KENNEBEC RIVER
ANADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT - 1994

MAINE DEPARTMENT OF MARINE RESOURCES
STATE HOUSE STATION #21
AUGUSTA, MAINE 04333

Prepared By: J. Stahlnecker & N. Gray

December, 1994
Revised February, 1995

Program Activities Presented in This Report
Were Funded through a Cooperative Agreement
Between the State of Maine
and
The Kennebec Hydro Developers Group [KHDG]

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INTRODUCTION -

This progress report covers the eighth year of the twelve-year interim trap and truck program for 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 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 from 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 in 1993.

For 1994, DMR focused on the Kennebec River as the primary source of alewife broodstock for upriver stocking. In 1994, Edwards fish pump captured 63,685 alewives. DMR seined an additional 6,597 alewives below Edwards Dam and transported 4,155 alewives from the Androscoggin River to the Sebasticook drainage. In total, 58,701 alewives were stocked in the Sebasticook drainage as part of the Kennebec River Phase I stocking. An additional 13,096 alewives trapped at Augusta were stocked in five other river drainages after the Sebasticook stocking was completed. The 1994 stocking of 58,701 alewives in the Sebasticook drainage holds the record for the most alewives stocked since the project began. All seven lakes slated for stocking received their Phase I stocking goal of six alewives per acre.

On December 14, 1994, FERC issued an order directing the Edwards Dam Licensees to construct fish passage facilities as proposed by the Licensees in December, 1990. The FERC order stipulates these interim passage facilities be completed by October 1, 1995. If construction of the interim passage is finished in the fall of 1995, DMR will begin utilizing the interim facility by the spring of 1996 as the primary source of broodstock for the KHDG stcoking program. The license for the Edwards Dam expired in 1993 and the relicensing process is currently underway. The State of Maine is in favor of removal of this dam in order to restore the river segment above the dam 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 1995, prior to interim passage construction, DMR plans to obtain broodstock from fish pumping at Edwards Dam and if necessary, seining below Edwards Dam. If necessary, the Brunswick Fishway may also be utilized as an alewife source if the magnitude of the run there permits trucking from the site.

Under Phase I of the plan, only those lakes which had approval for stocking by the Department of Inland Fisheries and Wildlife (DIF&W) were to be stocked with six alewives per surface acre. This amounted to 11 out of 21 lakes to be stocked under Phase I with 10 of these to be stocked commensurate with the initiation of the plan. This would require the stocking of 72,894 adult alewives. The Maine Department of Environmental Protection (DEP) has requested that the stocking of all ponds (3) in the Seven-Mile Stream drainage system be deferred in order for them to establish a long-term water quality data base for these environmentally stressed systems. **This results in a total stocking requirement of 57,750 adult alewives.**

In past years, American shad have been obtained from the Connecticut and Merrimack Rivers 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. As directed by FERC, construction of interim passage may provide access for shad to pass above the Edwards Dam. 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.**

The interim plan for Atlantic salmon is to move whatever salmon become available at the Augusta Dam upriver. 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 Sea-Run Salmon Commission. Interim passage construction at the Edwards Dam may provide passage for Atlantic salmon as soon as the fall of 1995.

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 involves the capture and enumeration of emigrating adult and juvenile alewives. In addition to smelt stomachs, both adult and juvenile alewife stomachs were collected in 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 as per the study plan.

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

METHODS: Alewife

In 1994, the Department of Marine Resources [DMR] focused on the Kennebec River as the primary source of broodstock alewives for the stocking program in the Sebasticook drainage ponds. The small 1993 alewife run (5,114) at the Brunswick Fishway on the Androscoggin River and the abundance of alewives on the Kennebec River in 1993 (40,620 trapped) led DMR to the decision to acquire alewives from the Kennebec in 1994.

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 1993 and some years before would be reinstalled and operated during the 1994 season. The pump was placed at the south side of the upper tailrace in the same spot it had been in 1993. The pump was affixed to girders above the south side of the tailrace; the 10-inch diameter intake pipe was submerged and stabilized with a cable and "come along" arrangement so that it fished in the eddy created by the concrete abutment located between the discharges from the two southern turbines in the upper powerhouse. This pump intake location was the same as that used in 1993.

The principle modification to the pump system for the 1994 season was the addition of a three-foot long section of transparent lexan, 10 inches in diameter, to the intake end of the pipe. This 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 modification 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. During the 1993 season, dipping alewives from this tank proved difficult and the practice which developed for removing them was to dewater the tank and dip the alewives out as the water level fell. Draining the tank was accomplished by stopping the pump and removing a drain plug in the tank floor.

During the 1994 season, the pump tank was usually drained only when no DMR personnel could be present for a prolonged period of time or at the end of the day. More often, alewives were intercepted before they entered the holding tank as they exited the pipe downstream of the pump. While standing on staging planks 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 the staging planks 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. A fourth loading/counting worker was also utilized when loading the rear twin tank or single tank truck when alewife densities were high and the pump produced large numbers of fish. The extra worker counting and loading fish made the process much faster.

During the 1994 alewife run, DMR also trapped alewives below Edwards Mill with a beach seine. When netting alewives, DMR personnel used a beach seine that measured 80' x 8' deep and was constructed of ¼" delta mesh. The seine was fished at the southern margin of the fast water in the upper powerhouse tailrace and brought 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.

Twenty-five fish lots of alewives were placed in five-gallon buckets half-filled with water. Buckets were immediately removed from the riverbank as they were filled and were hand-carried to the base of the granite wall at the south side of the upper tailrace. Edwards Manufacturing Company constructed and installed a davit and pulley arrangement at the top of this granite wall. 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. This worker would then swing the bucket in, detach it from the rope, and place the alewives in the truck tank.

In addition to the alewives beach-seined in this area, some alewives were simply scooped up into dip nets. In certain areas where alewife density was extremely high, this dip netting could be effective for brief periods until the alewives left the area. Alewives caught in this manner were lifted via the rope method described above.

Prior to the initiation of seining, dip netting, or removal of alewives from the fish pump tank, the stocking trucks in use were filled with water from the lower forebay. Water was circulated in the stocking tanks with the truck-mounted pumps described below. Oxygen was introduced into the stocking tank water via the porous pipe arrangement, also described below. 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. The smaller of these trucks was acquired in early 1987 and is equipped with a circular fiberglass shad transportation tank. This insulated tank has a volume of 1,100 gallons, is 88" in diameter and 42" deep.

A water pump driven by a 3.5 horsepower gasoline engine circulates the tank water. Two water inlets entering tangential to the tank circumference provide a circular water flow. Gas exchange across the water surface/air interface is supplemented by the introduction of air bubbles into the tank water. A valve on the water pipe between the tank outlet and the pump intake is opened to allow air to be drawn into the water pipe by venturi action. This air is mixed with the water by the pump impeller and the resultant mixture is piped through the tangential inlets to the tank. This eight-foot diameter tank and the associated pump/plumbing are affixed to a 14' platform body mounted on a straight framed truck. In 1992, improvements were made in the oxygen injection system by installing porous pipe in the tanks through which the oxygen was introduced into the water. This oxygen delivery system is described in greater detail in the **METHODS: Shad** section of this report. The capability to boost dissolved oxygen levels in the hauling tanks proved useful at the Edwards Mill site in 1993 and 1994. The long loading and holding periods at Edwards during the 1993 alewife season may have precluded fully loading the truck tanks with alewives if good supplemental oxygenation was not possible. The larger loads of alewives transported during the 1994 season were made possible, in part, by the supplemental oxygenation systems on the tank trucks.

In June, 1988, the second, larger stocking truck purchased with KHDG funds was placed in service. Although used to truck American shad in 1988, it was first used to transport alewives in the spring of 1989. The design of the larger twin tank truck is similar to that of the single tanker, except that the larger truck is fitted with two of the tanks and pumps previously described. These two tanks are mounted one behind the other on a 20' platform body affixed to a straight truck. The tanks were connected by an 18" diameter tunnel for the purpose of unloading both tanks through the rear of the back tank. In this way, all fish and water on board are emptied by backing the truck down to the water to be stocked. While in transit, each tank on the twin tanker operated independently of the other. Each tank is equipped with a water pump venturi gas exchange system and supplemental oxygen system, as previously described. Fish are confined by gates to the tanks in which they were originally placed. When the truck is unloaded, the gates are raised to allow fish from the front tank to exit the truck by passing through the rear tank.

Both trucks are equipped with a four-foot long cylindrical chute designed to aid in the release of the fish. The chute is placed over the rear part of the tank and fish/water are off-loaded through the chute and into the receiving waters. By exiting through this chute, the fish are not required to drop as far through the air and are discharged into deeper water farther from the truck. In addition, the chute prevents the fish from striking any portion of the truck while they are being unloaded.

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 1994 stocking. The juvenile alewives were collected with beach seines fished from the shores of the lakes stocked. Three beach seines were employed, one measuring 80' long x 8' deep, one measuring 66' long x 6' deep, and one 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 or on the surface, 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 10' in diameter. Dip net frames varied in their dimensions but were hung with either ¼" or 1/8" delta mesh netting.

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

Selected lake outlet streams were surveyed to determine the presence of obstacles to downstream passage of juvenile and adult postspawner alewives. The streams were travelled by boat or on foot; obstructions to juvenile alewife migration were noted and their structure and location recorded.

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; the locations of the dams are illustrated in Figure 1.

RESULTS & DISCUSSION: Alewife

In 1994, 58,701 broodstock alewives were stocked into seven ponds in the Sebasticook River subdrainage of the Kennebec River. These seven ponds 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, 9,625 acres of lake surface in the Sebasticook subdrainage were stocked to an overall density of 6.1 fish x $acre^{-1}$. Stocking densities were very similar between ponds and only varied from 6.0 alewives x $acre^{-1}$ in Sebasticook Lake to 6.4 alewives x $acre^{-1}$ in Douglas Pond (Table 3).

