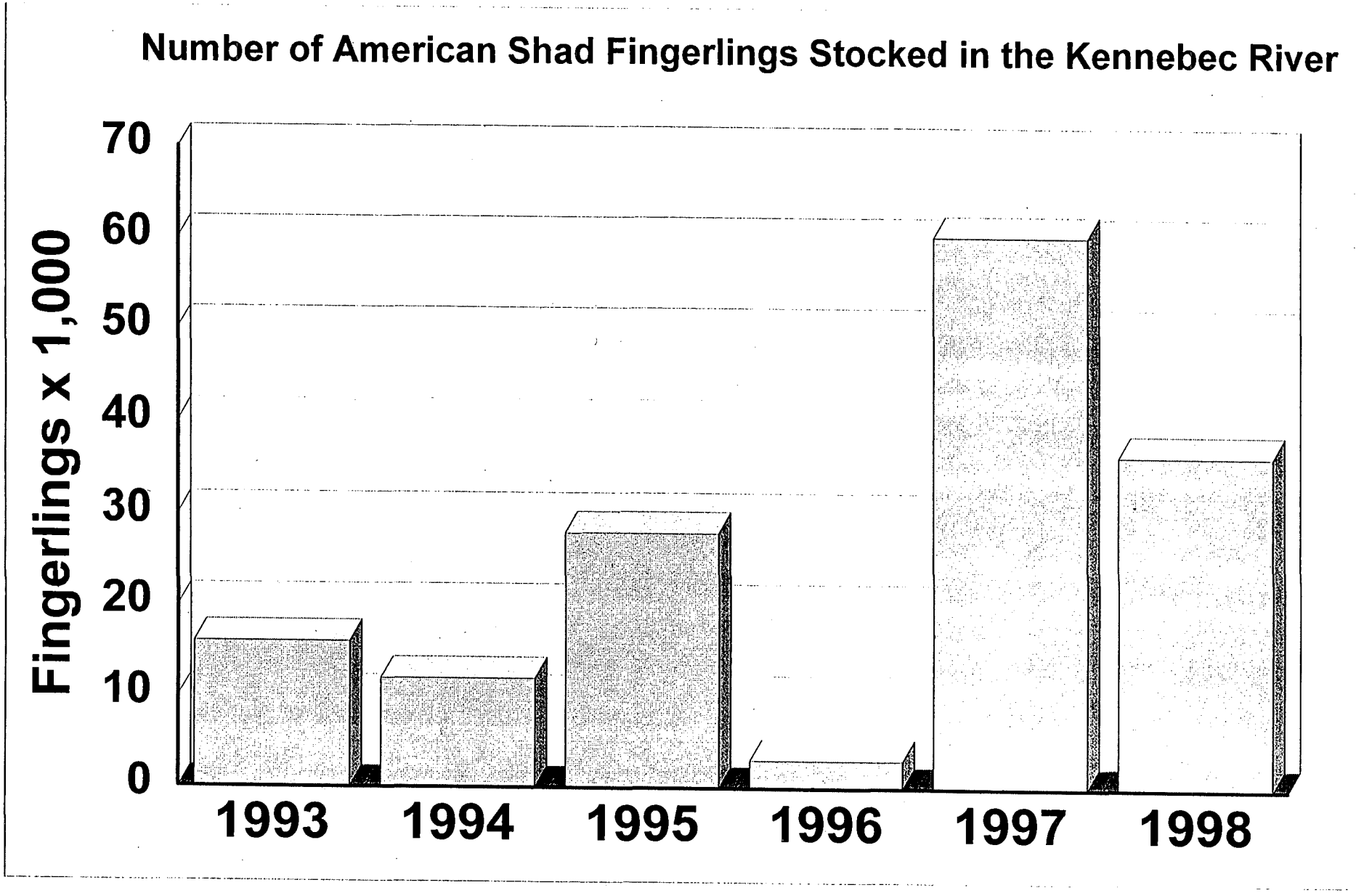
ATLANTIC SALMON

Atlantic salmon biologists from Maine's ASA [Atlantic Salmon Authority] have recommended against seining and handling salmon, particularly during periods of hot weather. For this reason, MDMR did not make any attempts to seine Atlantic salmon in Bond Brook during the summer of 1998.

