KENNEBEC RIVER ANADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT - 1991

MAINE DEPARTMENT OF MARINE RESOURCES
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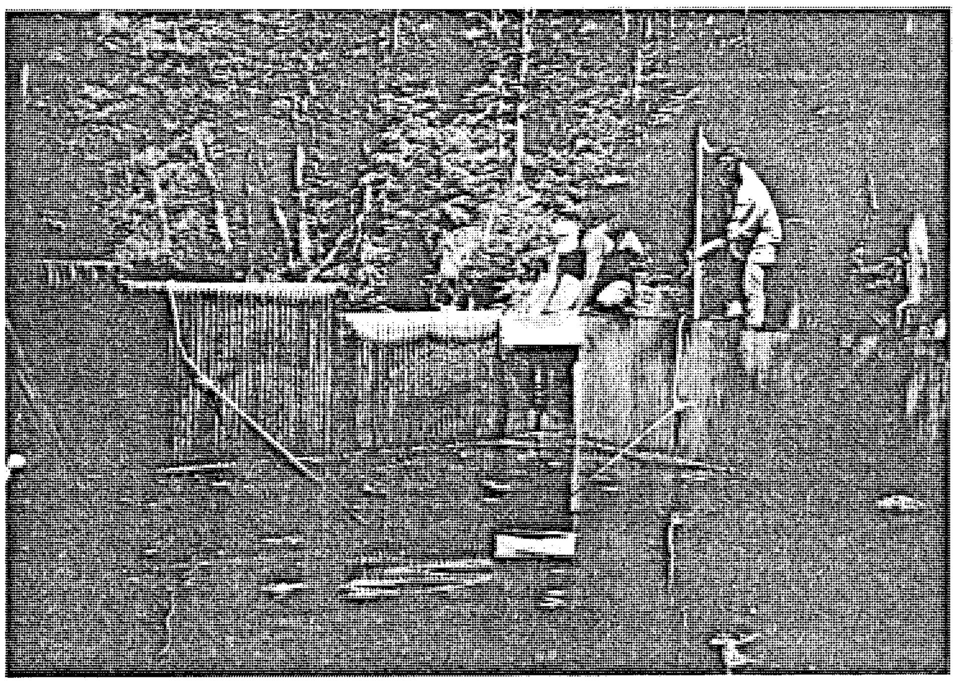

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INTRODUCTION -

This progress report covers the fifth 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. The future of this dam as a collection site for broodstock is unclear. The license for this dam expires 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. It appears that it will be necessary for the near future to continue to obtain broodstock from other sources. All adult alewives have been obtained from the head-of-tide Brunswick Dam fish passage/trapping/sorting facility (owned by Central Maine Power and operated by the DMR) on the Androscoggin River since 1987. American shad have been obtained from the Connecticut and Merrimack Rivers in Massachusetts and the Narraguagus River in Maine.

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 eleven (11) out of twenty-one (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.**

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 additional sources. Since 1987, fish passage for shad at the Augusta Dam has been nonexistent or ineffective. Although shad have been obtained from other sources, as noted previously, the numbers stocked have not approached the goal of 2,500. **Therefore, unless new sources become available, the goal for American shad is to stock 1,000 adult shad annually.**

The interim plan for Atlantic salmon is to move whatever salmon become available at the Augusta Dam upriver. It was also planned to capture Atlantic salmon at the mouth of Bond Brook and stock them above the Augusta Dam.

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 in 1991 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.

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 1991, broodstock alewives were captured at the trapping facility at the Brunswick Fishway at head-of-tide on the Androscoggin River. As in past years at Brunswick, trapped alewives were separated from other fish species and counted as they were released from dip nets. When the desired number of alewives had been collected in the holding tank, the fish and water were sluiced into the tank trucks through a 12-inch diameter flexible hose attached to the holding tank.

No broodstock alewives were captured at the Augusta Dam in 1991. In the spring, DMR advised Edwards not to operate the interim experimental fish passage/trapping facility ("fish pump") at the Augusta Dam during the 1991 season. DMR made this recommendation because of the level of DMR/KHDG manpower required to check this facility daily when it is operating and the small numbers of alewives and/or shad broodstock trapped at the facility in 1989 and 1990. The fish pump never produced the number of alewives or shad necessary to make truck stocking feasible from this site. For 1991, DMR decided to commit its KHDG-funded labor to stocking alewives from the Brunswick trapping site in the belief that this was the most efficient use of that labor for alewife broodstocking.

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 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 and a supplemental venturi gas exchange 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 off-loading 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, 1991, stocking. The juvenile alewives were trapped with beach seines fished from the shores of the lakes stocked. Two beach seines were employed, measuring 80′ long x 8′ deep and 40′ long x 4′ deep. Both seines were constructed of 1/4" 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 1/4" bar mesh and was ten feet in diameter. Dip net frames varied in their dimensions but all were hung with 1/4" delta mesh netting.

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

Selected lake outlet streams were surveyed to determine the presence of obstacles to downstream passage of juvenile and adult post-spawner 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 1991, 44,755 adult broodstock alewives were stocked into eight ponds in the Kennebec River drainage. All the alewives stocked in the Kennebec in 1991 were trapped at the Brunswick Fishway at head-of-tide on the Androscoggin River. Of the 44,755 alewives stocked, 42,725 were stocked into the seven ponds in the Sebasticook River subdrainage which are currently under 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 4.5 fish x $acre^{-1}$. Stocking densities ranged from a low of 1.8 alewives x $acre^{-1}$ in Unity Pond to a high of 6.1 alewives x $acre^{-1}$ in Lovejoy, Pattee, Pleasant, and Plymouth Ponds (Table 3).

Alewife stocking in Webber, Three Mile, and Three Cornered Ponds was deferred again in 1991 as a result of a request by DEP to continue to establish long term water quality data bases prior to alewife stocking.

In addition to the Phase I alewife stocking underway in the seven Sebasticook drainage lakes, 1991 saw the first stocking of alewives in Lake George (the joint DMR/DEP/IFW study lake). On May 24, 1991, DMR personnel stocked 2,030 adult alewives into Lake George as part of the ongoing joint study.

The 2,030 alewives introduced at Lake George, combined with the 42,725 stocked in the Sebasticook subdrainage, yields the 44,755 fish total for 1991. This figure represents the second highest number of alewives stocked since the KHDG Agreement was implemented and falls only 412 fish short of the 1989 record year of 45,167 fish (Table 5). The large number of alewives transported in 1991 is also reflected in the total number of stocking trips completed. In the spring of 1991, 55 alewife stocking trips were made while only 30 were completed in 1990, when 26,685 alewives were stocked. DMR took steps to solve the problems encountered during the 1990 alewife season and remedied most of them before the 1991 season began.

One major problem encountered in 1990 was a lack of manpower during the alewife and shad hauling season. DMR made early efforts to staff up for the 1991 spring season. The new KHDG technician started work on March 18, 1991, allowing her to become familiar with the stocking equipment and procedures before the season started in May.

One Seasonal Conservation Aide started work in April so that he was able to assist in the pre-season maintenance and preparation of the stocking equipment. This early start also allowed him to become familiar with the equipment and procedures prior to the busy

May/June season. The remaining two Seasonal Conservation Aides started work as they finished their college semesters in the middle of May. One of these two Aides worked for the KHDG Project in 1990 and so was already familiar with the spring fish stocking procedures.