TABLE 1. 1994 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
			42,582
Additional Ponds:			
Unity Pond	Unity	Main Stem	15,168
Webber Pond	Vassalboro	Kennebec River	7,512
Three Mile Pond	China	Kennebec River	6,462
Three Cornered Pond	Augusta	Kennebec River	1,170
			30,312
Study Lake:			
Lake George	Skowhegan	Kennebec River	2,010
			2,010

*Six adult alewives per lake surface acre

FIGURE 1: **Kennebec River Drainage**

ANADROMOUS FISH RESTORATION PROGRAM

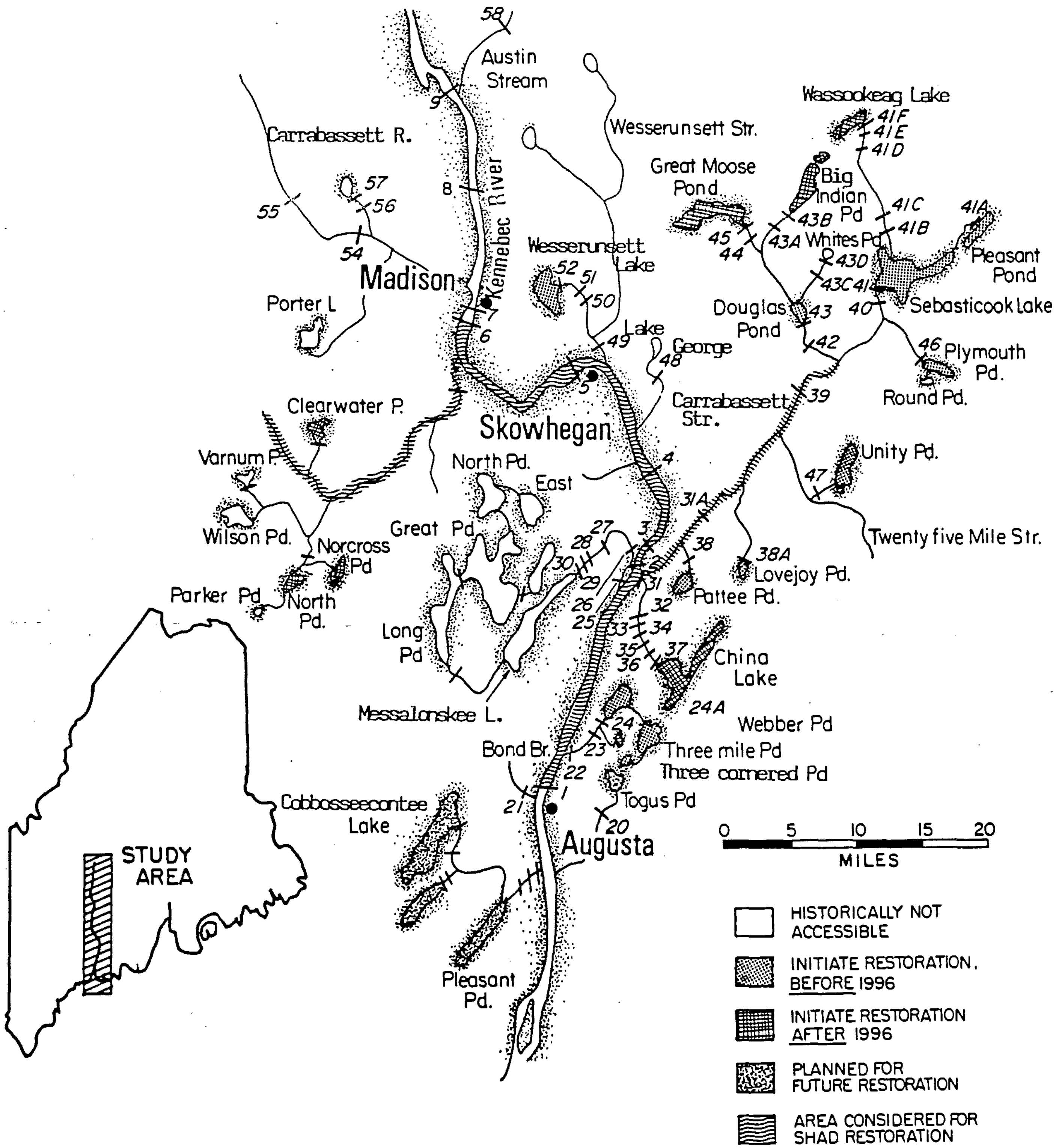


TABLE 2. HYDROELECTRIC FACILITIES MONITORED FOR DOWNSTREAM PASSAGE, 1994

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. 1994 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	3,333	3	106%	6.4
Lovejoy Pond	324	1,944	2,008	2	103%	6.2
Pattee Pond	712	4,272	4,315	2	101%	6.1
Pleasant Pond	768	4,608	4,789	4	104%	6.2
Plymouth Pond	480	2,880	3,002	2	104%	6.3
Sebasticook Lake	4,288	25,728	25,911	17	101%	6.0
Unity Pond	2,528	15,168	15,343	6	101%	6.1
TOTALS:	**9,625**	**57,750**	**58,701**	**36**	**102%**	**6.1**

* Six fish per acre

Alewife stocking in Webber, Three Mile, and Three Cornered Ponds was deferred again in 1994 as a result of a request by DEP to continue to establish long term water quality data bases prior to alewife stocking.

The joint DMR/DEP/IFW study lake, Lake George, was not stocked with alewives in 1994. The 1993 stocking was the final year of three years of alewife introduction at Lake George. Phase III of the study plan calls for three years of post alewife introduction data collection beginning in 1994.

The 58,701 alewives stocked in the Sebasticook drainage in 1994 represents the highest number of alewives stocked since the KHDG Agreement was implemented (Table 4). The 1994 alewife total also reflects the first time that all seven Sebasticook drainage restoration lakes were stocked up to their target stocking density of 6.0 alewives x $acre^{-1}$. In all, 36 alewife stocking trips were made to the Sebasticook drainage ponds. These 36 trips included 33 trips from Augusta (with Kennebec River alewives) and three trips from Brunswick (with Androscoggin River alewives). The 36 trips in 1994, yielding 58,701 alewives stocked (1,631 x $trip^{-1}$) compares favorably to 1993 (28 trips from Augusta for 36,503 alewives or 1,303 x $trip^{-1}$) and to 1992 (31 trips from Brunswick for 23,579 alewives or 761 x $trip^{-1}$). Reasons for the relative efficiency during the 1994 season are discussed below.

Some alewives were trucked from the Brunswick Fishway early in the 1994 season. The fish pump at Edwards Dam had only produced 550 alewives prior to the completion of the last of these three trips on May 27. Once the fish pump began producing larger quantities of alewives, both KHDG trucks were committed to stocking operations from Augusta.

Edwards personnel got the fish pump on line for the first time late in the day on May 26, 1994. Despite only one hour of operation, 550 alewives were captured. On May 27, DMR crews returned to Edwards after stocking alewives from Brunswick. The fish pump had run some five hours on the afternoon of the 27th and DMR was able to load 770 alewives into the single tank truck. The pump had captured 2,500 more alewives but these were dead or in very poor condition on the pump tank floor. In total, over 3,270 alewives were pumped up in a five-hour period. The large number of mortalities probably occurred due to the overcrowding of the alewives in the pump tank. In an effort to prevent further crowding, Edwards personnel shut down the main portion of the pump system to prevent more alewives from entering the pump tank. Some limited amount of freshwater input was possible with the main pump shut down, but the limited circulation was apparently unable to keep pace with the oxygen demands of the large number of alewives already in the pump tank. Later in the season, an additional circulating water input was added to allow the main fish pump to be shut down in overcrowding situations. Since the pump had captured 3,270 alewives in a five-hour period, on May 27, DMR personnel and trucks were shifted to Edwards for May 28. DMR was able to complete six stocking trips on May 28, transporting 11,387 pump-caught alewives and 680 seined alewives to Sebasticook

TABLE 4. KENNEBEC RIVER ALEWIFE STOCKING SUMMARY 1985-1994

	Year	# Stocked
Sebasticook Lake (4288 acres):	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):	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	---------
Pleasant Pond (768 acres):	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	---------
	1985	---------
Douglas Pond (525 acres):	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	---------
Lovejoy Pond (324 acres):	1994	2,008
	1993	699
	1992	1,952
	1991	1,976
	1990	2,077
	1989	1,741
	1988	2,055
	1987	1,949
	1986	---------
	1985	---------

TABLE 4 (CONTD)

Pattee Pond (712 acres):	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	---------
	1985	---------
Unity Pond (2528 acres):	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-
Lake George (335 acres):	1994	-0-
	1993	2,021
	1992	2,005
	1991	2,030
TOTALS:	**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**

drainage ponds. From May 28 onward through the 1994 season, all KHDG alewife stocking efforts focused on trucking fish from the Edwards site in Augusta.

The 1994 stocking of the Sebasticook drainage ponds required 12 days to complete. Stocking began on May 23 with seined alewives from the Kennebec and concluded on June 3 with alewives trapped by the fish pump at Edwards Mill. A chronological list of individual stocking trips to the seven Sebasticook drainage ponds can be found in Table 5.

A summary of the 1994 alewife trapping at Edwards Mill can be found in Table 6. During the 1994 season, 70,282 alewives were trapped at the Augusta Dam. Of these, 63,685 alewives were trapped by the fish pump, including the 2,500 mortalities on May 27, and 6,597 were either seined or dip netted by DMR personnel. These totals include alewives trucked by DMR to the Androscoggin River and other drainages. Trucking mortalities totalled 49 alewives of 67,782 loaded: only 0.07%.

The daily contribution of the fish pump and seine to alewife trapping at Edwards (data from Table 6) is presented graphically in Figure 2. In looking at Figure 2, it is easy to see the shift from seined to pump-trapped alewives after the pump came into operation on May 26. After all Sebasticook drainage stocking was completed, DMR's KHDG Project took Sunday, June 5, off. Consequently, the fish pump was not operated this day, nor on June 8 and 9 when DMR personnel were all working on American shad egg taking operations on the Connecticut River. According to Edwards Dam personnel, alewives remained thick below the dam through June 9. Pump operations on June 10 produced only 89 alewives, all of which were released upriver. The Kennebec River temperature had risen to 18°C by June 10 and few alewives were visible in the river below the dam. Subsequent checks at the site indicated that the bulk of the 1994 run had passed as few alewives were visible at the site.