TABLE 12. AMERICAN SHAD FINGERLING RELEASES IN THE KENNEBEC RIVER, 1998

RIVER	DATE	# LOADED AT HATCHERY	# MORTALITIES	# RELEASED	STOCKING LOCATION TOWN	STOCKING LOCATION ACCESS POINT
Kennebec	10/15/98	8,803	87	8,716	Sidney	Boat Launch
	10/16/98	5,010	0	5,010	Waterville	Boat Launch
	10/16/98	4,081	0	4,081	Waterville	Boat Launch
	10/16/98	4,800	0	4,800	Sidney	Boat Launch
	10/16/98	2,675	0	2,675	Sidney	Boat Launch
	10/20/98	2,725	100	2,625	Sidney	Boat Launch
TOTAL:		**28,094**	**187**	**27,907**		

Figure 5.


Number of American Shad Fingerlings Stocked in the Kennebec River
Fingerlings x 1,000
70
60
50
40
30
20
10
0
1993
1994
1995
1996
1997
1998

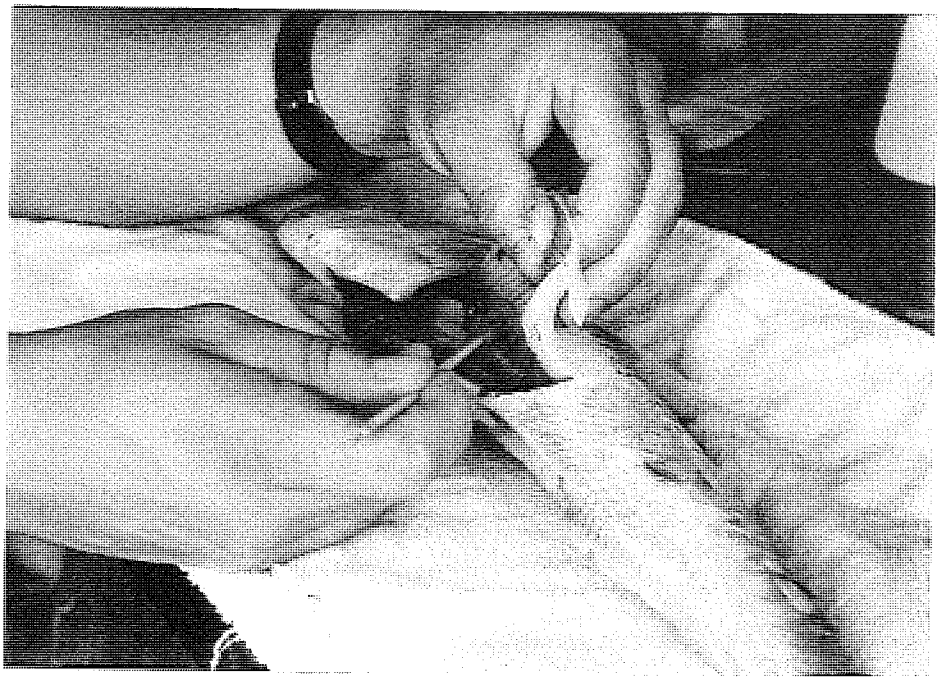


Figure 6: American shad fish health inspection. A blood sample was withdrawn from the kidney tissue and used to inoculate the culture media.

