KENNEBEC RIVER
ANADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT - 1996

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INTRODUCTION -
This progress report covers the tenth year of the twelve-year interim trap and truck program for American shad and alewives on the upper Kennebec River. The interim trap and truck program is being carried out by the Department of Marine Resources (DMR) 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 Augusta Dam. This group of dam owners, known as the "Kennebec Hydro Developers Group [KHDG]," is providing 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 this plan is to restore American shad and alewives to their historical habitat above the Augusta Dam. The long-term objectives are:

1. To achieve an annual production of 6 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) involves the initiation of restoration by means of trap and truck for alewives and shad to selected water bodies. Originally the Augusta 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. No facilities were available at this dam during 1987 and 1988. In 1989, an experimental fish pump was installed by the owner but this facility proved to be ineffective in capturing sufficient numbers of adult alewives for stocking in upriver lake systems. From 1987 through 1992, all the alewife broodstock stocked in the Sebasticook drainage came from outside the Kennebec River, mostly from the Androscoggin River.

In 1993, DMR obtained alewife broodstock for the Kennebec River Phase I stocking from the Kennebec itself. DMR personnel netted 34,055 alewives below the Edwards Dam while the modified Edwards fish pump contributed 6,565 alewives for trucking upriver. No alewives were available from the Androscoggin River due to the limited run there in 1993.

In 1994, DMR obtained alewife broodstock from both the Kennebec and Androscoggin Rivers. The Edwards fish pump trapped 63,685 alewives while the DMR crew seined an additional 6,597 alewives at Edwards for trucking upriver. In addition, DMR transported 4,155 alewives from the Androscoggin River to stocking sites in the Sebasticook drainage. In total, 58,701 alewives were stocked in the

Sebasticook drainage as part of the Kennebec River Phase I stocking. This total represented a record high number in 1994 and included stocking all seven Sebasticook drainage lakes up to the Phase I goal of six alewives per acre.

In 1995, DMR obtained all the alewife broodstock for the restoration program from the Kennebec River. The Edwards Dam fish pump collected over 69,218 alewives during the spring run. DMR/KHDG-funded personnel trucked 59,185 alewives to the seven Phase I Sebasticook drainage lakes. This figure represented the second consecutive year that all seven lakes were stocked at a density of six alewives per acre. After completing the Sebasticook drainage stocking, DMR/KHDG-funded personnel trucked 10,033 alewives to four other river drainages to assist in restoration efforts there.

For 1996, DMR concentrated on obtaining alewife broodstock from the Kennebec River at the Edwards Dam. The fish pump trapped 98,928 alewives in May and June of 1996 with DMR seining another 1,929 fish. DMR/KHDG-funded personnel transported 67,441 broodstock alewives to eight Phase I lakes. Seven Sebasticook River drainage lakes were stocked to their target density of six alewives per surface acre for the third consecutive year. Wesserunsett Lake, which drains into the Kennebec River rather than the Sebasticook River, was stocked with alewives for the first time in 1996. Wesserunsett also was stocked at the target rate of six alewives per acre, with 8,706 alewives stocked.

When stocking of the lakes was nearly completed, DMR trucked 20,232 alewives to the impoundment above Edwards Dam where they were released and allowed to move upriver. In addition, DMR/KHDG-funded personnel trucked 11,814 alewives to five other river drainages to assist in restoration efforts there.

The future of improved fish passage at Edwards Dam remains uncertain. The December, 1994 FERC Order directing the Edwards Licensees to construct fish passage facilities has been negated by a May, 1995 FERC Order partially granting rehearing, as requested by the Licensees. Currently it appears that fish passage or dam removal will come through the relicensing process. Although the license expired in 1993, this process may take several years to complete. The State of Maine is in favor of removal of this dam in order to restore the river segment above it as a spawning and nursery area for all anadromous fish species, including striped bass, rainbow smelt, shortnose sturgeon and Atlantic sturgeon, which do not utilize conventional fish passage facilities.

In the spring of 1997, DMR plans to obtain alewife broodstock from fish pumping at Edwards Dam. Seining at Edwards or transfers from the Androscoggin River may be utilized if the fish pump fails to produce adequate numbers of alewives.

Under Phase I of the plan, only those lakes which had approval for stocking by the Department of Inland Fisheries and Wildlife (IF&W) were to be stocked with six alewives per surface acre. This amounted to 11 lakes (out of 21 lakes 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, DMR has not stocked the three Phase I lakes in the Sevenmile Stream drainage to allow the Maine Department of Environmental Protection (DEP) to establish a better, long-term water quality data base on these lakes.

In January, 1995, DEP indicated support for the stocking of Webber Pond (one of the three Sevenmile drainage lakes) on a trial basis. DMR, DEP, and IF&W met with the local public in March, 1995 and May, 1996 regarding alewife restoration. Because some concern was expressed over the proposed stocking, DMR agreed to defer stocking at Webber at least until 1997. As a result, no alewives were stocked in Webber Pond in 1995 or 1996. DMR, DEP, and IF&W will schedule an additional meeting to discuss local concerns and issues about the proposed stocking prior to any introduction of alewives in Webber Pond.

In past years, American shad broodstock for 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 Augusta Dam. If this objective could not be met at the Augusta Dam, then additional shad would 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 noted previously, 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 1996, DMR transferred 462 broodstock American shad from the Connecticut River to the Kennebec River. Few shad were available for trucking from the Connecticut River due to high river flows during the spring run. In 1996, DMR stocked 599,990 American shad fry and 3,070 fall fingerlings in the Kennebec River at Waterville. These fish were raised at the Medomak Hatchery in Waldoboro from Connecticut River eggs.

The interim plan for Atlantic salmon is to move whatever salmon become available at the Augusta Dam upriver. In 1996, 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 later in the year during high water temperatures, following recommendations of the Maine Atlantic Salmon Authority. DMR assisted the USF&WS in electrofishing Atlantic salmon fry, parr, and spawning adults to collect tissue samples for genetic analysis. Atlantic salmon were collected in Bond Brook and Togus Stream in both 1995 and 1996. As granted in the KHDG/State Agreement, various studies and monitoring activities were undertaken. These included: monitoring downstream emigration of juvenile 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 DIF&W, DEP, and DMR. The Lake George Alewife Interaction Study was expanded from 1991-1993 to include the alewife introduction phase, which involved the capture and enumeration of emigrating adult and juvenile alewives. In addition to smelt stomachs, both adult and juvenile alewife stomachs were collected from 1991 through 1993. Phase III of the study began in 1994 and involves collecting data on smelt and lake ecology ***after*** alewives are no longer in the system. No alewives were stocked in Lake George in 1994 - 1996, per the study plan.

In 1996, DMR constructed and tended a weir at the outlet of Pattee Pond on the Sebasticook River drainage. This weir project was preliminary work to determine feasibility of trapping at the site and determine rough alewife emigration numbers at the six alewife per acre stocking level. DMR plans to continue trapping at Pattee and other lake outlet(s) to determine YOY numbers and growth from six per acre and higher stocking densities. This project will probably involve at least an additional two years of trapping.

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 1996, the Department of Marine Resources [DMR] focused on the Kennebec River as the primary source of broodstock alewives for the stocking program in the upriver ponds. The abundance of alewives in the Kennebec River from 1993 through 1995 and the increased efficiency of stocking from Augusta rather than Brunswick led DMR to the decision to acquire alewives from the Kennebec again in 1996.

Prior to the alewife run, DMR and Edwards Manufacturing Company (i.e. Edwards Dam) agreed that the fish pump, which had been used at the site in 1994 and 1995, would be reinstalled and operated during the 1996 season. The pump was positioned, as in the past two years, at the south side of the upper tailrace and was affixed to girders above the tailrace. The 10" diameter pump intake pipe was fished in two different locations during the 1996 season. Early in the season, the intake was located at the extreme upstream end of the north side of the discharge of the most southern turbine at the upper powerhouse. After the first few days of the season, the intake was moved to the eddy created by the concrete abutment located between the discharges from the two southern turbines in the upper powerhouse. This intake location was the same as that used in 1994 and 1995, and was used for most of the 1996 season.

Improvements to the pump system from 1994-1995 were utilized again during the 1996 season. As in past years, a three-foot long section of transparent lexan, 10 inches in diameter, was added to the intake end of the pipe. The clear tip on the pipe was added to allow the pump to be less obtrusive to the fish and allowed it to fish with more stealth. The intake end of the pipe, just above the lexan tip, was fastened in place with cable. Cable tension and the position of the intake were maintained by adjusting a "come along" attached to the cable and the concrete pier. This retention device prevented 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 fish less than the previous intake arrangement.

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. For 1996, the floor of the pump tank was painted white to provide better visual contrast with the alewives in the tank 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 in the tank. Alewives were also removed by draining the tank, especially when alewife density was low. Draining was accomplished by stopping the pump and removing a drain plug in the tank floor. A supplemental water supply was added to the pump holding tank during 1994 and was utilized again for the 1996 season. This water was supplied by an electric pump and was 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 pump 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 loss of stored fish due to low DO levels.

During the 1996 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, DMR 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 DMR personnel manipulated the dip nets to catch the alewives while another worker was handed the full nets 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. This second person was helpful especially for loading the front tank on the twin tanker as it was impossible to get the front of the truck close to the pump tank because of site configuration. The front tank was typically loaded by walking the length of the truck on top of the tanks until the front tank was reached, while the truck was parked with its back end at the pump tank.

During the 1996 alewife run, DMR also trapped alewives below Edwards Mill with a beach seine. When netting alewives, DMR personnel used a beach seine that measured 66' x 6' deep and was constructed of 1/8" delta mesh. A seine borrowed from CMP was also used for part of the season. The seines were fished at the southern margin of the fast water in the upper powerhouse tailrace and brought in to shore in this area. The seine was then held in the water along shore until the alewives were removed from the seine with dip nets hung with ¼" delta mesh netting.

When alewives were seined, twenty-five fish lots of alewives were placed in five-gallon buckets half-filled with water. Buckets were immediately removed from the river bank as they were filled and were hand-carried to the base of the granite block wall at the south side of the upper tailrace. The davit, rope and pulley 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 in use 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 DMR upon request.

Alewives were trucked from their loading site directly to the lake to be stocked and were immediately released. The name, location, and programmed alewife stocking figures for each 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 alewives, the progeny of the spring 1996 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 multifilament ¼" bar mesh and was 8' in diameter. Dip net frames varied in their dimensions but were hung with either ¼" or 1/8" delta mesh netting. A Smith-Root boat electrofishing unit was used to sample juvenile alewives and American shad in the Sebasticook River in 1996.

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 sometimes an annual occurrence 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 usually allows downstream passage for several days or until it is

TABLE 1. 1996 ALEWIFE STOCKING PLANS

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
			57,750

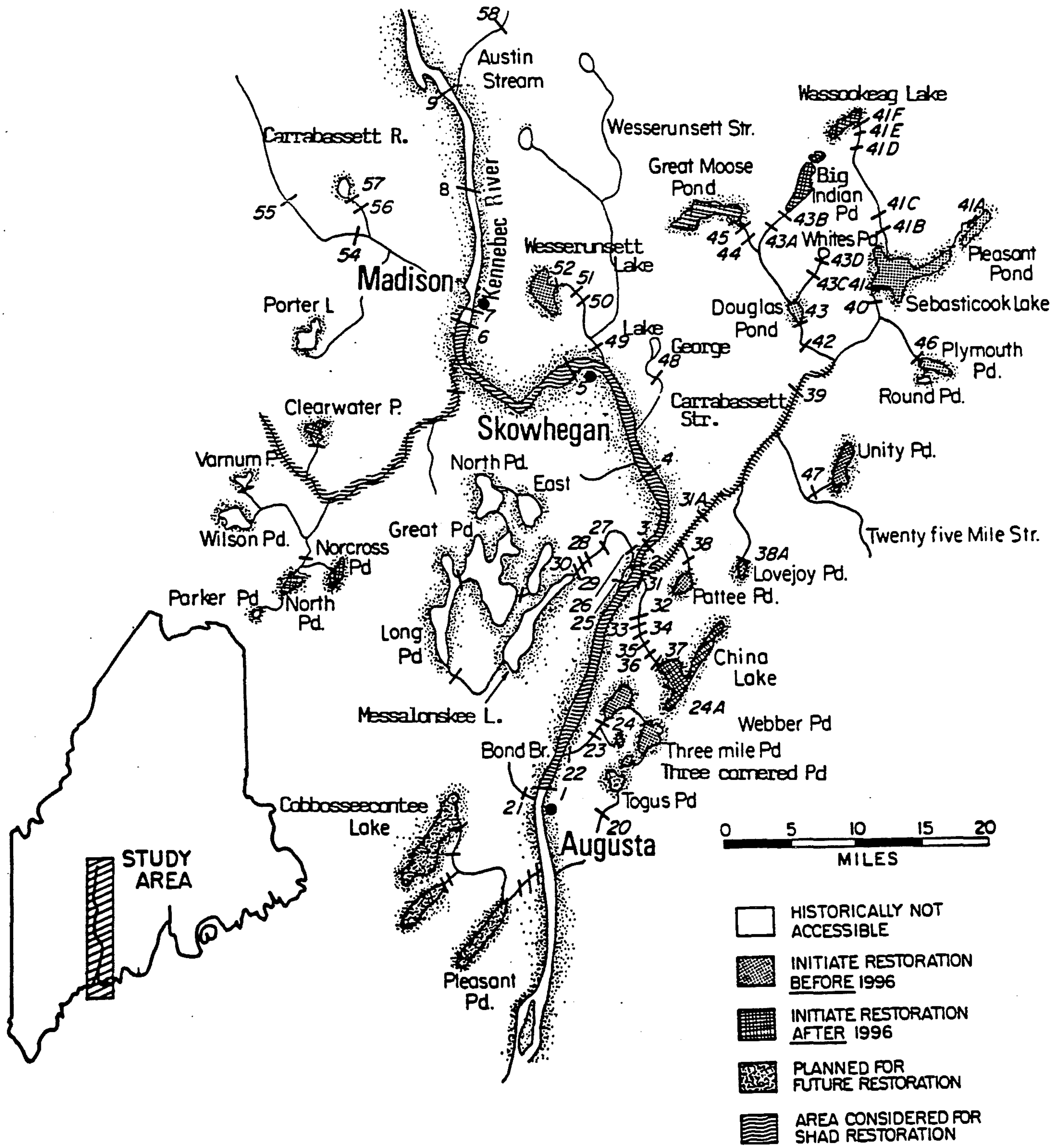
KENNEBEC RIVER

Lake System	Location	River Section	# to be Stocked*
Wesserunsett Lake	Madison	Kennebec River	**8,676**
Additional Ponds:			
Webber Pond	Vassalboro	Kennebec River	7,512
Three Mile Pond	China	Kennebec River	6,462
Three Cornered Pond	Augusta	Kennebec River	1,170
			23,820

*Six adult alewives per lake surface acre

FIGURE 1: **Kennebec River Drainage**

ANADROMOUS FISH RESTORATION PROGRAM



repaired by the beavers. Downstream passage through the lake outlet streams was improved overall in 1996 due to elevated flow levels which resulted from frequent summer and fall rains.

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 at these barriers. 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; locations of the dams are illustrated in Figure 1.

RESULTS & DISCUSSION: Alewife

In 1996, 67,441 broodstock alewives were stocked into eight lakes in the Kennebec River drainage. These eight lakes are programmed for restoration as described in Phase I of the ***"Strategic Plan and Operational Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta."*** In total, 11,071 acres of lake surface were stocked to an overall density of 6.1 alewives x acre^{-1}. Stocking densities in all eight lakes were close to 6 alewives x acre^{-1} and only varied from 6.0 alewives x acre^{-1} in Sebasticook and Wesserunsett Lakes to 6.4 alewives x acre^{-1} in Douglas Pond (Table 3).

Seven of the eight lakes stocked in 1996 were on the Sebasticook River subdrainage and have been stocked in previous years as part of the ongoing alewife restoration program in the Kennebec drainage. The restoration program was expanded in 1996 to include the stocking of alewives in the first lake outside the Sebasticook subdrainage: Wesserunsett Lake. The addition of Wesserunsett Lake to the list of current alewife restoration ponds increased surface acreage under production from 9,625 acres to 11,071 acres in the Kennebec drainage, a 15% increase.

Alewives were reintroduced for the first time in 1996 to Wesserunsett Lake in Madison. Wesserunsett Lake has a surface area of 1,446 acres and drains through Wesserunsett Stream, which enters the Kennebec River below Skowhegan. The Phase I target stocking rate of 6 alewives x acre^{-1} was achieved for the 1996 season after DMR stocked 8,706 alewives in Wesserunsett Lake. Wesserunsett is included in the eight lakes, 11,071 surface acres, and 67,441 alewives stocked mentioned above (Table 3).