The vast majority of the alewives stocked in the Sebasticook drainage in 1994 came from the Kennebec River (Figure 3). With the Androscoggin River's Brunswick Fishway contributing only 7% of the alewives stocked, the Kennebec provided 93% of the broodstock for 1994. The fish pump contributed 82% of alewife broodstock, with seining and dip netting adding the other 11%.

Early in the 1994 season, the KHDG Project trucked 4,155 alewives from the Androscoggin River to the Sebasticook drainage ponds. Later in the season, as surplus alewives became available from the fish pump, DMR's Androscoggin River Project trucked 5,449 Kennebec River alewives to Androscoggin River drainage ponds (Table 7). DMR sent Kennebec alewives to the Androscoggin due to the surplus available in Augusta and the unpredictable nature of the Androscoggin run. While the 1994 Androscoggin run did reach over 19,000 alewives ultimately, the small 5,000 fish run in 1993 left doubts about the magnitude of the 1994 run during the 1994 season. In this unpredictable climate, DMR chose not to gamble and so supplemented Androscoggin drainage stocking with Kennebec River alewives.

TABLE 5. 1994 KENNEBEC RIVER ALEWIFE STOCKING BY DATE/TRIP

Date	Location	# Loaded	# Morts	# Stocked
05/23/94	Sebasticook Lake	860	0	860
05/24/94	Sebasticook Lake	1,300	1	1,299
05/25/94	Sebasticook Lake	1,100	0	1,100
	Sebasticook Lake	1,675	0	1,675
05/26/94	Sebasticook Lake	1,001	0	1,001
	Sebasticook Lake	1,075	2	1,073
	Sebasticook Lake	457	0	457
05/27/94	Pleasant Pond	1,000	0	1,000
	Plymouth Pond	2,154	2	2,152
	Douglas Pond	770	0	770
05/28/94	Douglas Pond	1,250	0	1,250
	Unity Pond	2,430	1	2,429
	Sebasticook Lake	1,420	0	1,420
	Unity Pond	2,760	1	2,759
	Sebasticook Lake	1,500	0	1,500
	Unity Pond	2,707	2	2,705
05/29/94	Sebasticook Lake	1,200	0	1,200
	Sebasticook Lake	1,600	1	1,599
05/30/94	Sebasticook Lake	1,636	3	1,633
	Sebasticook Lake	1,631	0	1,631
05/31/94	Pleasant Pond	1,220	1	1,219
	Sebasticook Lake	1,000	2	998
	Lovejoy Pond	710	2	708
06/01/94	Sebasticook Lake	3,025	0	3,025
	Sebasticook Lake	3,006	0	3,006
	Unity Pond	3,200	3	3,197
	Pleasant Pond	1,248	0	1,248
	Pleasant Pond	1,324	2	1,322

TABLE 5 (CONTD)

Date	Location	# Loaded	# Morts	# Stocked
06/02/94	Unity Pond	2,725	0	2,725
	Pattee Pond	3,016	7	3,009
	Sebasticook Lake	2,439	5	2,434
	Douglas Pond	1,313	0	1,313
	Unity Pond	1,528	0	1,528
	Pattee Pond	1,306	0	1,306
06/03/94	Lovejoy Pond	1,310	10	1,300
	Plymouth Pond	850	0	850
TOTALS:		**58,746**	**45**	**58,701**

TOTAL DAYS: 12
TOTAL TRIPS: 36

TABLE 6. ALEWIFE TRAPPING & STOCKING FROM EDWARDS DAM/KENNEBEC RIVER - 1994

Date	# of Alewives* Fish Pump	Seined/Dipped	Loaded	Morts	Stocked
May 23		860	860	0	860
24		1,300	1,300	1	1,299
25		2,775	2,775	0	2,775
26	550	982	1,532	2	1,530
27	3,270**		770	0	770
28	11,387	680	12,067	4	12,063
29	2,800		2,800	1	2,799
30	3,267		3,267	3	3,264
31	3,631		3,631	5	3,626
Jun 1	11,803		11,803	5	11,798
2	13,050		13,050	12	13,038
3	2,868		2,868	10	2,858
4	1,708		1,708	0	2,708
5					
6	5,436		5,436	4	5,432
7	3,826		3,826	2	3,824
8					
9					
10	89		89`		89`
TOTALS:	**63,685**	**6,597**	**67,782**	**49``**	**67,733**

* Includes alewives that went into Androscoggin & other drainages
**2500 pump system morts included
` Released into Edwards Mills impoundment
``Represents .07% trucking mortality

FIGURE 2.

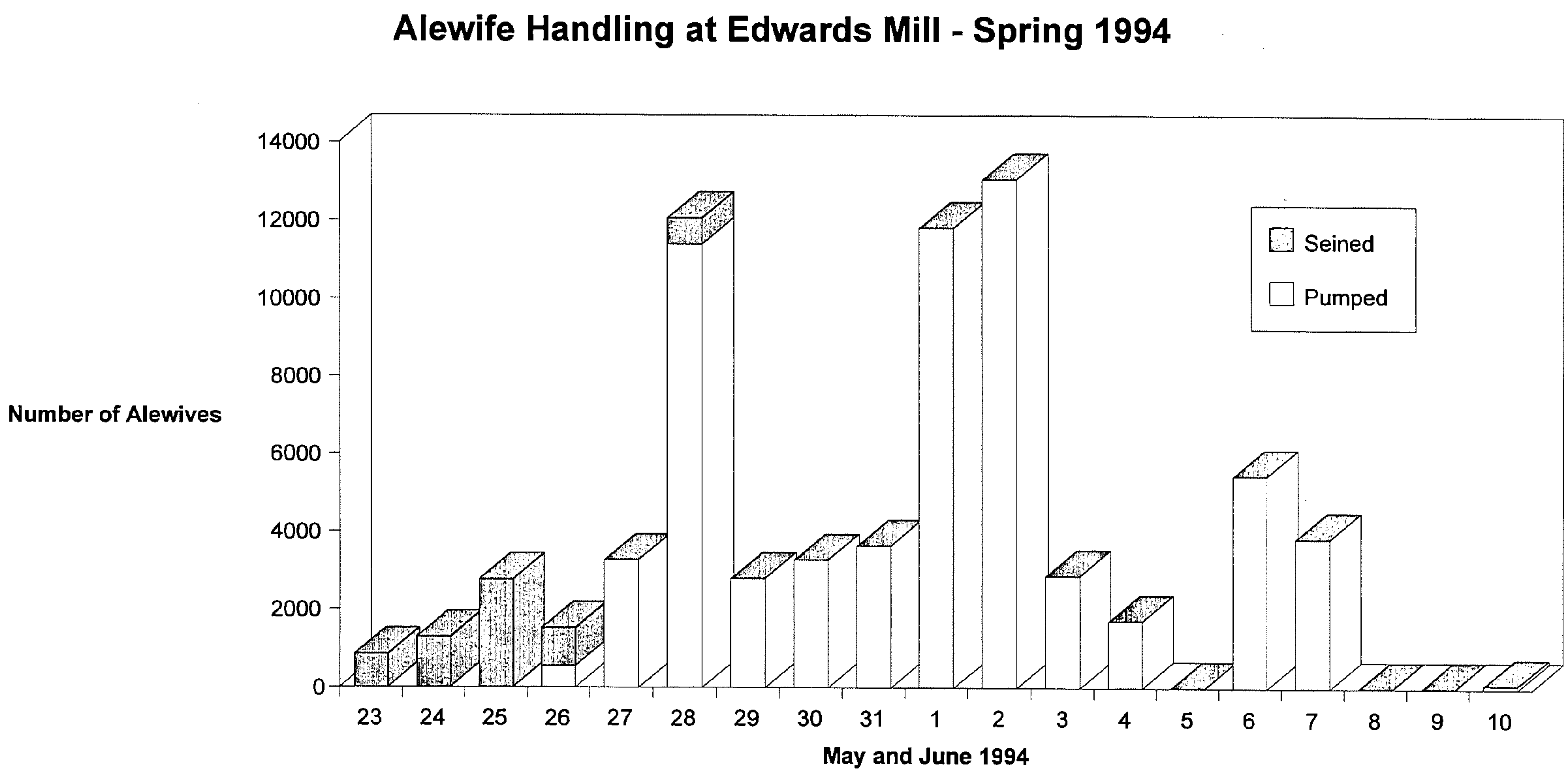
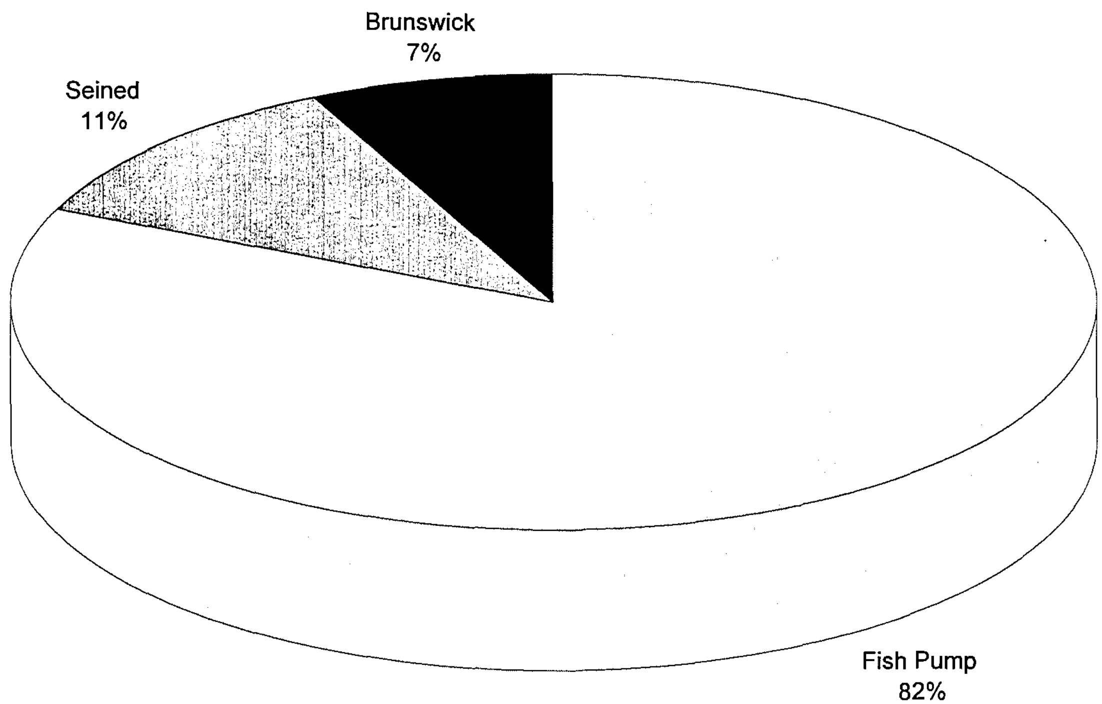