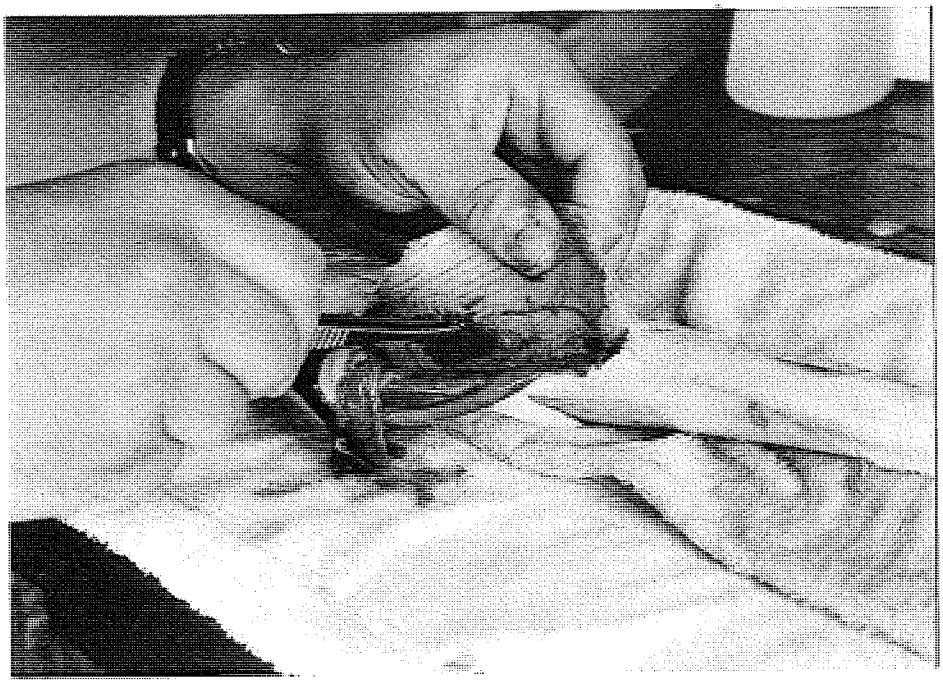


Figure 7: American shad fish health inspection. Kidney tissue was removed with Russian forceps for use in the culture of potential viral pathogens.

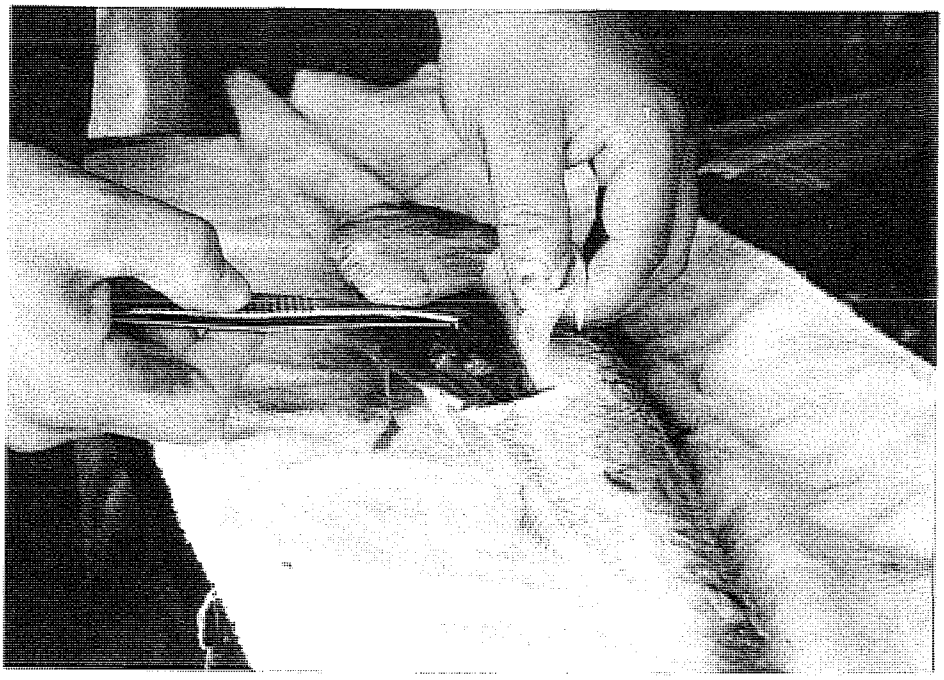


Figure 8: American shad fish health inspection. The tip of the spleen was removed with Russian forceps for use in the culture of potential viral pathogens.

Figure 9: American shad fish health inspection. Gill lamellae were removed with Russian forceps for use in the culture of potential viral pathogens.