DMR met with regional DIF&W fisheries biologists about alewife restoration at Wesserunsett Lake in early 1996. A public meeting was held at the Colony House in Lakewood on May 15, 1996 and was attended by DMR and IF&W biologists, as well as the public. During this meeting, the decision was made to commence alewife restoration at Wesserunsett Lake in 1996.

TABLE 2. HYDROELECTRIC FACILITIES MONITORED FOR DOWNSTREAM PASSAGE, 1996

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

TABLE 3. 1996 ALEWIFE STOCKING IN KENNEBEC DRAINAGE

Ponded Area	Surface Acreage	Target Number To Be Stocked*	Number Stocked	# of Trips	% of Target # Achieved	Fish •Acre^{-1}
Douglas Pond	525	3,150	3,349	3	106%	6.4
Lovejoy Pond	324	1,944	2,045	3	105%	6.3
Pattee Pond	712	4,272	4,366	4	102%	6.1
Pleasant Pond	768	4,608	4,718	4	102%	6.1
Plymouth Pond	480	2,880	3,032	3	105%	6.3
Sebasticook Lake	4,288	25,728	25,913	11	101%	6.0
Unity Pond	2,528	15,168	15,312	9	101%	6.1
Wesserunsett Lake	1,146	8,676	8,706	4	100%	6.0
TOTALS:	**11,071**	**66,426**	**67,441**	**41**	**102%**	**6.1**
Edwards Impoundment	------	20,000	20,232	11	101%	---

* Six fish per acre

The introduction of alewife restoration in Webber Pond was postponed until 1997. DMR had previously deferred stocking alewives in 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 DEP, local residents, lake associations and the China Region Lake Alliance. In early 1995, DMR, DEP and IF&W agreed that alewife restoration at 6 alewives x acre^{-1} would have no negative impact on water quality and may 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 went well at Webber, the other lakes would be stocked in future years.

DMR, DEP and IF&W held a public meeting about alewife restoration in Webber Pond in March of 1995. Based on the meeting, stocking in 1995 was deferred for several reasons. Some concern was expressed that any negative impact on water quality by alewives might have detrimental effects 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 DMR not to stock alewives in Webber Pond.

DMR held another public meeting on May 28, 1996 to further discuss alewife introductions 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, the Webber Pond residents present were split approximately 50/50 when a show of hands was requested. Based on the response from the public meeting, DMR decided to postpone alewife reintroduction for one more year. DMR plans to meet with the Lake Association again in early 1997 to discuss the potential for stocking alewives in Webber Pond. DMR would still prefer to initiate alewife reintroduction in the Sevenmile Stream drainage by beginning stocking at Webber Pond.

DMR decided to stock broodstock alewives in the Edwards Dam impoundment if fish were still available after sufficient numbers had been trapped to satisfy upriver stocking of the eight lakes. DMR hoped that the alewives released could be observed upstream where their passage would be obstructed by the Fort Halifax Dam at the mouth of the Sebasticook River or by the Lockwood Dam if they continued up the Kennebec past the Sebasticook. On June 4 - 6, 20,232 alewives trapped by the pump at Edwards were trucked just above the gatehouse and released into the Edwards impoundment.

DMR's Tom Squiers checked the tailwaters of the Fort Halifax, Lockwood and Union Gas Project Dams on June 6 and was able to observe hundreds of alewives below only Fort Halifax. Video was taken of alewives swimming near the ledges on the south side of the Sebasticook on the opposite side of the river from the Fort Halifax powerhouse. No alewives were observed at the other projects. DMR personnel checked both Fort Halifax and Lockwood tailwaters again on June 10. No alewives were visible at either site on this day. CMP hydro operations personnel present at Lockwood speculated that any fish at the project would likely be found below the spillway due to the flow over the dam at the time. During DMR's June 10 visit, CMP hydro operations personnel related anecdotal observations of alewives made in 1974 when the Edwards Dam in Augusta was breached. In 1974, alewives were observed below the Lockwood Project's spillway by CMP hydro operations personnel.

Alewife stocking efficiency from Edwards Mill in 1996 was similar to that of 1994 and 1995. American shad broodstock transfers from the Connecticut River only overlapped with alewife stocking on June 5, after nearly all alewife transfers to Kennebec drainage ponds were completed. This allowed the twin tank truck to be employed regularly for alewife transport. Alewife hauling tank densities in 1996 were similar to loading densities of the previous two years. The heavy alewife run and good 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}
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 67,441 alewives stocked in the Sebasticook and Kennebec drainages in 1996 is the highest number of alewives stocked since the KHDG Agreement was implemented (Table 4). The 1996 alewife total represents the third year in a row that all seven Sebasticook drainage restoration lakes were stocked to their target stocking density of 6 alewives x acre^{-1}. In addition, 1996 marked the first year of stocking in a Kennebec drainage restoration lake with the reintroduction of 8,706 alewives at Wesserunsett Lake. In total, 41 alewife stocking trips were made to the upriver ponds. All 41 trips originated in Augusta and the Kennebec River was nearly the sole source of alewife broodstock in 1996, except for 340 alewives trapped in the Sheepscot River on June 4. The stocking truck was brought to Edwards Mill from the Sheepscot River and the load was supplemented with Kennebec River alewives to make a full load. Stocking on the Sheepscot was canceled that day due to the low number of alewives available at the Coopers Mills fishway. Despite the small stocking of the Sheepscot River alewives in the Kennebec drainage, it was not necessary to import alewife broodstock from outside the Kennebec to meet the goals of the program.

TABLE 4. KENNEBEC RIVER ALEWIFE STOCKING SUMMARY 1985-1996

	Year	# Stocked
Sebasticook Lake (4288 acres):	1996	25,913
	1995	25,934
	1994	25,911
	1993	17,281
	1992	2,853
	1991	21,030
	1990	11,166
	1989	24,966
	1988	14,850
	1987	12,099
	1986	8,478
	1985	3,567
Plymouth Pond (480 acres):	1996	3,032
	1995	3,012
	1994	3,002
	1993	3,199
	1992	2,903
	1991	2,921
	1990	2,530
	1989	2,925
	1988	3,027
	1987	2,797
	1986	1,220
	1985	-0-
Pleasant Pond (768 acres):	1996	4,718
	1995	4,628
	1994	4,789
	1993	2,224
	1992	3,546
	1991	4,689
	1990	3,475
	1989	4,614
	1988	2,648
	1987	2,688
	1986	-0-
	1985	-0-
Douglas Pond (525 acres):	1996	3,349
	1995	3,229
	1994	3,333
	1993	3,504
	1992	3,188
	1991	3,150
	1990	2,959
	1989	3,257
	1988	3,099
	1987	2,286
	1986	525
	1985	-0-
Lovejoy Pond (324 acres):	1996	2,045
	1995	2,000
	1994	2,008
	1993	699

TABLE 4 (CONTD)

	1992	1,952
	1991	1,976
	1990	2,077
	1989	1,741
	1988	2,055
	1987	1,949
	1986	-0-
	1985	-0-
Pattee Pond (712 acres):	1996	4,366
	1995	4,316
	1994	4,315
	1993	4,450
	1992	4,287
	1991	4,327
	1990	3,919
	1989	4,363
	1988	3,393
	1987	4,031
	1986	-0-
	1985	-0-
Unity Pond (2528 acres):	1996	15,312
	1995	15,961
	1994	15,343
	1993	3,125
	1992	2,845
	1991	4,632
	1990	559
	1989	3,301
	1988	-0-
	1987	-0-
	1986	-0-
	1985	-0-
Wesserunsett Lake (1446 acres):	1996	8,706
Lake George (335 acres):	1996	-0-
	1995	-0-
	1994	-0-
	1993	2,021
	1992	2,005
	1991	2,030
TOTALS:	**1996**	**67,441**
	1995	**59,080**
	1994	**58,701**
	1993	**36,503**
	1992	**23,579**
	1991	**44,755**
	1990	**26,685**
	1989	**45,167**
	1988	**29,072**
	1987	**25,850**
	1986	**10,223**
	1985	**3,567**

The 1996 alewife stocking program required 14 days to complete, including June 1 and 2 when no alewives were available for trapping. Stocking commenced on May 23 and terminated on June 5. A chronological list of individual stocking trips to the eight lakes can be found in Table 5.

Table 6 is a summary of the 1996 alewife trapping at Edwards Mill. Figure 2 shows the daily trapping data in chart form. During the 1996 season, 100,857 alewives were trapped at the Edwards Dam. Of these, 98,928 were captured by the fish pump and 1,929 were seined or dipped. The 100,857 alewives trapped includes 11,814 alewives stocked in other river drainages, 19,892 stocked in the Edwards Dam impoundment (plus another 340 alewives from the Sheepscot River), 67,441 stocked in the eight upriver lakes, 1,390 released below the Edwards Dam, and 320 trucking mortalities.

The 320 alewives lost while trucking represent a 0.3% mortality of the 99,807 total alewives loaded. On May 25, 292 mortalities (of the 320 total for the season) occurred on a trip to Sebasticook Lake with the twin tank truck. Approximately one third of the alewives on board in the 3,012 fish load had been seined below Edwards Mill. The increased handling involved in seining, holding and hoisting the fish in buckets may have stressed some of the alewives and contributed to the high mortality on this trip. With this one trip factored out, mortality levels drop to 0.03% of alewives loaded in the trucks (28 alewife mortalities).

Kennebec River flows were still high in late May 1996, making alewife trapping (pumping or seining) impossible for DMR until May 22. While the Kennebec was still high and the Moosehead Lake level was being drawn down (personal communication with Kim Chapman at Edwards Dam), DMR observed alewives in the tailwaters at Edwards on May 22. DMR was able to seine 68 alewives, although the tailwater level was up in the bushes and trees on the banks below the Edwards powerhouse. The Kennebec water temperature was 13°C on May 22 below Edwards Mill. These 68 alewives were transported to the DMR Aquarium in Boothbay Harbor to serve as a public exhibit.

On May 23, the fish pump intake was moved to the new location described in the "**METHODS**" section of this report. Although the river flow was still high, alewife pumping was successful on May 23 with 2,679 alewives being trapped by the pump in half a day of pumping (river temperature was above 14°C). The first two stocking trips to upriver ponds were completed on May 23.

Alewife pumping improved on May 24 (6,435 trapped) and remained steady through May 26, with the intake still at the new location previously described. On Memorial Day, May 27, DMR and Edwards personnel moved the pump intake back to its 1994-1995 location to take advantage of the lower river level and alewives observed

TABLE 5. 1996 KENNEBEC RIVER ALEWIFE STOCKING BY DATE/TRIP

Date	Location	# Loaded	# Morts	# Stocked
05/23/96	Sebasticook Lake	2,011	0	2,011
	Sebasticook Lake	688	0	688
05/24/96	Sebasticook Lake	3,037	1	3,036
	Plymouth Pond	1,207	0	1,207
	Unity Pond	2,191	1	2,190
05/25/96	Pleasant Pond	1,350	0	1,350
	Lovejoy Pond	707	0	707
	Sebasticook Lake	3,012	292	2,720
	Lovejoy Pond	636	0	636
05/26/96	Pattee Pond	1,515	0	1,515
	Sebasticook Lake	2,103	1	2,102
	Pleasant Pond	710	1	709
	Pattee Pond	782	0	782
05/27/96	Pleasant Pond	1,153	1	1,152
	Unity Pond	2,423	0	2,423
	Pattee Pond	1,007	0	1,007
05/28/96	Douglas Pond	1,001	0	1,001
	Unity Pond	2,674	3	2,671
	Unity Pond	1,306	0	1,306
	Unity Pond	2,344	1	2,343
05/29/96	Sebasticook Lake	2,107	0	2,107
	Pleasant Pond	1,508	1	1,507
	Sebasticook Lake	3,020	0	3,020
	Sebasticook Lake	1,511	2	1,509
05/30/96	Sebasticook Lake	2,820	2	2,818
	Plymouth Pond	951	1	950
	Lovejoy Pond	702	0	702
	Pattee Pond	1,063	1	1,062

TABLE 5 (CONTD)

05/31/96	Douglas Pond	1,176	0	1,176
	Unity Pond	1,240	0	1,240
06/03/96	Douglas Pond	1,172	0	1,172
	Unity Pond	1,563	0	1,563
	Sebasticook Lake	2,916	5	2,911
	Sebasticook Lake	3,013	2	3,011
	Unity Pond	1,061	0	1,061
06/04/96	Edwards Impoundment	3,649	0	3,649
	Edwards Impoundment	1,500	0	1,500
	Edwards Impoundment	1,708	0	1,708
	Edwards Impoundment	1,750	0	1,750
	Edwards Impoundment	2,010	0	2,010
	Edwards Impoundment	2,002	0	2,002
	Edwards Impoundment	1,402	0	1,402
	Wesserunsett Lake	3,067	0	3,607
	Wesserunsett Lake	3,021	0	3,021
	Plymouth Pond	876	1	875
06/05/96	Unity Pond	515	0	515
	Edwards Impoundment	2,003	0	2,003
	Edwards Impoundment	2,005	0	2,005
	Wesserunsett Lake	1,009	1	1,008
	Wesserunsett Lake	1,610	0	1,610
06/06/96	Edwards Impoundment	1,200	0	1,200
	Edwards Impoundment	1,003	0	1,003
TOTAL FISH:		**87,990**	**317**	**87,673**

TOTAL DAYS: 15
TOTAL TRIPS: 52 (To Lakes: 41; to Impoundment, 11)

TABLE 6. ALEWIFE TRAPPING & STOCKING FROM EDWARDS DAM/KENNEBEC RIVER - 1996

	# of Alewives*					Released
Date	Fish Pump	Seined/Dipped	Loaded	Morts	Stocked	Below Dam
May 22		68	68	0	68	
23	2,679		2,679	0	2,679	
24	6,435		6,435	2	6,433	
25	4,198	1,507	5,705	292	5,413	
26	5,110		5,110	2	5,108	
27	4,242	341	4,583	1	4,582	
28	7,325		7,325	4	7,321	
29	9,863		9,863	3	9,860	
30	6,509	13	6,137	4	6,133	385
31	3,181		3,181	0	3,181	
Jun 1						
2						
3	9,725		9,725	7	9,718	
4	22,205	340	22,545	1	22,544	
5	8,136		8,136	1	8,135	
6	7,385		6,380	3	6,377	1,005
7	1,466		1,466	0	1,466	
8						
9						
10	469		469	0	469	
TOTALS:	**98,928**	**1,929****	**99,807**	**320*****	**99,487**	**1,390**

* Includes alewives that went into the Edwards Impoundment, Androscoggin River & other drainages

** Includes 340 of Sheepscot River origin

***Represents 0.3% trucking mortality

congregating in the intake area. Trapping picked up on May 28 and 29, with 9,863 pumped on the 29th. Hauling continued through late May until rain on June 1 and 2 interrupted alewife movement and made trapping ineffective for these two days. Trapping resumed on June 3 with 9,725 alewives pumped.

On June 4, with upriver lake stocking nearly completed, DMR stocked 14,021 alewives in the Edwards impoundment (including 340 from the Sheepscot River). In addition, 6,964 alewives were loaded to be stocked in upriver ponds and 1,560 alewives were stocked in the Androscoggin by Androscoggin River Project personnel. Because the single tank truck remained "on site" at Edwards all afternoon on June 4 stocking fish in the impoundment, the pump ran continuously while the alewives were very abundant below the powerhouse. As a result, a record highest single day trapping total of 22,205 alewives was achieved on June 4.

Trapping continued on June 5 when DMR completed stocking of the eight target lakes by making two trips to Wesserunsett Lake and one trip to Unity Pond. In addition, DMR stocked another 4,008 alewives into the Edwards impoundment. Stocking within the Kennebec drainage itself concluded on June 6, after another 2,203 alewives were placed in the impoundment at Edwards.

Trapping and trucking continued from Edwards Dam to other coastal drainages on June 7 and June 10 (see Table 7). DMR refrained from alewife stocking on June 8 and 9 to minimize overtime and rest personnel, although an American shad transfer occurred on June 9.

Out-of-basin transfers from the Edwards Dam trapping site in 1996 totalled 11,817 alewives loaded, with 11,814 stocked and three mortalities (Table 7). Alewives transferred out-of-basin represented 12% of the total number of alewives trapped at Augusta. Early season out-of-basin transfers were mostly to the Androscoggin drainage and were completed by DMR's Androscoggin River Project personnel and truck. After KHDG-funded personnel were nearly finished with in-basin transfers, they also participated in supplemental stocking to other drainages (see Figure 3).