Alewife Handling at Edwards Mill - Spring 1994
Number of Alewives
14000
12000
10000
8000
6000
4000
2000
0
Seined
Pumped
23
24
25
26
27
28
29
30
31
1
2
3
4
5
6
7
8
9
10
May and June 1994

FIGURE 3.

Sources of Alewives Stocked in the Sebasticook Drainage in 1994



Total Sebasticook drainage stocking = 58,701

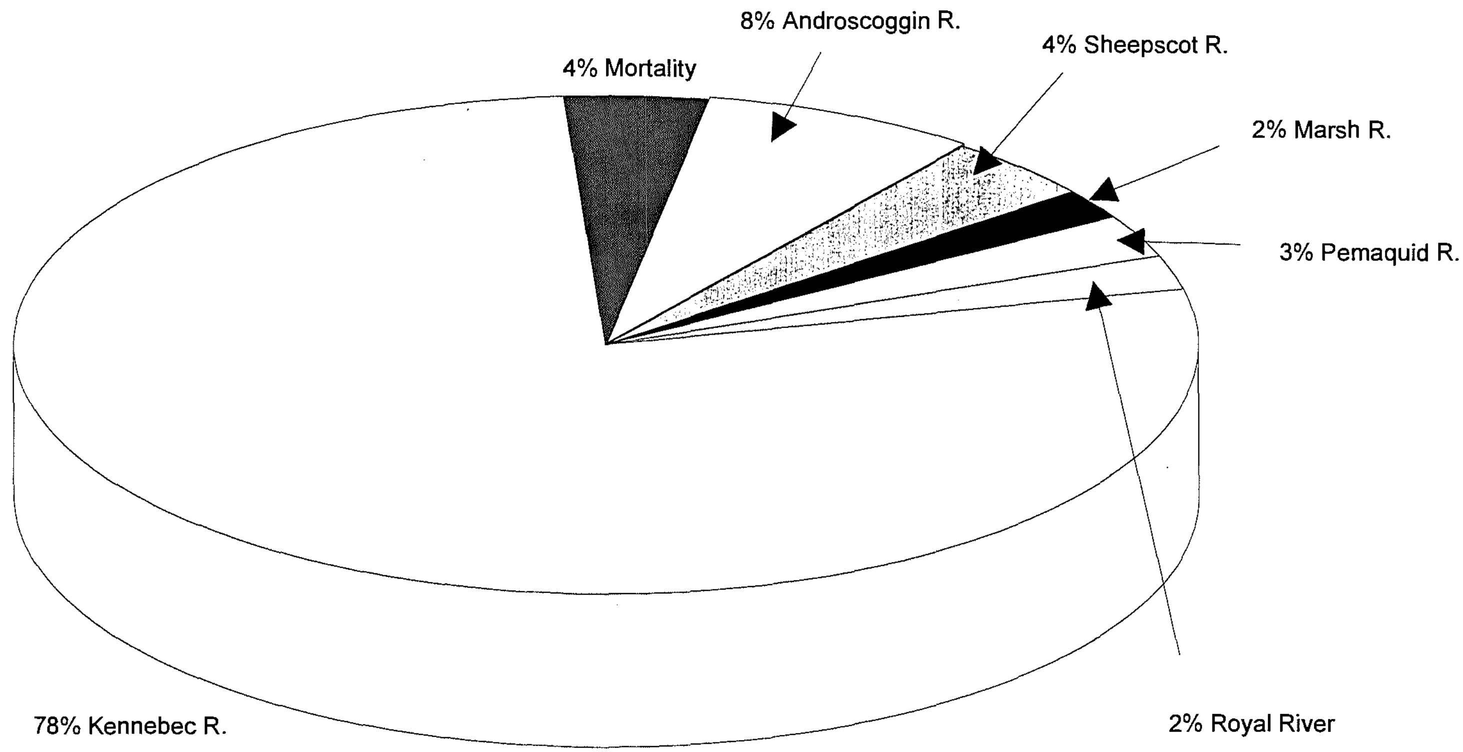
TABLE 7. DISPOSITION OF KENNEBEC RIVER ALEWIVES STOCKED IN OTHER DRAINAGES

TO: ***ANDROSCOGGIN RIVER DRAINAGE***

Date	Location	Number Loaded	Morts	Stocked
5/31	Tripp Pond	701	0	701
6/02	Range Pond	723	0	723
6/03	Tripp Pond	708	0	708
6/04	Tripp Pond	702	0	702
6/07	Taylor Pond	696	0	696
6/07	Taylor Pond	1,205	0	1,205
6/07	Taylor Pond	714	2	712
		5,449	2	5,447
SHEEPSCOT RIVER DRAINAGE				
6/06	Branch Pond	1,004	0	1,004
6/06	Branch Pond	1,011	0	1,011
6/06	Turner Mill Pond	886	0	866
		2,901	0	2,901
MARSH RIVER				
6/07	Sherman Lake	1,211	0	1,211
PEMAQUID RIVER				
6/04	Pemaquid River	1,006	0	1,006
6/06	Pemaquid River	1,017	0	1,017
		2,023	0	2,023
ROYAL RIVER				
6/06	Elm Street Hdpd	1,518	4	1,514
TOTALS:		**13,102**	**6**	**13,096**

FIGURE 4.

% Disposition of Alewives Trapped at Edwards Mill - 1994



Kennebec R. includes 6597 seined alewives.
All other alewives were collected with the fish pump.

After the Sebasticook drainage stocking was completed and during the Androscoggin River stocking, DMR/KHDG Project staff trucked surplus alewives from the Kennebec to four other drainages slated for stocking by DMR. The results are summarized in Table 7 and Figure 4. In total, 7,649 alewives were stocked into these additional four drainages with only four trucking mortalities. Combined with the Androscoggin River drainage stocking from the Kennebec, 13,102 alewives were trucked outside the Kennebec River with only six mortalities (13,096 alewives actually stocked), or 19% of the alewives handled at Augusta.

The efficiency of trapping and loading alewives at Edwards Mill in 1994 was much improved over 1993. While there was some improvement in loading seined alewives by using the davit and rope arrangement, the most important gain was made in the much improved function of the fish pump. On the best day for the fish pump during the 1993 season, 3,540 alewives were trapped. In 1994, over 3,500 alewives were trapped on six different days (Table 6, Figure 2). On May 28 and June 1, 1994, over 11,000 alewives were pumped and trucked each day. June 2 was the peak day for the fish pump in 1994, with 13,050 alewives pumped and truck stocked. Seven truck loads were transported on June 2: six to the Sebasticook drainage and one to the Androscoggin drainage (Tables 5 and 7).

When the alewife density was very high in the pump intake area, as many as 40-50 alewives were captured on some pump cycles. This number of fish available immediately adjacent to the tank trucks made it possible to load the trucks much more rapidly than in 1993. By intercepting the alewives with the dip net as they exited the pump pipe, loading was accelerated and less time was wasted chasing fish in the pump tank.

After considering the pump tank crowding mortalities of May 27 and the speed with which alewives were being captured during some peak periods, the decision was made to shut the pump system down when DMR trucks were away from the site delivering loads of alewives to the ponds. As the stocking season progressed and an operational strategy for the pump began to take shape, Edwards Manufacturing personnel would restart the pump and stockpile alewives in the pump tank prior to the estimated time of arrival of the DMR stocking trucks. This allowed even greater efficiency in loading. The stockpiled alewives were loaded and any remaining fish needed to achieve a full load were dipped as they entered the pump tank. If DMR crews were delayed from returning to the site, a telephone call to Edwards' employees could prevent excessive alewife trapping or crowding. The supplemental water supply added to the pump tank during the 1994 season helped to minimize the effects of any pump tank crowding or delays in loading.

The faster loading possible during the 1994 season meant that the stocking trucks did not sit for long periods of time with partial loads of fish on board. From the pump it was usually possible to load the single tank truck with two crew members, while the double tanker was easier to load if three or more crew members were present. In short, once a truck was loaded it was dispatched to a lake to unload and the remaining crew was able to load the other truck. This strategy allowed more trips to be completed each day when possible. In addition, trucks were not required to arrive back at Edwards at the same time to help in very labor intensive loading as in 1993. In 1994, staggered arrival of trucks at Edwards was a more efficient system.

Several factors made it possible for DMR to truck heavier loads of alewives in 1994. The availability of large numbers of pumped alewives and the speed with which these fish could be loaded have already been highlighted. The lack of any large scale trucking mortalities from the Edwards site in 1993 and very early in 1994 was encouraging when considering the plausibility of denser loading. The configuration of the hauling tank system and the operational procedure used by the DMR/KHDG crew were very important in hauling larger loads of alewives. The porous pipe/oxygen delivery system that was fitted to the truck in 1992 for American shad hauling was used extensively during the 1993 and 1994 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.