DMR made the decision to hire three Seasonal Aides for 1991 for two reasons: first, the additional manpower would help during the busy May/June alewife and shad stocking season, especially if one crew member was ill, injured, or found another job at the last minute (as in 1990); second, the extra person would be needed throughout the season to complete the additional workload brought about as DMR entered Phase II of the Lake George Study in 1991. These additional duties included stocking Lake George with alewives; constructing, maintaining, and daily monitoring of a downstream weir trap on the outlet stream; and biweekly sampling for juvenile alewives in the lake itself. An update on activities at Lake George can be found in the section, *Interim Progress Report on the Lake George Study.*

The final factor that made 1991 a successful year for alewife stocking was the nearly flawless operation of the project's two tank trucks. Both these vehicles had undergone repairs during the 1990 hauling season, with the older Chevrolet single tank truck receiving a new engine. Pre-season maintenance and checks showed no problems prior to the 1991 season and both trucks finished out the season without a breakdown. During fall storage of the Chevrolet, the clutch broke and is currently inoperable. This vehicle will be repaired in the spring of 1992, prior to the spring truck stocking season.

During the summer and fall of 1991, juvenile alewives were captured in all of the eight ponds stocked with adults. KHDG-funded DMR personnel caught juvenile alewives in 48 beach seine hauls of the total 116 hauls completed overall. Dip nets and cast nets contributed an additional three samples for seven attempts completed. In total, of the 4,920 juvenile alewives captured, 1,140 fish were measured for total length. The results of juvenile alewife sampling are presented in Table 6.

Heavy rains during the late summer and fall of 1991 facilitated the passage of juvenile alewives out of their natal ponds. Hurricane Bob in August and heavy rains in late September/early October caused high flows out of the seven Sebasticook drainage ponds that contained juvenile alewives. These pulses of high water acted to ease the out-migration of the juvenile alewives over the sometimes troublesome beaver dams or town water control dams.

PATTEE POND outlet was checked on June 18 and found to be free of obstructions other than the beaver dam that maintains the pond level. Subsequent checks on August 26 and October 2, 8, and 23, revealed that the stream flow over the dam provided ample downstream passage for alewives.

LOVEJOY POND is drained by Mill Stream. That section of Mill Stream, from Lovejoy to the Benton Road crossing in Albion, was surveyed on June 19 and determined to be free of obstructions. The dam on Mill Stream at Chalmer's Lumber in Albion was checked several times over the season to determine if alewives could pass over this barrier. Inspections on August 20, September 4, and 18, revealed that low flows provided no downstream passage at this leaky dam. Subsequent inspections on October 1, 9, and 23 showed adequate downstream passage over the spillway with the high stream flows documented on these days. On October 9, DMR personnel recovered several juvenile alewives trapped in the grass below the spillway, indicating juveniles had passed out of the pond recently.

A downstream passage survey of Twenty-five Mile Stream, which drains **UNITY POND**, was conducted on June 20 and 27. The survey revealed a partially submerged beaver dam and an abandoned weir, but no obstacles to downstream passage. The full length of the stream was checked from the lake itself through to the Sebasticook River.

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** was dependent on rains and high lake water levels causing the town to open the gates at the dam. DMR personnel seined juvenile alewives at the Pleasant Pond outlet on July 22, August 6 and 21, and October 3, as these fish waited for flows that would allow them to pass downstream. Adequate flows for passage were observed on September 3 and October 3, and probably occurred later in October after rain events.

DMR personnel attempted to obtain juvenile alewife samples at the **PLYMOUTH POND** Dam on at least six occasions in 1991. Adequate flows for downstream passage were observed on August 2 and 20, and on October 9 and 23.

The fish emigration from **SEBASTICOOK LAKE** depends on passage through the water control dam that controls the lake level in Newport. The bulk of downstream passage takes place after the dam gate is lowered late each summer to provide for the lake drawdown recommended by DEP. DMR personnel observed that the drawdown began on September 6, when the gate was opened a slight amount. Juvenile alewives attracted by the flow schooled in the lake near the dam. On September 7, the gate was opened (lowered) much wider, providing a large surface spill and excellent passage out of the lake. However, the gate had been nearly closed up again by September 9, when DMR next visited the site. According to Gary MacPheters of CHI/ Burnham Dam, the drawdown was postponed and would resume again on

September 9, in order to allow the completion of construction at the Burnham Dam. When DMR personnel visited the Sebasticook Lake outlet on September 19 and October 9, the gate had been opened again and excellent downstream passage and high water flows were observed.

The downstream emigration of juvenile alewives through the Sebasticook River was monitored throughout the summer and fall of 1991, as in previous years. Hydroelectric power facilities of the Sebasticook River were surveyed regularly to permit observation of juvenile migration and to assess any problems which juveniles might encounter at these barriers. Field observations at the hydroelectric stations are summarized in Table 7.

The lowermost dam on the Sebasticook River is the **FORT HALIFAX PROJECT** in Winslow, operated by the Central Maine Power Company. In past years (1987-1990), temporary downstream alewife passage was afforded through an open trash sluice located just downriver from the trash racks. From 1987 through 1990, plywood sheeting installed over the trash racks down to a depth of four feet helped to deter the alewives from passing through the trash racks and directed them toward the open sluiceway.

The present KHDG Agreement calls for the installation of permanent downstream fish passage facilities at Fort Halifax by December 31, 1991. However, due to intervention by American Rivers et al, this schedule has been delayed until FERC resolves the KHDG appeal and issues an amended license. As a result, interim passage continued during the 1991 season.

Construction on the spillway from July through October had some impact on downstream passage at Fort Halifax in 1991. On June 4, Robert Richter of CMP and Lewis Flagg of DMR discussed the construction plans and the constraints it would place on the interim passageway. Since the spillway was to be repaired, a drawdown of two feet was necessary. This afforded a six-inch deep spill through the trash sluice bypass during construction hours. After hours, the pond was to be raised an additional six inches to provide a 12-inch spill through the trash sluice. In addition, no plywood deflection screen was installed over the trash racks, as this would have severely impaired intake water flow and power generation since the pond was already depressed by two feet. Finally, to allow access to the length of the spillway, a temporary access road was constructed along the base of the spillway. The first two visits by DMR to Fort Halifax on July 19 and 29 showed little opportunity for safe fish passage. On the 19th, the trash sluice was clogged with debris, allowing only a one-inch spill through the bypass. Adult alewives were visible in the impoundment near the bypass, apparently unable to use it. In addition, a turbine was running at the site. On July 29, both turbines were operating and there was no water passing through the bypass.

DMR visits to the site in August showed some improvement in passage, with bypass flows present on nearly all occasions. However, on August 9, a large school of juvenile alewives was visible in the turbine forebay. The turbine was not operating at the time. This occurrence of juveniles in the forebay might be attributed to the lack of plywood screening on the trash racks.

A recurring problem in 1991 at Fort Halifax was uncontrollable spill over the crest of the spillway. Normally high flows and spillway overflow are beneficial to the downrunner juvenile alewives. However, the presence of the temporary construction road below the spillway caused many alewives to become impinged after passing over the spillway. Much of this spill occurred as a result of Hurricane Bob on August 19.

DMR visits on August 22 and 27 revealed that spillway overflow was passing through the expanded metal access road and that fish were probably being impinged. Juvenile alewives were observed in the headpond on August 22. By the August 27 visit, workers were removing dead alewives from the access road and on August 28, Robert Richter called to notify DMR that about 15 gallons of dead juvenile alewives had been picked up by the construction crew. DMR was told that approximately 95% of the dead fish were juvenile alewives with adults making up the other 5% of those recovered. This recovered volume of alewives probably represents a fraction of the fish injured or killed.

Spillway overflow occurred again in late September and throughout October as a result of the Sebasticook Lake drawdown in combination with frequent heavy rains. On at least one occasion (October 11), numerous seagulls were observed feeding on the alewives passing over the spillway and expanded metal access road.

DMR last visited Fort Halifax on November 29, 1991. Construction was finally finished and the cleanup process was in progress. On December 2, DMR telephoned Robert Richter at CMP to confirm the seasonal shutdown of the interim bypass facility.

In retrospect, little could be done to prevent the loss of alewives which took place on the temporary access road below the Fort Halifax spillway. Once the high flows from Hurricane Bob and the other, later, rain events hit the project spillway, no control could be exerted over the water or passage route of the alewives. Looking forward, DMR will try to apply these lessons to its evaluation of future construction schedules and plans to prevent the loss of more fish under similar circumstances.