Trapping and trucking of alewives from Augusta was terminated for the 1996 season on June 10 with the transfer of 469 alewives to the Sheepscot River drainage. However, DMR assisted CMP in acquiring 292 alewives from the Edwards Dam tailwaters on June 13. Most of these alewives were seined below the Edwards powerhouse and all were transported by CMP for use in the Saco River drainage. The Kennebec River temperature was 17°C on June 7 and reached 17.5°C by June 10. Alewife abundance below Edwards diminished sharply after June 7 and seining the 292 alewives on June 13 was a slow process as the majority of the fish were dispersed and the 1996 spawning run was essentially over. DMR personnel observed several schools of adult alosids in the Kennebec River below Edwards after June 13,

TABLE 7. DISPOSITION OF KENNEBEC RIVER ALEWIVES STOCKED IN OTHER DRAINAGES - 1996

	Date	Location	Number Loaded	Morts	Stocked
ANDROSCOGGIN RIVER DRAINAGE:	5/29	Tripp Pond	800	0	800
	5/29	Tripp Pond	807	0	807
	5/30	Lower Range Pond	601	0	601
	5/31	Taylor Pond	765	0	765
	6/04	Tripp Pond	779	0	779
	6/04	Tripp Pond	781	0	781
	6/05	Sabattus River	994	0	994
			(5,527)	(0)	(5,527)
SHEEPSCOT RIVER DRAINAGE:	6/10	Branch Pond	(469)	(0)	(469)
MARSH RIVER:	6/06	Sherman Lake	(1,023)	(0)	(1,023)
PEMAQUID RIVER:	6/06	Pemaquid River	1,003	3	1,000
	6/06	Pemaquid River	1,012	0	1,012
	6/06	Pemaquid Pond	1,139	0	1,139
			(3,154)	(3)	(3,151)
ST. GEORGE RIVER:	6/07	Seven Tree Pond	704	0	704
	6/07	South Pond	762	0	762
			(1,466)	(0)	(1,466)
DMR AQUARIUM:	5/22	Aquarium	68	0	68
	5/29	Aquarium	110	0	110
			(178)	(0)	(110)
TOTALS:			**(11,817)**	**(3)**	**(11,814)**

Figure 2.

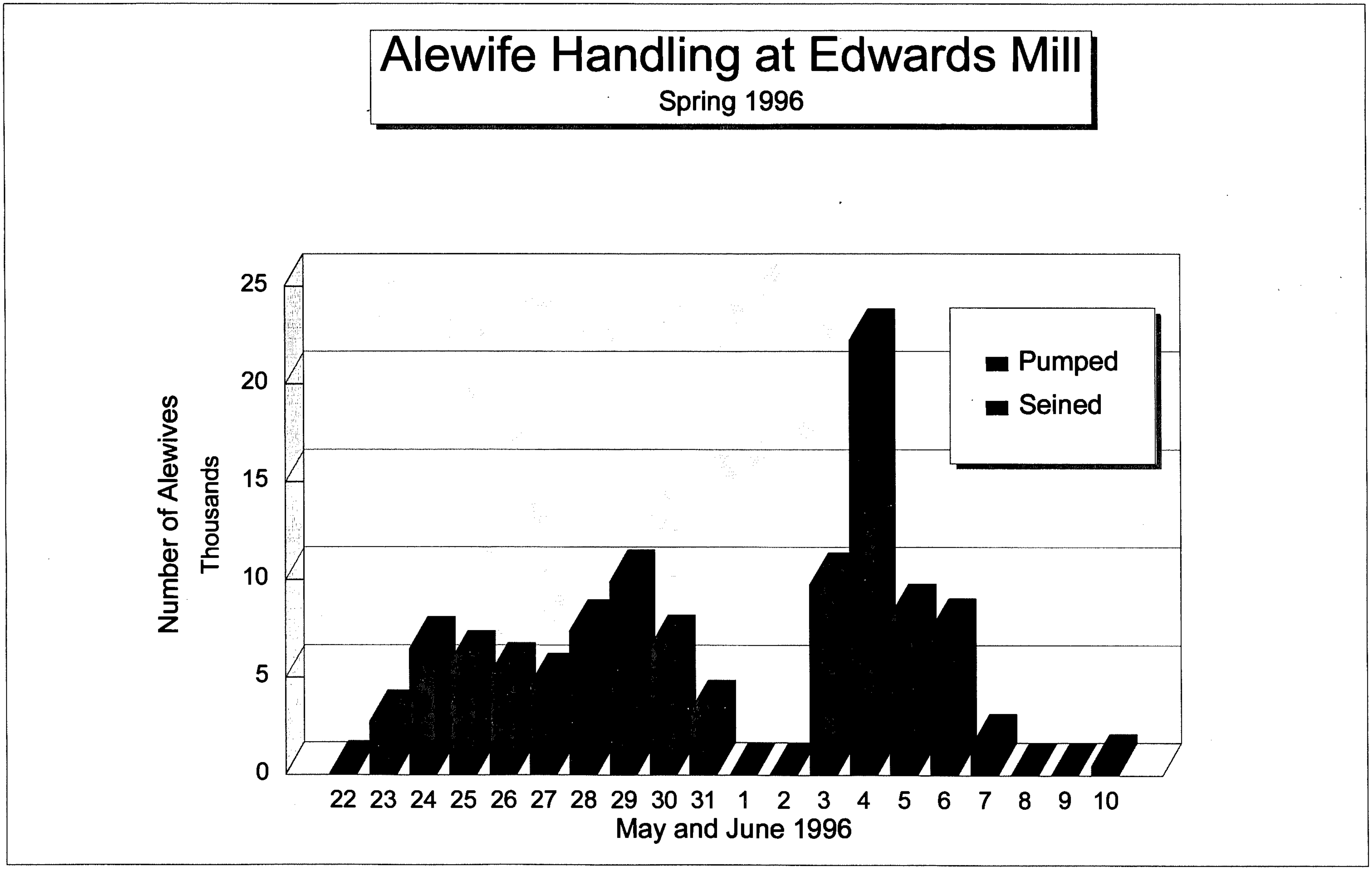
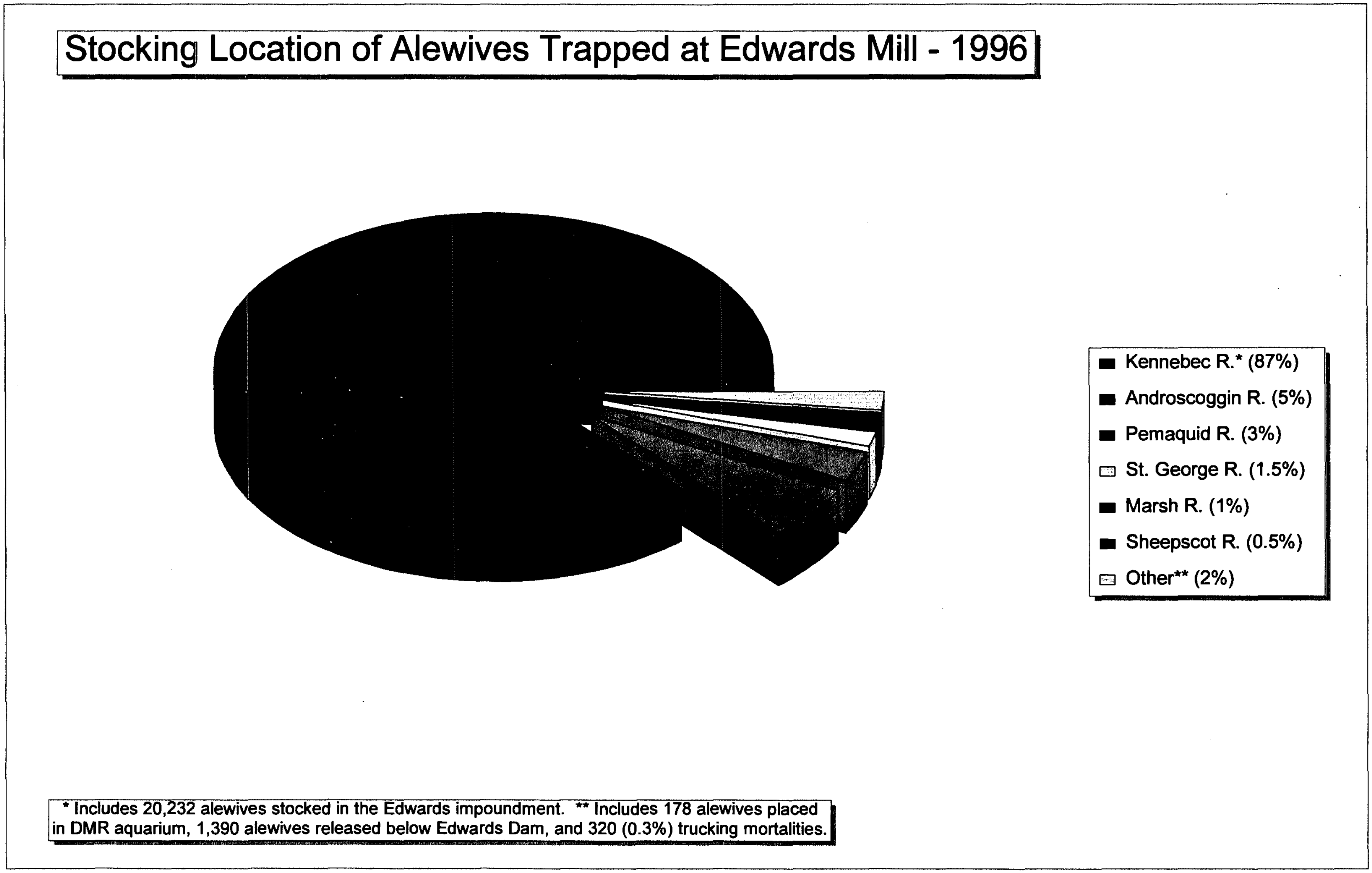

Alewife Handling at Edwards Mill
Spring 1996
Number of Alewives
Thousands
25
20
15
10
5
0
Pumped
Seined
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10
May and June 1996

Figure 3.


Stocking Location of Alewives Trapped at Edwards Mill - 1996
Kennebec R.* (87%)
Androscoggin R. (5%)
Pemaquid R. (3%)
St. George R. (1.5%)
Marsh R. (1%)
Sheepscot R. (0.5%)
Other** (2%)
* Includes 20,232 alewives stocked in the Edwards impoundment. ** Includes 178 alewives placed in DMR aquarium, 1,390 alewives released below Edwards Dam, and 320 (0.3%) trucking mortalities.

but they were not congregated as thickly as they had been at their peak and were spread out over a large part of the river. Some of these fish were probably blueback herring ascending the river to spawn later than the bulk of the alewife run.

The efficiency of trapping at Edwards Dam in 1996 was comparable to the previous seasons of 1995 and 1994. However in 1996, the peak day of pumping on June 4 far exceeded any other year's previous peak day with 22,205 alewives trapped.

YEAR	PEAK TRAPPING DAY
1996	22,205 alewives
1995	10,634
1994	13,050

In 1996, the pump was operated on 18 days and trapped alewives successfully on 15 of those days. Over 3,000 alewives were pumped on 13 days; over 5,000 on nine days; and over 9,000 on three days (Table 6, Figure 2).

The most stocking trips completed to Kennebec drainage ponds in one day was five, on June 3. If the short trips to the Edwards impoundment are included, 10 trips were completed on June 4 (three to lakes, seven to the impoundment) and five trips were completed on June 5 (three to lakes and two to the impoundment). The mode was four trips to the Kennebec drainage ponds in one day. Four trips a day were completed on five days in 1996.

Based on experience gained during alewife trapping at Edwards in previous years, DMR developed a basic standard operating procedure for using the fish pump in an efficient manner. Since all but one of the shad transfers in 1996 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 Mill to coordinate pump operations.

Based on the pump's alewife trapping rate and the time trucks were due back at the site, the DMR 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 the 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 (1,400-1,600) of alewives could be stockpiled in the pump tank. If the double tanker or both trucks were due to return, the maximum stockpile (2,500) of alewives 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 (perhaps as many as 3,200 alewives).

This operational mode allowed loading to be as efficient as possible without sacrificing the quality of the alewives being loaded. Because of efficient loading, the alewives also spent less time in the truck tanks at the loading site. Both these factors helped to 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 Mill 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 DMR/KHDG crew were very important in hauling the large loads of alewives. The porous pipe/oxygen delivery system fitted to the truck in 1992 for American shad hauling was used extensively during the 1996 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 a lesser 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 season. This experimental application continued to work about as well as the porous polyethylene tubing for delivering oxygen, but may be more durable. Evaluation 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 given 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 1996.

The maximum alewife density hauled to the lakes during the 1996 season was approximately 1,500 alewives/1,000 gallons of water per tank. However, seven tank loads of 1,700 to 2,000 alewives/1,000 gallons were transported the short time and distance to the Edwards impoundment. The alewives were observed to be in excellent condition upon their release into the river. These trips only lasted approximately one-half hour from the initiation of loading to the release of the alewives back to the river above the dam. If necessary, it may be possible in future years to experiment with heavier loads like those on the longer trips to the upriver lakes. Significant mortalities may occur and time spent collecting alewives lost will prove less efficient at some theoretical density.

Both of the KHDG project tank trucks ran well during the 1996 stocking season. The PVC plumbing on the twin tank truck received extensive repairs on May 20-21, 1996 after winter breakage was discovered. The tarp protecting the truck tanks came loose and allowed water to enter the plumbing during the winter. Complete repairs were effected, the tanker was returned to service on May 22, and it worked well for the duration of the season.

During the summer and fall of 1996, young-of-the-year [YOY] alewives were captured in six of the eight alewife restoration lakes stocked with adults (Table 8). Juvenile alewives were observed at the outlet dam of Lovejoy Pond but none were captured at Lovejoy in 1996. No YOY alewives were captured or observed at Douglas Pond in 1996. High river flows in the Sebasticook and regular spills over the spillway probably allowed YOY alewives to move over the Waverly Avenue Dam at the Douglas Pond outlet and prevented DMR from readily acquiring samples at the dam since YOY alewives were not delayed at the project site.

Juvenile alewives were captured in five of the ten seine hauls made in 1996. Dip nets and cast nets contributed an additional two samples out of the two attempts completed. A fyke net was used extensively at Pattee Pond to monitor YOY alewife emigration from the lake prior to the installation of a permanent weir on Pattee Pond Brook. The majority of the 1996 alewife emigration from Pattee Pond was trapped by either the weir or the fyke net (in the early part of the 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, after FERC issued an amended license for the project.

TABLE 8. 1996 JUVENILE ALEWIFE SAMPLES FROM PONDS

Ponded Area	Stocking Density[1]	# of Seine Hauls[2]	# of Cast Net Throws[3]	# of Dip Net Dips[4]	# of Fyke Sets[5]	# of Electro Transects[6]	Number of Juveniles[7]	Mean Total Length
Douglas Pond	6.4	0/0	0/0	0/0	0/0	0/0	-------	------
Lovejoy Pond	6.3	0/0	0/0	0/0	0/0	0/0	-------	------
Pattee Pond[8]	6.1	0/1	0/0	0/0	11/21	0/0	*	*
Pleasant Pond	6.1	1/1	1/1	0/0	0/0	0/0	50/1000+	52mm
Plymouth Pond	6.3	0/1	0/0	1/1	0/0	0/0	50/53	71mm
Sebasticook Lake	6.0	1/1	0/0	0/0	0/0	0/0	50/50+	50mm
Unity Pond	6.1	1/3	0/0	0/0	0/0	0/0	50/1000+	39mm
Wesserunsett Lake	6.0	2/3	1/1	0/0	0/0	0/0	150/150+	44mm
TOTALS:		**5/10**	**1/1**	**1/1**	**11/21**	**0/0**	**350/2253+**	

[1]Adult alewives/surface acre
[2]Number of hauls producing alewives/total number of hauls (seasonal total)
[3]Number of throws producing alewives/total number of throws (seasonal total)
[4]Number of dips producing alewives/total number of dips (seasonal total)
[5]Number of fyke net sets producing alewives/total number of fyke net sets (seasonal total)
[6]Number of lake transects electrofished producing alewives/total number of transects electrofished
[7]Number of juveniles measured/total number of juveniles caught (seasonal total)
[8]The Pattee Pond outlet was monitored with a weir or fyke net during much of the season
*See Pattee Pond weir section of this report

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. Mark/recapture studies completed by CMP in 1993 indicated that the experimental four-foot deep, plywood trash rack overlay - used in lieu of installing a reduced clear space trash rack overlay - was not providing the bypass efficiency desired at the site.

Twelve-foot deep, fine mesh, plastic screens attached to support frames were tested as a new alternative trash rack overlay in eight separate trials during the 1994 season. While the plastic mesh screens were effective at preventing the alewives from passing through the upper portion of the trash racks, YOY alewives sometimes sounded and passed under the plastic screens into the forebay. This was especially noticeable when the alewife density near the trash racks was high. In addition, the plastic mesh was difficult to clean and was apt to tear when heavily fouled with debris.

CMP tested a metal punch plate trash rack overlay during the 1995 season. Rack overlays up to 12 feet in depth were tested in 1995. Two different sized punch holes were compared for fish impingement, fish exclusion, ease of cleaning, and durability. Cleaning was accomplished by using a compressed air wand to blow debris off the face of the punch plate after the turbines were shut down to reduce water pressure on the debris.