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 maintained 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 alewife oxygen demand at the increased fish densities and temperatures experienced in 1994.

The maximum alewife density hauled during the 1994 season was approximately 1600 alewives/1000 gallon water per tank. Several loads of this density were carried by both the single tank truck and the double tank truck with neglible mortalities. These trips were completed when river and tank water temperatures were in the 14-16°C range. It may be possible to push the edge of "the envelope" even further until physical crowding stress or other unknown factors interfere.

Both stocking trucks performed well during the 1994 trucking season. No mechanical breakdowns were experienced and only routine maintenance and minor repairs should be necessary to prepare them for the 1995 season.

During the summer and fall of 1994, young-of-the-year alewives were captured in all of the seven Sebasticook drainage ponds stocked with adults. Juvenile alewives were captured in six of the 16 seine hauls made in 1994. Dip nets and cast nets contributed an additional 10 samples for 12 attempts completed. Fyke nets fished in lakes or outlet streams contributed another two samples for seven fyke net sets completed. In total, of the approximately 6,579 YOY alewives captured, 630 fish were measured for total length. The results of juvenile alewife sampling are presented in Table 8.

The outlet streams of the seven stocked Sebasticook drainage ponds were checked during the summer and fall to determine the availability of downstream passage for out-migrating alewives.

PATTEE POND outlet was surveyed on June 20, 22, and 27 in 1994. As in previous years, beaver activity was high on Pattee Pond Brook. DMR crews noted two active beaver dams and an older inactive dam on the brook. Both of the active dams were judged to be potential barriers to alewife emigration. During September and October, DMR crews visited the dam sites on 18 different days. Sections of the dams were removed on 13 of these visits to allow free passage of emigrating alewives. Alewives were observed exiting over one of the beaver dams on October 20.

LOVEJOY POND is drained by Mill Stream, which flows into Fifteenmile Stream. While DMR personnel surveyed Fifteenmile Stream and found it free of impassable barriers, the major hurdle for downstream migration was the dam at Chalmer's Lumber on Mill Stream in Albion. In 1994, as in past years, this dam presented a barrier to alewife migration when low stream flows and Mill Pond levels prevented alewife movement through the site. DMR stocked one load of alewives in Lovejoy Pond on May 31, 1994, to keep the pond in alewife production. Because of downstream passage problems in prior seasons, DMR completed stocking Lovejoy Pond to six alewives/acre on June 3 only after other Sebasticook drainage stocking was essentially completed.

Twentyfive Mile Stream, which drains **UNITY POND**, was surveyed on June 16, 1994. One beaver dam was judged to be a significant obstacle to alewife passage. On eight subsequent visits in September and October, the DMR crew opened a hole in the dam to allow free passage of alewives through Twentyfive Mile Stream. Juvenile alewives captured in fyke nets on Twentyfive Mile Stream on September 22 and October 20 confirmed that alewives could emigrate successfully from Unity Pond.

A large school of adult alewives (1000s) was sighted below the Burnham Dam by the plant operator in early June of 1994. During a FERC Inspection on June 14, DMR personnel sighted small numbers of adult alewives in the Burnham tail waters. While these adult alewives may have dropped out of lakes upriver, it seems likely that they moved out of Unity Pond and down Twentyfive Mile Stream before ascending the Sebasticook River below Burnham. While they may also have dropped out of Lovejoy Pond through Fifteenmile Stream and then ascended the Sebasticook, it seems likely they originated from fish stocked in Unity Pond. The outlet of Unity Pond sometimes backs up and flows into the pond during certain hydraulic conditions in Twentyfive

TABLE 8. 1994 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]	Number of Juveniles[6]	Mean Total Length
Douglas Pond	6.4	0/0	0/0	2/4	0/0	100/100+	61mm
Lovejoy Pond	6.2	1/1	0/0	0/0	0/0	50/58	41mm
Pattee Pond	6.1	0/2	0/0	2/2	0/4	55/55	82mm
Pleasant Pond	6.2	1/1	1/1	1/1	0/0	150/1130	55mm
Plymouth Pond	6.3	0/0	1/1	3/3	0/0	119/119	59mm
Sebasticook Lake	6.0	4/12	0/0	0/0	0/0	103/5064	68mm
Unity Pond	6.1	0/0	1/1	0/0	2/3	53/53	102mm
TOTALS:		**6/16**	**2/2**	**8/10**	**2/7**	**630/6579**	

[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 juveniles measured/total number of juveniles caught (seasonal total)

Mile Stream and Sandy Stream. Sandy Stream enters Twentyfive Mile Stream near the Unity Pond outlet. If the streams flow into the pond for a time in the spring, it is plausible that alewives in the lake could be attracted by the flow and enter the lake outlet perceiving that they were continuing upstream. In fact, the fish sighted below Burnham showed a strong inclination for upstream migration, supporting the conclusion that they were prespawners and not downrunner postspawners.

The levels of Douglas Pond, Plymouth Pond, Pleasant Pond, and Sebasticook Lake are all maintained by manmade dams. The downstream passage record at **DOUGLAS POND** will be explored later in this report when the Waverly Avenue Dam hydroelectric station is discussed. The dams on the other three lakes are all water control structures managed to control lake levels.

Passage out of **PLEASANT POND** is usually dependent upon rains and high lake levels causing the town to open the gates at the dam. DMR personnel seined, dipped or cast netted juvenile alewives near the outlet dam on three days in 1994: July 20 and 26 and September 12. By removing accumulated debris from the narrow gate opening, downstream passage was provided on several site visits. Portions of Stetson Stream were surveyed on five different days in June, July, and October of 1994. Three beaver dams were observed on the stream and DMR crews opened holes in the two dams judged to be potential barriers to alewife emigration. During subsequent visits to the sites over the summer and fall to reopen the breaches, juvenile alewives were never observed to be retained behind the beaver dams.

The major obstacle to downstream passage in 1994, as in prior years, seems to have been the outlet dam. However, one gate was slightly open during most visits and DMR personnel removed any accumulated debris from this opening to maximize the passage of juvenile alewives through the site.

DMR personnel cast netted and dip netted samples of juvenile alewives at **PLYMOUTH POND** Dam on July 14, 18, and 26, and September 14, 1994. Fall rains and the resulting dam gate openings probably allowed adequate downstream passage of alewives from Plymouth Pond.

Martin Stream, the outlet of Plymouth Pond, was surveyed on June 21, 1994. While there was still some stream flow in June, an August 23 visit to the dam noted that stream flows originating from dam gate leakage were minimal. Despite low summer flows typical of Martin Stream, fall rains and water releases for headpond level adjustments should have provided adequate downstream passage for emigrating alewives.

Fish emigration from **SEBASTICOOK LAKE** depends on passage through the water control dam in Newport that controls the lake level. The bulk of the downstream migration takes place after the dam gate is lowered late each summer to provide for the lake drawdown recommended by DEP. DMR's September 7, 1994 visit to the site confirmed that the drawdown had begun. A temporary interruption in the drawdown occurred just after it began and DMR noted that the gate was closed on September 9. This postponement of the drawdown allowed spillway repairs at Edwards Dam to continue by allowing Edwards better control over the Kennebec without the addition of high flows from the Sebasticook. Within a few days, the Sebasticook outlet gate was reopened and the sustained outflow of water provided good downstream passage out of the lake during the fall of 1994.

The lowermost dam on the Sebasticook River is the **FORT HALIFAX PROJECT** in Winslow, operated by the Central Maine Power Company. CMP completed construction of the permanent downstream bypass gate and flume during the 1993 field season, following the issuance of the amended license by FERC.

The permanent bypass uses the same trash sluice opening that was used in past years for the interim facility. This 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. CMP indicated that screen testing took place on August 16, 17, and 23; September 16 and 20; and October 11, 12, and 13.

CMP observed adult alewives for the first time in 1994 on June 13. DMR's first visit to Fort Halifax occurred on June 20, 1994. During DMR's visit on June 20 and all the subsequent eight visits through September 12, the bypass was open and operational. CMP first observed juvenile alewives at the site on July 25. DMR did not observe any juvenile alewives at the site up to and including the September 12 visit.

During the September 19 visit, DMR staff observed large numbers of juvenile alewives (10,000+ estimated) in the forebay area inside the trash racks at the Fort Halifax project. No turbines were operating and the downstream bypass was fully operational at the time the observations were made. CMP related that they have data indicating this is typical alewife behavior at the Fort Halifax site. Juvenile alewives move out of the forebay/intake area soon after the turbine(s) are shut down.

Prior to the September 26 visit, substantial rains had increased flows in the Sebasticook River. During the September 26 visit, the DMR crew noted that the bypass water flow was reduced below normal (6-12" deep spill) and that the trash racks were nearly plugged by algae and debris. Both turbines were in operation at the time of the visit and the DMR crew observed many juvenile alewives entering the turbine forebay through the only section of the trash rack that was clear (near the bypass). DMR personnel observed many juvenile alewives in the turbine tailrace and over 50 seagulls feeding on the discharged alewives. Very few juvenile alewives were observed to be using the bypass.

CMP's Bob Richter provided information regarding the circumstances surrounding the debris problems at the Fort Halifax site on September 26. CMP crews had been busy during the previous weekend at many hydro sites (including Fort Halifax) cleaning trash racks of the debris resulting from the heavy rains. The Fort Halifax trash racks had been clogged by mats of algae present in the Sebasticook River. High flows following eight inches of rain which fell during the previous weekend aggravated the situation. Early in the morning of the 26th, the racks were so plugged that headpond levels were five feet higher than intake levels at the site. In removing and flushing the algae and debris downstream through the trash sluice/fish bypass flume, the automatic sluice control was probably placed in a manual setting to allow the gate to be lowered while debris was sluiced through. As headpond levels continued to change through the day, the static gate setting caused a reduced flow in the fish bypass. CMP indicated that the gate was reset to "Automatic" mode the following morning.