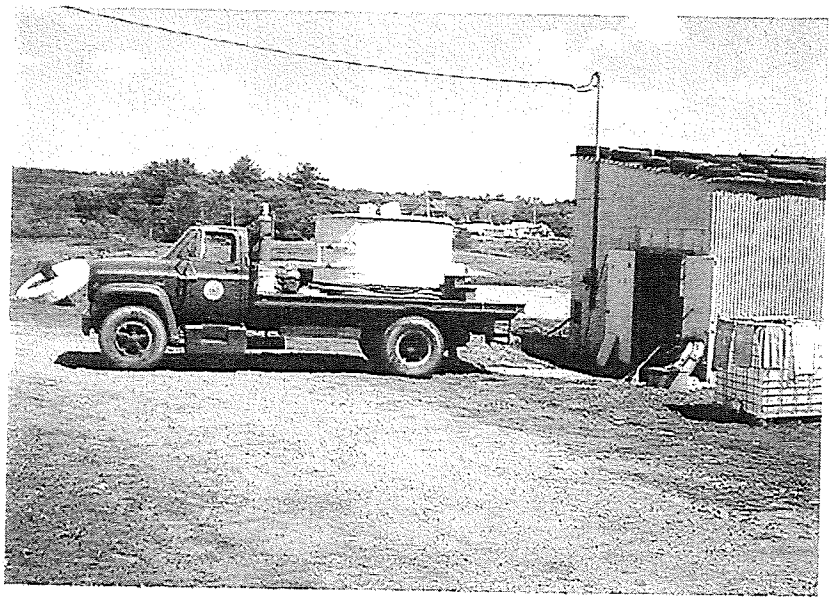


Figure 10: American shad broodstock were transported to the Waldoboro hatchery and placed in the spawning tank housed in this hatchery building.

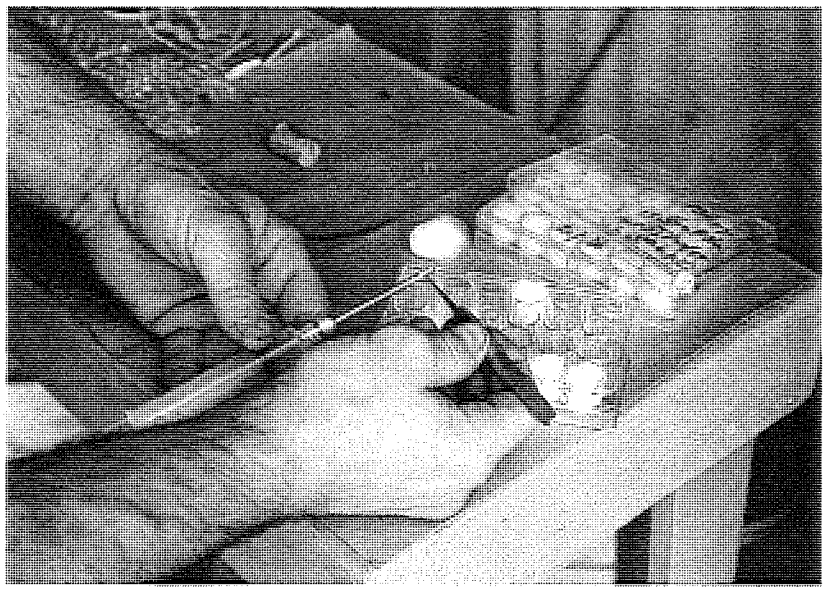


Figure 11: Some American shad broodstock received hormonal implants before they were placed in the spawning tank. A cellulose pellet infused with hormones is loaded into the needle used to implant the pellet.

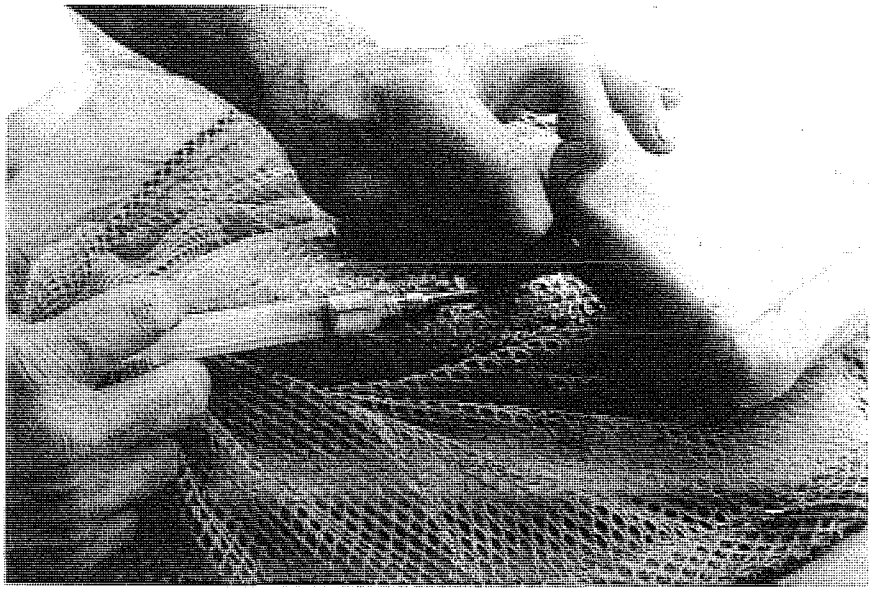


Figure 12: The hormonal implant was introduced into the muscle tissue of the American shad using the needle. Note the application of betadyne to minimize infection.