Testing of the punch plate overlays in 1995 was promising. Cleaning was easy with the compressed air and the tearing common to the earlier plastic system was eliminated. DMR observed large numbers of YOY alewives passing through the downstream facilities on three visits in 1995 and the arrangement seemed to direct many YOY alewives away from the turbines and through the downstream bypass to the river below the dam. However, DMR did observe YOY alewives inside the punch plate overlay, in the forebay at Fort Halifax on October 11, 1995, despite the downstream bypass being fully operational. These observations and one possible explanation are discussed in the 1995 version of this report.

During early 1996, CMP and the state and federal resource agencies met and decided that the metal punch plate overlay system would be installed again for the 1996 downstream passage season. The configuration previously described was operated for the 1996 alewife emigration period to allow further study and assessment.

DMR first visited Fort Halifax in 1996 on July 18 and observed high river flows and spill over the spillway through missing flashboards. These conditions also were noted on July 29 during the next site visit. The downstream bypass was open and operating on both these visits. The subsequent visit on August 14 confirmed that passage was still afforded by the downstream bypass, although alewives had not yet been sighted at Fort Halifax in 1996.

DMR first sighted YOY alewives at Fort Halifax in 1996 on August 28. DMR personnel observed 100-200 YOY alewives in the turbine pit, inside the punch plate trash rack overlay. One turbine and the downstream bypass were operating at the time of these observations. CMP records indicate the downstream bypass weir was open to a depth of two feet on August 28. No other alewives were observed in the headpond outside the racks, or using the downstream bypass, or anywhere else at the site.

DMR next observed YOY alewives at Fort Halifax on September 10, 1996. On this visit, alewives were noted in the headpond, near the trash racks, and very near the downstream bypass (probably passing through it). Once again, YOY alewives were observed in the turbine pit, inside the punch plate trash rack overlay. DMR personnel observed an estimated thousand plus alewives swimming in the upstream forebay and also noted that a turbine and the downstream bypass were both in operation at this time. DMR personnel observed over 1,000 YOY alewives swimming in the Unit #1 (upstream) forebay and also noted that both the turbine and downstream bypass were in operation at this time. CMP records indicate that both turbines were operating at 50% capacity and that the downstream bypass weir was open to a depth of two feet at the time of the DMR observations on September 10.

On October 2, DMR's Lew Flagg and Nate Gray and Ben Rizzo, representing the USF&WS, met CMP's Bob Richter at the Fort Halifax Project. All personnel present observed large numbers of YOY alewives in the Fort Halifax headpond and as well as YOY alewives using the downstream bypass. During this visit, no alewives were observed in the project forebays and CMP records have shown that the downstream bypass weir was open to a depth of three feet.

DMR personnel observed YOY alewives once again at Fort Halifax on October 24, DMR's last visit to the site in 1996. Alewives were observed in the project headpond, passing through the open and operational downstream bypass, and in the river below the dam. No alewives were visible in the forebays on October 24. CMP records indicate that the downstream bypass weir was open to a depth of three feet at the time of these observations on October 24.

As in 1995, the punch plate trash rack overlay appeared to divert significant numbers of alewives away from the turbines and through the downstream bypass at the Fort Halifax facility and it continued to show promise regarding cleaning and reliability as well. DMR believes that CMP has developed a plausible passage system, insofar as most of the design, engineering, operational and maintenance components of the trash rack overlays have been refined. facility's perceived efficiency. DMR will review

CMP's 1996 Fort Halifax downstream passage report after it is completed and will meet with CMP to evaluate the results and discuss future downstream passage at the site.

Overall, DMR made nine visits to the Fort Halifax Dam in 1996. The fish bypass was open and operational on all nine visits (see Table 9).

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 re-enter the headpond. Large numbers of juvenile alewives were observed passing through the facilities while they were operated during the 1988-1995 seasons.

During the 1990-1993 seasons, KHDG conducted downstream passage studies at Benton Falls using VHS cameras to count fish passing through the facilities. The successful study work in 1990 led to the continuation of the study in 1991 and 1992. In 1993 and 1994, Benton Falls Associates continued the study work to collect additional data on downstream fish passage efficiency. VHS cameras were placed over the weir intakes located over both turbines and the camera at the large turbine weir intake recorded fish passage throughout the season. The large turbine weir intake is open throughout the migration period and the small turbine weir intake is typically closed.

July, 1996 marked the release of American shad fry above Benton Falls for the first time since the initiation of the restoration program. Fry were released below the next project upstream (known as Burnham Dam) and so were capable of using as nursery habitat the extensive riverine segment below Burnham Dam as well as the Benton Falls impoundment. This topic is explored further in the American shad section of this report, but is of interest here due to the potential presence of YOY shad along with the YOY alewives normally sighted at the Benton Falls Project. DMR personnel felt comfortable discriminating between alewife and shad YOY based on school behavior, when the two species were in distinct schools. However, the observations below are noted as "alosids" rather than one species or the other without having them in hand from an actual sample. DMR does believe, based on the observed fish behavior, that YOY shad were present on all days alosids were observed except for the possible exclusion of October 24.

DMR personnel observed the Benton Falls downstream passage during 12 visits in 1996. The bypass was open and operating on all 12 of these site visits. DMR observed YOY alosids (possibly alewife or American shad) during six visits at Benton

TABLE 9. DOWNSTREAM PASSAGE OBSERVATIONS AT HYDROELECTRIC FACILITIES - SEBASTICOOK RIVER, 1996

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly
7/02	-	-	X	X	X
7/18	X	X	X	X	X
7/25	-	X	X	X	X
7/29	X	-	-	-	-
7/30	-	X	X	X	X
8/14	X	X	X	X	X
8/28	Xf	X	X	O	X
8/29	-	X	X	-	-
9/03	-	X	O	X	X
9/05	X	X	-	-	-
9/10	Xaf	Xa	X	O	X
9/23	X	X	X	X	X
10/02	Xa	-	-	O	-
10/09	X	X	X*	O	X
10/24	Xa	X	X	O	X
11/04	-	-	-	X	X
TOTAL NUMBER SITE VISITS:	**10**	**12**	**12**	**13**	**12**

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 = Only passage available over dam spillway

Falls in 1996: August 28, 29; September 3, 5, 10; and October 24. On the two August and the September 3 sightings, the alosids were observed to be schooling in the headpond above the project. On September 5, DMR attempted to sample the alosids to confirm the species composition of the schools sighted, but problems with the project boat prevented a sample collection. Extensive numbers of YOY alewives and shad were later collected in the Benton Falls impoundment with the use of an electrofishing boat. Further information about this sample collection can be found in the American shad section of this report.

DMR personnel observed dense schools of YOY alosids in the project headpond on September 10 and observed fish passing the bypass in high numbers. DMR last observed alosids at Benton Falls on October 24, 1996. Alosids observed on this date were believed to be alewives rather than shad or an alewife/shad mixture and were sighted moving about in the project headpond.

DMR first visited the **Burnham Dam** on July 2, 1996 to attend a FERC inspection at the site. 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 interim downstream passage. This type of controlled spill for downstream passage has been utilized in past years at the Burnham Dam.

Some level of controlled spill was available as an interim downstream bypass during 11 of the 12 DMR visits to Burnham in 1996. No bypass flow was available on September 3, when some work on a turbine was underway. However, low bypass flows were observed during two DMR visits in 1996: on both August 14 and October 9, bypass flows were only approximately 12 inches in depth. These low bypass flows are due to variations in headpond level since the crest of the notched flashboard comprising the temporary bypass is of fixed height. This flow may lack the volume needed to attract emigrating alewives and prevent them from being entrained in the project penstock. Alewife entrainment is already a concern at the site at higher bypass flows.

DMR visits on August 28 and 29 coincided with the installation of new trash racks and supporting structures at Burnham. The old wooden racks had collapsed under the strain caused by a floating, marshy island that had become caught on the racks in earlier high river flow conditions. The headpond was drawn down to river bed level and run-of-river flow was passing the open stop log bays at the project. DMR's Tom Squiers and CHI's Kevin Webb agreed via telephone that downstream passage at the project during the pond refill would be maintained by freewheeling a turbine during the refill, since no gate is present at the project to allow a controlled spill during refill. USGS flow records downstream did show a period of time with no minimun flow, but this was probably caused by the delay in filling the pond to the level necessary to put flow through the penstock and into the freewheeling turbine.

DMR did not observe any alewives using the controlled spill for downstream passage in 1996. As was noted in several KHDG Project reports, alewife entrainment problems at Burnham may be related to the distance between the controlled spill and the penstock intake, the wide clear space of the station's racks, and/or the ratio of water flow through the controlled spill vs the turbine. This latter hypothesis is supported by observed low bypass flows due to headpond fluctuations, as mentioned above.

DMR observed injured and dead YOY alewives exiting the turbines at Burnham on October 9, 1996. October 9 was also one of the days noted above as having very low bypass flow due to a depressed headpond level. This correlation was observed twice in 1995. After this observation was made again in the fall of 1996, DMR did seek increased bypass flows by requesting additional flashboards be notched to increase interim passage opportunities at the Burnham Project, at least during the peak of the downstream migration. CHI did not agree that increased interim bypass flows were necessary at Burnham and declined to provide them at the current time.

From 1987 through 1993, downstream passage at the **Pioneer Dam** in Pittsfield has consisted of intermittent controlled spills over the crest of the spillway. Construction of the downstream bypass at Pioneer began during the summer of 1990. The wood bypass trough and associated concrete work were completed during the summer and fall of 1993. During the 1994 season, bypass sluice stop logs were added near the entrance to the downstream bypass. These stop logs were added to control flow through the bypass and to prevent alewives from backing out of the bypass flume after entering it.

Pioneer's owner, Chris Anthony, has attempted 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 for much of the 1996 passage season does have a small clear space and would probably physically exclude alewives from passing through it. However, it does not fit securely and gaps are sometimes present. The biggest problem with this fine mesh overlay is that it apparently clogs very rapidly when a turbine is operated. 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.

There are still several problems at the Pioneer site which will need to be resolved. First, the overlay should be improved so as to be operable and cleanable - and then maintained - 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, the bypass is usually stop logged to further restrict bypass flow. More flow through the bypass, routine checks to adjust bypass flow, and regular debris removal would be an improvement over the current conditions. The project's owner has requested that he be allowed to install flashboards at the site. This would provide deeper bypass flows given the current elevation of the bypass. 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.

Of the 13 site visits conducted by DMR in 1996, five visits revealed that no downstream passage was available at the site. On seven of the days when some limited passage was available, less than four inches of water was flowing through the bypass. The trash rack overlay was absent on another four days and fouled with debris (rendering it ineffective) on another day. DMR had to clean debris from the bypass flume on yet another site visit in order for it to be effective. Turbines at the site were running on two days when absolutely no downstream passage was available. Spill over the project spillway provided the only downstream passage available on two days. In addition, DMR noted that repairs to the downstream bypass trough were needed since high water had pushed some of the flume boards off their supports from the outside and forced them into the interior of the flume, partially blocking the flow and trapping debris.

DMR's first 1996 visit to the **Waverly Avenue Dam** on July 2 coincided with a FERC inspection of the site. One major change which immediately became apparent was that the site had been off-line since February, 1996 when the plant's gearbox failed. With no immediate plans for repairs to the site and no repairs completed during the 1996 passage season, downstream passage centered on fish passing over the spillway where most of the river flow at the dam was going.

During the July 2, 1996 visit, several other problems with the downstream bypass and its operations that were noted in previous seasons were reexamined. First, gate leakage at the stop log bays on the far side of the spillway from the powerhouse remained a problem. This leakage causes downstream migrants to be attracted away from the bypass during low flow conditions. Second, the bypass itself was in a poor state of repair with several broken boards partially clogging the trough of the bypass and collecting more debris as it passed by. 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. However, the problems were minimized by the lack of generation at the plant in 1996 and the frequent spill at the site during the passage season.

DMR visited Waverly Avenue on 12 days in 1996 and found passage via spill over the spillway on nine of these days. Some passage was available through the bypass on the other three days, although clogging and broken boards were a problem on all three days. DMR sighted YOY alewives in the headpond at the site on three days in 1996: August 28, September 3 and 10.

DMR will continue to pursue repairs and modifications at Waverly Avenue to improve downstream passage at the site for future years. This will become critical when gearbox repairs are completed. If turbine operation during the migration season is reinstituted, the appropriate angle rack or trash rack overlays will need to be installed prior to the initiation of generation.

During the summer and fall of 1996, DMR personnel made observations on 16 different days at the downstream passage at **Edwards Mill** on the Kennebec River. Adult or YOY alosids were observed in the forebay near the downstream bypass on nine of these visits. Adult alewives were observed in the forebay on three days, while adult American shad were observed on one day. Adult alewives or American shad were not observed using the downstream bypass during site visits in 1996.

DMR observed YOY alosids, either alewives or shad, in the Edwards forebay on six visits in 1996. Alosid YOY were observed using the downstream bypass on four of these six days.

Samples of YOY alosids were collected at Edwards Mill whenever possible during the 1996 passage season. Samples were collected on seven different days in 1996, from August 21 to October 2. Samples were collected with scoop net, dip net, and fly rod. In total, 187 YOY American shad were collected from the Edwards Mill forebay during the 1996 season. YOY shad were collected on all seven sampling days, as were 193 YOY alewives. The American shad YOY may have been the progeny of adult broodstock transfers from the Connecticut River or survivors of the 1996 fry stocking from the Medomak Hatchery to the Edwards impoundment.

Adult American shad were observed in the Edwards Mill forebay on only one day in 1996, on June 19. These shad were survivors of the broodstock transfers in June from the Connecticut River. The observation of these shad indicates that some survived the transfers and did not suffer mortality immediately after stocking. Fewer postspawner shad were observed in the Edwards forebay in 1996 than in previous years. Several factors may have contributed to fewer shad observed this year: first, only three transfers from the Connecticut occurred in 1996, so there were fewer fish placed in the impoundment. Second, high river flows in the Kennebec throughout early and mid-summer allowed fish to pass over the Edwards Dam spillway with the large and long-lasting spills taking place this year.

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; only those changes which occurred during the 1996 shad hauling season will be noted in this report.

Changes for the 1996 hauling season included hauling adult prespawner shad from the Hadley Falls facility to the Westfield River above the first fishway. These additional transfers of fish represent the most significant change to the 1996 shad hauling season. The Connecticut River was subject to extreme high water flows during the hauling season which contributed to the poor overall condition of adult shad broodstock received at the Hadley Falls facility. All transferred adult shad were stocked at the Waterville boat launch; this site is preferred because of its proximity to prime spawning habitat.

During the 1996 field season, the Edwards Dam #7 and #8 turbine forebay and the Benton Falls Dam impoundment were sampled to obtain information on the abundance of juvenile shad. Sampling in 1996 was accomplished using again the five different types of gear utilized in 1995: dip nets, fly rods, cast nets, electro-shocking and shad scoop nets. With all five types of sampling gear, fish collected were identified by species, shad were enumerated, and a sample measured for total length.

RESULTS & DISCUSSION: American shad

A fish health inspection was performed on the Connecticut River shad stock in the spring of 1996. A 150-fish sample of adult American shad was collected at the Holyoke fish lift on May 15, 1996. Kidney and spleen samples were taken in accordance with the AFS Fish Health Blue Book Procedures and returned to Dave Tillinghast of 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 were necessary to comply with state law concerning importation of live fish and eggs into Maine waters.

Adult Transfers -

Since 1991, the Connecticut River has been the **only** source for shad broodstock introductions into the Kennebec. In total, 515 shad were loaded at Holyoke; 513 were stocked at the Westfield River for a trucking mortality rate of .4%. Three shad transfers were completed from Holyoke to the Kennebec River between June 5 and June 9, 1996. Of the 692 shad loaded at Holyoke, 462 were stocked into the Kennebec for an overall trucking mortality of 33.3%. Results of the 1996 shad transfers are presented in Table 10.

The remote DO probe mounted on the tank truck in 1992 was used again for the 1996 stocking season and was connected to a Model 57 YSI DO meter located in the cab of the truck. This system allowed constant monitoring of DO levels while the fish were loaded and also allowed DO levels to be maintained while on the road.

The commercial anti-foam agent (NO FOAM) was used again during the 1996 shad hauling season.