Of the 31 visits DMR made to Fort Halifax in 1991, passage through the bypass or over the spillway was available on 25 of these days. Passage over the spillway crest and onto the temporary access road was present on 12 of the 25 visits when some passage was available.

The **BENTON FALLS PROJECT** is equipped with permanent downstream passage facilities that have been on line since 1988. The bypass at Benton Falls consists of two surface weirs (one located above each turbine intake) which interconnect and discharge into the tailrace through a large diameter pipe. Water flow into each weir is regulated by a gate which can be lowered to allow a controlled surface spill into the weir. After passing over this gate, fish become committed to the bypass and cannot reenter the headpond. Large numbers of juvenile alewives were observed passing through the facilities while they were operated during the 1988, 1989, and 1990 seasons.

During the 1990 and 1991 seasons, KHDG conducted downstream passage studies at Benton Falls using VHS cameras to count fish passing through the facilities. The successful study work in 1990 led to the continuation of the study in 1991. A VHS camera was placed over the weir intake located over the large turbine and it recorded fish passage through that weir intake throughout the season.

During the summer of 1991, the Benton Falls impoundment had to be drawn down because of low dissolved oxygen levels (probably a result of algae in the impoundment). The pond was drawn down two feet on August 4, while still allowing a one-foot deep spill through the bypass weir.

On August 5, Scott Williams of Lake and Watershed Resource Management telephoned DMR and notified Lewis Flagg that an additional two foot drawdown would be required because of continued low DO readings. DMR was notified because this second two foot drawdown would dewater the downstream passage intake weirs. Mr. Williams and Mr. Flagg agreed that the turbines would not be operated once the headpond level was drawn below the bypass intake. In addition, interim passage and minimum flows were to be provided by opening a gate.

Observations made at the next DMR visit to the site on August 9 confirmed that the Benton Falls impoundment was nearly full again, at a gauge reading of 84.3 feet (normal pond elevation is approximately 85 feet). DMR observations on the 9th indicated that a large volume of water was being released through the dam's spillways or gates, in addition to the smaller turbine, in an effort to flush much of the problem algae from the impoundment. A subsequent DMR visit on August 12 showed that the water release from the spillway had been terminated and that the smaller turbine was in operation. Juvenile alewives were observed passing downstream through the weir intake located over the larger turbine.

KHDG-funded DMR personnel observed the Benton Falls downstream passage during 32 visits in 1991. The bypass at Benton Falls was operational during 29 of these 32 visits. On one of the visits when the bypass was not operating (September 23), consultants working for Benton Falls were busy conducting downstream passage studies. The bypass had been closed temporarily to allow this work to be completed. On the other two days (September 16 and November 15), repairs and modifications to the downstream passage were in progress.

DMR personnel observed juvenile alewives passing through the downstream bypass on five visits in 1991: August 12, 19, 22, and 30, and October 4. DMR personnel observed juvenile alewives in the turbine tailrace once in 1991, on October 11, despite the availability of alternate bypass passage.

Overall in 1991, downstream passage at Benton Falls was very consistent, despite the hurricane, high flows, and a headpond drawdown. The results of KHDG downstream passage studies in 1991 should be of great interest, especially due to the large number of broodstock alewives transplanted this year. Of the 44,755 alewives trucked this year, 38,398 were placed in waters above the Benton Falls Dam.

The first DMR visit to the **BURNHAM DAM** in 1991 occurred on July 19. 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 seasons at the Burnham Dam.

On August 6, Gerald Stevens of CHI telephoned Lewis Flagg to notify DMR that the Burnham headpond would be drained over the weekend of August 10-11. CHI planned to draw the impoundment to riverbed level by Monday, August 12, to allow construction to begin on the dam. Mr. Stevens and Mr. Flagg agreed that stoplogs would be removed as the pond level dropped to allow a continual controlled spill and bypass route for the downstream migrating alewives.

DMR observations on August 9 indicated that the drawdown had begun with the removal of stoplogs and the initiation of a controlled spill through the stoplog bays. The DMR visit on Monday, August 12, confirmed that the headpond had been reduced to riverbed level and downstream passage was provided through two open stoplog bays and a large drain in the base of the spillway.

Conditions at Burnham remained essentially the same until Hurricane Bob produced heavy rains beginning on August 19. Three days later, the August 22 visit to Burnham revealed the impoundment had been partly refilled by the hurricane runoff and the two open stoplog bays were passing approximately ten feet of water each. There was also a large flow passing through the drain in the base of the spillway. Construction had resumed by the August 27 visit and the high waters following the hurricane had receded.

The refilling of the impoundment began on September 6, as construction was completed. Lewis Flagg of DMR worked out a plan with CHI to provide temporary downstream fish passage and minimum flows as the pond was refilled. The plan called for the incremental installation of additional stoplogs in the dam as headpond level spilled over the top of the stoplog previously installed. In this way, some minimum flow and some limited amount of downstream passage was provided during the rise in pond level. DMR observations on September 6, 7, and 9, followed the rise in pond level and the addition of stoplogs to two feet below full pond by September 9.

Subsequent inspection by DMR personnel on September 13 indicated that the notched flashboard was again providing a controlled spill and fish passage since the pond had been completely refilled by the 13th.

Controlled spill or spill over the whole spillway was available as an interim downstream bypass during the remainder of DMR visits at Burnham in 1991. DMR personnel observed juvenile alewives exiting the turbines at the station on September 27. A sample of these juveniles was collected and its analysis revealed that many of the alewives had been struck by the blades or injured as a result of their passage through the turbines. Downstream passage around the turbines was available at this time via a six-inch spill over the entire spillway, in addition to the notched flashboard/controlled spill temporary bypass measure. It is clear that despite the availability of alternative routes, some juvenile alewives became entrained in the turbines at the Burnham station. In addition, some fraction of the juveniles passed by the turbine are injured or killed.

Overall in 1991, an interim downstream passage route was always available as a bypass around the turbines at Burnham. On all 31 occasions when DMR personnel made observations at Burnham in 1991, there was some form of downstream passage available for the alewives to use.

From 1987 through 1990, downstream passage at the **PIONEER DAM** in Pittsfield has consisted of controlled spills over the crest of the spillway. While construction of a downstream bypass at Pioneer began during the summer of 1990, the owner has made no visible progress on the bypass since November of 1990. At that time, the entrance of the bypass channel had been cut through a reinforced concrete canal wall just upstream of the trash racks. During the off season, DMR will contact the owner, Chris Anthony, to work out a schedule for the completion of the bypass during the 1992 construc-tion season.

In 1991, downstream passage around the turbines at Pioneer took place when controlled spills over the crest of the spillway allowed the alewives to pass. Spillway overflow was observed on 22 of the 31 DMR survey days during 1991.

Construction of a downstream bypass at **WAVERLY AVENUE DAM** was initiated in September of 1990. The structure was largely completed by early November, 1990. This winter, DMR will seek some modifications or additions to the facility through communications with David Cashman of Express Hydro Services, Inc., the dam's owner. A weir-type gate at the entrance of the downstream passage and a flume for discharging fish to the tailrace will need to be incorporated into the existing passageway. DMR will consult further with the fishway engineering staff at the USFWS to develop suitable solutions in conjunction with Express Hydro Services.

On three occasions in 1991, juvenile alewives were observed in the headpond (Douglas Pond) at Waverly Avenue. On all three occasions, juveniles were spotted near the stoplog spillways on the west side of the dam away from the bypass and turbine intake. DMR believes that the alewives use this frequent surface spill as another downstream migration route. Downstream passage through the current bypass, through the west side spillways or over the dam spillway crest, was available during all 31 DMR site visits in 1991.