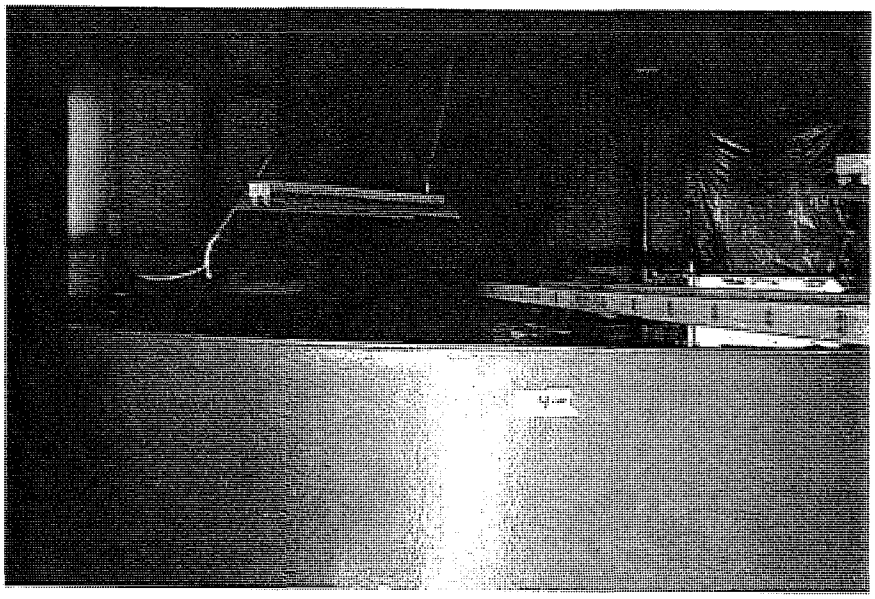


Figure 13: The spawning tank held American shad during the egg collection season. The tank used during the 1998 season was twelve feet in diameter.

AMERICAN EEL

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord* requires that KHDG dam owners and MDMR, in consultation with NMFS and the USF&WS, and subject to approval by FERC, undertake a three-year research project to determine 1) the appropriate placement of upstream passage for American eels at each of the seven KHDG facilities, based upon field observations of where eels are passing or attempting to pass upstream at each facility, and 2) appropriate permanent downstream fish passage measures, based on radio telemetry and other tracking mechanisms and field observations. The research is to begin in the 1998 migration season if possible, but no later than the 1999 season.

Activities in 1998

MDMR personnel initiated a study to determine the appropriate placement of upstream passage for eels. Because much of the spring migration season had passed when the settlement accord was signed, portable upstream passages, which are used to monitor the migration, were installed at only two facilities (Lockwood and Fort Halifax). Each passage is a self-supporting wooden trough, six feet long, one foot wide, and four inches high. The bottom of the trough is covered with nylon mesh on which the eels climb; an aluminum cover discourages predators. Water is allowed to trickle down the nylon mesh to keep it moist and to attract eels. All eels which climb the passage are captured and retained alive in a bucket suspended from the top. These portable units can be easily moved to determine where eels congregate at each facility.

The passage at Fort Halifax was initially placed below the dam on the western side of the river. One eel was captured between July 23-31, so the passage was removed based on the assumption that migration had ceased. On August 12, CMP personnel notified MDMR that eels were attempting to scale the dam, apparently in response to the use of a jackhammer. The same day, MDMR personnel netted 1,077 eels from the shallow pools below the east side of the dam. A passage was installed at this location the following day, and elvers were captured on August 14. A total of 5,684 elvers were captured between August 12 and September 11, but 98% were caught between August 12 and August 24. The "run" was of short-duration (Fig. 14a), but demonstrated that a substantial number of migrating eels were unable to move past the dam without assistance. The inability of the eels to scale the dam may be due to their size (Fig. 14b) or the low flow conditions necessary for installation of the minimum flow gate.