TABLE 10. AMERICAN SHAD STOCKING IN THE KENNEBEC RIVER, 1996

ADULT SHAD TRUCK STOCKING:

Date	Broodstock Source	# Loaded	# Morts	# Stocked	Site	Water Temp C° Source	Water Temp C° Kennebec
6/05	CT River, Holyoke	254	67	187	Wtvl	18.50	---------
6/07	CT River, Holyoke	193	64	129	Wtvl	19.00	16.00
6/09	CT River, Holyoke	245	99	146	Wtvl	20.00	18.00
TOTALS:		**692**	**230**	**462**			

TRUCK STOCKING:	**462**
FISH PASSAGE:	**+ 0**
TOTAL STOCKED:	**462**

TABLE 11. HISTORICAL AMERICAN SHAD STOCKING IN THE KENNEBEC RIVER

River Source	Lower Kennebec River Georgetown			Narraguagus River Cherryfield			Connecticut River Holyoke			Kennebec River Edwards Fish Pump		
	L	M	S	L	M	S	L	M	S	L	M	S
1996							692	230	462			
1995							1666	148	1518			
1994							1435	537	879			
1993							1378	498	880			
1992							1323	329	994			
1991							1113	474	639			
1990				56	20	36	991	423	568			
1989				180	6	174	600	156	444	2	1	1
1988							965	349	616			
1987	28	12	16	185	2	183						

L = Loaded
M = Mortalities
S = Stocked

Juvenile Sampling -
One of the most effective gear types used to sample 1996 YOY alosids was a fly rod. This simple yet effective tool could be easily employed at the #7 and #8 forebay to collect samples of both YOY shad and alewives. On August 27; September 4, 9, 23, 30; and October 2, 1996, a total of 164 juvenile shad were captured using this method.

The shad scoop net was again used in the #7 and #8 turbine forbay to sample YOY alosids. On August 21, 1996 the scoop net captured 23 juvenile shad. Unfortunately, during this operation the scoop net was lost and became entrained on the racks of the turbine intakes. A subsequent search with a pick pole failed to turn up the missing net. A new net was obtained later in the year but was not deployed again.

The cast net was used on several occasions in the forebay of #7 and #8 turbines at Edwards Dam. The net was deployed on several occasions in the more shallow portions of the forebay and a few alosids were sampled; none of the alosids sampled with the cast net were shad.

A dip net was utilized throughout the 1996 season to take biological samples at the Edwards Dam interim downstream bypass; this net was used when YOY alosids were observed using the downstream bypass. Early in the field season, Edwards Dam employees installed a chainlink fence in front of the downstream bypass for safety reasons. This fence effectively cut off the use of the dip net and therefore no YOY shad were captured using this method.

In total, KHDG-funded personnel captured 187 juvenile shad in the Edwards impoundment in 1996. DMR is working on methods to discriminate between hatchery-raised and broodstock YOY shad. This could prove to be an important program assessment tool.

On September 6 and 19, 1996, the Benton Falls Dam headpond was sampled with the electrofishing boat. On several visits to this area, what appeared to be YOY shad were seen dimpling and jumping on the surface. Since this impoundment is very steep sided and access is limited, it was decided that the electrofishing boat was the best sampling device. A total of 70 juvenile shad were sampled in the impoundment using the electrofishing boat.

Shad Culture -
The experimental shad culture program initiated in 1991 was continued in 1996. The shad restoration program on the Medomak River is a cooperative program between the Department of Marine Resources (DMR), the Kennebec Hydro Developers Group, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development

Project, which was created and administered by the local Time & Tide Resource Conservation and Development Organization.

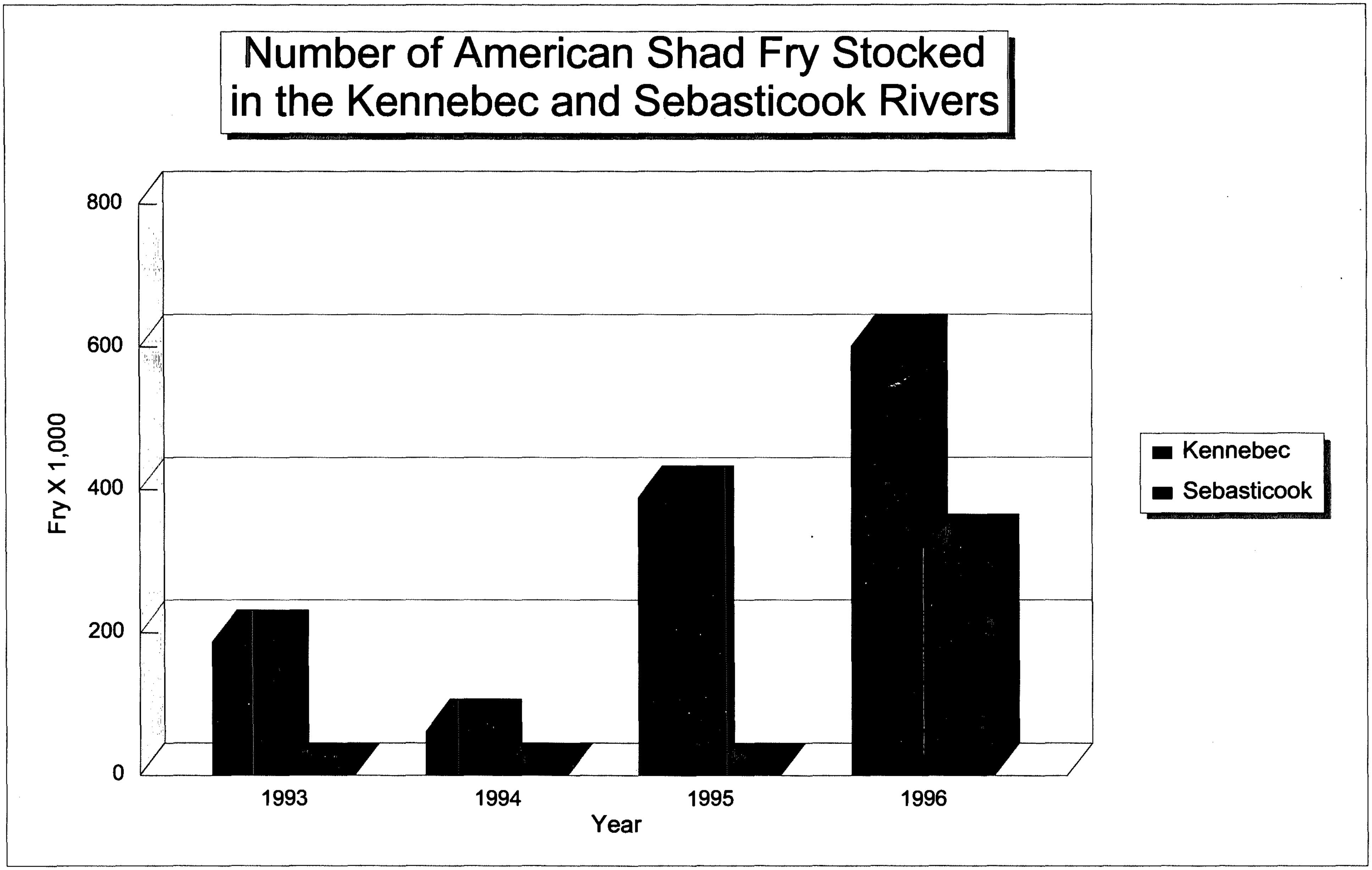
On the evenings of June 1-10, 1996 a total of 1,824,736 eggs were taken from ripe and running females, equating 49 liters. These eggs were transported to a small hatching facility located at the site of the former Medomak Canning Company in Waldoboro, Maine. The eggs were disinfected and then placed in four custom-built upwelling egg incubators where they remained until hatchout. Of the 1,824,736 eggs taken, an estimated 1,405,600 ultimately hatched. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp.

On June 24, an estimated 599,990 shad fry ranging from 14-23 days old were released into the Kennebec River at the Waterville boat launch. 320,000 shad fry were released in the tailrace of the Burnham Dam on the Sebasticook River. The history of shad fry stocking in the Kennebec and Sebasticook Rivers is represented in Figure 4.

DMR's decision to stock a portion of the shad fry available in 1996 into the Sebasticook River was based on several factors. DMR sought to ensure that returning adult shad could be collected and used for the future tank spawning egg take in the shad hatchery. Using shad broodstock collected from the Kennebec is preferred over continuing to collect broodstock from out-of-state. Fry stocked in 1996 would return in 2001 as five-year-old spawners. During this five-year period, the Edwards Dam relicensing is likely to be resolved. If Edwards Dam is removed, returning shad would have free access to Waterville. Fry stocked below Lockwood and Fort Halifax Dams would not 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 would be a more effective means of acquiring live, healthy broodstock than gill netting or attempting to trap shad in the open segment of the Kennebec River below Waterville.

DMR viewed the Sebasticook River as the logical choice to receive some of the shad fry in 1996 rather than the Kennebec above Lockwood Dam for two reasons, both related to fish passage. First, DMR 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. DMR believes stocking shad fry on the Sebasticook above these dams is a more reasonable action than stocking fry above Lockwood or HydroKennebec, both of which currently have no downstream passage.

Figure 4.



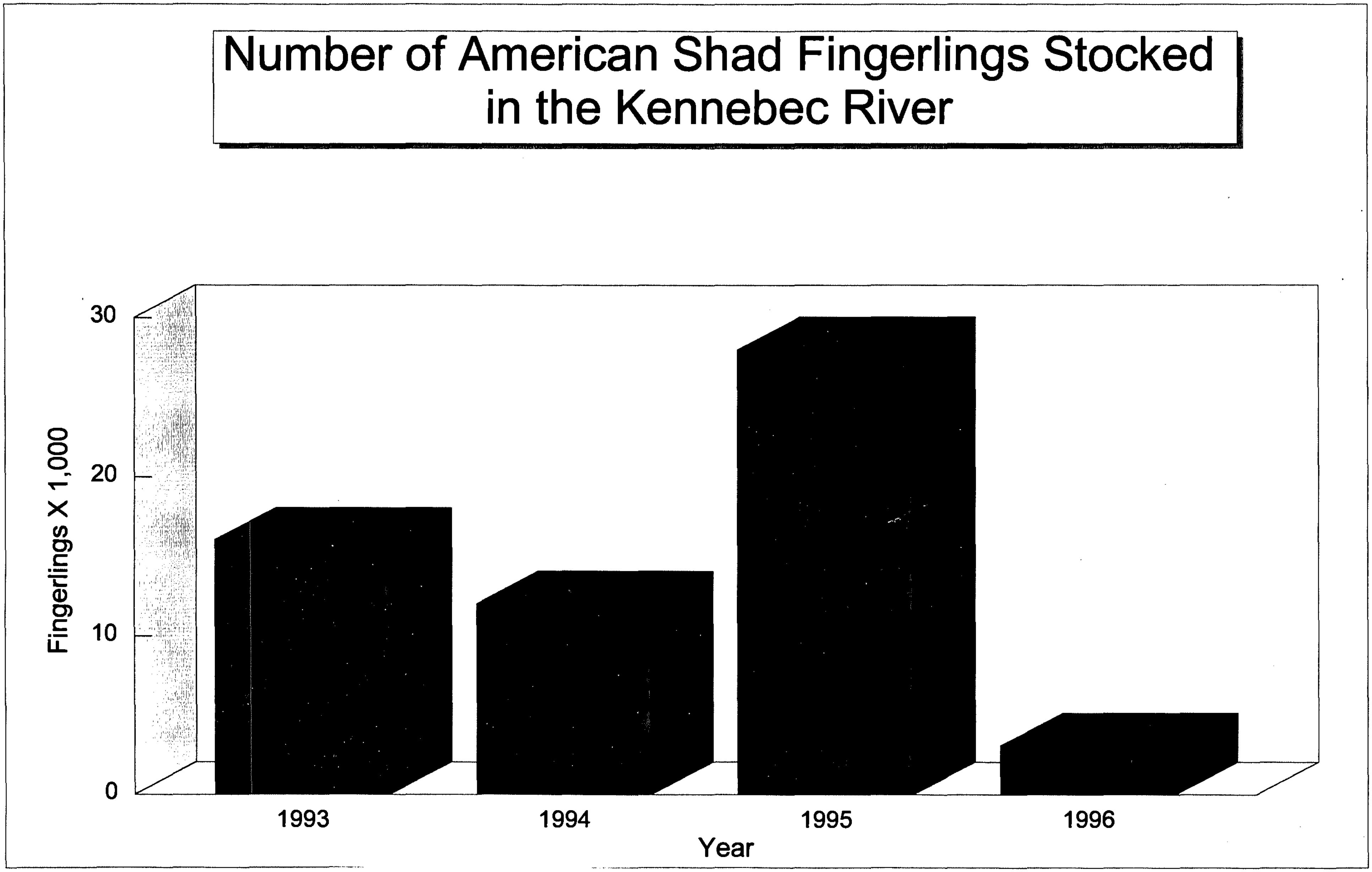
Number of American Shad Fry Stocked in the Kennebec and Sebasticook Rivers
800
600
400
200
0
Fry X 1,000
1993
1994
1995
1996
Year
Kennebec
Sebasticook

Furthermore, DMR did not want to stock all of the increased number of fry available in 1996 in one river segment. Since the 919,990 fry available for release in 1996 was more than twice the number of fry produced in 1995 (the previous record), DMR 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, DMR chose that section of the Sebasticook below the Burnham Dam and above Benton Falls to receive the shad fry because of the large amount of quality habitat available in this long segment. DMR believes this area is highly productive and conducive to good shad growth. American shad YOY collected by DMR above Benton Falls on September 9, 1996 had a mean total length of 73mm (n=69), appeared to be in good condition and were observed to be feeding actively on the surface prior to their capture.

The remaining fry were stocked into the three culture ponds at the hatchery and raised until late fall. On October 17 and 22, 3,070 fall fingerlings 2-6" in length were stocked into the Kennebec impoundment at the Waterville boat launch. The history of shad fall fingerling stocking in the Kennebec is represented in Figure 5.

Figure 5.



Number of American Shad Fingerlings Stocked in the Kennebec River
Fingerlings X 1,000
30
20
10
0
1993
1994
1995
1996
Year

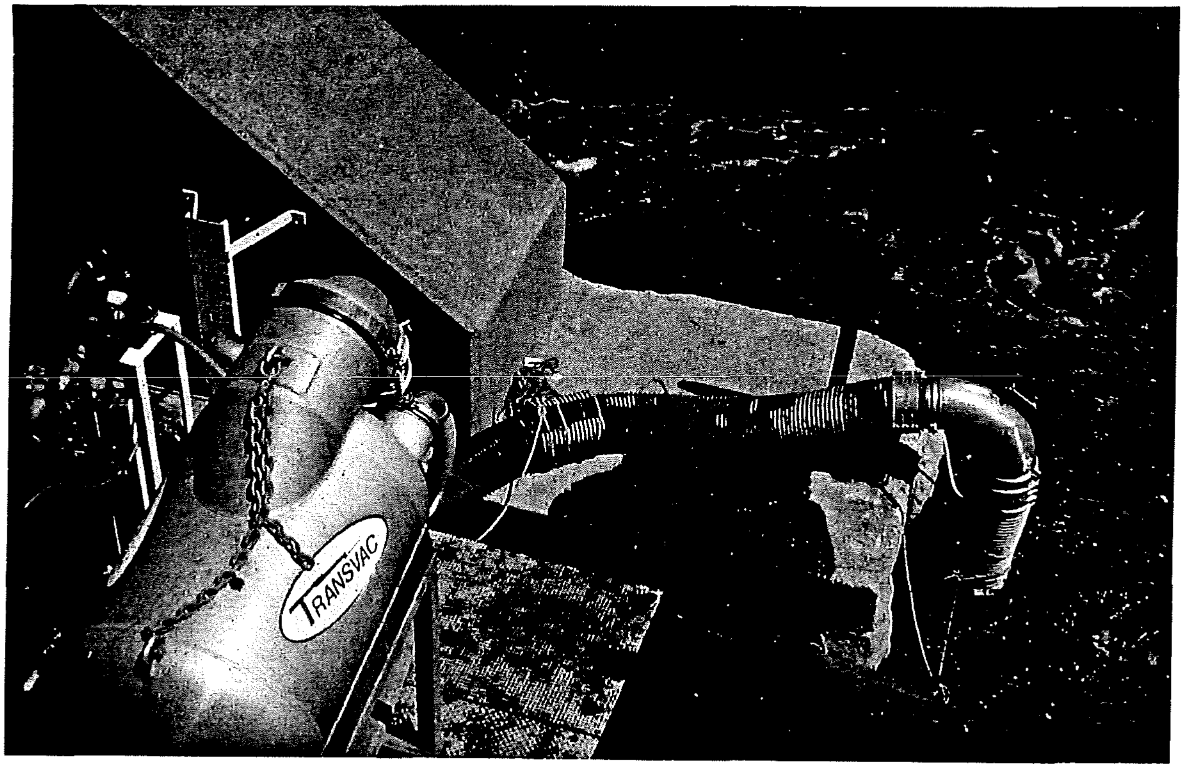


Figure 6: The fish pump used to trap alewives at Edwards Dam. Notice the intake pipe located adjacent to the concrete footing (intake location used during the later part of the 1996 season).

