KENNEBEC RIVER ANADROMOUS FISH RESTORATION

ANNUAL PROGRESS REPORT - 1992

MAINE DEPARTMENT OF MARINE RESOURCES
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INTRODUCTION -

This progress report covers the sixth 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 and 1992.

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.

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METHODS: Alewife

In 1992, 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 1992. In the spring, DMR advised Edwards not to operate the interim experimental fish passage/trapping facility ("fish pump") at the Augusta Dam during the 1992 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 1992, 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 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.

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, 1992, stocking. The juvenile alewives were trapped with beach seines fished from the shores of the lakes stocked. Three beach seines were employed, measuring 80′ long x 8′ deep and 40′ long x 4′ deep. Seines were constructed of 1/4" 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 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 1992, 23,579 adult broodstock alewives were stocked into eight ponds in the Kennebec River drainage. All the alewives stocked in the Kennebec in 1992 were trapped at the Brunswick Fishway at head-of-tide on the Androscoggin River. Of the 23,579 alewives stocked, 21,574 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 2.4 fish x $acre^{-1}$. Stocking densities ranged from a low of 0.7 alewives x $acre^{-1}$ in Sebasticook Lake to a high of 6.1 alewives x $acre^{-1}$ in Douglas Pond (Table 3).

Alewife stocking in Webber, Three Mile, and Three Cornered Ponds was deferred again in 1992 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, 1992 saw the second stocking of alewives in Lake George (the joint DMR/DEP/IFW study lake). On May 29 and 30, 1992, DMR personnel stocked 2,005 adult alewives into Lake George as part of the ongoing joint study.

The 2,005 alewives introduced at Lake George, combined with the 21,574 stocked in the Sebasticook subdrainage, yields the 23,579 fish total for 1992. This figure represents the third lowest number of alewives stocked since the KHDG Agreement was implemented (Table 5). The low number of alewives transported in 1992 reflects the low number of fish available at Brunswick. In the spring of 1992, 31 alewife stocking trips were made while 55 were completed in 1991, when 44,755 alewives were stocked.

The major problem encountered in 1992 was a lack of alewife broodstock during the alewife hauling season. No serious labor problems were encountered in 1992. The KHDG project technician was bumped out of her job by a more senior employee from DMR's Boothbay Harbor facility. This new technician was previously a Scienitst I at the Boothbay Lab and has a strong fisheries background. Despite his lack of familiarity with the KHDG project, he adapted quickly and proved an asset rather than a liability.

One Seasonal Conservation Aide was recalled to work in April so that he was able to assist in the pre-season maintenance and preparation of the stocking equipment. The remaining two Seasonal Conservation Aides started work in May. Both of these Aides worked for the KHDG Project in 1991 and so were already familiar with the spring fish stocking procedures.

DMR made the decision to continue with three Seasonal Aides for 1992 for two reasons: first, the additional manpower was necessary during the busy May/June alewife and shad stocking season, especially if one crew member was ill or injured, and because furlough days/shutdown days reduced available man days); second, the extra person was needed throughout the season to complete the additional workload brought about as DMR continued Phase II of the Lake George Study in 1992. 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 KHDG project's two tank trucks performed well during the 1992 alewife and shad stocking season. The Chevrolet single tanker's clutch was replaced prior to the hauling season. Pre-season maintenance and checks showed no problems prior to the 1992 season and both trucks finished out the season without a serious break-down. A front axle seal began to leak on the International double tanker late in the shad hauling trips. This problem is due to the length of time the truck sits idle in the non-stocking months. This problem will be repaired prior to the 1993 stocking season.

For 1992, improvements were made to the oxygen delivery systems on both stocking trucks. Porous polyethylene pipes (four feet long) were installed on the tank floors and connected to lexan ball-type flow meters downstream of the welding-type regulators used in past years. This porous pipe produced finer diameter bubbles and used a lesser volume of oxygen than the previous perforated rubber tube system. These fine bubble porous pipes are used on the Susquehanna River shad hauling trucks to increase dissolved oxygen levels. While KHDG project personnel did monitored DO levels on shad trips, formal monitoring was not practiced during alewife hauling. However, project personnel did observe that even heavy loads of alewives on warm days appeared to be in better condition when the oxygen delivery system was used to boost the DO levels in the tanks' water. The alewives were often more active and lively when released from the trucks into the lakes.

During the summer and fall of 1992, juvenile alewives were captured in all of the eight (8) ponds stocked with adults. KHDG-funded DMR personnel caught juvenile alewives in 20 beach seine hauls of the total 47 hauls completed overall. Dip nets and cast nets contributed an additional three (3) samples for three (3) attempts completed. In total, of the 4,424 juvenile alewives captured, 710 fish were measured for total length. The results of juvenile alewife sampling are presented in Table 6.

The outlet streams of the seven (7) 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 July 1 and 6, and on August 4, 1992. Five (5) beaver dams were noted on Pattee Pond Brook, but only two (2) were thought to be impassable to alewives. On October 20, DMR personnel opened breaches in each of these two dams to allow free passage of alewives through Pattee Pond Brook to the Sebasticook River.

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. Visits to the dam site on August 4, September 1, and October 21 confirmed that low water levels in the mill pond and low stream flows prevented downstream passage of alewives. Higher flows and free passage may have been present between DMR visits, but the lack of heavy rain events in the late summer and fall made downstream passage from Lovejoy Pond difficult in 1992.

Twenty-five Mile Stream, which drains **UNITY POND**, was surveyed on July 7, 1992. The two (2) DMR crews found the entire stream to be passable to alewives, although five blowdowns/log jams were noted on the upper segment. A submerged beaver dam/log jam acts as the hydraulic control for the Unity Pond water level, but water flow over this dam is interrupted only during dry periods. It poses no delay to migrating alewives during all but the driest periods.

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 (3) lakes are all water control structures managed to control lake levels.

Passage out of **PLEASANT POND** is dependent upon rains and high lake levels causing the town to open the gates at the dam. DMR personnel dipped and cast netted juvenile alewives at the outlet dam on July 13 and September 21 as these fish waited for flows that would allow them to pass downstream.

Stetson Stream was surveyed on July 8 and 15, and October 23. DMR personnel noted three (3) beaver dams on the stream, but no alewives were ever observed behind any of the dams.

The major obstacle to downstream passage in 1992 seems to have been the outlet dam. During eight (8) visits to the dam from June 30 through November 3, water control gates remained closed (or nearly closed) during all visits. Late fall rains or gate openings between DMR visits probably accounted for most of the downstream passage out of Pleasant Pond this year.

DMR personnel beach seined a sample of juvenile alewives at **PLYMOUTH POND** Dam on August 3, 1992. Data collected from observations at the dam on nine (9) days, from June 30 to November 3, indicated that the dam water control gates remained closed on all these days. Low lake levels and low inflow led to poor passage opportunities out of Plymouth Pond. Some passage may have been available between DMR visits when water control gates may have been opened.

Martin Stream was surveyed on July 15, 1992. The DMR crew noted one (1) beaver dam on the stream, but fish passage was judged to be adequate through this dam.

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 learned that the annual drawdown was to begin on September 8, 1992. Our inspection of the outlet on September 1 showed that the dam was still closed. Seven (7) subsequent site visits from September 11 through October 28 revealed good downstream passage through the open dam gate and gradually falling lake levels. By the November 10 visit, the gate had been partially raised and the drawdown completed. This sustained outflow of water provided good downstream passage out of Sebasticook Lake throughout late September and October, 1992.

In 1993, DMR plans to stock adult alewives in the same seven (7) lakes in the Sebasticook drainage. Early season stocking in 1993 will be focused towards ponds with dependable downstream passage for juvenile alewives. All seven (7) ponds will receive some adult alewife broodstock, but ponds with poorer downstream passage will not be stocked up to six alewives per acre unless there is ample broodstock available late in the season. Stocking will cease in all ponds at the six alewife per acre interim operational stocking density. With this approach, DMR plans to keep all the lake acreage in alewife production while maximizing the number of adults returning to the Kennebec system by minimizing the downstream mortalities inflicted on the juveniles.

The downstream emigration of juvenile alewives through the Sebasticook River was monitored throughout the summer and fall of 1992, 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 (1987-1991), temporary downstream alewife passage was afforded through an open trash sluice located just downriver from the trash racks. Plywood sheeting installed over the trash racks to a depth of four feet also helped to deter the alewives from passing through the trash racks and directed them toward the open sluiceway. The present KHDG Agreement called 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 was delayed until FERC resolves the KHDG appeal and issues an amended license. As a result, interim passage continued during the 1992 season.