Several factors at the Fort Halifax site probably served to lessen the effects of the restriction in bypass flow on the 26th. CMP observations indicated that fish movement was high from September 26 - October 1. The algae plugging problem was corrected early on September 27th and provided several days of normal bypass flow during this peak fish movement period. In addition, water spill over the project spillway from September 29 - October 1 (due to heavy rains) probably provided an opportunity for fish passage for several days.

Observations were made during visits to the site through the remainder of the season indicated that the bypass was open and operating properly on all these days. Juvenile alewives were observed using the bypass on October 18. Approximately 50-100 seagulls were observed feeding in the tailrace and bypass area on the 18th. CMP was notified on November 22 that the bypass could be closed for the season. Over the 1994 season, downstream passage through the bypass was available on all 17 of the DMR site 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 to 1993 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

TABLE 9. DOWNSTREAM PASSAGE OBSERVATIONS AT HYDROELECTRIC FACILITIES - SEBASTICOOK RIVER, 1994

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly
6/20	X	X	X	X	X
6/22	-	-	-	X	X
7/13	X	X	X	X	O
7/28	X	X	X	O	O
8/02	X	X	X	O	O
8/12	-	-	-	O	X
8/22	X	X	X	Xs	X
8/23	-	-	-	Xs	O
8/25	X	X	X	Xs	O
8/29	X	X	X	X	X
9/01	X	X	X	X	X
9/02	-	-	-	Xs	O
9/06	-	-	X	X	X
9/12	X	X	X	X	X
9/19	Xf	X	X	X	X
9/26	Xf*	Xa	X*	X	X
9/30	X	X	X	Xs	X
10/05	-	X	X	Xs	X
10/12	X	X	X	X	X
10/18	Xa	X	X	Xs	X
10/19	X	-	-	-	-
10/24	X	X	X	O	X
11/02	X	X	X	Xs	X
TOTAL NUMBER SITE VISITS:	**17**	**17**	**18**	**22**	**22**

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

successful study work in 1990 led to the continuation of the study in 1991 and 1992. In 1993, 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.

Studies were continued at Benton Falls in 1994, in an effort to gain more data on adult alewife passage at the site.

KHDG-funded DMR personnel observed the Benton Falls downstream passage during 17 visits in 1994. The bypass at Benton Falls was operational on all 17 of the site visits.

DMR observed juvenile alewives passing through the Benton Falls bypass on September 26, 1994. This was the only visit in 1994 during which DMR personnel observed alewives using the bypass. DMR personnel did observe roughly a dozen dead juvenile alewives on the deck of the floating net pen below the terminus of the bypass pipe on September 12. This small mortality probably represents a small fraction of the fish that passed through the bypass in the days prior to September 12.

DMR personnel observed Phil Andrews conducting studies at the Benton Falls bypass on October 5, 1994. The floating trap was deployed under the terminus of bypass, but DMR did not observe any alewives passing the facility during this site visit.

The first DMR visit to the **BURNHAM DAM** in 1994 occurred on June 20. Before this visit, the flashboard closest to the intake structure had already been notched down below the other flashboards. This modification allowed for a 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 was utilized in past years at the Burnham Dam.

Controlled spill was available as an interim downstream bypass during all 18 of the DMR visits at Burnham in 1994. Even with this interim downstream passage option, juvenile alewives were observed exiting the turbines at Burnham on September 26. The DMR personnel noted that many of the alewives exiting the turbines were dead. DMR counted approximately 30 visible juvenile alewives per minute emerging from one of the three turbines in operation on September 26. Assuming this figure to be representative of the other two turbines, as they share a common intake penstock, injury and/or mortality estimates would total approximately 90 juveniles/minute or 5400 juveniles/hour if these entrainment rates remained relatively constant over time. This figure represents only those alewives visible to DMR staffers and may be higher as many injured/killed alewives may have been too deep in the turbine tailrace to be observed and counted.

DMR did not observe any alewives using the controlled spill for downstream passage in 1994. As noted in the 1993 report, alewife entrainment problems at Burnham may be related to the considerable distance between the controlled spill area and the penstock intake, the ratio of water flow through the controlled spill vs the turbines and/or wide clear space of the Burnham station trash racks.

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.

The requirement to reduce trash rack spacing to one inch from June 15 to November 30 has not been met by the owner, Chris Anthony. The last DMR visit to the site on November 2 confirmed that a trash rack overlay has not yet been installed at Pioneer.

Passage available at the site during the 1994 season was a combination of flow through the bypass or sometimes via spill over the project spillway. No downstream passage was available on four DMR visits in 1994. On seven visits, passage was available over the project spillway. On 11 visits, some passage was available either over the spillway or through the bypass. In total, DMR made 22 visits to the Pioneer Dam site in 1994. Juvenile alewives were sighted only once, on September 26 in the headpond.

Several problems with the downstream bypass at Pioneer still need to be resolved. First, installation of the one-inch clear space trash rack overlay must be completed to aide in excluding alewives from passage through the turbines. Second, the level of the top stop log at the bypass entrance must be adjusted (lowered) such that adequate flow through the bypass is achieved over the full range of pond levels at the site. Finally, the vertical steel bars installed by the owner at the downstream terminus of the bypass flume must be removed. These bars were apparently installed to prevent trespassing in the bypass flume itself. However, they serve to collect water borne debris and clog the flume thereby preventing proper operation of the bypass. These steel bars were clogged with debris during four different 1994 site visits by DMR.

Construction of a downstream bypass at **WAVERLY AVENUE DAM** in Pittsfield was initiated in September of 1990. Most major components of the bypass were completed by early November, 1990. The remaining downstream passage requirements at the site were discussed at a December 15, 1993, meeting between David Cashman (Express Hydro Services, Inc.) and Malcolm Smith and Jim Stahlnecker of DMR. Following this meeting and subsequent discussion with the USF&WS Engineering Division, recommendations were forwarded from DMR to Express Hydro regarding the trash rack overlay requirements and improvements to the bypass.

On August 23, 1994, DMR observed Express Hydro's Waverly Avenue site operator, Chris Anthony, engaged in completing several recommended improvements to the bypass. Stop logs were added at the entrance to the bypass to control weir flows. A deflector board was added at the bypass terminus to prevent the bypass water and alewives from striking the draft tube in the project tailrace.

An expanded metal trash rack overlay was fitted to the project for the 1994 season. This overlay was not in place during the October 18 site visit. Apparently it had been removed because it became fouled with debris. This was a recurring problem with the overlay as it often became clogged shortly after generation began (personal communication with Chris Anthony). As a result, an overlay that is easier to maintain and clean may be required at the Waverly Avenue Dam. Express Hydro is weighing the cost of fabricating and installing an appropriate overlay vs revenue lost by not generating during the fish passage season. In the latter case, the resultant spill through the bypass or spillway crest should satisfy downstream passage needs.

DMR visited the Waverly Avenue Project on 22 days in 1994. The downstream bypass afforded some downstream passage on 16 of these days. No downstream passage was available on the other six visits as the bypass was either clogged with debris (four days) or stop logged shut (one day). On the remaining day when passage was unavailable, downstream passage modifications were under construction and the bypass flume was dewatered.

DMR personnel opened the bypass on July 13 (it was closed) and immediately began passing juvenile alewives downstream. After a sample was collected and the school passed, the bypass was returned to its original closed position. DMR also sighted juvenile alewives at the trash rack overlay on September 6, 1994. They were not observed using the bypass, which was passing four-inch flow of water at the time.

During the summer and fall of 1994, DMR personnel made observations on 19 different days at the downstream bypass at **EDWARDS MILL** on the Kennebec River. Juvenile and adult alosids were observed in the forebay near the bypass intake on all 19 of these visits. Juvenile alosids were observed using the downstream bypass on 12 of the 14 days they were sighted at Edwards. Adult alewives were observed using the downstream bypass on three of the five days they were sighted at Edwards. Adult postspawner American shad were never observed using the downstream bypass although they were present in the forebay on five different site visits in 1994.

Juvenile alosid samples were collected at the Edwards Mill bypass when possible during the 1994 passage season. Samples were collected on nine different days in 1994. A dip net was used on the first three days sampled and a flyrod was employed to catch juvenile alosids on the last six sampling days. In total, 195 young-of-the-year American shad were collected in the Edwards Mill forebay during the 1994 season. Of these 195 shad, 53 were captured using a dip net, cast net or electrofishing gear while the remaining 142 were caught with the flyrod. Over 123 young-of-the-year alewives were captured while attempting to sample shad at Edwards. Young-of- the-year shad were captured from July 29 through September 20, 1994, although they were probably present much later into the fall. These YOY American shad may have been the progeny of adult shad broodstock transfers from the Connecticut River or survivors from the 1994 shad fry stocking from the Medomak Hatchery to the Edwards impoundment.

On five days, from June 22 through July 28, postspawner adult American shad were observed in the Edwards Mill forebay. These shad were the survivors from broodstock transfers from the Connecticut River in May and June. It is encouraging that these fish survived in the impoundment (some until late July) and did not drop over Edwards Dam immediately following their introduction to the impoundment. Edwards personnel recovered at least 13 American shad mortalities from the project trash racks from May 26 to June 13, 1994.

METHODS: American Shad

In 1994, the DMR sought shad broodstock from one source in order to secure a minimum of 500 adults for truck stocking in the Kennebec River. Arrangements were made to obtain shad from the Connecticut River in Holyoke, Massachusetts.

No American shad broodstock were obtained from the Kennebec River in 1994. During the 1994 alewife stocking operations below Edwards Dam, several dozen adult American shad were seen in the upper powerhouse tailrace on several occasions. The experimental interim fish pumping system did not collect any shad during the 1994 stocking season. Seining for alewives at the Edwards site in 1994 did not produce any American shad, although seining was discontinued early in the season (Figure 2 and page 16).