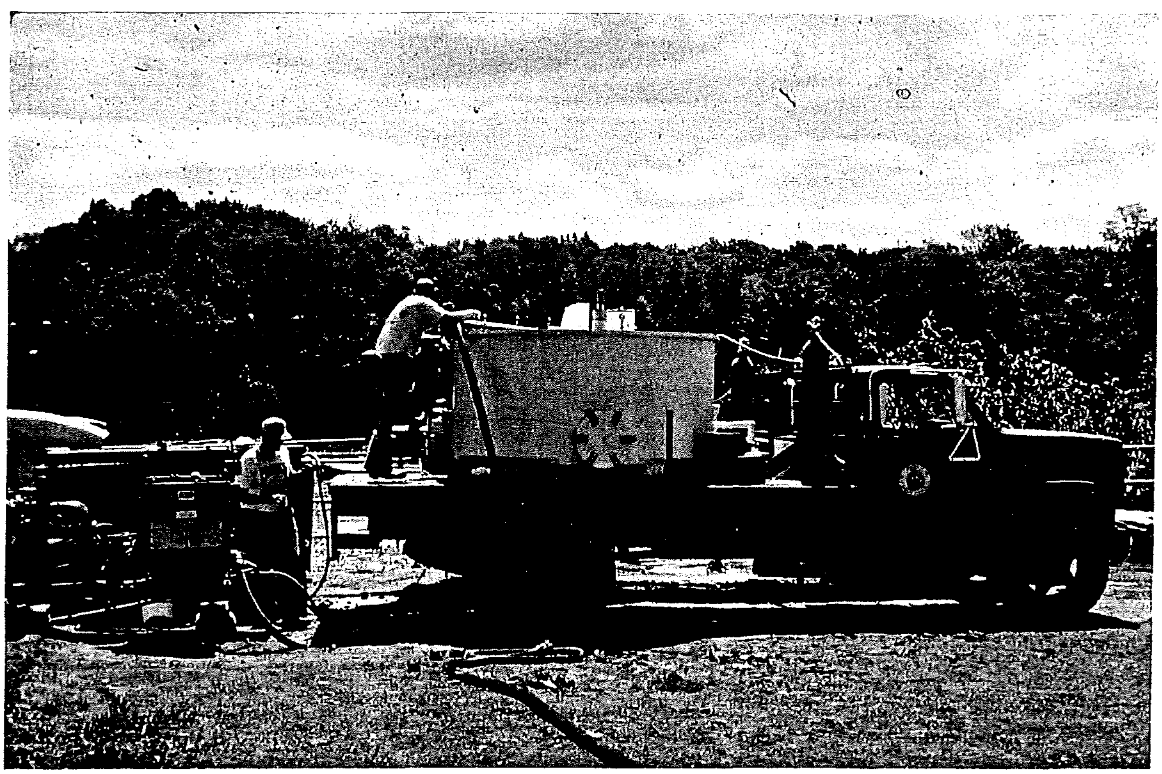


Figure 7: Prior to alewife loading at the Edwards Dam fish pump. Notice the holding tank behind the stocking truck with pump discharge pipe at far left. Fish pump controls are in front of the holding tank.

Figure 8: Alewives are sorted, counted and loaded in a stocking truck tank after their removal from the Edwards Mill fish pump storage tank with a dip net.

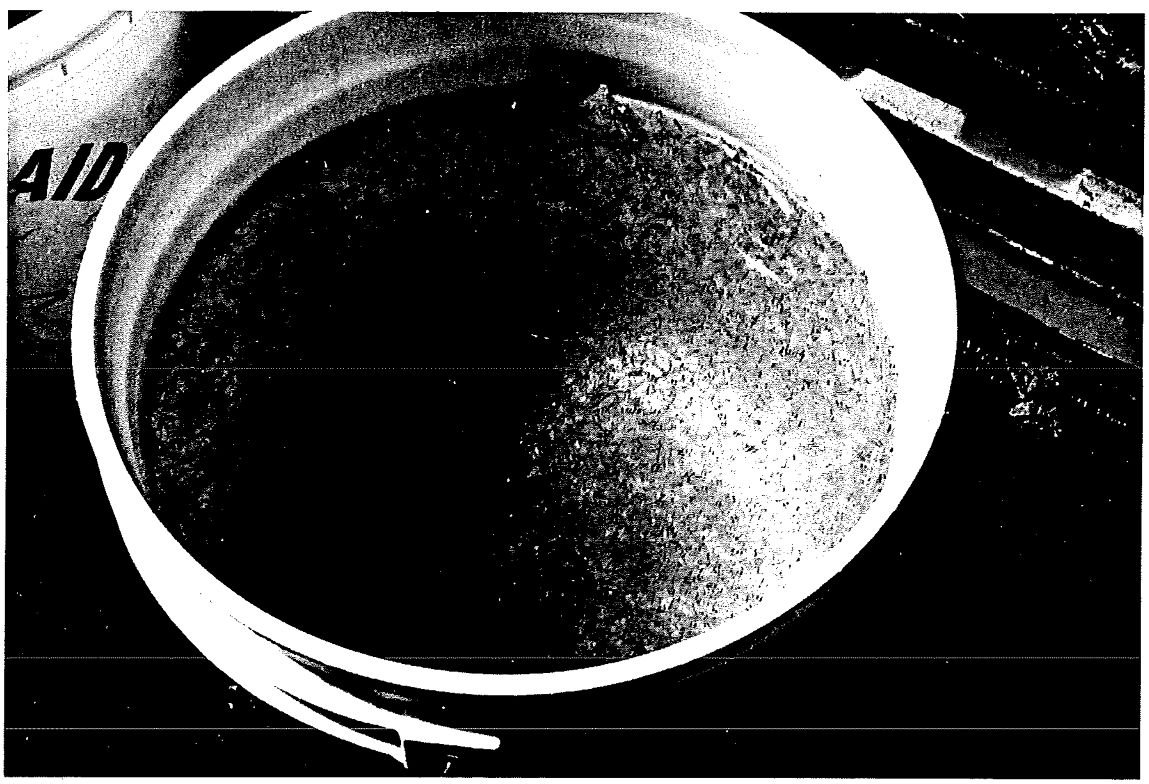


Figure 9: American shad fry (14 to 23 days old) hatched and raised at the Waldoboro hatchery. Fry have been removed from the culture tank and are ready for loading in the transport tank.

Figure 10: American shad fry are placed in the transport tank for the trip to the Kennebec drainage. Notice oxygen bubbles in the tank on the far left.

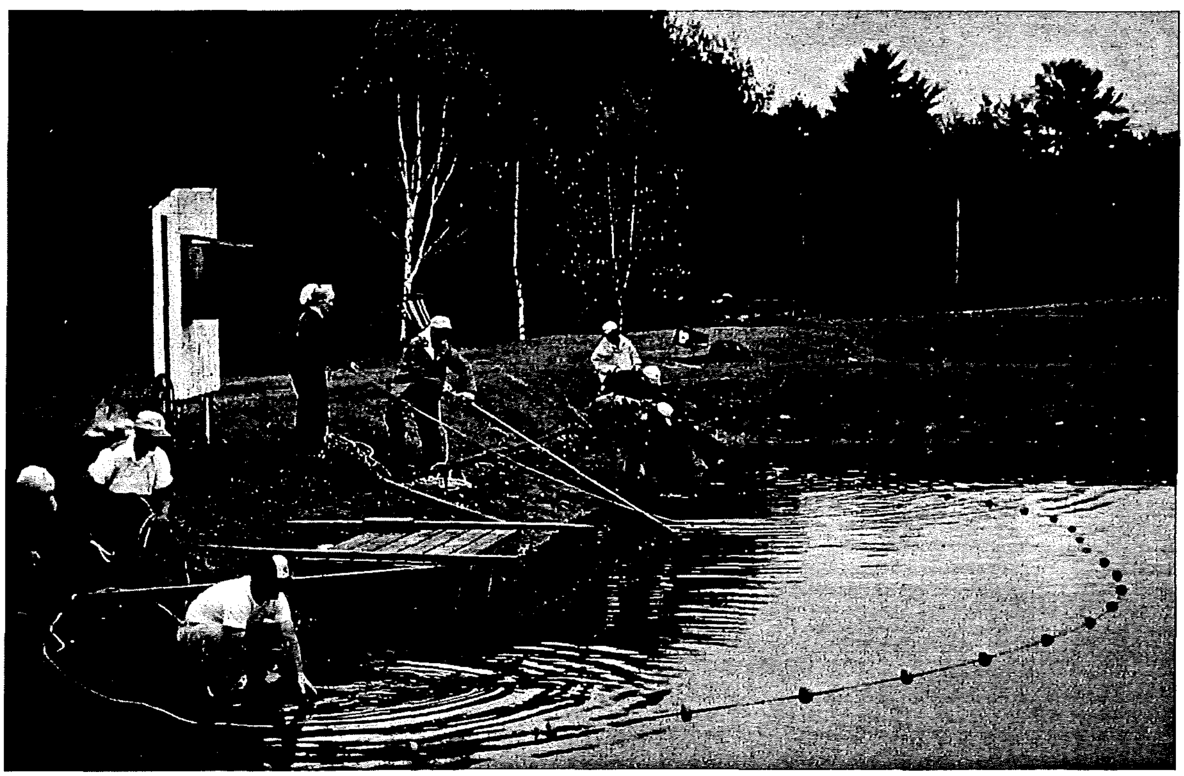


Figure 11: American shad fall fingerlings are seined from the rearing ponds at the Waldoboro hatchery in preparation for transport to the Kennebec River drainage.

Figure 12: American shad fall fingerlings caught in the seine from the Waldoboro hatchery rearing ponds.

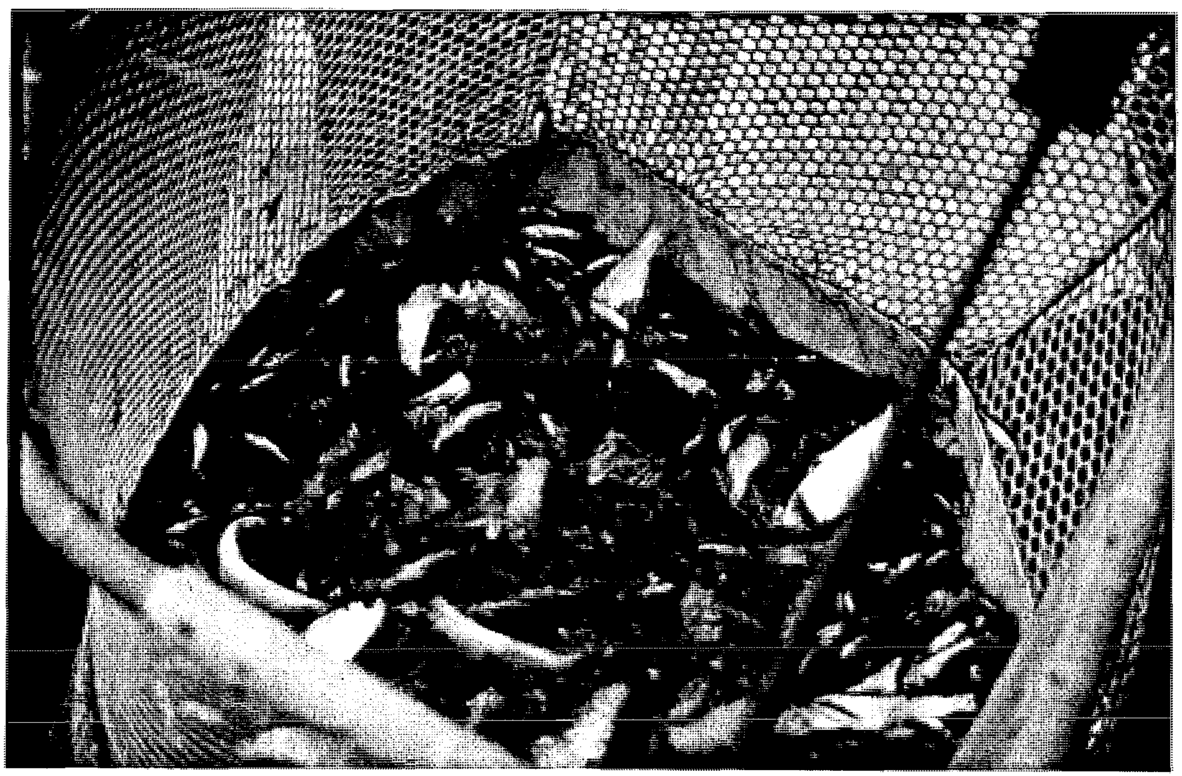


Figure 13: American shad fall fingerlings in a dip net after removal from the seine and prior to being placed in the stocking truck tank for transport to the Kennebec River drainage.

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, DMR did not make any attempts to seine Atlantic salmon in Bond Brook during the summer of 1996.

The experimental fish pumping system at Edwards Dam failed to entrain any Atlantic salmon during the past season.Throughout the 1996 field season, several Atlantic salmon were observed in both the upper and lower powerhouse tailraces, as well as at the base of the dam.

During the 1996 summer, as many as a dozen Atlantic salmon were seen below the Mt. Vernon Avenue Bridge in downtown Augusta. Numbers of salmon sighted varied throughout the season due to tidal conditions and weather; the numbers observed did not approach those seen during the 1995 field season. Bond Brook temperatures average 5-7°C cooler than those of the Kennebec main stem during the height of summer and thus provide much needed refuge from the warm water conditions of the Kennebec. DMR personnel visited the Mt. Vernon Avenue site regularly during the warm summer months when salmon were in residence to keep track of numbers and discourage opportunistic poaching.

DMR personnel assisted the Laconia, NH branch of the USF&WS in electrofishing Bond Brook and Togus Stream in order to compile DNA analysis on the stocks using these two water bodies for reproduction. Juvenile indices for spawning success can also be inferred from this study, as well as age structure of juvenile salmonids. Sampling was conducted on October 30 and 31 in Bond Brook and Togus Stream, respectively. DMR and USF&WS personnel shocked and captured juvenile Atlantic salmon, adult salmon, and juvenile and brown trout during the surveys.

INTERIM PROGRESS REPORT ON THE LAKE GEORGE STUDY

In 1987, DMR entered into a nine-year cooperative study with DEP and IF&W to explore the interactions of anadromous alewives and resident freshwater species. DMR'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, freshwater 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 - 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:

<u>PHASE I</u> - 4 years

A. Determine age distribution and growth rates of landlocked smelts annually (IF&W)

B. Determine population abundance of landlocked smelt annually (IF&W)

C. Determine food habits of landlocked smelt (capture by IF&W, stomach analyses by DMR)

    1. Sample zooplankton for species composition and densities (DEP)

D. Determine population parameters for salmonids

    1. Determine population size (IF&W)
        a. Since population is maintained through a stocking program, reduce variables as much as possible (number stocked, size at stocking, time of stocking) (IF&W)
    2. Determine age structure and growth rates (IF&W)

E. Determine population parameters for other gamefish: smallmouth bass, pickerel, white perch (IF&W)

PHASE II - 3 years

A. Stock adult alewives at 6 per surface acre of lake habitat annually (DMR)

B. Continue steps A-E of Phase I

C. Determine population parameters for the alewife population

1. Growth rate of juvenile alewives (DMR)
2. Monitor adult and juvenile emigration from lake (DMR)

D. Determine food habits of juvenile alewives; continue for smelt (DMR)

PHASE III - 2 years (3 years?)

A. Discontinue alewife stocking

B. Continue steps A-E of Phase I

CURRENT STATUS:

To date, DMR has completed analysis of the smelt stomachs collected by IF&W at Lake George from 1988-1995. 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 during the winter of 1997; 1996 smelt stomachs will be analyzed under directive from IF&W.

The results of the stomach content analysis of landlocked rainbow smelt (Osmerus mordax) collected in Lake George through 1995 are presented in Tables 12 and 13. Examination of the percent frequency of occurrence showed the importance of copepods (>77%) and cladocerans (>66%) in smelt diets. Insect numbers rose slightly in 1995 (>27%), as opposed to 24.2% in 1994. Copepods and cladocerans comprised the majority (>97%) of the food items enumerated (Table 13), with the slight majority being copepods. Identification of cladocerans to species level proved very difficult since a few spines and other hard parts were usually all that remained in the majority of stomachs. However, at least five species of Daphnia common to Maine lakes were encountered in the smelt stomachs.

The results of the stomach content analysis of juvenile alewives (Alosa pseudo-harengus) are presented in Tables 14 and 15. Examination of the percent frequency of occurrence showed the importance of copepods (>26%) and cladocerans (>57%) in juvenile alewife diets. These numbers are much lower than those from 1992. Insect numbers fell dramatically in 1993 (>18%) from 1992 (84%). Copepods and cladocerans comprised the majority (>98%) of the food items enumerated (Table 15). Cladocerans, particularly Bosmina, occurred in >96% of all stomachs analyzed and comprised >84% of the 5,764 food items enumerated. 1992 samples of juvenile smallmouth bass are incomplete.

The results of the stomach content analysis of adult alewives (Alosa pseudo-harengus) collected in Lake George in 1992 are presented in Tables 16 and 17. Examination of the percent frequency of occurrence showed the importance of insects (57%) in adult alewife diets. Cladocerans appeared in 44% of adult alewife stomachs as opposed to 3% in 1991. Larval fish were found in 12% of adult alewife stomachs. None of these fish were able to be identified due to their decomposed state. Insects again comprised the majority (>71%) of the food items enumerated (Table 17), while cladocerans comprised greater than 25%.