The first visit to Fort Halifax on June 14 found the facility locked up and DMR personnel were unable to survey the site, although there appeared to be an opportunity for safe fish passage. On June 19th, access was gained to the site and a one-foot spill was observed through the bypass. Access continued to be a problem since the site was open on only 12 of the 36 inspections. The site was unlocked and could be inspected only once in June, July, and October, and twice in August, but there was water passing through the bypass on every date of site inspection. Due to the limited access, juvenile alewives were observed using the downstream passage on only one date, September 25th, although the operator noticed a school emigrating in mid July. On several occasions (September 25, October 6, 8, 23, 28 and November 10), numerous seagulls were observed feeding on alewives passing through either the interim downstream bypass or the project's turbines.[1] DMR last visited Fort Halifax on November 16, 1992, and on November 19th telephoned Robert Richter at CMP to confirm the seasonal shutdown of the interim bypass facility. Of the 36 visits DMR made to Fort Halifax in 1992, passage through the bypass was available on all of these days.

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

[1]From the visual observations made at Fort Halifax, it is sometimes difficult to tell what path the alewives are taking through the project. Unless alewives are observed in the forebay (inside the trash racks) or exiting the draft tubes, it may not be factual to assume that they are passing through the turbines. However, whether these fish are passing through the interim bypass or through the turbines, some percentage are being lost to avian predation.

DMR hopes that the construction of the permanent bypass facilities at Fort Halifax will improve survival of alewives at the site, through increased bypass efficiency (if alewives are currently passing through the turbines) and/or through a less traumatic and disorienting bypass experience for the alewives. DMR hopes that studies conducted at the new bypass facility will provide answers to these important questions of overall survival of alewives at this site.

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 to 1992 seasons.

During the 1990 - 1992 seasons, KHDG conducted downstream passage studies at Benton Falls using VHS cameras to count fish passing through the facilities. The successful study work in 1990 led to the continuation of the study in 1991 and 1992. 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.

KHDG-funded DMR personnel observed the Benton Falls downstream passage during 36 visits in 1992. The bypass at Benton Falls was operational during 34 of these visits. On two of the visits when the bypass was not operating (July 24, August 11), consultants working for Benton Falls were conducting downstream passage studies. The bypass had been closed temporarily to allow this work to be completed. The downstream trap was also operating on the October 1 site visit. Additional studies on turbine mortality and downstream passage were underway on October 6 and 8.

DMR personnel observed juvenile alewives passing through the downstream bypass on six visits in 1992: July 28, August 25, and September 9, 11, 21, and 25. The dam operator observed adult alewives using the downstream passage on July 10 and large schools of juveniles on August 4. Several dead juvenile alewives were observed on the decks around the bypass sampling gear on September 11 and 25, and on October 16. These few stranded juveniles may indicate that some number of juveniles passed through the bypass previous to these site visits. Overall in 1992, downstream passage at Benton Falls was very consistent. Large flocks of gulls and cormorants, and occasionally bald eagles and herons, were observed feeding below the dam on September 9, 11, 21, 25, and October 1, 6, 8, and 16.

The first DMR visit to the **BURNHAM DAM** in 1992 occurred on June 14. 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.

Controlled spill or spill over the whole spillway was available as an interim downstream bypass during most of the DMR visits at Burnham in 1992. DMR personnel did not observe juvenile alewives exiting the turbines at the station on any dates. On June 26 very little spill was observed through the downstream passage. The operator at Benton Falls noted that the Burnham Project had drawn its headpond down on June 25 and DMR personnel observed that it had nearly been refilled when they visited the site on June 26. Very little spill was being released through the downstream bypass on the 26th and downstream passage was apparently interrupted during this drawdown/refill operation. Large flocks of gulls and cormorants were observed in the tailrace on September 21, 25, and 28, and October 1, 6, 8, and 16, suggesting that despite the availability of alternative routes, some juvenile alewives become entrained in the turbines at the Burnham station and some of these juveniles passing through the turbines may be injured or killed.

Overall in 1992, an interim downstream passage route was usually available as a bypass around the turbines at Burnham. On 35 of 36 occasions when DMR personnel made observations at Burnham in 1992, 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. On September 21, DMR personnel noticed the canal wall opening had been expanded to allow construction of a part of the downstream passage, but a piece of plywood had been placed in front of the spillway blocking any passage. The plywood remained in place through October and November.

In 1992, downstream passage around the turbines at Pioneer took place only when controlled spills occurred over the crest of the spillway and allowed the alewives to pass. Spillway overflow was observed on 17 of the 35 DMR survey days during 1992. On July 28, several dead juvenile alewives were observed at the site. These fish were caught on the ledge outcrop at the base of the dam and were apparently stranded as they passed over the spillway during one of the spills at the project. During the winter, DMR will contact the owner, Chris Anthony, to work out a schedule for the completion of the bypass during the 1993 construction season.

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 into the tailrace needs to be incorporated into the existing passageway. DMR also will consult with the fishway engineering staff at the USF&WS to develop suitable solutions in conjunction with Express Hydro Services.

On three occasions in 1992, juvenile alewives were observed in the headpond (Douglas Pond) at Waverly Avenue. On all these 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 28 of 35 DMR site visits in 1992. During late August and early September, water was drawn down to about six feet below the dam crest and no passage was available. Juvenile alewives were also observed in the headpond on several of these site visits.

During the summer and fall of 1992, DMR personnel made observations on 35 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 21 different days.

Juvenile alosids were observed using the downstream bypass on all 13 of the days they were sighted. Juvenile alosids were visible in the turbine tailrace at Edwards Mill on five days in 1992. It is interesting to note that on 12 of the 14 days in October and November juvenile alosids were observed using the bypass, there were also present large numbers of seagulls (100+), indicating that a substantial number of alosids may have been passed by the turbines. Seagulls were often observed feeding in the upper tailrace where no downstream passage is available. Some seagulls observed feeding in the lower tailrace may have been feeding on fish passing through the bypass, but often gulls were observed taking fish from the lower tailrace turbine outfalls (areas most likely discreet and isolated from the path used by fish utilizing the interim bypass facility).

Alosid samples were collected at the Edwards Mill bypass when possible during the 1992 passage season. A cast net and dip net 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 collect 76 juvenile alewives at Edwards in 1992. DMR will be studying options for more efficient collection gear for use at the Edwards bypass. DMR did purchase an inexpensive scoop net prior to the 1992 field season, but deployment of this net in the Edwards forebay appears to be too risky. Velocities in this area are very high and shifting and loss of the net onto the trashracks seems likely. Some method of sampling downstream migrating alosids must still be developed for this site.

Adult American shad were observed in the forebay near the bypass intake at Edwards Mill on nine days in 1992. Approximately 30 adult shad were swimming in the lower forebay on June 14th. Another dozen were seen in the same area on June 26. Fewer shad (about 1-2) were seen from late June into October (June 30, July 10, August 4, 21, and 28, September 9 and 11, and October 8). None of these shad were ever observed passing downstream through the bypass. On June 16 and 20, dead adult shad were found impinged on the trash racks in the lower forebay. These sightings indicate that at least some shad survived after truck stocking into the impoundment and remained in the impoundment until early October.

On October 8, 1992, Edwards Mill personnel drained the turbine canal to install a trash boom, resulting in a massive fish kill. The dead and dying fishes were adult alewives, adult shad, and American eels, with the majority being juvenile alewives. Dead fishes were over a foot deep in several areas of the drained forebay and conservatively estimated to number well over 100,000 individuals. The Edwards Mill personnel then reflooded the canal and swept the majority of the dead fishes out into the Kennebec River where a large shoal of fish over 100' long remained visible for over a week. Legal action and/or mitigation is pending.