During the summer and fall of 1991, DMR personnel made observations on 14 different days at the downstream bypass at **EDWARDS MILL** on the Kennebec River. Juvenile alosids were observed in the forebay near the bypass intake on five different days.

Juveniles were observed using the downstream bypass on three of the five days they were sighted. Juvenile alosids were visible in the turbine tailrace at Edwards Mill on three days in 1991. It is interesting to note that two of the days juvenile alosids were observed using the bypass, they were also present in the turbine tailrace. The presence of large numbers of seagulls (100+) on these two days indicates that a substantial number of alosids may have been passed by the turbines.

Alosid samples were collected at the Edwards Mill bypass when possible during the 1991 passage season. A cast net, dip net, and beach seine were employed at the forebay above the bypass in attempts to capture juvenile alosids. However, the targeted alosids were usually able to sound and avoid capture. DMR collected only 14 juvenile alewives at Edwards in 1991. DMR will be studying options for more efficient collection gear for use at the Edwards bypass. Options under consideration include a trap net in the forebay, a bag net rigged in the bypass flow itself, or electrofishing gear. A decision will be made this winter on a course of action for this sampling site.

Adult American shad were observed in the forebay near the bypass intake at Edwards Mill on two days in 1991. Lewis Flagg and James Stahlnecker observed approximately six adult shad swimming in the lower forebay during a FERC inspection at Edwards on August 7, 1991. On August 9, Melissa Robillard and James Stahlnecker observed approximately 24 adult shad swimming in the lower forebay.

None of these shad were ever observed passing downstream through the bypass. Previously, on June 10, James Stahlnecker observed two dead adult shad impinged on the trash racks in the lower forebay. The latter two sightings indicated that at least some shad survived after truck stocking into the impoundment and remained in the impoundment until early August.

FIGURE 1: **Kennebec River Drainage**

ANADROMOUS FISH RESTORATION PROGRAM

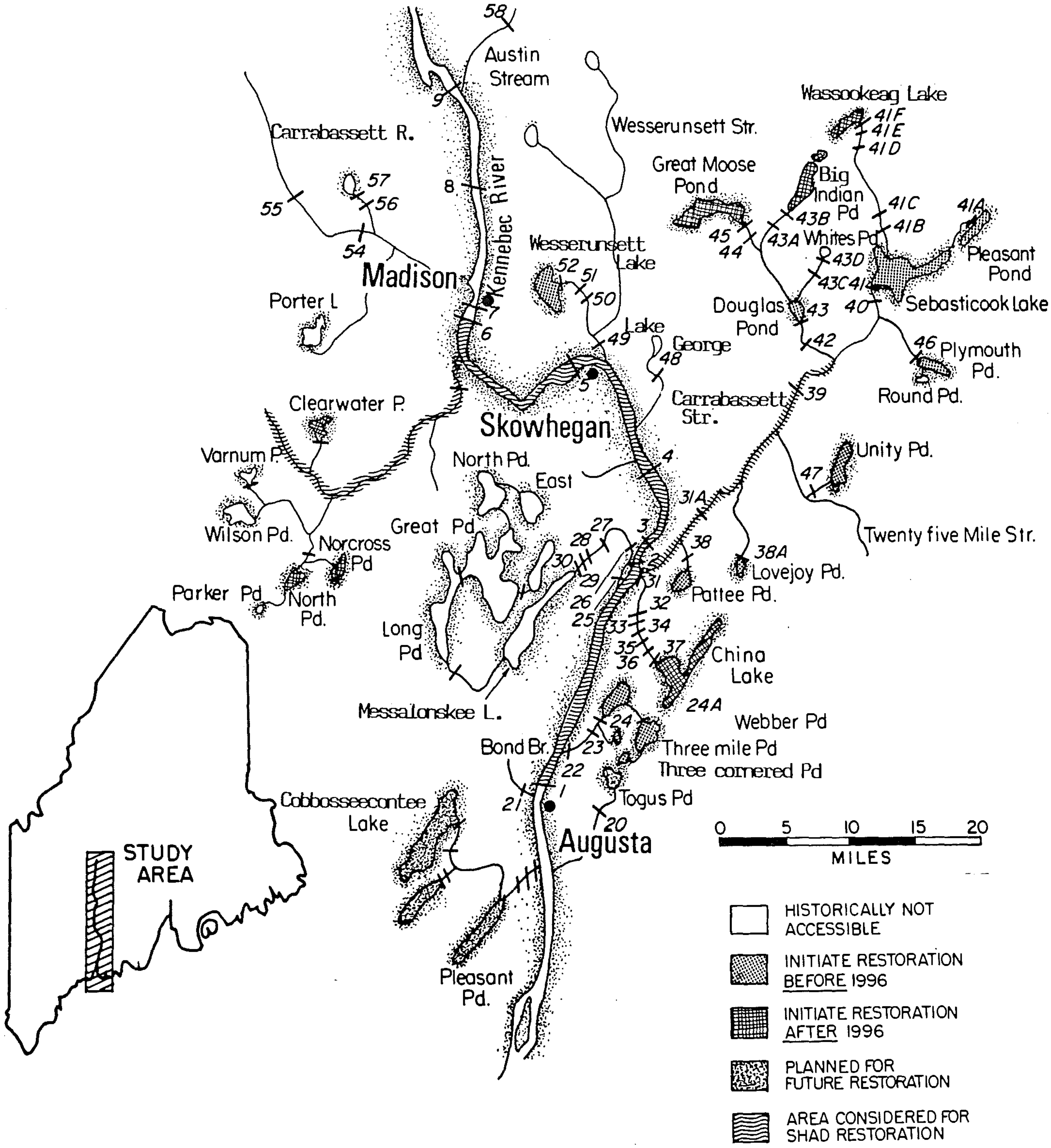


TABLE 1. 1991 Alewife Stocking Plans (Sebasticook River)

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

Table 2. Hydroelectric Facilities Monitored for Downstream Passage, 1991

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. 1991 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	3,150	4	100%	6.0
Lovejoy Pond	324	1,944	1,976	3	102%	6.1
Pattee Pond	712	4,272	4,327	7	102%	6.1
Pleasant Pond	768	4,608	4,689	7	102%	6.1
Plymouth Pond	480	2,880	2,921	5	102%	6.1
Sebasticook Lake	4,288	25,728	21,030	22	82%	4.9
Unity Pond	2,528	15,168	4,632	5	31%	1.8
Lake George**	335	2,010	2,030	2	101%	6.1
TOTALS:	**9,960**	**59,760**	**44,755**	**55**	**75%**	**4.5**

* Six fish per acre
**Study lake

Table 4. 1991 Kennebec River Alewife Stocking by Date/Trip

Date	Location	# Loaded	# Morts	# Stocked
05/16/91	Sebasticook Lake	1,700	44	1,656
	Sebasticook Lake	1,700	44	1,656
05/17/91	Pleasant Pond	807	14	793
	Pleasant Pond	575	117	458
	Plymouth Pond	505	1	504
	Plymouth Pond	789	0	789
05/18/91	Plymouth Pond	801	0	801
	Plymouth Pond	530	0	530
	Pleasant Pond	800	0	800
	Pleasant Pond	535	0	535
05/19/91	Douglas Pond	812	0	812
	Pattee Pond	533	0	533
	Douglas Pond	902	0	902
	Pattee Pond	611	0	611
	Pleasant Pond	850	0	850
	Pleasant Pond	501	0	501
05/20/91	Sebasticook Lake	550	1	549
	Pleasant Pond	752	0	752
	Sebasticook Lake	1,625	0	1,625
	Douglas Pond	525	0	525
	Douglas Pond	911	0	911
	Sebasticook Lake	1,717	133	1,584
	Sebasticook Lake	825	0	825
05/21/91	Pattee Pond	624	0	624
	Pattee Pond	902	1	901
	Sebasticook Lake	748	0	748
	Pattee Pond	613	0	613
	Sebasticook Lake	1,744	0	1,744
05/23/91	Unity Pond	1,666	9	1,657
	Sebasticook Lake	559	0	559
05/24/91	Lake George*	510	0	510
	Lake George*	1,521	1	1,520
05/25/91	Lovejoy Pond	903	0	903
	Lovejoy Pond	602	0	602
	Lovejoy Pond	471	0	471