The results of stomach contents analysis of white perch (M. Americana) are presented in Tables 16 and 17. Examination of the percent frequency of occurrence showed once again the importance of insects (>76%) in white perch diets. Cladocerans comprised the greatest change in perch diet with >14% of the stomachs containing remains vs zero in 1991. It is not known if white perch intentionally target these clodocerans or if they are a by-product (i.e., eating smaller fish that had eaten cladocerans) of other foraging habits. In 1992, >23% of white perch stomachs contained the remains of unidentified picean larvae. Of the food items enumerated, >48% were of insects.

DMR, DEP, and IF&W will meet in the spring of 1997 and review all current data to plan the 1997 field season and the future course of the study at Lake George. The results of the studies conducted at Lake George will be used by DMR, IF&W and DEP to chart the future of alewife restoration in the Kennebec drainage. Depending on the findings at Lake George, alewife stocking plans, as outlined in Phase II of the "***Operational Plan For the Restoration of Shad and Alewives to the Kennebec River***," [revised August, 1986], may be modified to reflect the new knowledge gained from the study. DMR and IF&W will review the Lake George findings and either continue to follow the 1985 plan's Phase II or propose a different schedule for future restoration.

TABLE 12. The frequency of occurrence (percent) of food items in the digestive tract of smelt (Osmerus mordax) collected in Lake George from 1987 - 1995. (#) = number of fish examined.

Percent Frequency of Occurrence:

Food Item	1988 (70)	1989 (71)	1990 (72)	1991 (50)	1992 (90)	1993 (70)	1994 (66)	1995 (80)	1996	1997
Copepoda	71.4	84.5	79.2	92.0	80.0	97.1	95.5	77.5		
Unidentified	34.3	28.2	20.8	74.0	80.0	92.8	69.7	48.8		
Cyclopoida	58.9	81.7	75.0	48.0	28.0	58.5	56.1	20.0		
Calanoida	41.4	46.5	19.4	64.0	79.0	95.7	71.2	53.6		
Nauplii	44.3	8.5	23.6	22.0	76.0	87.1	69.7	64.8		
Cladocera	71.4	76.1	81.9	66.0	57.0	64.2	72.7	66.3		
Unidentified	70.0	74.6	76.4	18.0	51.0	51.4	47.0	26.3		
Daphnia catawba	10.0	15.5	13.9	00.0	11.0	00.0	12.1	3.8		
D.ambigua	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0		
D.galeata mendotae	7.1	5.6	1.4	00.0	2.0	00.0	1.5	6.3		
D.dubia	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0		
D.longiremis	00.0	4.2	2.8	00.0	00.0	00.0	00.0	00.0		
D.pulex	00.0	00.0	1.4	00.0	4.0	2.8	40.9	32.5		
Bosmina sp.	48.6	21.1	44.4	62.0	20.0	48.5	19.7	42.5		
B.coregoni	00.0	14.1	00.0	00.0	9.0	00.0	00.0	00.0		
Insecta	5.7	8.5	30.6	62.0	24.0	37.1	24.2	27.5		
Trichoptera	1.4	2.8	4.2	6.0	1.0	00.0	3.0	10.0		
Odonata	00.0	2.8	5.6	00.0	2.0	00.0	9.1	7.5		
Diptera	2.9	2.8	23.6	60.0	23.0	37.1	15.2	15.0		
Hemiptera	00.0	00.0	1.4	00.0	00.0	00.0	00.0	00.0		
Ephemoptera	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0		

TABLE 13. The number (percent) of food items in the alimentary tract of smelt (Osmerus mordax) collected in Lake George from 1988 - 1995. (#) = number of food items.

Percent Number:

Food Item	1988 (4055)	1989 (3360)	1990 (2441)	1991 (3087)	1992 (6178)	1993 (7290)	1994 (3412)	1995 (2294)
Copepoda	49.2	42.9	46.4	60.9	92.0	88.3	78.8	61.1
Unidentified	3.6	2.4	6.4	23.9	26.0	12.0	14.9	8.7
Cyclopoida	14.1	30.6	29.7	6.7	4.0	5.7	6.7	3.4
Calanoida	18.6	9.	4.4	21.5	44.0	62.1	32.4	25.2
Nauplii	12.9	0.	5.9	8.8	18.0	8.3	24.8	25.8
Cladocera	50.7	56.6	50.6	21.6	6.0	10.6	17.2	36.8
Unidentified	42.9	51.7	29.2	0.6	3.0	2.2	3.5	8.9
Daphnia catawba	0.3	0.6	1.4	00.0	1.0	00.0	00.7	00.2
D.ambigua	<0.1	00.0	00.0	00.0	00.0	00.0	00.0	00.0
D.galeata mendotae	0.2	0.1	<0.1	00.0	00.0	00.0	00.1	00.3
D.dubia	<0.1	00.0	00.0	00.0	00.0	00.0	00.0	00.0
D.longiremis	00.0	0.2	0.1	00.0	00.0	00.0	00.0	00.0
D.pulex	<0.1	00.0	<0.1	00.0	00.0	00.0	10.1	6.0
Bosmina sp.	7.3	2.8	19.9	20.9	1.0	8.2	2.8	21.4
B. coregoni	00.0	1.1	00.0	00.0	1.0	00.0	00.0	00.0
Insecta	00.1	0.4	2.9	17.4	2.0	1.0	00.9	2.2
Trichoptera	<0.1	0.2	0.1	0.1	00.0	00.0	00.1	00.3
Odonata	00.0	0.1	0.2	00.0	00.0	00.0	00.3	00.4
Diptera	00.1	0.1	2.4	17.3	1.9	1.0	00.5	1.5
Hemiptera	00.0	00.0	0.2	00.0	00.0	00.0	00.0	00.0
Ephemoptera	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0

TABLE 14. The frequency of occurrence (percent) of food items in the digestive tract of fishes collected in Lake George in 1991 - 1993. (#) = number of fish examined.

Percent Frequency of Occurrence:

Food Item	Juvenile Alewife (A. pseudoharengus) 1991 (50)	Juvenile Alewife (A. pseudoharengus) 1992 (45)	Juvenile Alewife (A. pseudoharengus) 1993 (64)
Copepoda	86.0	95.0	26.5
Unidentified	38.0	93.0	12.5
Cyclopoida	62.0	64.4	10.9
Calanoida	26.0	75.5	9.3
Nauplii	24.0	60.0	10.9
Cladocera	76.0	97.0	57.8
Unidentified	58.0	82.0	34.3
Daphnia catawba	4.0	26.0	1.5
D. ambigua	00.0	00.0	00.0
D. galeata mendotae	00.0	00.0	00.0
D. dubia	00.0	00.0	00.0
D. longiremis	00.0	00.0	00.0
D. pulex	4.0	00.0	1.5
Bosmina sp.	64.0	100.0	54.6
B. coregoni	00.0	60.0	1.5
Amphipoda	00.0	00.0	4.6
Unidentified	00.0	00.0	4.6
Insecta	72.0	84.0	18.7
Trichoptera	14.0	44.0	00.0
Odonata	4.0	15.5	00.0
Diptera	70.0	84.0	18.7
Hemiptera	00.0	00.0	00.0
Ephemoptera	00.0	00.0	00.0
Pisces	00.0	00.0	00.0
Unidentified larvae	00.0	00.0	00.0
P. flavescens larvae	00.0	00.0	00.0
M. dolomeiu larvae	00.0	00.0	00.0
A. pseudoharengus larvae	00.0	00.0	00.0

TABLE 15. The number (percent) of food items in the alimentary tract of juvenile alewives collected in Lake George in 1991 - 1993. (#) = number of food items.

Percent Number:

Food Item	Juvenile Alewife (A. pseudoharengus) 1991 (1731)	Juvenile Alewife (A. pseudoharengus) 1992 (28,520)	Juvenile Alewife (A.pseudoharengus) 1993 (5764)
Copepoda	50.2	39.9	1.9
Unidentified	5.3	25.2	0.6
Cyclopoida	17.9	1.8	0.8
Calanoid	3.0	12.3	0.1
Nauplii	23.9	0.4	0.4
Cladocera	23.0	55.4	96.6
Unidentified	7.1	1.30	11.6
Dapnia catawba	0.4	0.24	00.0
Diaphanosoma	00.0	0.77	00.0
D. galeata mendota	00.0	0.00	00.0
Sida crystalina	00.0	1.90	00.0
D. longiremis	00.0	0.00	00.0
Polyphemus pedicatos	00.0	4.70	00.0
Bosmina sp.	15.4	44.40	84.85
B. coregoni	00.0	1.10	00.0
Water mite	00.0	0.00	00.0
Amphipoda	00.0	0.00	00.08
Unidentified	00.0	0.00	00.08
Insecta	26.4	4.60	00.5
Trichoptera	0.6	0.40	00.0
Odonata	00.0	0.04	00.0
Diptera	25.7	4.10	00.5
Hemiptera	00.0	0.00	00.0
Coleoptera	00.0	0.07	00.0
Ephemeroptera varia	00.0	0.00	00.0
Other	00.0	0.07	00.0
Pisces	00.0	0.00	00.0
Unidentified larvae	00.0	0.00	00.0
P. flavescens larvae	00.0	0.00	00.0
M. dolomieu larvae	00.0	0.00	00.0
A. pseudoharengus	00.0	0.00	00.0

TABLE 16. The frequency of occurrence (percent) of food items in the digestive tract of adult fishes collected in Lake George in 1991 & 1992. (#) = number of fish examined.

Percent Frequency of Occurrence:

Food Item	Alewife (A. pseudoharengus) 1991 (68)	Alewife (A. pseudoharengus) 1992 (41)
Copepoda	00.0	19.5
Unidentified	00.0	19.5
Cyclopoida	00.0	00.0
Calanoida	00.0	00.0
Nauplii	00.0	00.0
Cladocera	3.0	44.0
Unidentified	3.0	44.0
Daphnia catawba	00.0	00.0
D. ambigua	00.0	00.0
D. galeata mendotae	00.0	00.0
D. dubia	00.0	00.0
D. longiremis	00.0	00.0
D. pulex	00.0	00.0
Bosmina sp.	00.0	00.0
B. coregoni	00.0	00.0
Amphipoda	00.0	00.0
Unidentified	00.0	00.0
Insecta	52.0	57.0
Trichoptera	22.0	17.0
Odonata	39.0	15.0
Diptera	26.0	29.0
Coleoptera	25.0	12.0
Ephemeroptera	00.0	12.0
Pisces	22.0	12.0
Unidentified larvae	18.0	12.0
P. flavescens larvae	4.0	00.0
M. dolomeiu larvae	00.0	00.0
A. pseudoharengus larvae	00.0	00.0

TABLE 17. The number (percent) of food items in the alimentary tract of adult fishes collected in Lake George in 1991 & 1992. (#) = number of food items.

Percent Number:

Food Item	Alewife (A. pseudoharengus) 1991 (404)	Alewife (A. pseudoharengus) 1992 (395)
Copepoda	00.0	3.0
Unidentified	00.0	3.0
Cyclopoida	00.0	00.0
Calanoida	00.0	00.0
Nauplii	00.0	00.0
Cladocera	0.4	25.5
Unidentified	0.4	25.5
Dapnia catawba	00.0	00.0
D. ambigua	00.0	00.0
D. galeata mendotae	00.0	00.0
D. dubia	00.0	00.0
D. longiremis	00.0	00.0
D. pulex	00.0	00.0
Bosmina sp.	00.0	00.0
B. coregoni	00.0	00.0
Amphipoda	00.0	00.0
Insecta	73.5	71.3
Trichoptera	14.6	52.4
Odonata	31.6	1.5
Diptera	14.8	10.9
Hemiptera	00.0	00.0
Ephemoptera varia	00.0	3.5
Coleoptera	12.3	1.8
Mollusca	0.2	
Unidentified	0.2	
Pisces	25.6	1.2
Unidentified larvae	9.6	1.2
P. flavescens larvae	16.0	00.0
M. dolomieu larvae	00.0	00.0
A. pseudoharengus	00.0	00.0

APPENDIX I

1996 Survey of Atlantic Salmon Parr in Two Tributaries
Kennebec River, Maine

U.S. Fish and Wildlife Service staff from the Office of Fishery Assistance, Laconia N.H., Maine Anadromous Fish Coordinator's office, and staff from the Maine Division of Marine Resources conducted electrofishing sampling surveys for Atlantic salmon on October 29th and 30th, 1996. Two tributaries to the Kennebec River were surveyed, namely Bond Brook and Togus Stream.

Scope of Project

This survey was similar to others conducted in fall of 1994 and 1995. The scope of this survey was to obtain morphometric measurements of parr and to collect fin clips from each of the sampled parr. The fin clips (LPV=left pelvic) were obtained to provide tissue for DNA analyses in an effort to characterize the genetic composition of salmon within the Kennebec River.

Description of Study Sites

Bond Brook: Within the city of Augusta, two sites were sampled along Bond Brook on October 29, 1996 (map attached). The upper site began approximately 0.8 km downstream of the Interstate 95 overpass of Bond Brook Road and ended at the bridge on Leighton Road. The downstream site began approximately 91 m upstream from the intersection of Bond Brook Road and Route 11/27 and ended at the beginning of the upstream site.

Togus Stream: One site was sampled in Togus Stream on October 30, 1996 (map attached). This site was located in the town of Randolph, and began at the confluence of Stony Meadow Brook and terminated at the culvert under Barber Road.

Summary of Findings

Bond Brook: A total of 112 parr was collected from the combined sampling sites on Bond Brook. The total length of the parr ranged from 74 mm to 100 mm for age 0+ parr and from 118 mm to 171 mm for age 1+ parr. Redds were observed in both the upper and lower sites. A fin clip and scales were removed from one adult male kelt captured in the upper section. Total length of the fish was 81.3 cm and the fin clip sample was labeled BB1A. Scale characteristics indicated that it was a two sea-winter hatchery origin fish (H1.2). Several adults of unknown sex were observed in both sites. Additional redds were subsequently observed in November by staff of the Atlantic Salmon Authority at locations upstream and downstream from our study sites. Morphometric data from this survey are tabulated in Table 1 and shown in Figure 1a and c.

Togus Stream: A total of 85 parr was collected from Togus Stream. The total length of age 0+ parr ranged from 67 mm to 108 mm for age 0+ parr and 130 mm to 188 mm for age 1+ parr. Redds and adult salmon were observed at the collection site. Morphometric data from this survey are tabulated in Table 2 and shown in Figure 1b and c.

Table 1. Total length (mm), weight (g) and age of Atlantic salmon parr captured in both the upper (BB##) and lower sites (LB##) of Bond Brook on October 29, 1996.