FIGURE 1: **Kennebec River Drainage**

ANADROMOUS FISH RESTORATION PROGRAM

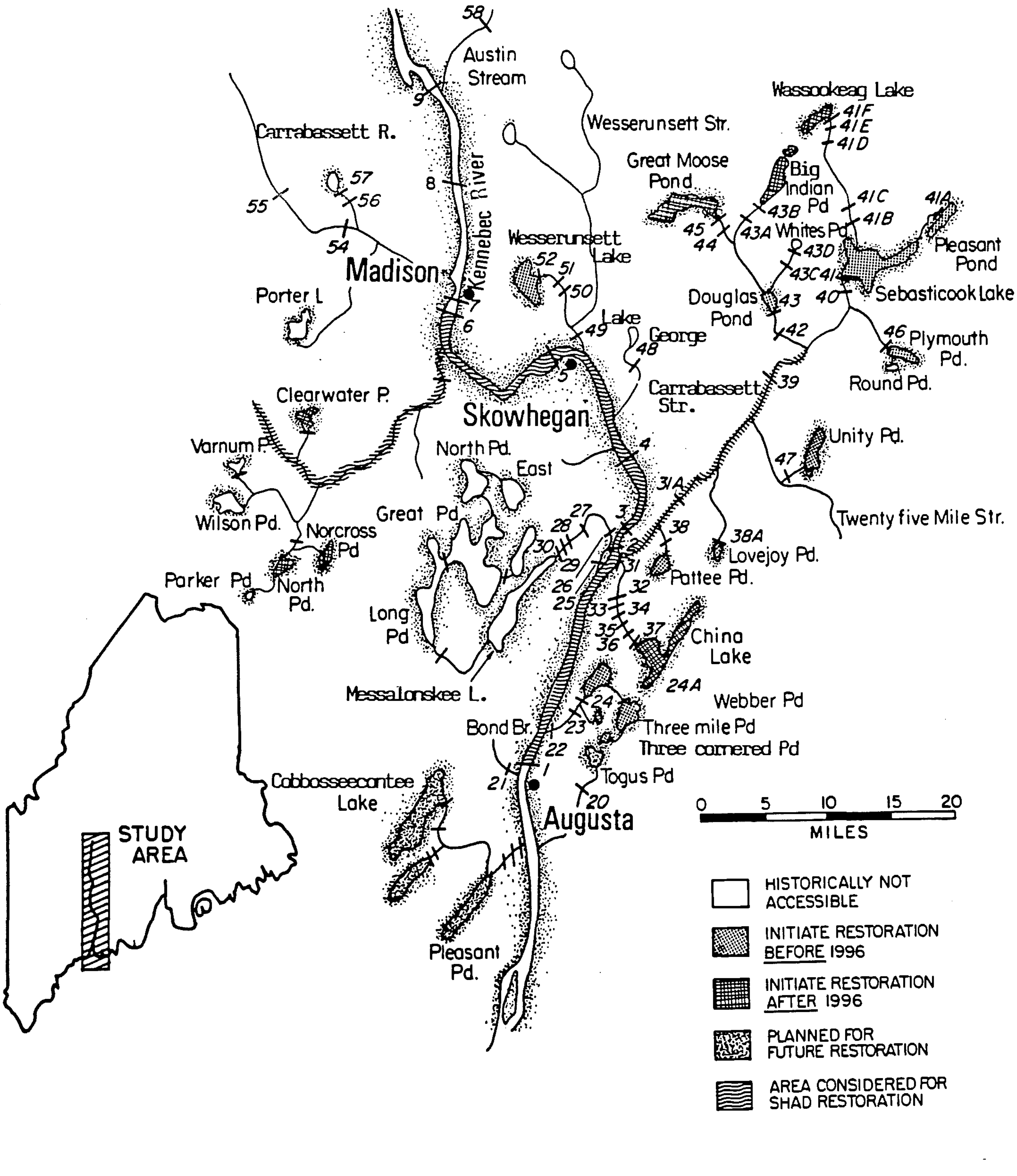


TABLE 1. 1992 Alewife Stocking Plans (Sebasticook River)

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, 1992

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. 1992 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	3,188	4	101%	6.1
Lovejoy Pond	324	1,944	1,952	3	100%	6.0
Pattee Pond	712	4,272	4,287	5	100%	6.0
Pleasant Pond	768	4,608	3,546	5	77%	4.6
Plymouth Pond	480	2,880	2,903	4	101%	6.0
Sebasticook Lake	4,288	25,728	2,853	3	11%	0.7
Unity Pond	2,528	15,168	2,845	4	19%	1.1
Lake George**	335	2,010	2,005	3	100%	6.0
TOTALS:	**9,960**	**59,760**	**23,579**	**31**	**39%**	**2.4**

* Six fish per acre
**Study lake

TABLE 4. 1992 Kennebec River Alewife Stocking by Date/Trip

Date	Location	# Loaded	# Morts	# Stocked
05/22/92	Pattee Pond	1,504	2	1,502
05/23/92	Pattee Pond	517	0	517
	Douglas Pond	690	1	689
	Sebasticook Lake	507	2	505
	Sebasticook Lake	750	1	749
	Douglas Pond	750	0	750
05/24/92	Plymouth Pond	600	0	600
	Plymouth Pond	808	0	808
	Lovejoy Pond	810	0	810
	Lovejoy Pond	602	3	599
	Unity Pond	804	1	803
	Unity Pond	608	0	608
05/25/92	Lovejoy Pond	543	0	543
	Douglas Pond	850	0	850
	Pleasant Lake	549	4	545
	Pleasant Lake	832	0	832
	Pattee Pond	851	1	850
05/26/92	Pleasant Pond	850	1	849
	Pleasant Pond	600	0	600
	Plymouth Pond	600	0	600
	Plymouth Pond	895	0	895
	Pattee Pond	850	0	850
05/27/92	Douglas Pond	900	1	899
	Unity Pond	659	0	659
	Pattee Pond	568	0	568
05/28/92	Pleasant Lake	720	0	720
05/29/92	Lake George*	900	0	900
	Lake George*	305	0	305
05/30/92	Lake George*	800	0	800
	Sebasticook Lake	1,600	1	1,599
	Unity Pond	775	0	755
TOTALS:		**23,597**	**18**	**23,579**

TOTAL DAYS: **9**
TOTAL TRIPS: **31**

*Study Lake

TABLE 5. Kennebec River Alewife Stocking Summary 1985-1992

	Year	# Stocked
Sebasticook Lake (4288 acres):	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):	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):	1992	3,546
	1991	4,689
	1990	3,475
	1989	4,614
	1988	2,648
	1987	2,688
	1986	-----
	1985	-----
Douglas Pond (525 acres):	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):	1992	1,952
	1991	1,976
	1990	2,077
	1989	1,741
	1988	2,055
	1987	1,949
	1986	-----
	1985	-----
Pattee Pond (712 acres):	1992	4,287
	1991	4,327
	1990	3,919
	1989	4,363
	1988	3,393
	1987	4,031
	1986	-----
	1985	-----
Unity Pond (2528 acres):	1992	2,845
	1991	4,632
	1990	559
	1989	3,301

TABLE 5 (CONTD)

Lake George (335 acres):	1992	2,005
	1991	2,030
TOTALS:	**1992**	**23,579**
	1991	**44,755**
	1990	**26,685**
	1989	**45,167**
	1988	**29,072**
	1987	**25,850**
	1986	**10,223**
	1985	**3,567**

TABLE 6. 1992 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	6.1	3/4	0/0	0/0	112/182	61mm
Lovejoy Pond	6.0	1/2	0/0	0/0	7/7	68mm
Pattee Pond	6.0	3/6	0/0	0/0	100/2126	71mm
Pleasant Pond	4.6	0/3	2/2	1/1	90/90	47mm
Plymouth Pond	6.0	1/1	0/0	0/0	50/500	53mm
Sebasticook Lake	0.7	2/2	0/0	0/0	64/64	76mm
Unity Pond	1.1	1/6	0/0	0/0	50/97	28mm[6]
Lake George	6.0	9/23	0/0	0/0	237/1358	51mm
TOTALS:		**20/47**	**2/2**	**1/1**	**710/4424**	

[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)
[6]Only one sample collected on July 30, 1992, fairly early in the year

TABLE 7. Downstream Passage Observations at Hydroelectric Facilities - Sebasticook River, 1992

Date	FORT HALIFAX	BENTON FALLS	BURNHAM	PIONEER	WAVERLY
6/14	XL	X	X	X	X
6/19	X	X	X	-	-
6/24	XL	X	X	0	X
6/26	XL	X	0	0	0
6/30	XL	X	X	0	X
7/10	XL	X	X	0	X
7/14	XL	X	X	X	X
7/21	XL	X	X	X	X
7/24	XL	X	X	X	X
7/28	X	Xa	X	0*	X
7/31	XL	X	X	0	X
8/04	XL	X	X	X	X
8/07	XL	X	X	X	X
8/11	XL	0[1]	X	0	Xa
8/17	X	X	X	0	X
8/21	XL	X	X	0	X
8/25	XL	Xa	X	X	0
8/28	X	X	X	0	0
8/30	XL	X	X	0	0
9/03	X	X	X	X	0
9/09	XL	Xa	X	0	0
9/11	X	Xa	X	X	0
9/21	XL	Xa	X	0	X
9/25	Xa	Xa	X	X	X
9/28	X	X	X	0	X
10/01	XL	X	X	0	X
10/06	XL	X	X	X	X
10/08	XL	X	X	X	X
10/14	XL	X	X	X	X
10/16	XL	X	X	0	X
10/20	XL	X	X	0	X
10/23	X	X	X	X	X
10/28	XL	X	X	0	X
11/02	X	X	X	X	X
11/10	X	X	X	X	X
11/16	X	X	X	X	X
TOTAL NUMBER SITE VISITS:	**36**	**36**	**36**	**35**	**35**

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

[1]Bypass facility shut down during research

METHODS: American Shad

In 1992, 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 1992. As was previously mentioned in the "**METHODS: Alewife**" section, the experimental interim fish pumping system at the Augusta Dam was not operated in 1992. 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 1992, 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 decided not to obtain shad caught in this trap from the Commission or from the commercial alewife fisherman working the site because of a perceived decline in the Narraguagus River shad run in recent years.