The passage at Lockwood was installed on the river side of the canal wall, approximately halfway between the turbines and the dam. Only two elvers were captured between July 22-31, so the passage was removed. Based on our experience at Fort Halifax, it will be relocated to the east side of the river in 1999.

During the summer and fall, MDMR personnel visited the five other KHDG facilities and scoped locations for placement of portable passages at each facility. These will be installed in the spring of 1999 when water flow conditions are appropriate.

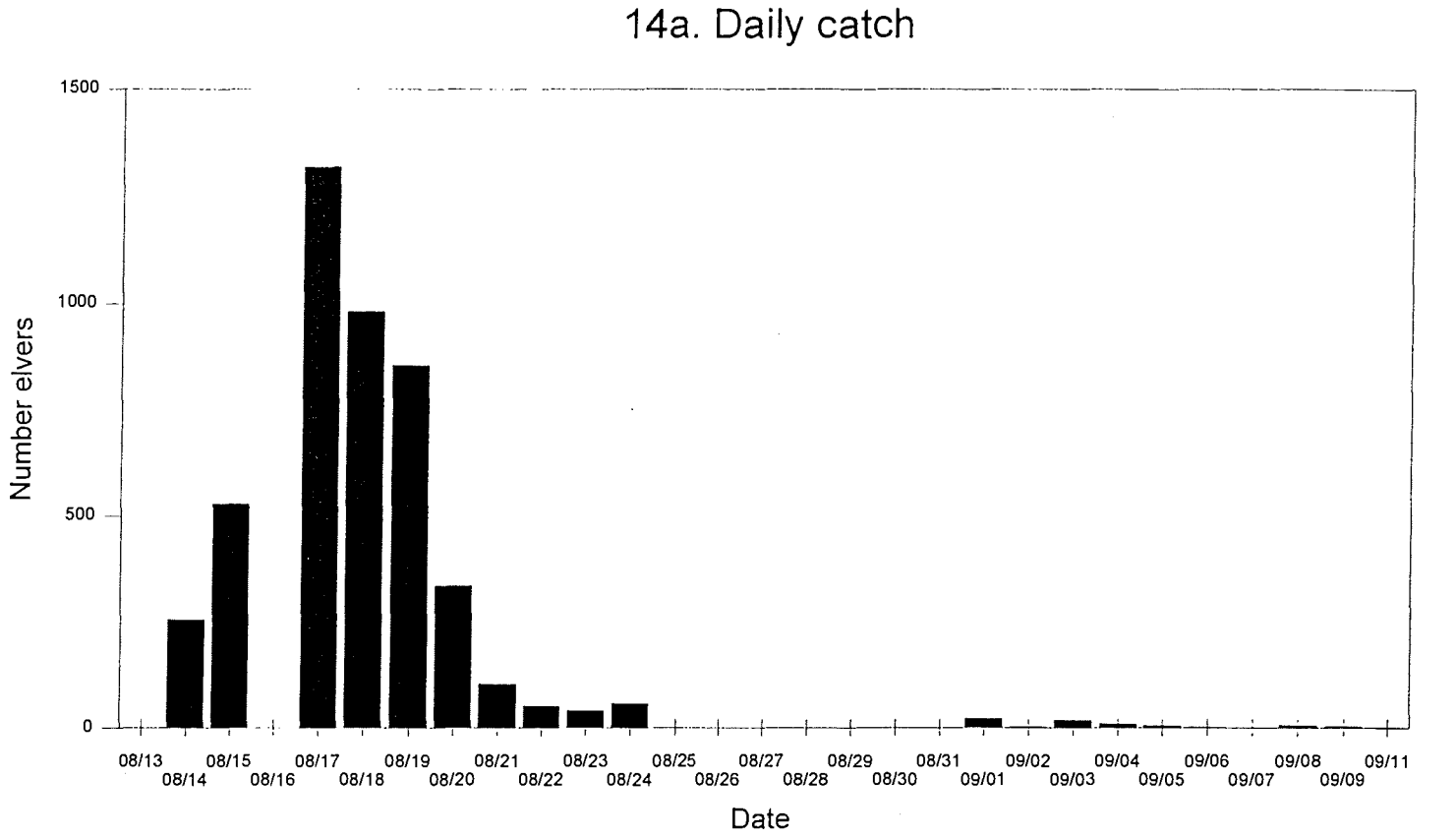
MDMR personnel also began preparing for a telemetry study of the behavior of downstream migrating eels. Some tracking equipment was purchased and personnel scoped locations for placement of data loggers and antennae. The study will be initiated on the Sebasticook River in the fall of 1999. The Sebasticook was chosen because several eel weirs are located within the drainage, indicating a population of adult eels in the system that will attempt to migrate downstream. Commercial fishing activity for eels on the mainstem Kennebec has diminished in recent years, indicating a reduced population of large eels. MDMR personnel will conduct electrofishing surveys at a few sites to obtain an estimate of the eel population and to locate a source of eels for tracking through KHDG facilities on the Kennebec River.