Fish No.	Length (mm)	Weight (g)	Age	Mark	Scales
BB01	148	28	1+	LPV	Yes
BB02	92	5	0+	LPV	No
BB03	86	5	0+	LPV	No
BB04	121	15	1+	LPV	Yes
BB05	96	8	0+	LPV	Yes
BB06	136	24	1+	LPV	Yes
BB07	85	6	0+	LPV	Yes
BB08	139	21	1+	LPV	Yes
BB09	126	19	1+	LPV	Yes
BB10	141	24	1+	LPV	Yes
BB11	118	15	1+	LPV	Yes
BB12	82	5	0+	LPV	No
BB13	95	8	0+	LPV	Yes
BB14	141	23	1+	LPV	Yes
BB15	142	27	1+	LPV	Yes
BB16	159	33	1+	LPV	Yes
BB17	137	23	1+	LPV	Yes
BB18	146	30	1+	LPV	Yes
BB19	163	39	1+	LPV	Yes
BB20	86	6	0+	LPV	Yes
BB21	141	27	1+	LPV	Yes
BB22	136	20	1+	LPV	Yes
BB23	154	31	1+	LPV	Yes
BB24	100	8	0+	LPV	Yes
BB25	85	6	0+	LPV	Yes
BB26	90	8	0+	LPV	Yes
BB27	141	23	1+	LPV	Yes
BB28	159	35	1+	LPV	Yes
BB29	156	31	1+	LPV	Yes
BB30	135	20	1+	LPV	Yes
BB31	85	5	0+	LPV	Yes
BB32	145	29	1+	LPV	Yes
BB33	86	7	0+	LPV	Yes
BB34	150	29	1+	LPV	Yes
BB35	152	29	1+	LPV	Yes
BB36	140	26	1+	LPV	Yes
BB37	95	7	0+	LPV	Yes
BB38	121	17	1+	LPV	Yes
BB39	84	6	0+	LPV	Yes
BB40	90	7	0+	LPV	Yes
BB41	130	21	1+	LPV	Yes
BB42	139	27	1+	LPV	Yes
BB43	141	31	1+	LPV	Yes
BB44	96	10	0+	LPV	Yes
BB45	129	19	1+	LPV	Yes
BB46	162	34	1+	LPV	Yes
BB47	89	7	0+	LPV	Yes
BB48	96	8	0+	LPV	Yes
BB49	138	24	1+	LPV	Yes
BB50	90	8	0+	LPV	Yes
BB51	94	8	0+	LPV	Yes
BB52	120	16	1+	LPV	Yes
BB53	90	6	0+	LPV	Yes
BB54	80	5	0+	LPV	No
BB55	77	5	0+	LPV	No
BB56	79	4	0+	LPV	No
BB57	93	8	0+	LPV	Yes
BB58	94	7	0+	LPV	Yes
BB59	90	7	0+	LPV	No
BB60	78	5	0+	LPV	No
BB61	93	7	0+	LPV	No
BB62	82	6	0+	LPV	No
BB63	92	6	0+	LPV	No
BB64	94	7	0+	LPV	No
BB65	86	6	0+	LPV	No
BB66	162	38	1+	LPV	Yes
BB67	91	7	0+	LPV	No
BB68	91	7	0+	LPV	No
BB69	126	17	1+	LPV	Yes
BB70	91	7	0+	LPV	No
BB71	85	5	0+	LPV	No
BB72	74	4	0+	LPV	No
BB73	155	25	1+	LPV	Yes
BB74	171	43	1+	LPV	Yes
LB01	151	30	1+	LPV	Yes
LB02	116	12	0+	LPV	Yes
LB03	159	35	1+	LPV	Yes
LB04	195	64	1+	LPV	Yes
LB05	175	45	1+	LPV	No
LB06	168	41	1+	LPV	Yes
LB07	109	11	0+	LPV	Yes
LB08	150	31	1+	LPV	No
LB09	152	27	1+	LPV	No
LB10	166	44	1+	LPV	No
LB11	158	36	1+	LPV	No
LB12	120	17	1+	LPV	No
LB13	168	40	1+	LPV	No
LB14	170	41	1+	LPV	No
LB15	158	33	1+	LPV	No
LB16	110	12	0+	LPV	No
LB17	96	7	0+	LPV	No
LB18	140	25	1+	LPV	No
LB19	155	36	1+	LPV	No
LB20	160	38	1+	LPV	No
LB21	129	19	1+	LPV	No
LB22	126	18	1+	LPV	No
LB23	104	11	0+	LPV	Yes
LB24	128	18	1+	LPV	Yes
LB25	166	41	1+	LPV	No
LB26	165	42	1+	LPV	No
LB27	162	38	1+	LPV	No
LB28	167	38	1+	LPV	No
LB29	159	34	1+	LPV	No
LB30	172	41	1+	LPV	No
LB31	85	5	0+	LPV	No
LB32	168	38	1+	LPV	No
LB33	138	25	1+	LPV	No
LB34	174	49	1+	LPV	No
LB35	166	37	1+	LPV	No
LB36	168	40	1+	LPV	No
LB37	161	33	1+	LPV	No
LB38	146	29	1+	LPV	No

Table 2. Total length (mm), weight (g) and age of Atlantic salmon parr captured in Togus Stream on October 30, 1996.

Fish No.	Length (mm)	Weight (g)	Age	Mark	Scales	Fish No.	Length (mm)	Weight (g)	Age	Mark	Scales
TS01	105	9	0+	LPV	Yes	TS44	94	6	0+	LPV	Yes
TS02	83	5	0+	LPV	Yes	TS45	188	6	1+	LPV	No
TS03	90	6	0+	LPV	Yes	TS46	92	6	0+	LPV	No
TS04	82	5	0+	LPV	No	TS47	97	8	0+	LPV	Yes
TS05	181	49	1+	LPV	Yes	TS48	162	39	1+	LPV	Yes
TS06	159	35	1+	LPV	Yes	TS49	174	49	1+	LPV	Yes
TS07	92	7	0+	LPV	No	TS50	91	7	0+	LPV	Yes
TS08	77	3	0+	LPV	No	TS51	101	9	0+	LPV	Yes
TS09	76	3	0+	LPV	Yes	TS52	84	5	0+	LPV	No
TS10	73	4	0+	LPV	No	TS53	93	9	0+	LPV	Yes
TS11	75	3	0+	LPV	No	TS54	79	4	0+	LPV	No
TS12	67	2	0+	LPV	No	TS55	83	6	0+	LPV	No
TS13	180	44	1+	LPV	Yes	TS56	86	5	0+	LPV	No
TS14	178	48	1+	LPV	Yes	TS57	90	6	0+	LPV	No
TS15	86	6	0+	LPV	No	TS58	70	3	0+	LPV	No
TS16	87	6	0+	LPV	No	TS59	86	5	0+	LPV	No
TS17	91	6	0+	LPV	Yes	TS60	99	9	0+	LPV	Yes
TS18	74	4	0+	LPV	Yes	TS61	85	6	0+	LPV	No
TS19	74	4	0+	LPV	No	TS62	89	6	0+	LPV	No
TS20	80	4	0+	LPV	Yes	TS63	150	30	1+	LPV	Yes
TS21	71	4	0+	LPV	No	TS64	79	4	0+	LPV	No
TS22	74	3	0+	LPV	No	TS65	96	7	0+	LPV	No
TS23	74	3	0+	LPV	No	TS66	81	4	0+	LPV	No
TS24	82	5	0+	LPV	No	TS67	83	5	0+	LPV	No
TS25	75	3	0+	LPV	No	TS68	93	7	0+	LPV	No
TS26	80	4	0+	LPV	No	TS69	102	10	0+	LPV	Yes
TS27	73	3	0+	LPV	No	TS70	96	8	0+	LPV	No
TS28	95	7	0+	LPV	Yes	TS71	90	5	0+	LPV	No
TS29	76	3	0+	LPV	No	TS72	76	4	0+	LPV	No
TS30	164	36	1+	LPV	Yes	TS73	86	5	0+	LPV	No
TS31	74	4	0+	LPV	No	TS74	82	4	0+	LPV	No
TS32	80	4	0+	LPV	No	TS75	86	5	0+	LPV	No
TS33	87	6	0+	LPV	Yes	TS76	108	10	0+	LPV	Yes
TS34	69	2	0+	LPV	Yes	TS77	88	6	0+	LPV	No
TS35	146	27	1+	LPV	Yes	TS78	75	4	0+	LPV	No
TS36	83	6	0+	LPV	No	TS79	89	5	0+	LPV	No
TS37	80	6	0+	LPV	No	TS80	93	7	0+	LPV	No
TS38	85	5	0+	LPV	Yes	TS81	83	5	0+	LPV	No
TS39	73	3	0+	LPV	No	TS82	161	34	1+	LPV	Yes
TS40	71	3	0+	LPV	Yes	TS83	137	22	1+	LPV	Yes
TS41	140	21	1+	LPV	Yes	TS84	134	20	1+	LPV	Yes
TS42	130	20	1+	LPV	Yes	TS85	167	36	1+	LPV	Yes
TS43	85	5	0+	LPV	No						

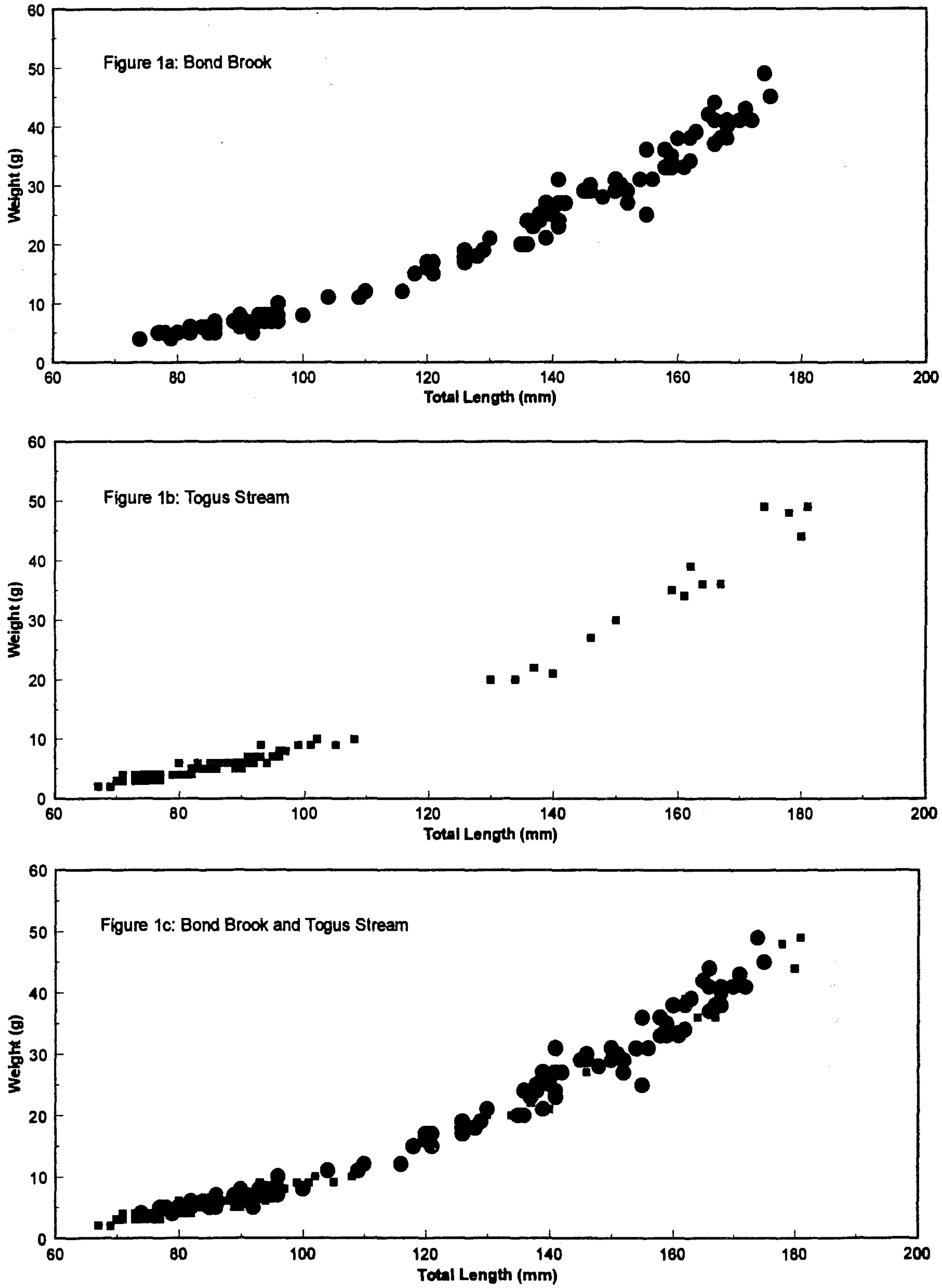
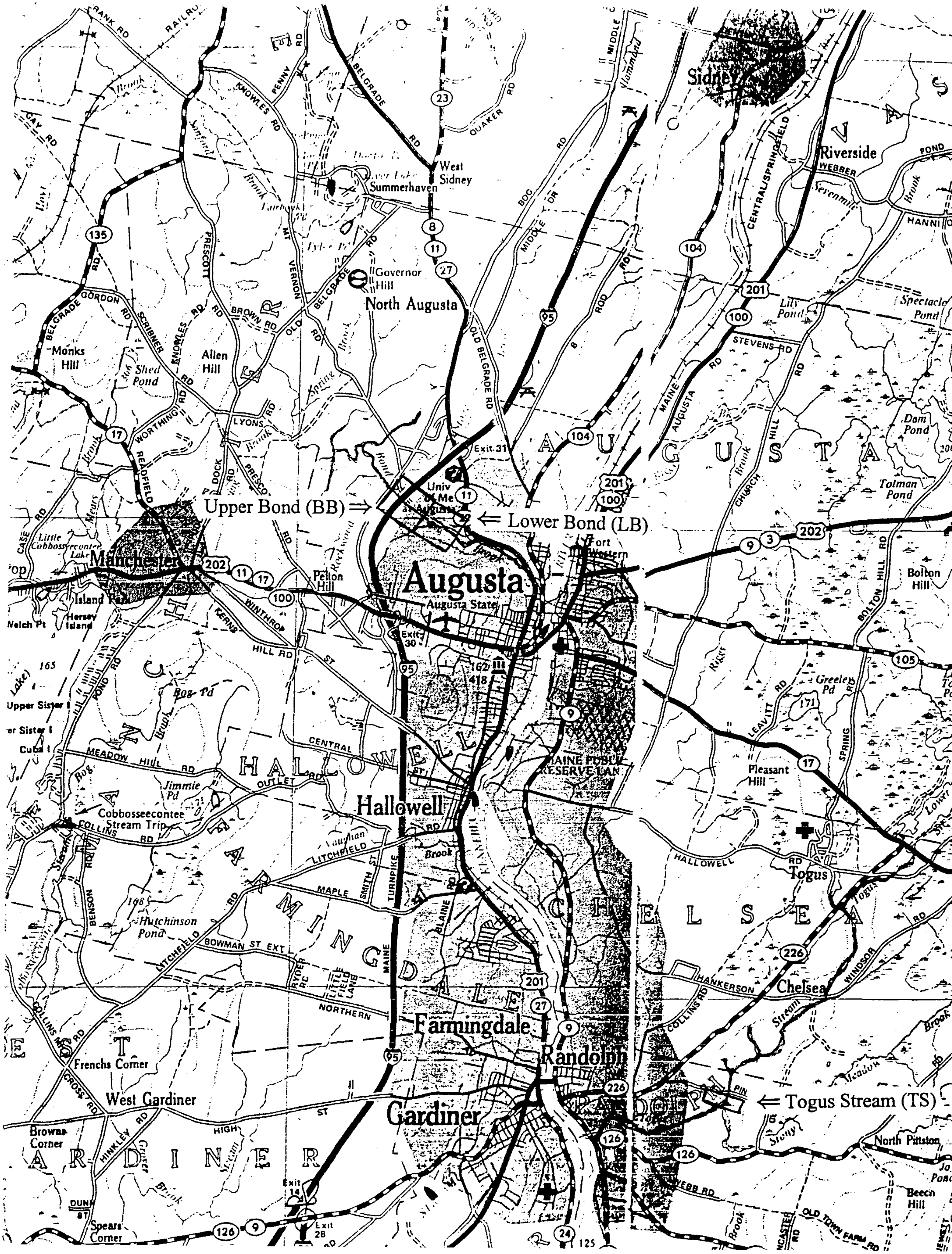


Figure 1a-c. Total Length (mm) - Weight (g) relationships for Atlantic salmon parr from Bond Brook (Fig.1a), Togus Stream (Fig.1b) and a composite for Bond Brook and Togus Stream (Fig.1c).



Upper Bond (BB) ⇒
⇐ Lower Bond (LB)
⇐ Togus Stream (TS)
Augusta
Augusta State
Univ of Me at Augusta
Fort Western
Exit 31
Exit 30
Hallowell
Farmingdale
Randolph
Gardiner
Chelsea
Togus
Sidney
West Sidney
Riverside
Summerhaven
North Augusta
Governor Hill
Monks Hill
Allen Hill
Pelton Hill
Bolton Hill
Pleasant Hill
Beech Hill
Manchester
Island Park
Hersey Island
Welch Pt
Upper Sister I
Cuba I
Little Cobbosseecontee Lake
Shed Pond
Bog Pd
Jimmie Pd
Hutchinson Pond
Lily Pond
Spectacle Pond
Dam Pond
Tolman Pond
Greeley Pd
Cobbosseecontee Stream Trip
MAINE PUBLIC RESERVE LAN
Frenchs Corner
West Gardiner
Browns Corner
Spears Corner
North Pittston
Exit 14
Exit 28
A U G U S T A
H A L L O W E L L
F A R M I N G D A L E
C H E L S E A
G A R D I N E R
CENTRAL/SPRINGFIELD
BELGRADE RD
QUAKER RD
OLD BELGRADE RD
MIDDLE RD
BOG RD
KNOWLES RD
PENNY RD
PRESCOTT RD
MT VERNON RD
GORDON RD
SCRIBNER RD
BROWN RD
WORTHING RD
LYONS RD
DOCK RD
READFIELD RD
CASE RD
WINTHROP ST
KERNS HILL RD
POND RD
MEADOW HILL RD
OUTLET RD
COLLINS RD
CENTRAL ST
LITCHFIELD RD
MAPLE ST
SMITH ST
TURNPIKE
BLAINE RD
KENNEBEC
BOWMAN ST EXT
BENSON RD
RYDER RD
NORTHERN
CROSS RD
HINKLEY RD
HIGH ST
STEVENS RD
WEBBER POND
HANNIFORD
CHURCH HILL RD
BOLTON HILL RD
LEAVITT RD
SPRING
HALLOWELL RD
HANKERSON
COLLINS RD
WINDSOR
WEBB RD
OLD TOWN FARM RD
135
17
23
8
11
27
95
104
201
100
202
9
3
105
226
126
24
162
418