American shad broodstock was secured from the Hadley Falls fish lift on the Connecticut River at Holyoke, MA. Early in 1992, 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 MA 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 two tank trucks purchased with KHDG funds were used to transport the shad from the Connecticut River 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 new porous polyethylene pipe arrangement. This oxygen supplement was operated in lieu of the air venturi system previously described in the "**<u>METHODS</u>: Alewife**" section.

During the 1992 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 1992, 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 three (3) different types of gear. A fyke net was set at several sites in the impoundment in an effort to trap young-of-the-year American shad. This fyke net had a 13-foot long throat, four feet wide by four feet deep, with three (3) funnels (cones) built into it. Attached to the throat of the net were two (2) 25-foot wings. The entire net was constructed of 1/8-inch Delta type machine woven mesh and was dipped in a black tar net treatment. This fyke net was generally set in shallow water (< or = four feet deep) and allowed to fish for approximately 24 hours each time it was set.

A push net was also employed to sample the impoundment for juvenile shad. This net was attached to a steel pipe frame which deployed over the bow of a 17-foot fiberglass boat. The net was then pushed through the water using the boat's outboard motor for propulsion. This net measured five feet by five feet (square) across its mouth and tapered down to a narrow cod end over its 15-foot length. This net was constructed of 5/8-inch stretch knotless nylon for the first eight feet and 1/4" Delta mesh over its last seven feet. It was treated with a net dip for durability. After the push was completed, the frame could be raised up over the boat and the cod end of the net could be opened to release any fish pushed into the back of the net. Pushes were normally of ten minutes' duration, after which fish would be removed promptly from the net.

A beach seine was also employed to sample selected areas of the impoundment. This seine measured 80 feet long, eight feet deep, and was constructed of 1/4-inch Delta nylon mesh. It was fished by wading, or the deep water end of the seine was sometimes pulled by a boat.

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

<u>RESULTS & DISCUSSION</u>: American shad

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 May 5, 1992. Kidney and spleen samples were taken in accordance with the AFS Fish Health Blue Book Procedures and shipped to the USF&WS 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 (96% over the last five years combined). In 1992, as in 1991, the Connecticut River was the **<u>only</u>** source for shad broodstock introductions in the Kennebec.

Eight shad transfers were completed from Holyoke in 1992 between May 23 and June 13. In total, 1,323 shad were loaded at Holyoke and 994 survived the trip and were stocked at Sidney. These numbers represent an overall trucking/handling mortality of 24.9%. Results of the 1992 shad transfers are presented in Table 8.

During the 1990 and 1991 Connecticut River shad transfers, hauling mortalities averaged 43% each year. For 1992, DMR made several improvements in hauling techniques that helped to reduce mortalities in 1992 to 25%.

Data collected over past hauling seasons indicated that the dissolved oxygen (DO) level in the hauling tank water dipped very low during the time the shad are first loaded in the tanks. The supplemental oxygen system that was used in past seasons could not keep pace with the rapid DO drop observed when the fish were loaded. This old system used fairly high pressure O_2 gas bubbled into the water through a perforated rubber hose. This system was very durable, but produced fairly large O_2 bubbles. The larger bubbles do not dissolve as efficiently as the smaller bubbles since the smaller bubbles have the better surface area/volume ratio. A system that could produce finer bubbles would have a better impact on the DO level in the tank water.

Consultation with Chris Freese of RMC (responsible for truck stocking shad on the Susquehanna River) yielded the idea of using a porous plastic pipe to produce a smaller bubble and improve the DO level. The Susquehanna hauling trucks had been fitted with this type of diffuser and it had proved effective. DMR ordered some of this porous pipe and installed it in the two KHDG stocking trucks, in all three tanks.

The porous pipe DMR installed was described by the vendor (Aquatic Eco-systems, Inc.) as porous polyethylene (HDPE) with an omni-directional, interconnecting pore structure. It was one-inch wide (outside diameter) and a four-foot long section was installed in each 1,000-gallon tank. Pipe ends were capped and O_2 gas was introduced into the pipes interior via a fitting tapped into one of the end caps.

Twin lexan floating ball flow meters were installed between the O_2 regulator and the diffuser pipes in each tank on the twin tank truck (used as the primary shad mover). These flow meters were located in the cab of the truck and could be manipulated separately, while on the road, to adjust O_2 flow to each tank.

In addition, DMR mounted a remote DO probe in one of the shad hauling tanks to allow monitoring of the DO level **while** on the road. The probe was connected to the YSI DO meter located in the cab of the truck. With this arrangement, DMR hoped not only to boost DO levels as shad were loaded, but to also monitor DO levels and adjust DO flow to maintain a tank environment conducive to maximum shad survival.

DMR believes that this constant feedback system offers a good means to combat the problem of depressed hauling tank DOs. Unfortunately, remote probe failure between the first and second hauling trips prevented continued monitoring. However, data from the first trip proved very interesting. With the new plastic pipe diffuser and flow meter arrangement, tank DOs were pushed up to 19.5$mg \cdot l^{-1}$ during preloading (running the flow meter at 15 $l \cdot minute^{-1}$). DOs during loading fell to 16$mg \cdot l^{-1}$ (at 8 $l \cdot minute^{-1}$ O_2 flow) but this was well above the 4$mg \cdot l^{-1}$ readings of past years before the installation of the porous pipe system. DOs continued at 15-16$mg \cdot l^{-1}$ (at 8 $l \cdot minute^{-1}$ O_2 flow) for the remainder of the trip home. Mortalities on this trip were 20% of the shad loaded.

DMR made several other improvements in its shad transport scheme for 1992. First, use of the air venturi system was discontinued to prevent any warming effect it may have had on tank water. Its impact on DO levels was probably negligible after the installation of the O^2 diffuser.

Second, DMR purchased and applied a commercial anti-foam agent (NO FOAM) to the hauling tank water. This foam control agent worked very well, eliminating almost all the thick brown foam that had been such a problem in past years.

Third, DMR personnel made it a point to select only vigorous, lively shad for hauling from Holyoke. Shad that exhibited strong swimming behavior were netted from the trap and loaded into the rolling hoppers. As the hoppers were unloaded via dip net into the truck tanks, any weak, immobile shad were set aside and left behind. In this crude fashion, perceived weak fish were culled from the pool of fish hauled back to Maine.

In addition, salting hauling tank water was continued during the 1992 transfers, with one exception. No salt was used on the May 28 trip and oxygen input and NO FOAM levels were held at levels on previous trips. Mortalities were 28% for this trip (above the 25% average for the season). DMR continued to use salted water for the rest of the season.

DMR staff noticed a big difference in the behavior of the shad this year, compared to past years, after they were loaded into the truck tanks. In the past, slow swimming speeds and lethargic behavior were the norm. During the 1992 season, energetic shad were the rule. Fish seemed to swim faster and tried to jump out of the hauling tank hatchway. One successful leaper nearly knocked a DMR employee off the top of the stocking tank as it leaped to "freedom" on the blacktop below. The elevated DO levels really appear to have had a positive impact.

Improvements planned for the 1993 season include: painting the hauling tank interiors black (to provide a less stressful environment), application of a commercial "buffer" to hauling tank water, and installation of an additional DO probe in the second tank on the twin tank truck. The faulty probe will be replaced and the new one will be installed.

DMR is pleased with the 994 shad stocked in the Kennebec River this year. This represents a 36% increase over the best previous year, 1991, and is very close to the interim goal of 1,000 shad stocked per year. Mortalities are down from 43% to 25% and DMR will try to reduce mortalities further in an effort to stock even more live fish in 1993.