Table 4. (CONTD)

05/26/91	Sebasticook Lake	900	0	900
	Sebasticook Lake	622	1	621
	Sebasticook Lake	865	0	865
	Sebasticook Lake	615	0	6150
5/27/91	Sebasticook Lake	616	0	616
	Pattee Pond	500	0	500
	Unity Pond	1,679	0	1,679
	Pattee Pond	545	0	545
05/28/91	Sebasticook Lake	900	0	900
	Sebasticook Lake	855	0	855
05/31/91	Sebasticook Lake	854	0	854
	Unity Pond	554	1	553
06/01/91	Plymouth Pond	297	0	297
06/02/91	Sebasticook Lake	900	900	0
	Sebasticook Lake	671	0	671
	Unity Pond	817	774	43
06/03/91	Unity Pond	700	0	700
	Sebasticook Lake	1,375	1	1,374
	Sebasticook Lake	668	0	668
	Sebasticook Lake	1,145	0	1,145
TOTALS:		**46,797**	**2,042**	**44,755**

TOTAL DAYS: 16
TOTAL TRIPS: 55

*Study Lake

TABLE 5. Kennebec River Alewife Stocking Summary 1985-1991

	Year	# Stocked
Sebasticook Lake (4288 acres):	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):	1991	2,921
	1990	2,530
	1989	2,925
	1988	3,027
	1987	2,797
	1986	1,220
	1985	-----
Pleasant Pond (768 acres):	1991	4,689
	1990	3,475
	1989	4,614
	1988	2,648
	1987	2,688
	1986	-----
	1985	-----
Douglas Pond (525 acres):	1991	3,150
	1990	2,959
	1989	3,257
	1988	3,099
	1987	2,286
	1986	525
	1985	-----
Lovejoy Pond (324 acres):	1991	1,976
	1990	2,077
	1989	1,741
	1988	2,055
	1987	1,949
	1986	-----
	1985	-----
Pattee Pond (712 acres):	1991	4,327
	1990	3,919
	1989	4,363
	1988	3,393
	1987	4,031
	1986	-----
	1985	-----
Unity Pond (2528 acres):	1991	4,632
	1990	559
	1989	3,301
Lake George (335 acres):	1991	2,030
TOTALS:	**1991**	**44,755**
	1990	**26,685**
	1989	**45,167**
	1988	**29,072**
	1987	**25,850**
	1986	**10,223**
	1985	**3,567**

Table 6. 1991 Juvenile Alewife Samples from Ponds

Ponded Area	Stocking Density[1]	# of Seine Hauls[2]	# of Cast Net Throws[3]	# of Dip Net Dips[4]	Number of Juveniles[5]	Mean Total Length
Douglas Pond	6.0	3/3	0/0	0/0	150/330	6.7cm
Lovejoy Pond	6.1	12/16	1/1	1/1	111/111	7.9cm
Pattee Pond	6.1	1/9	0/0	0/0	50/269	8.8cm
Pleasant Pond	6.1	4/5	0/0	0/0	195/2357	5.3cm
Plymouth Pond	6.1	2/14	0/1	1/1	100/1050	6.5cm
Sebasticook Lake	4.9	10/26	0/0	0/0	172/178	9.0cm
Unity Pond	1.8	4/18	0/2	0/0	136/245	8.2cm
Lake George	6.1	12/25	0/0	0/1	226/380	4.6cm
TOTALS:		**48/116**	**1/4**	**2/3**	**1140/4920**	

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

Table 7. Downstream Passage Observations at Hydroelectric Facilities - Sebasticook River, 1991

Date	FORT HALIFAX	BENTON FALLS	BURNHAM	PIONEER	WAVERLY
6/05	-	X	-	-	-
7/19	0	X	X	0	X
7/29	0	X	X	X	X
8/09	X	X	X	X	X
8/12	L	Xa	X	X	X
8/15	XL	X	X	X	X
8/19	XL	Xa	X	X	X
⊗8/22	X	Xa	X	X	X
8/27	X	X	X	0	X
8/30	X	Xa	X	X	X
9/03	X	X	X	0	X
9/06	0	X	X	0	X
9/09	X	X	X	0	X
9/13	OL	X	X	0	X
9/16	X	0	X	0	X
9/20	0	X	X	0	X
9/23	XL	0	X	0	X
9/27	XL	X	X*	X	X
⊗9/30	X	X	X	X	X
10/04	XL	Xa	X	X	X
10/07	X	X	X	X	X
10/09	-	-	-	-	X
10/11	XL	X*	X	X	X
10/16	XL	X	X	X	-
10/21	X	X	X	X	X
10/24	X	X	X	X	X
10/28	XL	X	X	X	X
11/01	X	X	X	X	X
11/05	X	X	X	X	X
11/08	X	X	X	X	X
11/15	X	0	X	X	X
11/21	X	X	X	-	-
11/22	-	-	-	X	X
11/26	X	X	X	X	X
TOTAL NUMBER SITE VISITS:	**31**	**32**	**31**	**31**	**31**

X = Downstream Passage Available
0 = No Downstream Passage Available
- = Not Surveyed on This Day
* = Dead or Juvenile Alewives Present Exiting Turbine(s)
a = Juvenile Alewives Using Downstream Passage Facilities
A = Adult Alewives Using Downstream Passage Facilities
L = Facility Locked Up

⊗ = 8/22 site visit was post Hurricane Bob; 9/30 "Son of Bob"

<u>METHODS</u>: American Shad

In 1991, the DMR sought shad broodstock from two sources in order to secure a minimum of 500 adults for truck stocking in the Kennebec River. Arrangements were made to obtain shad from the Narraguagus River in Cherryfield, Maine, and the Connecticut River, in Holyoke, Massachusetts.

No American shad broodstock was obtained from the Kennebec River in 1991. As was previously mentioned in the **"<u>METHODS</u>: Alewife"** section, the experimental interim fish pumping system at the Augusta Dam was not operated in 1991. DMR requested Edwards not operate the pump system to prevent the nonproductive daily expenditure of DMR manhours to check the pump's holding tank. This decision was based on the fact that in 1989 and 1990 the fish pump system was ineffective in trapping the numbers of American shad and alewives necessary to allow trucking of fish from this site.

In previous years, the commercial alewife fishery on the Narraguagus River has provided a source of shad for stocking in the Kennebec River. In early 1991, DMR contacted the Maine Atlantic Sea Run Salmon Commission to discuss the feasibility of obtaining shad broodstock at the Cherryfield fishway. The Salmon Commission staff installed a new fishway trap at Cherryfield in 1991 to trap Atlantic salmon as part of their current research efforts on the Narraguagus. DMR personnel planned to obtain shad caught in this trap from the Commission or from the commercial alewife fisherman also working the site.

In past years, shad trapped by the commercial alewife fishery were placed in a holding pen in the Narraguagus; the shad were then removed from this pen and placed in a DMR stocking truck which had been previously filled with river water. Shad would then be transported to the Kennebec River at Sidney and released into the impoundment. Problems were encountered in obtaining shad broodstock at Cherryfield this year; these difficulties will be discussed in the **"Results & Discussion"** section.

Additional American shad broodstock was secured from the Hadley Falls fish lift on the Connecticut River at Holyoke, MASS. Early in 1991, 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.

Adult shad exiting the twin fish lifts into the headpond level canal were trapped by Connecticut River personnel from the University of MASS 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. Shad and water were dumped into the tank which had been previously half-filled with river water. [The two tank trucks purchased with KHDG funds were used to transport the shad from the Connecticut and Narraguagus Rivers to the Kennebec; these trucks and the manner in which they were 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 porous hose arrangement. This oxygen supplement was operated in addition to the air venturi system previously described in the **"METHODS: Alewife"** section.