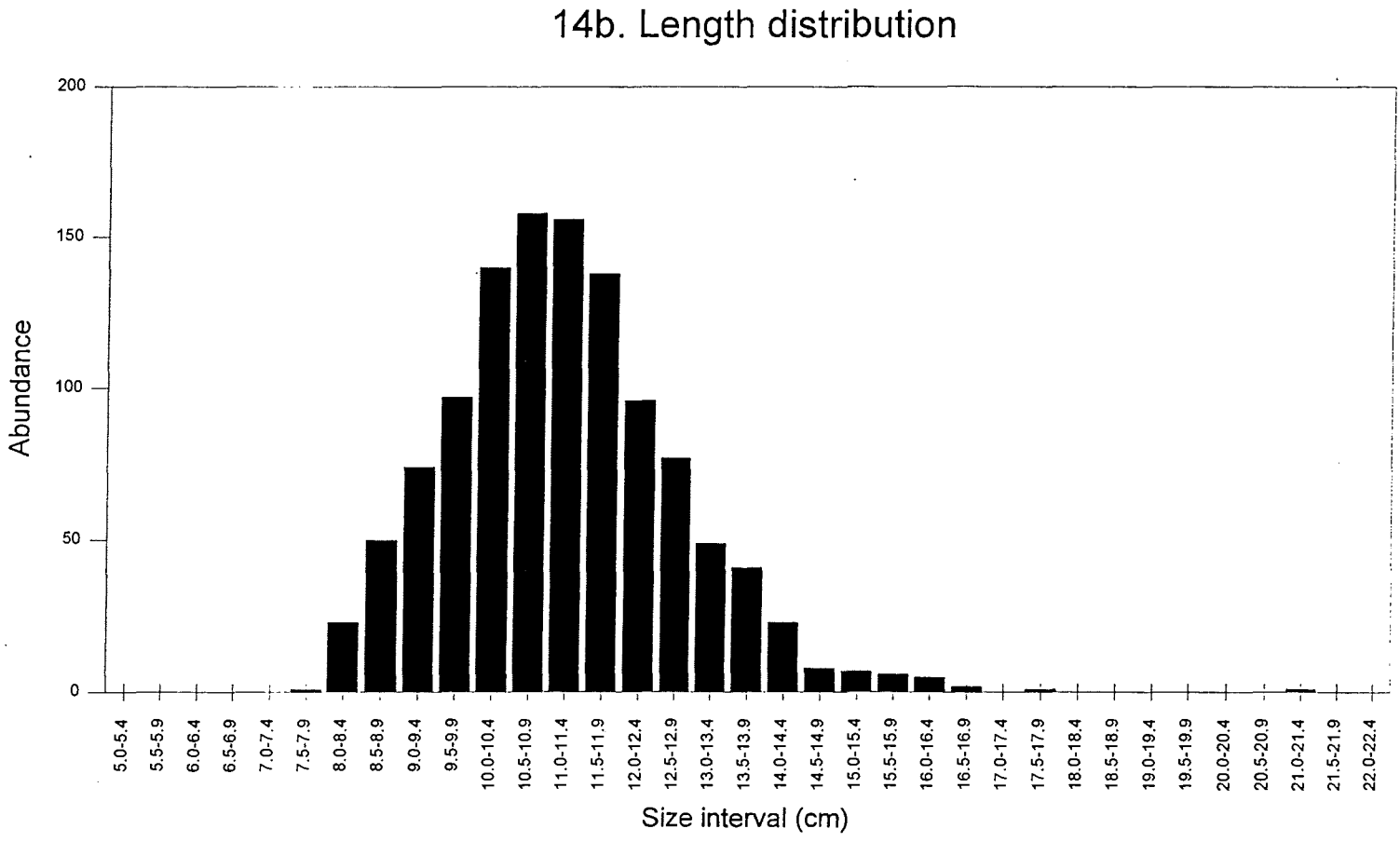
Proposed activities in 1999

Eel passages will be installed at each of the seven KHDG facilities when water flow decreases in the spring, estimated between mid-May and early June. Passages will be installed on the eastern shore at the Fort Halifax, Benton Falls, Burnham, Lockwood, and Shawmut Projects. Passages at Hydro-Kennebec will be installed near the western edge of the tailrace and at Weston on the western shore of the west channel. The passages will be tended daily until no eels are passed for two weeks, at which point they will be removed. Eels will be counted, measured, weighed, and released above the dam. In the second and third year of the study, eels will also be fin-clipped to provide an estimation of migration rate and population density. The study will be conducted from 1999-2001, inclusive.

Radio and ultrasonic telemetry will be used to study the downstream migration of adult eels on the Sebasticook River beginning in 1999. Specifically, in the first year of the study, normal downstream passage measures will be evaluated for their efficiency in passing adult eels. The eels will be captured above the Burnham Project, fitted with radio tags, and released immediately. Data loggers and antennae will be installed at each of the three KHDG facilities on the river to detect and automatically record the presence of any tagged eel. Personnel from MDMR will download the data every 1-3 days. Equipment will be calibrated in July; tracking will begin in July or August and will terminate in September or October, depending upon the weather.

Figure 14. Elver passage at Ft. Halifax





INTERIM PROGRESS REPORT ON THE LAKE GEORGE STUDY

In 1987, MDMR entered into a nine-year cooperative study with MDEP and MIF&W to explore the interactions of anadromous alewives and resident fresh water species. MDMR's role is funded by a portion of the study funds provided by the KHDG Agreement.

All three of the above noted state agencies have an interest in learning more about the relationships between alewives, fresh water fish and the water quality of the lakes. This study was formulated to address some of the unanswered questions about these relationships. Lake George, located in Skowhegan/Canaan Twps., was chosen as the study site because of its manageable size (335 acres), its species composition (rainbow smelt, smallmouth bass, and salmonids, such as brook and brown trout), and its location/accessibility.