DMR fished a fyke net at several sites in the central portion of the Kennebec impoundment between Waterville and Augusta. The fyke net was generally fished overnight for approximatley 24 hours, although one 48-hour set was made. Nine fyke net sets were completed between August 25 and September 17, 1992. Several fish species were trapped including: American eel, white sucker, spottail shiner, smallmouth bass, and several species of sunfish. No juvenile alewives or American shad were taken by fyke net in the impoundment. The fyke net purchased by KHDG funding was badly vandalized and ruined while it was set in the impoundment late in 1992. A decision will be made this winter as to the feasibility of this sampling scheme and the possibility of replacing this net for 1993.

In the cause of setting and recovering the fyke net off the mouth of Town Farm Brook, Sidney, the crew observed juvenile alosids in the area around the set fyke net on September 1. The fyke net was recovered but it did not contain any alosids. The DMR crew then attempted two seine hauls in the area with two different beach seines (40 x 4 feet and then 80 x 8 feet, both 1/4-inch Delta mesh). Juvenile alosids were captured on both seine hauls. In all, 11 YOY alosids were captured, ten alewives and one American shad. This American shad was the only one captured in the impoundment during 1992.

In addition to the fyke net, DMR also used a push net to sample the impoundment for American shad. DMR's old steel push net frame was straightened and fitted with a new net for 1992. The 17-foot Aqua-sport boat that pushed this net was fitted with work lights to allow late evening/nighttime sampling (when it was judged that the pushnet would be most effective in sampling the impoundment for YOY alosids). The DMR push net team first attempted to sample the head-pond with the pushnet on the evening of July 28. A three-person crew launched at Sidney in early evening, well before sunset. Several potential push net sites were examined with a depth finder in preparation for sampling later that evening.

As the light began to fade, the DMR crew began to experiment with several "pushes" at previously selected sites. Several YOY alewives were taken on the first two passes. At the next site, the lower edge of the pushnet frame was damaged as it struck a submerged ledge outcrop. The pushnet frame was badly bent and several of the old, rusted welds failed, leaving the rig in unusable condition. The net portion of the pushnet rig was left in good condition.

DMR was forced to stop its sampling and seek repairs for the pushnet frame. Repairs (mainly welding) were completed, but not until the end of September. This pushnet sampling strategy will be employed again in 1993, in the hope of sampling YOY American shad in the impoundment.

DMR purchased a small "scoop" net with the intention of fishing it near the downstream bypass at Edwards Mill in Augusta. This scoop net was three feet in diameter across its round mouth, 72 inches deep, and constructed of 1/4-inch heavy Delta mesh. It was rigged with a three lead bridle tied to a single rope. 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 interim bypass. However, water velocities in the forebay near this bypass are rapidly changing and sometimes exceedingly fast. No attempts to deploy the scoop net in this forebay were made because of the high probability of losing it or having it swept onto the trash racks by the changing velocities. Dip nets were also employed at Edwards' bypass in attempts to capture juvenile alosids. No shad were captured in this fashion in 1992 (see "Edwards Mill" section of **RESULTS & DISCUSSION: Alewife**).

The morning after the fish kill at Edwards Mill [October 8, 1992], Lewis Flagg recovered a sample of the dead fish from the tailrace area below the outflow of the downstream bypass. A sample of these mortalities was examined by Mr. Flagg. All 250 of the fish he measured and identified were juvenile alewives. No juvenile shad were found in the sample.

Fyke netting and beach seining on the impoundments of the Androscoggin River in 1992 by another project in DMR's Anadromous Fish Division failed to capture any juvenile American shad or alewives. DMR has stocked American shad broodstock from Holyoke below Lewiston Falls on the Androscoggin since 1985 and, to date, efforts to find the progeny of these broodstock introductions have been fruitless.

However, during the fall of 1992, over 130 juvenile shad were sampled as they passed downstream through the Brunswick Fishway at head-of-tide on the Androscoggin River. Some portion of juvenile shad used the upstream verticle slot fishway as their downstream migration path rather than the downstream bypass in place at Brunswick. In short, 566 broodstock shad were stocked below Lewiston Falls in 1992 and 130+ juveniles were documented passing downstream at Brunswick, despite extensive sampling efforts upstream which yielded no shad.

A similar scenario may be occurring on the Kennebec. KHDG funded personnel stocked 994 broodstock shad at Sidney and found only one juvenile shad in the impoundment. However, the limitations of current sampling techniques at Edwards Mill make it difficult to determine what number of juvenile shad are passing through this facility. It may be possible that significant numbers of juvenile shad are being produced in the impoundment, but current sampling schemes are not contacting these fish in the impoundment.

Improvements must be made in sampling gear, selecting more productive sites, or in development of a sampling scheme at Edwards Mill.

In 1992, DMR planned to secure ripe broodstock shad suitable for egg stripping from the Eastern or Kennebec Rivers. The effort to gillnet shad on the Eastern River was delayed for several reasons. DMR tried to contact a local commercial fisherman to procure shad broodstock on the Eastern. DMR was not able to acquire the experimental shad drift gillnet from the vendor recommended by the fisherman. DMR was promised time and time again that the specified net would be completed. It was not and DMR sought to have the fisherman use an older gillent that DMR already had on hand. The fisherman did not think it worthwile to attempt gillnetting with the older net, believing it to be in too poor condition to capture any significant number of shad.

DMR personnel undertook gillnetting on their own on the mainstem of the Kennebec River on a limited basis due to manpower constraints. Gillnets were fished at night on June 16 and 17, 1992, in the vicinity of the Augusta Dam (Edwards Mill). No American shad were captured on multiple sets over these nights.

DMR plans to order the appropriate experimental drift gillnet from a new vendor over the winter of 1992-1993 and proceed with plans to contract with a local fisherman on the Eastern River in the spring of 1993. The fisherman seemed eager to attempt the broodstock gill-netting given a new net. DMR personnel will cooperate with this individual as necessary to acquire and fertilize shad eggs for an experimental fry rearing program.

The experimental shad culture program which was initiated in 1991 was continued in 1992. The shad restoration program on the Medomak River is a cooperative program between the Department of Marine Resources (DMR), 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 evening of June 8, 1992, 500,000 fertilized shad eggs from the Connecticut River were obtained, compliments of the Susquehanna River Anadromous Fish Restoration Committee. The fertilized 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 were incubated until they hatched on June 14, 1992. After hatching, the larvae were raised in a 575-gallon circular fiberglass tank where they were fed brine shrimp. On July 2, 1992, approximately 300,000 shad larvae were released into the Medomak River. An additional 50,000 were stocked in two culture ponds where they were raised until late fall. In late October and early November, approximately 15,000 fall fingerlings four inches in length were stocked in the Medomak River.

The hatchery has the capability of hatching an additional 400,000 to 500,000 shad eggs and raising them to 20-day old fry. This system was set up to hatch fertilized eggs from the Kennebec River and raise them to 20-day fry if eggs had been available in 1992.

TABLE 8. American Shad Stocking in the Kennebec River, 1992

TRUCK STOCKING:

Date	Broodstock Source	# Loaded	# Morts	# Stocked	Site	Water Temp C° Source	Water Temp C° Kennebec
5/23	CT River, Holyoke	185	37	148	Sidney	20.0	16.0
5/25	CT River, Holyoke	118	2	116	Sidney	18.0	----
5/28	CT River, Holyoke	167	46	121	Sidney	17.0	18.0
6/05	CT River, Holyoke	193	75	118	Sidney	18.0	----
6/06	CT River, Holyoke	149	30	119	Sidney	18.0	16.5
6/07	CT River, Holyoke	210	40	170	Sidney	17.5	----
6/11	CT River, Holyoke	135	23	112	Sidney	19.0	19.0
6/13	CT River, Holyoke	166	76	90	Sidney	21.0	20.5
TOTALS:		**1323**	**329**	**994**			

TRUCK STOCKING:	**994**
FISH PASSAGE:	**+ 0**
TOTAL STOCKED:	**994**

TABLE 9. Historical American Shad Stocking in the Kennebec River

RIVER SOURCE	1987 L	1987 M	1987 S	1988 L	1988 M	1988 S	1989 L	1989 M	1989 S	1990 L	1990 M	1990 S	1991 L	1991 M	1991 S	1992 L	1992 M	1992 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	1323	329	994
Kennebec Edwards Fish Pump							2	1	1									
TOTALS:	213	14	199	965	349	616	782	163	619	1047	443	604	1113	474	639	1323	329	994

L = Loaded

M = Mortalities

S = 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 1992. Very few salmon were seen by DMR personnel in Bond Brook or the Kennebec River in 1992. Even if salmon were available, Atlantic salmon biologists have recommended against seining and handling of salmon, particularly during hot weather periods.

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 is seeking 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 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:

<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 from 1988 -1990. Analysis of the 1991 and 1992 samples will begin this winter. In addition, the tech will also analyze the contents of juvenile alewife stomachs collected by DMR during the 1991 and 1992 field seasons.