American shad broodstock were secured from the Hadley Falls fish lift on the Connecticut River at Holyoke, MA. Early in 1994, DMR received permission from the Connecticut River Technical Advisory Committee to truck shad out of the trap at Hadley Falls. Fish health inspection is required by the Maine Department of Inland Fisheries & Wildlife for any fish being stocked into the inland waters of Maine if the fish are imported from outside the borders of the state. Since the impoundment above the Edwards Dam in Augusta where the shad were to be stocked is inland waters, the appropriate health work was performed.

At Holyoke, adult shad exiting the twin fish lifts into the headpond level canal were trapped by Connecticut River personnel from the University of Massachusetts Cooperative Fisheries Unit. Shad were then dip netted into water-filled rolling hoppers in 20-25 fish lots and lowered on an electric chain hoist down to the stocking truck. The healthiest, most vigorous shad were dip netted into the tank which had been previously half-filled with river water. [The double tank truck purchased with KHDG funds was used to transport the shad from the Connecticut River to the Kennebec; this truck and the manner in which it was operated were previously described in the "**METHODS: Alewife**" section of this report.] American shad were loaded up to a maximum of 120 per truck tank to minimize crowding stress during long trips. Oxygen was introduced into the tank water from compressed oxygen bottles through a regulator and the porous polyethylene pipe arrangement installed in 1992. This oxygen

"**METHODS: Alewife**" section. During the 1994 hauling season, DMR used salt in all tank water before transporting shad.

In 1994, all American shad obtained as broodstock for the Kennebec River restoration were stocked into that segment of the river between Augusta and Waterville. In 1993, as in prior years, shad were stocked in the Kennebec River at Sidney. In 1994, all shad were stocked at the Waterville boat launch. The stocking site was shifted to Waterville in order to release the shad closer to prime spawning habitat and minimize any tendency for fish to drop back over the Augusta Dam. During the summer, the impoundment between Augusta and Waterville was sampled to obtain information on the abundance of juvenile shad. This sampling was accomplished with four different types of gear. A fly rod was used to sample juvenile shad in the forebay at Edwards Dam; this method of sampling proved to be the most efficient. A small fly (size 20-22) was tied to the line's leader and dangled close to the water surface. The juvenile shad attracted by the fly would leap up and hook themselves onto it.

An electrofishing boat was borrowed from the U.S. Fish & Wildlife Service for sampling juvenile American shad. The 14' aluminum john boat was fitted with a generator to provide electrical current, which is delivered to the water via a 14' insulated pole fitted with copper 10-gauge wire to increase conductivity. The boat's aluminum hull serves as a ground to complete the electrical circuit. Any fish in proximity to the boat is momentarily stunned by the electrical current enabling easy capture and identification. A dip net was used to retrieve the stunned fish from the water.

A dip net was also employed to sample juvenile alosids using the interim downstream bypass at Edwards Dam. The dip net measured 18" wide x 12" long x 12" deep, with a six-foot extension handle and was fished by quickly pushing it downstream in front of the bypass causing the fish to either use the bypass or be captured.

A cast net with an 8' diameter was used to sample shad in the forebay of #7 and #8 turbines at Edwards. The net, when properly thrown, opens in the air and sinks rapidly upon hitting the water, trapping fish beneath it. A radial harness connected to the circumference of the net serves to close the cast net, trapping the fish within. A ¼" nylon rope passes through the center of the net and connects to the harness, serving to retrieve the net and close it.

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

RESULTS & DISCUSSION: American shad

A fish health inspection was performed on the Connecticut River shad stock. A 150-fish sample of adult American shad was collected at the Holyoke fish lift on May 5 and 6, 1994. 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 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 -
In past years, trapping and transport from the Connecticut River at Holyoke has contributed the lion's share of shad broodstock to the Kennebec restoration effort (97% over the last five years combined). Since 1991, the Connecticut River has been the **only** source for shad broodstock introductions in the Kennebec. Eight shad transfers were completed from Holyoke in 1994 between May 22 and June 16. In total, 1,435 shad were loaded at Holyoke and 879 survived the trip and were stocked at Sidney. These numbers represent an overall trucking/handling mortality of 38%. Results of the 1994 shad transfers are presented in Table 10.

The remote DO probe mounted in 1992 was used again for the 1994 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. During the 1994 American shad hauling season, DO levels were maintained at or above 90% saturation for those days that DOs were taken. DMR believes that this constant feedback system offers a good means to combat the problem of depressed hauling tank DOs.

A commercial anti-foam agent (NO FOAM) was used during the 1994 shad hauling season. This foam control agent had worked very well in 1993, eliminating almost all the thick brown foam that had been such a problem in past years. In addition, salting hauling tank water was continued during the 1994 transfers. DMR staff noted that the physical condition of American shad broodstock at the Hadley Falls facility was generally quite poor during the 1994 stocking season.

Juvenile Sampling -
DMR personnel used a fly rod to sample juvenile shad in the Edwards forebay. The flyrod proved to be an efficient tool for sampling YOY shad as it imitated a natural food source. The fly rod was used a total of six times, from August 24 through September 20, and captured a total of 141 juvenile shad. Alewife, brown trout, and landlocked salmon were also captured by this method.

DMR also employed an electrofishing boat to sample juvenile American shad and alewives in the Kennebec impoundment. An electrofishing course was attended by two DMR personnel on August 2-4, in order to increase our electrofishing efficiency. The electrofishing boat was used to sample the impoundment a total of four days, after which the motor was stolen. A three-man team was required to operate the electrofishing boat: one to operate the boat's motor and steer, one to dip up any stunned fish, and a third as a general safety observer. Several species of fish were sampled by this method including spottail shiner, smallmouth bass, white sucker, sunfish, and yellow perch. No juvenile American shad were captured in the headpond by electrofishing; however, 29 juvenile shad were sampled by the electrofishing boat in the forebay at the #7 and #8 turbines at Edwards Dam by using the remote prober off the boat.

The cast net was used on several occasions in the forebay of #7 and #8 turbines at Edwards Dam. On August 20, 20 shad were captured by this method. The cast net is an effective tool for sampling fish in shallow water; however, the forebay's depth allows both shad and alewives to easily outsound this type of net as it sinks.

A dip net was employed throughout the 1994 season to take biological samples at the Edwards Dam interim downstream bypass. This dip net was 18" wide x 12" long x 12" deep with a six-foot extension handle. All KHDG stocked alosids pass this hydro site on their downstream migration and the interim downstream passage would be a natural choice as a sampling station due to the concentration of fish observed schooling near this area. On July 29 and August 10, 1994, during regular sampling operations, DMR staff sampled 23 juvenile American shad.

In total, KHDG-funded personnel captured 194 juvenile shad in the impoundment in 1994. The 1993 season only produced five captured juvenile American shad. Sampling techniques have improved markedly, as well as insight relating to juvenile shad emigration. Problems still exist with sampling juvenile shad in the impoundment due to its size. The numbers of juvenile shad seen and sampled in the forebay at Edwards Dam indicate that significant numbers are being produced or are surviving fry stocking; however, current sampling techniques are not contacting these fish as they move through the impoundment. DMR is working on methods to discriminate between hatchery raised and broodstock YOY shad. This could prove to be an important program assessment tool.

During the summer of 1994, DMR planned to secure ripe broodstock shad suitable for egg stripping from the Kennebec and Abagadasset Rivers. The Eastern River sites were not fished during the 1994 season due to low catch rates in 1993. One experimental gill net constructed of single strand nylon was used to fish the Kennebec and Abagadasset. The net was 150' long x 8' deep, divided into three 50' panels of 4.5, 5.0, and 5.5 " stretch. Three sites were fished on the Kennebec River on the nights of June 29, 30 and July 5. No shad were captured on these nights. The Abagadasset River was fished one night and also produced no fish.

The experimental shad culture program initiated in 1991 was continued in 1994. 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 and Tide Mid-Coast Fisheries Development Project, which was set up and administered by the local Time and Tide Resource Conservation and Development Organization. On the evenings of June 7, 8, 9, 10, and 11, a total of 372,870 viable American shad eggs were taken. Of these, 300,000 hatched. These eggs were transported to a small hatching facility located at the site of the former Medomak Canning Company in Waldoboro, Maine. These eggs were disinfected and then placed in four custom-built upwelling egg incubators where they remained until hatchout. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp. During normal fry rearing operations, a kink developed in one of the water circulation hoses, resulting in a 50% mortality of shad fry. On July 5, 6, and 7, 51-61,000 shad fry ranging from 27-32 days old were released into the Kennebec River at the Waterville and Sidney boat launches. The remaining fry were stocked into two culture ponds at the hatchery and raised until late fall. A large algal crash in the second shad rearing pond caused an estimated 66% mortality to the shad in that pond. On October 4, an additional 15,600 fall fingerlings of 2-6" in length were stocked into the Kennebec impoundment at the Waterville boat launch. During this operation, a 10-20% mortality occurred due to high levels of contaminants in the truck tank. These contaminants (unconsolidated squash sludge) were dredged up by the seine used to capture the shad at the rearing ponds.

The hatchery manager, Sam Chapman, has been attempting to develop methodology to collect fertilized shad eggs from adult shad held at the hatchery. To assist in this experiment, KHDG personnel transferred 16 broodstock shad from the Connecticut River and 10 broodstock shad from the Saco River (from CMP's Cataract fish lift) to the Waldoboro hatchery site. No viable eggs were collected from these fish, which were held on-site in a tank.