The overall study can be outlined in three temporal segments or phases: Phase I was four years in length, beginning in 1987 and ending in 1990. During this phase, baseline background data was collected prior to the introduction of anadromous alewives:

PHASE I - 4 years

A. Determine age distribution/growth rates of landlocked smelts annually (MIF&W)
B. Determine population abundance of landlocked smelt annually (MIF&W)
C. Determine food habits of landlocked smelt (capture by MIF&W, stomach analyses by MDMR)
    1. Sample zooplankton for species composition and densities (MDEP)
D. Determine population parameters for salmonids
    1. Determine population size (MIF&W)
        a. Since population is maintained through a stocking program, reduce variables as much as possible (number stocked, size at stocking, time of stocking) (MIF&W)
    2. Determine age structure and growth rates (MIF&W)
E. Determine population parameters for other gamefish: smallmouth bass, pickerel, white perch (MIF&W)

PHASE II - 3 years

A. Stock adult alewives at six per surface acre of lake habitat annually (MDMR)
B. Continue steps A-E of Phase I
C. Determine population parameters for the alewife population
    1. Growth rate of juvenile alewives (MDMR)
    2. Monitor adult and juvenile emigration from lake (MDMR)
D. Determine food habits of juvenile alewives; continue for smelt (MDMR)

PHASE III - 3 years

A. Discontinue alewife stocking
B. Continue steps A-E of Phase I

CURRENT STATUS:
To date, MDMR has completed analysis of the smelt stomachs collected by MDIF&W at Lake George from 1987-1995. In addition, the technician will analyze the stomach contents of adult and juvenile alewives as well as those of smallmouth bass and white perch collected during the 1993 and 1994 field seasons. There are a small number of these samples remaining and they should be completed in the near future. The 1996 smelt stomachs will be analyzed for contents if the joint committee decides that they should be done. The writing of the final report on the project is under way and may be completed in 1999.