During the 1991 hauling season, DMR experimented with salting the tank water before transporting shad. Several different salt concentrations were tried during the shad hauling season. The apparent effects of this salting procedure will be discussed in the **"Results & Discussion"** section.

In 1991, all American shad obtained as broodstock for the Kennebec River restoration were stocked into that segment of the river between Augusta and Waterville. 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 an 80′ long, 8′ deep, 1/4" square mesh beach seine. One end of the net was pulled out and then back to shore with a boat. All fish collected were identified by species, enumerated, and a sample was measured for total length. All American shad collected were measured for total length. All fish trapped were released immediately after data collection was completed.

Two other methods of collecting juvenile shad in the impoundment were planned for the 1991 season, but neither of these was implemented this year. The reasons for this postponement and a discussion of future sampling plans for juvenile shad in the impoundment are discussed in the **"Results & Discussion"** section.

RESULTS & DISCUSSION: American shad

No American shad were obtained from the Narraguagus River in 1991. Difficulties with shad collection on the Narraguagus stemmed from the installation of a new fishway trap by the Maine Atlantic Sea Run Salmon Commission during the shad and alewife run and the alewife harvester's reluctance to continue operating his trap for shad because of the relatively poor alewife run. In addition, the 1991 Narraguagus shad run was poor, based on reports from the commercial alewife fisherman and shad sportfishermen. Attempts will be made again in 1992 to obtain up to 200 shad from the Narraguagus River. Shad will be obtained from either the Salmon Commission or the alewife harvester, or both.

A fish health inspection was performed on the Connecticut River shad stock. A 60-fish sample of adult American shad was collected at the Holyoke fish lift on April 30, 1991. Kidney and spleen samples were taken in accordance with the AFS Fish Health Blue Book Procedures and shipped to the USFWS Fish Health Center at Lamar, PA. Samples were processed for 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.

In past years, trapping and transport from the Connecticut River at Holyoke, MASS, has contributed the lion's share of shad broodstock to the Kennebec restoration effort (80% over the last four years combined). In 1991, the Connecticut River was the **only** source for shad broodstock introductions in the Kennebec.

Six shad transfers were completed from Holyoke in 1991 between May 18 and June 2. In total, 1,113 shad were loaded at Holyoke and 639 survived the trip and were stocked at Sidney. These numbers represent an overall trucking/handling mortality of 43%. Results of the 1991 shad transfers are presented in Table 8.

One of the causes of this high mortality is the crude fish sorting and handling facilities at Holyoke. After the initial crowding and shock of a fish lift hopper ride, shad must be dip netted, placed in small rolling hoppers and lowered by chain hoist to the waiting trucks. Besides the rough handling, the fish must wait out the slow and laborious loading of their kin since only 25-fish lots can be accommodated by each hopper. After this ordeal, the shad face a five-hour ride in May temperatures, which sometimes push the tank water temperatures to 4 ^{o}C above that of the loading site.

DMR has examined some of the tank water quality data associated with the shad transfers in an attempt to shed some light on potential reasons for the high mortalities. Temperature, dissolved oxygen, and salinity levels are all recorded at the beginning, middle and end of each trip.

For the last two trips in 1990, DMR mixed seawater and river water together in an attempt to decrease mortality. This step led to further experimentation in 1991. During the first three trips (on May 18, 19, and 25), 50 pounds of an "instant seawater" type mixture was added to each 1,000-gallon water tank. Salinities ranged from 2.5-5.5% over the course of these three trips. For the remaining three trips of 1991, 100 pounds of the salt mixture was added to each 1,000-gallon water tank. Salinities ranged from 6.5% to 11.5% over the course of these three trips. DMR believes that no firm conclusions can be drawn at this time about the impact of adding salt to the shad hauling water. So many variables are working over each trip that the linkage of the actual percent mortality to any one variable is not possible.

The only factor that appears to have a recurring impact on mortality is the density of shad loaded into each tank. When relatively light loads are carried, percent mortality can be as low as 20%. This effect can be observed by comparing Figure II and III with the number of shad loaded on these trips. The 1990 trips on June 11 and 16 were loads of only 148 and 174 shad, respectively. Percent mortalities on these two trips were 22% and 29%, respectively. A look at May 19 and 27 in 1991 presents a similar view: loads of 158 and 65 shad (with small tanker) yielded percent mortalities of 20% and 27%, respectively.

DMR is striving to place 1,000 or more shad into the impoundment each year. In any given year it has been possible to make six or seven transfers from Holyoke to the Kennebec River. Clearly, it is critical that DMR maximize the number of shad stocked alive into the Kennebec on each of these few trips. Analysis of 1990-1991 stocking data indicates that the lower density loads (with the lower mortality rates) actually yield more **live** fish stocked in the Kennebec at the end of the trip.

Analysis of the 1990-1991 data by Bob Richter of CMP suggests that loads of approximately 75 shad$\cdot$1,000 gallons^{-1} yield the most live fish at trip's end. Bob also makes the point that survivors from a less crowded tank are probably healthier/less stressed than survivors from a crowded, high mortality tank and might suffer lower delayed mortalities after their release.

For 1992, DMR plans to concentrate on light loads of shad with the hope of stocking more live fish at trip's end. DMR believes that this approach will produce the highest number of shad stocked using the current methodology. DMR also plans to keep experimenting with improvements and modifications to the hauling methodology, possibly including: using a chemical buffer, foam control agent, further salinity modifications, lower water temperature, and increased oxygen regulation.

Dissolved oxygen measurements taken during the hauling trips yielded some useful information: oxygen levels dipped after shad were loaded at Holyoke and usually improved over the remainder of the trip. The stressed fish loaded at Holyoke probably place a high demand on the available dissolved oxygen after they have entered the tank. As fish stabilize or weaker fish die, more oxygen is measured in the tank water at the end of the trip.

DMR will try to address this problem by reworking the compressed oxygen delivery system on the trucks. If more oxygen can be delivered effectively, initial mortalities that may be caused by this DO dip may be avoided.

In 1992, DMR will continue to collect data on DO, salinity, temperature, and loading density from all shad hauling trips. In 1992, DMR will attempt to haul as many live shad as possible from Holyoke on the limited number of days we are allowed to use the facility. Once again, DMR's interim goal for 1992 will be to truck stock up to 1,000 adult shad into the Kennebec River. The bulk of these fish will come from the Connecticut River, with Narraguagus River shad contributing when possible.

DMR towed a one-meter diameter plankton net in the Edwards impoundment at five sites on June 13, 1991. The samples collected on that day will be worked up this winter; any ichthyoplankton or fish eggs found in the samples will be keyed out with the hope of finding juvenile American shad.

DMR fished beach seines at six different sites in the impoundment on July 24 and August 8, 1991. No juvenile shad were collected, although a large school of juvenile alewives were taken on August 8.

DMR was unable to reconstruct its push net during the 1991 sampling season. The metal framework of the pushnet is bent and will be repaired and refurbished, but the net itself must be replaced. A replacement net will be purchased and the frame repairs will be completed for the upcoming 1992 field season.

Alosid samples were captured at the Edwards Mill bypass when possible during the 1991 passage season. A cast net, dip net, and even a beach seine were employed at the forebay above the bypass in attempts to capture juvenile alosids. However, the targeted alosids were usually able to sound and avoid capture. DMR did capture 14 juvenile alewives at the bypass and forebay in 1991. No juvenile shad were captured at Edwards Mill in 1991. DMR will be studying options for more efficient collection gear for use at the Edwards bypass. Options under consideration include a trap net in the forebay, a bag net rigged in the bypass flow itself, or electrofishing gear. A decision will be made this winter on a course of action for this sampling site.