The results of the stomach content analysis of landlocked rainbow smelt (Osmerus mordax) collected in Lake George through 1990 are presented in Tables 10 and 11. Examination of the percent frequency of occurrence showed the importance of copepods and cladocerans (>70%) in smelt diets. Insects formed a smaller part of their diet (<10%) in 1988 and 1989, but occurred in 30% of smelt stomachs in 1990. Copepods and cladocerans comprised the majority (>95%) of the food items enumerated (Table 11), with cladocerans being slightly more abundant. Insects, though few in number, were often quite large and would provide high nutritive value. 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 the stomachs. However, at least five species of Daphnia common to Maine lakes were encountered in the smelt stomachs.

Phase II of the study continued with the DMR stocking of 2,005 adult broodstock alewives into Lake George on May 29-30, 1992. 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 11-12, before adult alewife stocking took place, and remained in place until November 20, 1992, 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 was weighed and measured for total length each day.

During the 1992 season, a total of 1,420 adult alewives passed out of Lake George (or were netted in the lake); this represents 71% of the total number stocked on May 29-30. Adult alewife passage out of the lake began on June 1 and terminated on November 11. The peak adult alewife passage occurred on June 22 when 101 adults were trapped. Adult alewife passage out of Lake George in 1992 is depicted in Figure 2.

During the 1992 season, a total of 1,359,354 juvenile alewives passed out of Lake George. Juvenile alewife passage out of the lake began on July 15 and terminated on November 19. The peak juvenile alewife passage occurred on July 20 when 344,862 juvenile alewives were trapped (25% of 1992 total). The three-day period from July 18-20 accounts for 56% of the 1992 total juvenile alewife passage out of Lake George and is depicted in Figure 3.

Sizes of juvenile alewives trapped at the weir increased through the trapping season, both in 1991 and 1992. The mean lengths of juvenile alewives by day (mean length of a 50-fish sample when available) are presented in Figure 4 (1991) and Figure 5 (1992). The cumulative weight of the entire juvenile alewife sample for each day was divided by the number of fish in each sample to determine a mean weight for the juveniles that day. Mean weights for juvenile alewives are presented in Figure 6 (1991) and Figure 7 (1992).

DMR personnel also collected biweekly juvenile alewife samples from the lake itself. These 1992 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 1991-92 alewife and smelt stomach samples will be presented at a later date.

Information bulletins by the Maine Department of Inland Fisheries and Wildlife regarding the Lake George study are included in Appendix I of this report.

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 10.

The frequency of occurrence (percent) of food items in the digestive tract of smelt (Osmerus mordax) collected in Lake George from 1987 - 1990. (#) = number of fish examined.

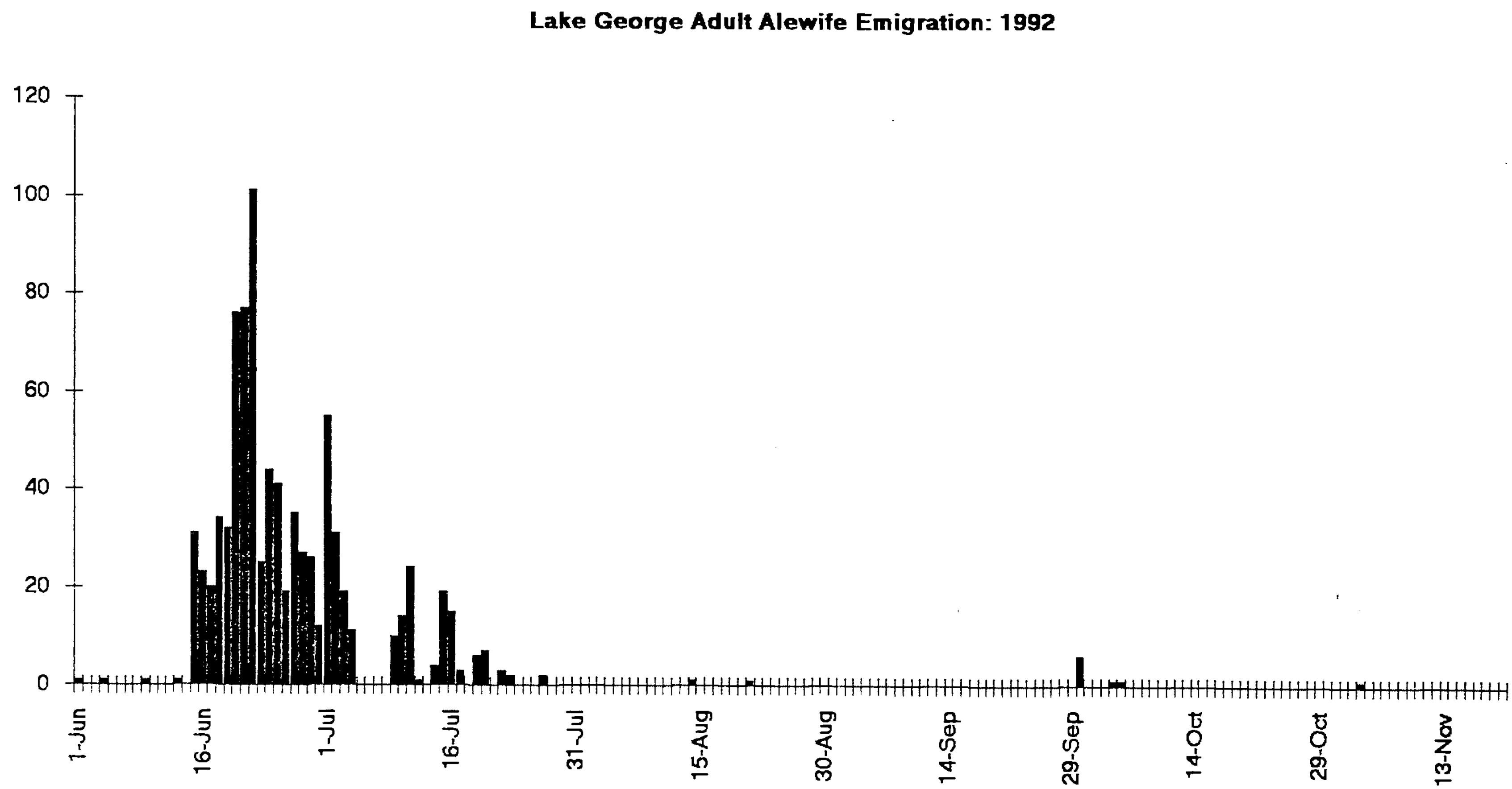
Food item	Percent frequency of occurrence 1987 (40)	1988 (70)	1989 (71)	1990 (72)
Copepoda	-	71.4	84.5	79.2
Unidentified	67.5	34.3	28.2	20.8
Cyclopoida	58.0	58.9	81.7	75.0
Calanoida	55.0	41.4	46.5	19.4
Nauplii	7.5	44.3	8.5	23.6
Cladocera	-	71.4	76.1	81.9
Unidentified	72.5	70.0	74.6	76.4
Dapnia catawba	42.5	10.0	15.5	13.9
D. ambigua	5.0	0	0	0
D. galeata mendotae	5.0	7.1	5.6	1.4
D. dubia	2.5	0	0	0
D. longiremis	7.5	0	4.2	2.8
D. pulex	5.0	0	0	1.4
Bosmina sp.	35.0	48.6	21.1	44.4
B. coregoni	0	0	14.1	0
Insecta	-	5.7	8.5	30.6
Trichoptera	5.0	1.4	2.8	4.2
Odonata	0	0	2.8	5.6
Diptera	20.0	2.9	2.8	23.6
Hemiptera	0	0	0	1.4

TABLE 11.

The number (percent) of food items in the alimentary tract of smelt (<u>Osmerus mordax</u>) collected in Lake George from 1988 - 1990. (#) = number of food items.

	Percent number		
Food item	1988 (4055)	1989 (3360)	1990 (2441)
Copepoda	49.2	42.9	46.4
Unidentified	3.6	2.4	6.4
Cyclopoida	14.1	30.6	29.7
Calanoida	18.6	9.0	4.4
Nauplii	12.9	0.8	5.9
Cladocera	50.7	56.6	50.6
Unidentified	42.9	51.7	29.2
Dapnia catawba	0.3	0.6	1.4
D. ambigua	<0.1	0	0
D. galeata mendotae	0.2	0.1	<0.1
D. dubia	<0.1	0	0
D. longiremis	0	0.2	0.1
D. pulex	<0.1	0	<0.1
Bosmina sp.	7.3	2.8	19.9
B. coregoni	0	1.1	0
Insecta	0.1	0.4	2.9
Trichoptera	<0.1	0.2	0.1
Odonata	0	0.1	0.2
Diptera	0.1	0.1	2.4
Hemiptera	0	0	0.2

FIGURE 2.