TABLE 10. AMERICAN SHAD STOCKING IN THE KENNEBEC RIVER, 1994

TRUCK STOCKING:

Date	Broodstock Source	# Loaded	# Morts	# Stocked	Site	Water Temp C° Source	Water Temp C° Kennebec
5/22	CT River, Holyoke	169	60	109	Wtvl	14.0	13.0
5/24	CT River, Holyoke	203	65	138	Wtvl	17.0	13.5
5/29	CT River, Holyoke	223	100	123	Wtvl	17.0	-------
5/31	CT River, Holyoke	220	98	122	Wtvl	17.0	14.25
6/04	CT River, Holyoke	203	81	122	Wtvl	18.25	14.5
6/09	CT River, Holyoke	185	78	107	Wtvl	20.0	17.0
6/11	CT River, Holyoke	165	50	115	Wtvl	21.0	17.0
6/16	CT River, Holyoke	67*	5	43	Wtvl	21.0	------
TOTALS:		1435*	537	879			

TRUCK STOCKING: 879
FISH PASSAGE: + 0

TOTAL STOCKED: 879

*Included 19 American shad transported to Waldoboro shad hatchery for experimental eggtake

TABLE 11. HISTORICAL AMERICAN SHAD STOCKING IN THE KENNEBEC RIVER

	1987			1988			1989			1990			1991		
RIVER SOURCE	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S
Lower Kennebec Georgetown	28	12	16												
Narraguagus Cherryfield	185	2	183				180	6	174	56	20	36			
Connecticut Holyoke				965	349	616	600	156	444	991	423	568	1113	474	639
Kennebec Edwards Fish Pump							2	1	1						
TOTALS:	213	14	199	965	349	616	782	163	619	1047	443	604	1113	474	639

	1992			1993			1994			1995		
RIVER SOURCE	L	M	S	L	M	S	L	M	S	L	M	S
Lower Kennebec Georgetown												
Narraguagus Cherryfield												
Connecticut Holyoke	1323	329	994	1378	498	880	1435	537	879			
Kennebec Edwards Fish Pump												
TOTALS:	1323	329	994	1378	498	880	1435	537	*879*			

L = Loaded

M = Mortalities

S = Stocked

ATLANTIC SALMON

Atlantic salmon biologists from Maine's ASRSC have recommended against seining and handling of salmon, particularly during hot weather periods. For this reason, DMR did not make any attempts to seine Atlantic salmon in Bond Brook during the summer of 1994.

In a December 19, 1994 FERC order, the Licensees of the Edwards Dam were directed to construct interim fish passage at Edwards by October 1, 1995. If this construction schedule is maintained, salmon passage could begin in the fall of 1995 and be fully operational for the entire 1996 season. Salmon trapped in the interim lift would be passed into the impoundment between Augusta and Waterville. Trucking to upriver areas would be initiated after all available salmon habitat below Waterville is saturated.

On June 28, 1994, the experimental fish pumping system at Edwards Dam caught an Atlantic salmon. This salmon was carried to the canal and released. Throughout the 1994 field season, several Atlantic salmon were seen in both the upper and lower powerhouse tailrace as well as at the base of the dam. Salmon were also seen in Bond Brook during the 1994 field season.

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. The DMR's role is funded by a portion of the study funds provided by the KHDG Agreement.

All three of these state agencies have an interest in learning more about the relationships between the alewives, the 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:

PHASE I - 4 years

A. Determine age distribution and growth rates of land-locked 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 1988-1992. Analysis of the 1993 and 1994 samples will begin this winter. 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.

The results of the stomach content analysis of landlocked rainbow smelt (Osmerus mordax) collected in Lake George through 1992 are presented in Tables 12 and 13. As in 1991, examination of the percent frequency of occurrence showed the importance of copepods (80%) and cladocerans (57%) in smelt diets. Insect numbers dropped significantly in 1992 (24%), as opposed to 62% in 1991. Copepods and cladocerans comprised the majority (98%) of the food items enumerated (Table 13), with the vast majority being copepods. Insect numbers were down significantly in 1992. 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 pseudoharengus) collected from Lake George in 1992 were conducted by Douglas Saball. Results are presented in Tables 14 and 15. Examination of the percent frequency of occurrence showed the importance of copepods (95%) and cladocerans

(97%) in juvenile alewife diets. Insects appeared almost as regularly (84%) as in 1992. Copepods and cladocerans comprised the majority (>95%) of the food items enumerated (Table 15). Cladocerans, particularly Bosmina, occurred in 100% of all stomachs analyzed and comprised >44% of the 28,520 food items enumerated. 1992 samples of juvenile smallmouth bass are incomplete.

The results of the stomach content analysis of adult alewives (Alosa pseudoharengus) 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%. 1992 samples of white perch are incomplete.

A fyke net was set upstream of the culvert at Lake George on April 12 and was fished a total of 12 days intermittently until May 11. The fyke net was set in hopes of intercepting alewives which may have failed to migrate during the fall of 1993. No alewives were captured by this fyke net. The weir on Lake George was functional on May 12 and fished throughout the 1994 field season; it was removed on October 10. No alewives were captured by the weir.

DMR, DEP, and IF&W will meet in the spring of 1995 and review all current data to plan the 1995 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 - 1992. (#) = number of fish examined.

	Percent Frequency of Occurrence				
Food Item	1988 (70)	1989 (71)	1990 (72)	1991 (50)	1992 (90)
Copepoda	71.4	84.5	79.2	92.0	80.0
Unidentified	34.3	28.2	20.8	74.0	80.0
Cyclopoida	58.9	81.7	75.0	48.0	28.0
Calanoida	41.4	46.5	19.4	64.0	79.0
Nauplii	44.3	8.5	23.6	22.0	76.0
Cladocera	71.4	76.1	81.9	66.0	57.0
Unidentified	70.0	74.6	76.4	18.0	51.0
Daphnia catawba	10.0	15.5	13.9	00.0	11.0
D. ambigua	00.0	00.0	00.0	00.0	00.0
D. galeata mendotae	7.1	5.6	1.4	00.0	2.0
D. dubia	00.0	00.0	00.0	00.0	00.0
D. longiremis	00.0	4.2	2.8	00.0	00.0
D. pulex	00.0	00.0	1.4	00.0	4.0
Bosmina sp.	48.6	21.1	44.4	62.0	20.0
B. coregoni	00.0	14.1	00.0	00.0	9.0
Insecta	5.7	8.5	30.6	62.0	24.0
Trichoptera	1.4	2.8	4.2	6.0	1.0
Odonata	00.0	2.8	5.6	00.0	2.0
Diptera	2.9	2.8	23.6	60.0	23.0
Hemiptera	00.0	00.0	1.4	00.0	00.0
Ephemoptera	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 - 1992. (#) = number of food items.

	Percent Number				
Food Item	1988 (4055)	1989 (3360)	1990 (2441)	1991 (3087)	1992 (6178)
Copepoda	49.2	42.9	46.4	60.9	92.0
Unidentified	3.6	2.4	6.4	23.9	26.0
Cyclopoida	14.1	30.6	29.7	6.7	4.0
Calanoida	18.6	9.0	4.4	21.5	44.0
Nauplii	12.9	0.8	5.9	8.8	18.0
Cladocera	50.7	56.6	50.6	21.6	6.0
Unidentified	42.9	51.7	29.2	0.6	3.0
Daphnia catawba	0.3	0.6	1.4	00.0	1.0
D. ambigua	<0.1	00.0	00.0	00.0	00.0
D. galeata mendotae	0.2	0.1	<0.1	00.0	00.0
D. dubia	<0.1	00.0	00.0	00.0	00.0
D. longiremis	00.0	0.2	0.1	00.0	00.0
D. pulex	<0.1	00.0	<0.1	00.0	00.0
Bosmina sp.	7.3	2.8	19.9	20.9	1.0
B. coregoni	00.0	1.1	00.0	00.0	1.0
Insecta	0.1	0.4	2.9	17.4	2.0
Trichoptera	<0.1	0.2	0.1	0.1	00.0
Odonata	00.0	0.1	0.2	00.0	00.0
Diptera	0.1	0.1	2.4	17.3	1.9
Hemiptera	00.0	00.0	0.2	00.0	00.0
Ephemoptera	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 & 1992. (#) = number of fish examined.

Food Item	Percent Frequency of Occurrence	
	Juvenile Alewife (A. pseudoharengus) 1991 (50)	Juvenile Alewife (A. pseudoharengus) 1992 (45)
Copepoda	86.0	95.0
Unidentified	38.0	93.0
Cyclopoida	62.0	64.4
Calanoida	26.0	75.5
Nauplii	24.0	60.0
Cladocera	76.0	97.0
Unidentified	58.0	82.0
Daphnia catawba	4.0	26.0
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	4.0	00.0
Bosmina sp.	64.0	100.0
B. coregoni	00.0	60.0
Amphipoda	00.0	00.0
Unidentified	00.0	00.0
Insecta	72.0	84.0
Trichoptera	14.0	44.0
Odonata	4.0	15.5
Diptera	70.0	84.0
Hemiptera	00.0	00.0
Ephemoptera	00.0	00.0
Pisces	00.0	00.0
Unidentified larvae	00.0	00.0
P. flavescens larvae	00.0	00.0
M. dolomeiu larvae	00.0	00.0
A. pseudoharengus larvae	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 & 1992. (#) = number of food items.

	Percent Number	
Food Item	Juvenile Alewife (A. pseudoharengus) 1991 (1731)	Juvenile Alewife (A. pseudoharengus) 1992 (28,520)
Copepoda	50.2	39.9
Unidentified	5.3	25.2
Cyclopoida	17.9	1.8
Calanoid	3.0	12.3
Nauplii	23.9	0.4
Cladocera	23.0	55.4
Unidentified	7.1	1.30
Dapnia catawba	0.4	0.24
Diaphanosoma	00.0	0.77
D. galeata mendota	00.0	00.00
Sida crystalina	00.0	1.90
D. longiremis	00.0	00.00
Polyphemus pedicatos	00.0	4.70
Bosmina sp.	15.4	44.40
B. coregoni	00.0	1.10
Water mite	00.0	00.00
Amphipoda	00.0	00.0
Unidentified	00.0	00.0
Insecta	26.4	4.6
Trichoptera	0.6	0.40
Odonata	00.0	0.04
Diptera	25.7	4.10
Hemiptera	00.0	00.00
Coleoptera	00.0	0.07
Ephemeroptera varia	00.0	00.00
Other	00.0	0.07

TABLE 15 (CONTD)

Pisces	00.0	00.0
Unidentified larvae	00.0	00.0
P. flavescens larvae	00.0	00.0
M. dolomieu larvae	00.0	00.0
A. pseudoharengus	00.0	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