In 1991, another project within DMR's Anadromous Fish Division began a pilot program to raise shad fry from fertilized eggs. The KHDG Project is interested in this effort since the acquired knowledge and expertise may allow for the stocking of shad fry in the Kennebec (if such a stocking program could be initiated for the Kennebec drainage).

In June, 1991, KHDG personnel fished gillnets at night on the Eastern River in the hope of capturing ripe broodstock shad that were suitable for egg stripping. No shad were captured while gillnetting in 1991, but KHDG personnel will try again in 1992. If possible, a local gillnet fisherman will be contracted to capture broodstock shad in the Eastern River. Analysis of ichthyoplankton samples collected by another project within the Anadromous Fish Division (during the spring and early summer over the past three years) indicates that the Eastern River produces a good number of larval shad each year. A local commercial fisherman has confirmed the presence of large numbers of adult shad in the Eastern River at specific sites. For these reasons, DMR plans to concentrate on obtaining eggs from the Eastern River. If eggs are taken, experimental fertilization and rearing will be undertaken with cooperation between the KHDG Project and the shad rearing project of the Anadromous Fish Division.

Table 8. American Shad Stocking in the Kennebec River, 1991

TRUCK STOCKING:

Date	Broodstock Source	# Loaded	# Morts	# Stocked	Site	Water Temp C° Source	Water Temp C° Kennebec
5/18	CT River, Holyoke	241	131	110	Sidney	19.0	14.5
5/19	CT River, Holyoke	158	31	127	Sidney	18.5	15.0
5/25	CT River, Holyoke	220	105	115	Sidney	20.5	15.0
5/27	CT River, Holyoke	65	17	48	Sidney	----	16.0
5/31	CT River, Holyoke	202	79	123	Sidney	24.0	----
6/02	CT River, Holyoke	227	111	116	Sidney	25.0	17.0
TOTALS:		**1113**	**474**	**639**			

TRUCK STOCKING: **639**
FISH PASSAGE: **+ 0**

TOTAL STOCKED: **639**

Table 9. 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	<u>199</u>	965	349	<u>616</u>	782	163	<u>619</u>	1047	443	<u>604</u>	1113	474	<u>639</u>

L = Loaded

M = Mortalities

S = Stocked

FIGURE 2

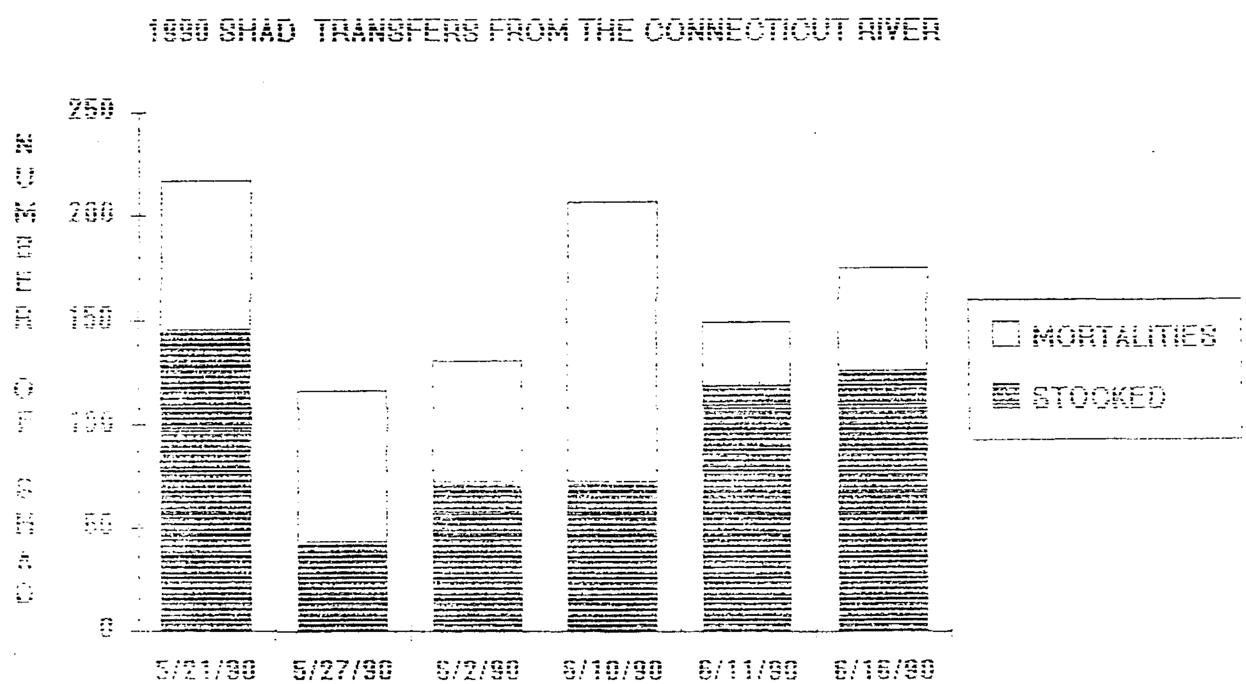
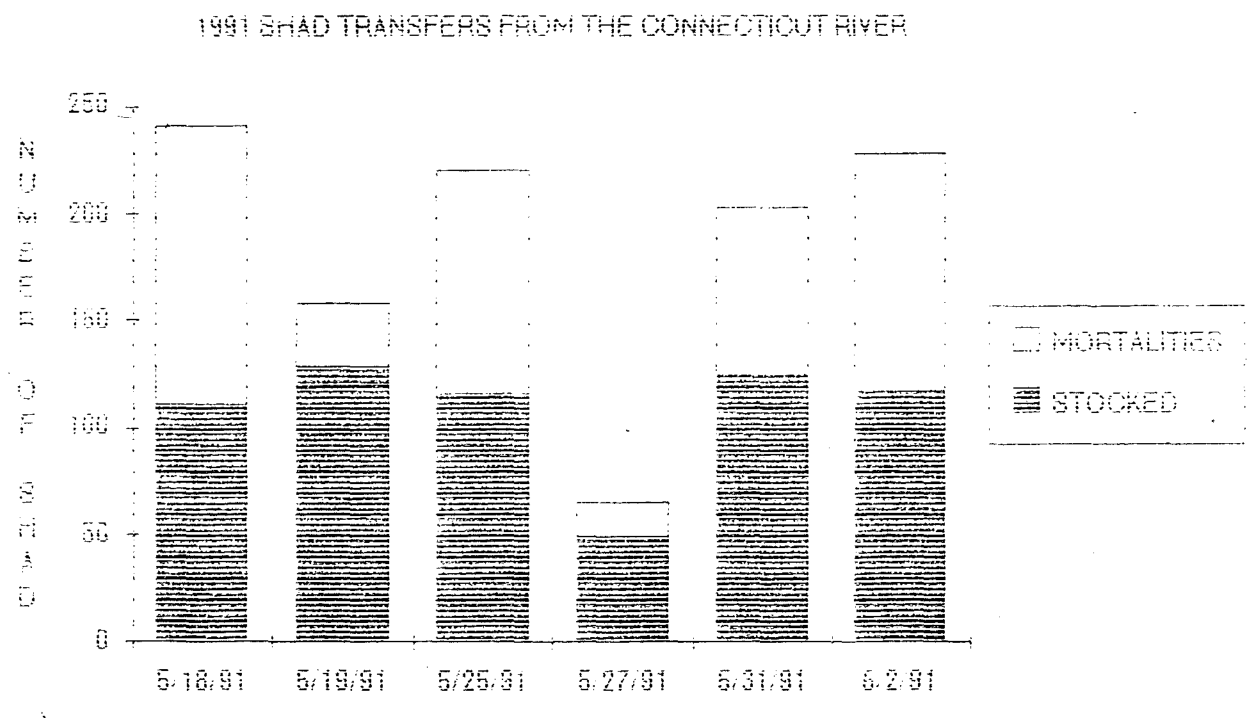

1990 SHAD TRANSFERS FROM THE CONNECTICUT RIVER
NUMBER OF SHAD
250
200
150
100
50
0
5/21/90
5/27/90
6/2/90
6/10/90
6/11/90
6/16/90
MORTALITIES
STOCKED

FIGURE 3



1991 SHAD TRANSFERS FROM THE CONNECTICUT RIVER
NUMBER OF SHAD
250
200
150
100
50
0
5/18/91
5/19/91
5/25/91
5/27/91
5/31/91
6/2/91
MORTALITIES
STOCKED

ATLANTIC SALMON

Due to poor performance in 1989 and 1990, DMR requested Edwards Manufacturing, Inc., not operate its experimental interim fish pumping system during 1991. Very few salmon were seen in Bond Brook or the Kennebec River due to the generally poor salmon run statewide in 1991. Even if salmon were available, Atlantic salmon biologists have recommended against seining and handling of salmon, particularly during hot weather periods. In 1991, hot weather, high water temperatures, and low river flows through July made handling of any available salmon a high risk activity.