Lake George Adult Alewife Emigration: 1992
120
100
80
60
40
20
0
1-Jun
16-Jun
1-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov

FIGURE 3.

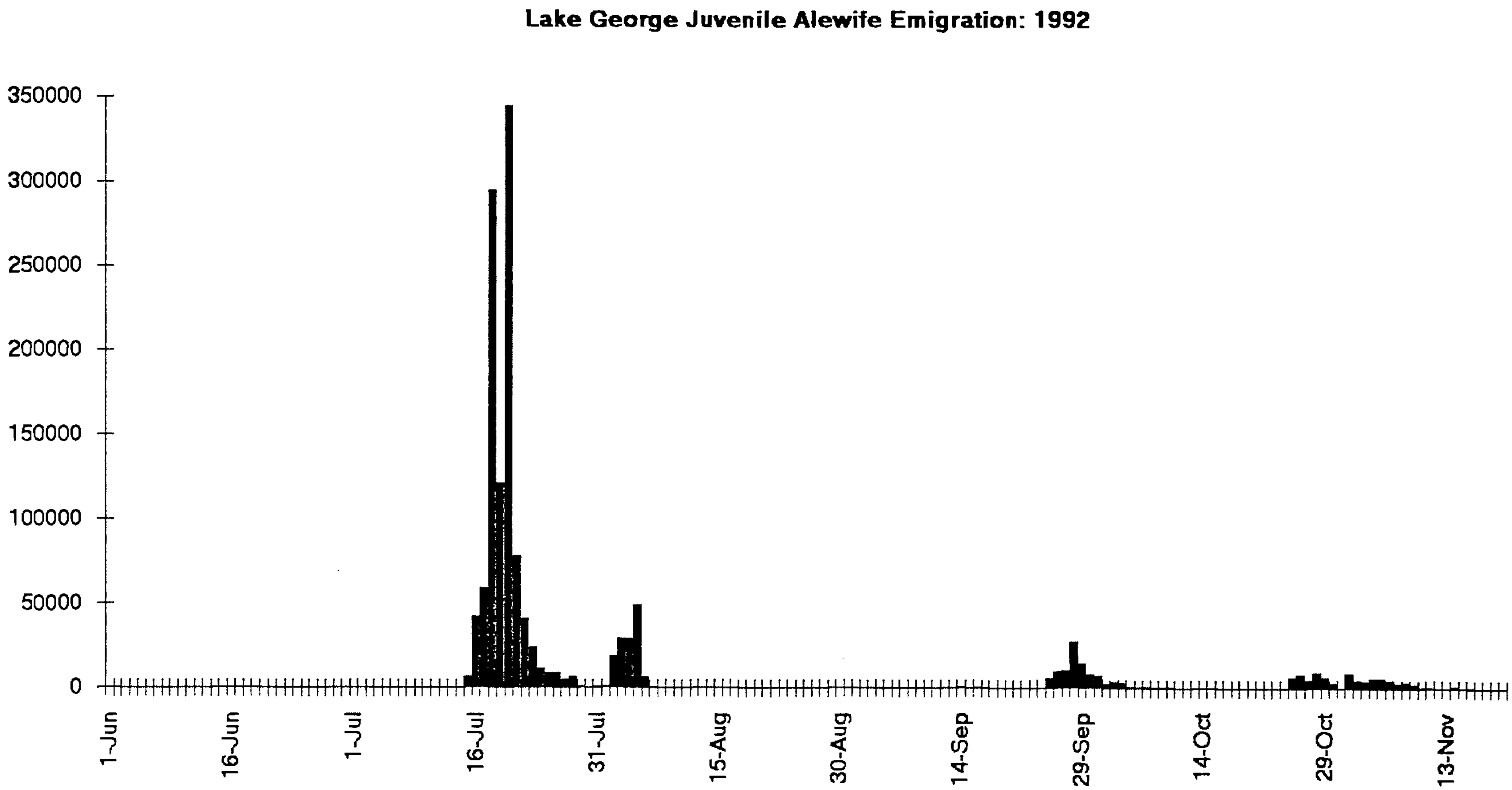

Lake George Juvenile Alewife Emigration: 1992
350000
300000
250000
200000
150000
100000
50000
0
1-Jun
16-Jun
1-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov

FIGURE 4.

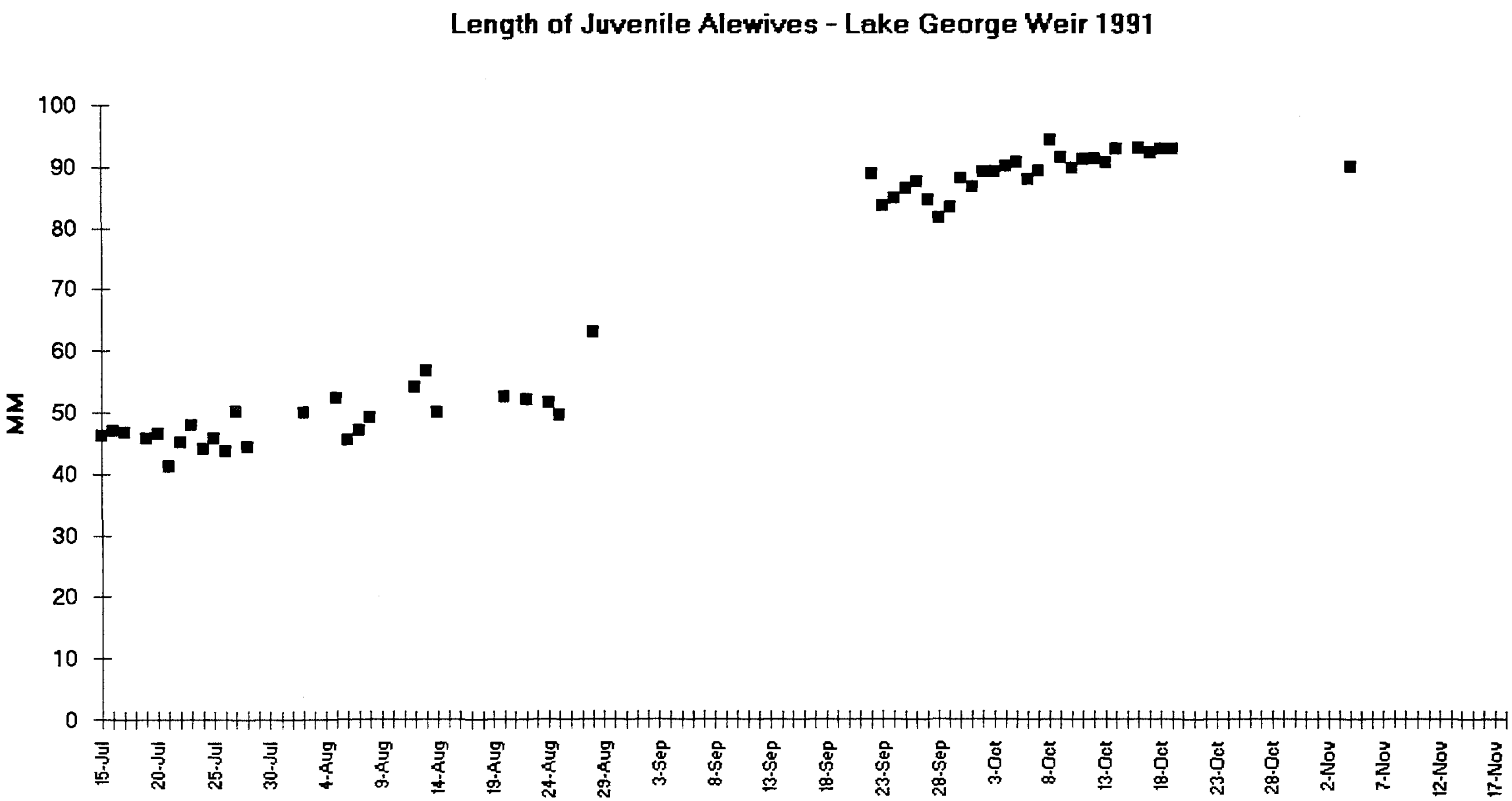
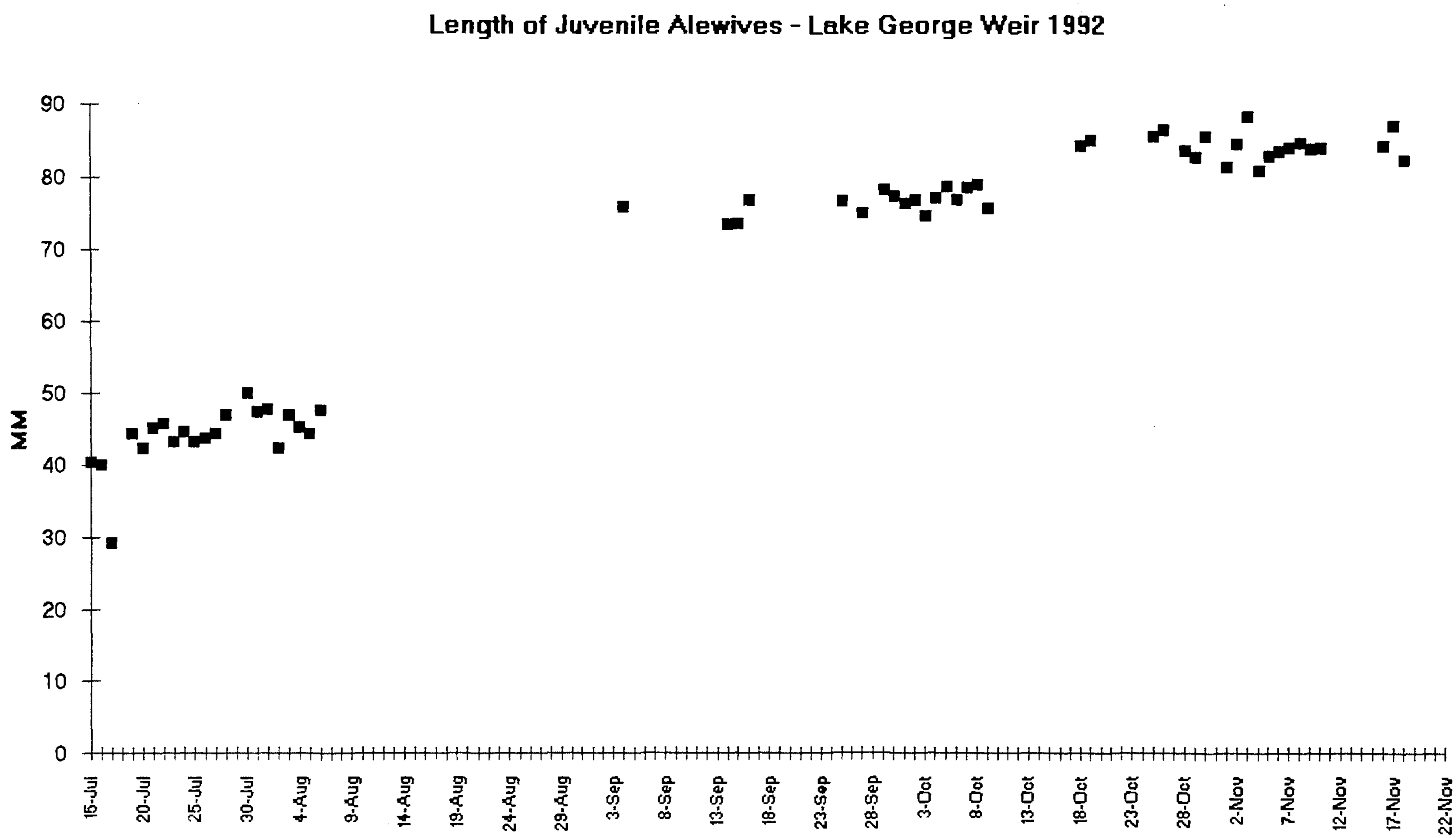