Future plans for salmon restoration on the Kennebec will depend upon the outcome of the relicense process for the Augusta Dam. The State of Maine seeks dam removal and opposes interim fishway construction because fish restoration goals for all anadromous species cannot be achieved if the Augusta Dam is not removed. Rather than approve a license amendment for installation of a fishway, the state plans to seek dam removal during the FERC relicensing process. Until FERC rules on the future of the Edwards Dam, salmon passage through to Waterville is unlikely. DMR currently has no interim plans for active salmon restoration on the Kennebec River.

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 interaction(s) of anadromous alewives and resident freshwater species. The DMR's role in this study is funded by a portion of the studies money 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:

<u>PHASE I</u> - 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 in 1988 and 1989. The 1990 and 1991 sample analysis will commence this winter, now that the KHDG technician position has been filled. In addition, the tech will also analyze the contents of juvenile alewife stomachs collected by DMR during the 1991 field season.

Phase II of the study began with the DMR stocking of 2,030 adult broodstock alewives into Lake George on May 24, 1991. Before alewives were introduced, DMR personnel installed a weir on the Lake George outlet stream to trap all emigrating adult and juvenile alewives.

Throughout the spring, summer, and fall, DMR personnel tended the weir daily. Daily duties included cleaning the surface of the weir, making necessary repairs or adjustments, and collecting fish samples (and other pertinent data) at the trap. The weir was installed on May 14, before adult alewife stocking took place, and remained in place until November 21, 1991, when it was removed for the season.

All fish trapped at the weir were identified, enumerated, and passed downstream. Adult alewives were removed from the trap and worked up back at the lab. Information recorded for adults included weight, length, sex, and spawning condition.

Juvenile alewives were enumerated by direct counts when numbers were low. When large numbers of juveniles were encountered, a volumetric measure was used to calculate the amount passed downstream. Juvenile alewives were removed from the trap and a strainer was used to measure the volume of alewives passed. Each day, three or more strainers of juveniles were hand counted to determine a correction factor and obtain the number of alewives passed in that day. A subsample of 50 juvenile alewives each day was weighed and measured for total length.

DMR personnel also collected biweekly juvenile alewife samples from the lake itself. These samples will be analyzed for stomach contents during the winter. This data can be compared to the smelt stomach data as these juvenile alewife and smelt samples were taken on the same days. The results of the alewife and smelt stomach samples will be presented at a later date after they are worked up.

Adult alewife passage through the weir is presented in Figure 4. Juvenile alewife passage through the weir is presented in Figure 5. During the whole 1991 season, 1,035,493 juvenile alewives were passed out of Lake George. A total of 1,435 adult alewives passed out of the lake during the course of the season; this represents 71% of the total number stocked on May 24.

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.

FIGURE 4

ADULT ALEWIFE PASSAGE OUT OF LAKE GEORGE - 1991

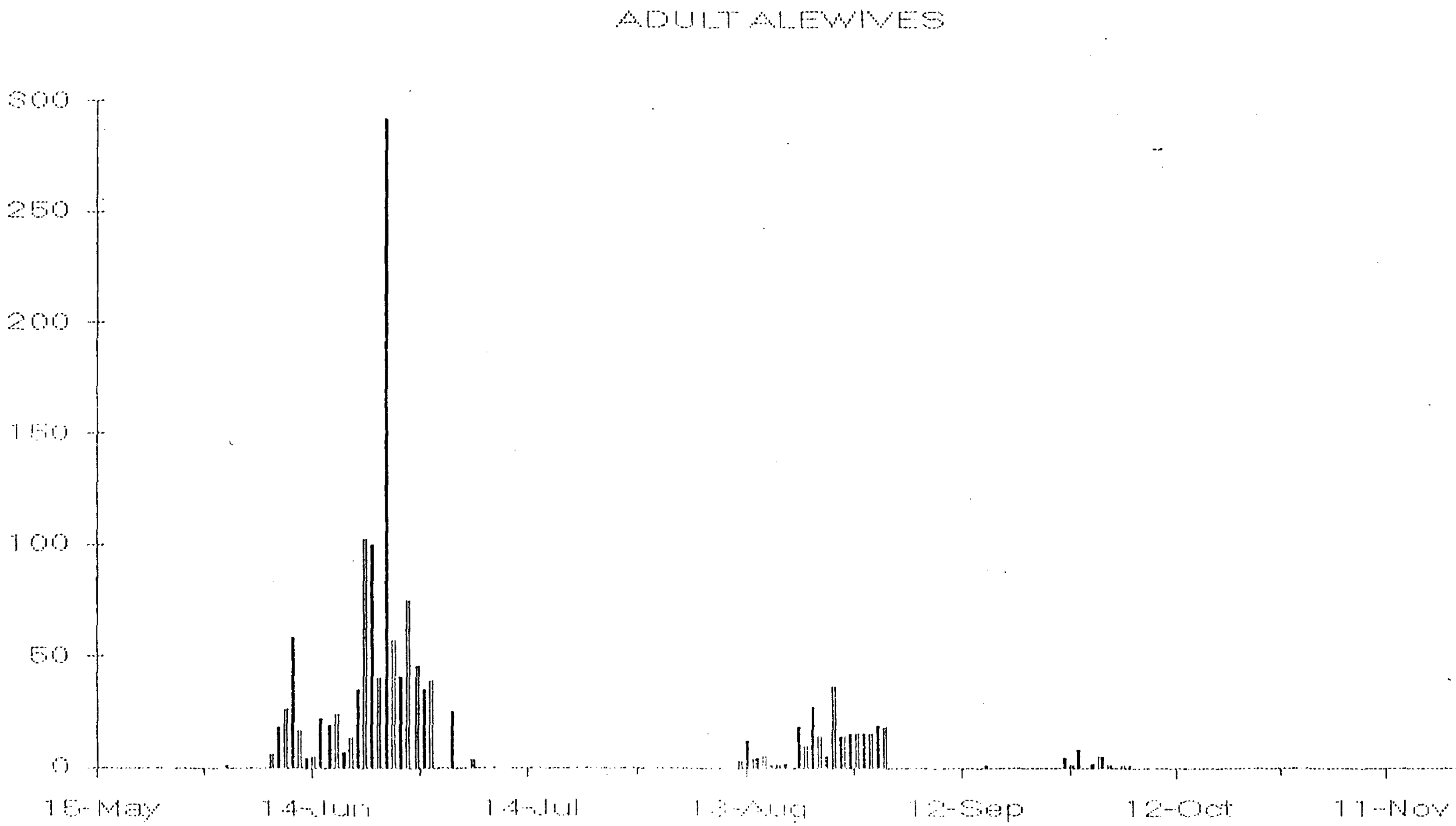


FIGURE 5

JUVENILE ALEWIFE PASSAGE OUT OF LAKE GEORGE - 1991