Length of Juvenile Alewives - Lake George Weir 1991
MM
100
90
80
70
60
50
40
30
20
10
0
15-Jul
20-Jul
25-Jul
30-Jul
4-Aug
9-Aug
14-Aug
19-Aug
24-Aug
29-Aug
3-Sep
8-Sep
13-Sep
18-Sep
23-Sep
28-Sep
3-Oct
8-Oct
13-Oct
18-Oct
23-Oct
28-Oct
2-Nov
7-Nov
12-Nov
17-Nov

FIGURE 5.



Length of Juvenile Alewives - Lake George Weir 1992
MM
90
80
70
60
50
40
30
20
10
0
15-Jul
20-Jul
25-Jul
30-Jul
4-Aug
9-Aug
14-Aug
19-Aug
24-Aug
29-Aug
3-Sep
8-Sep
13-Sep
18-Sep
23-Sep
28-Sep
3-Oct
8-Oct
13-Oct
18-Oct
23-Oct
28-Oct
2-Nov
7-Nov
12-Nov
17-Nov
22-Nov

FIGURE 6.

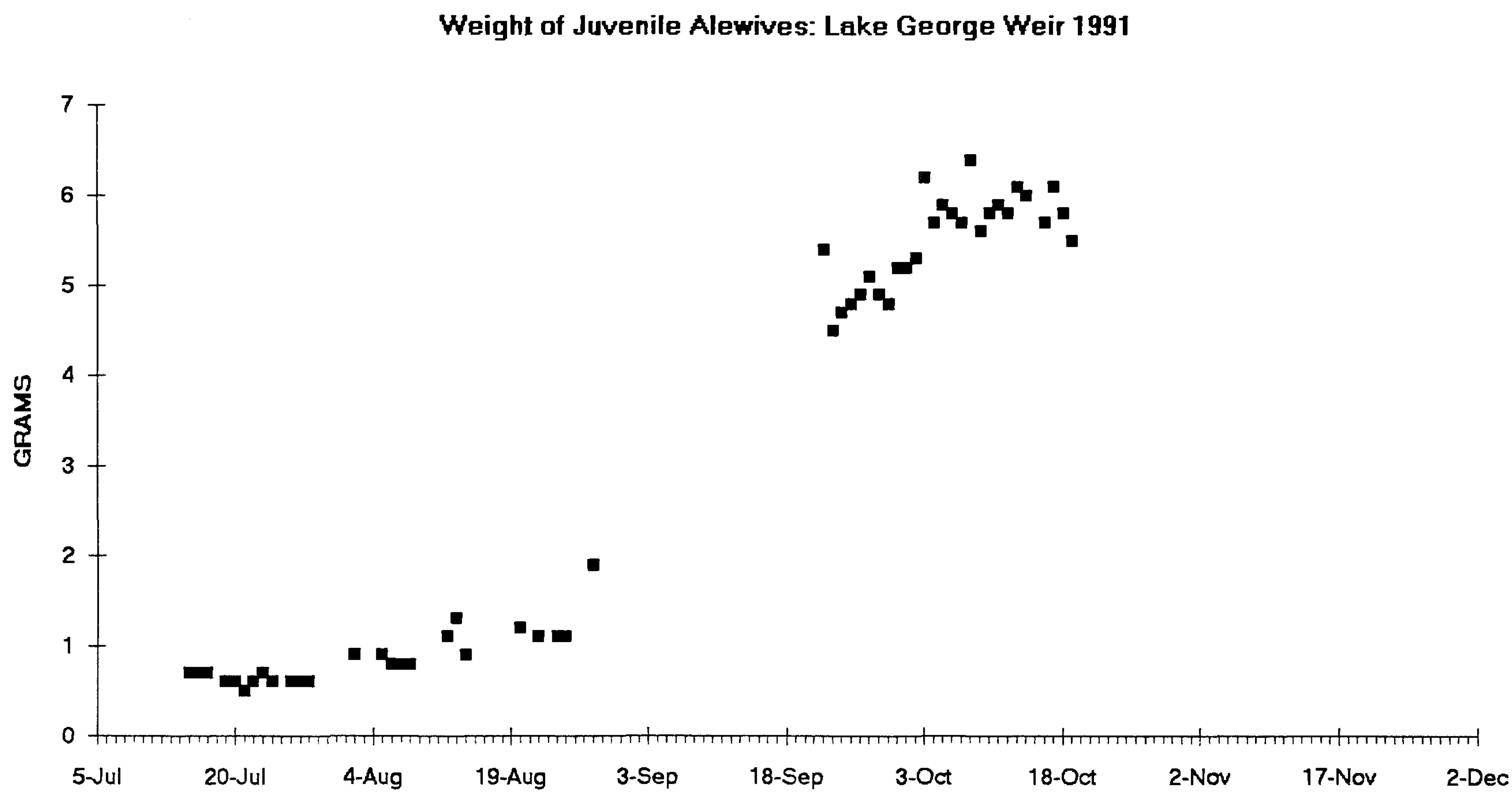
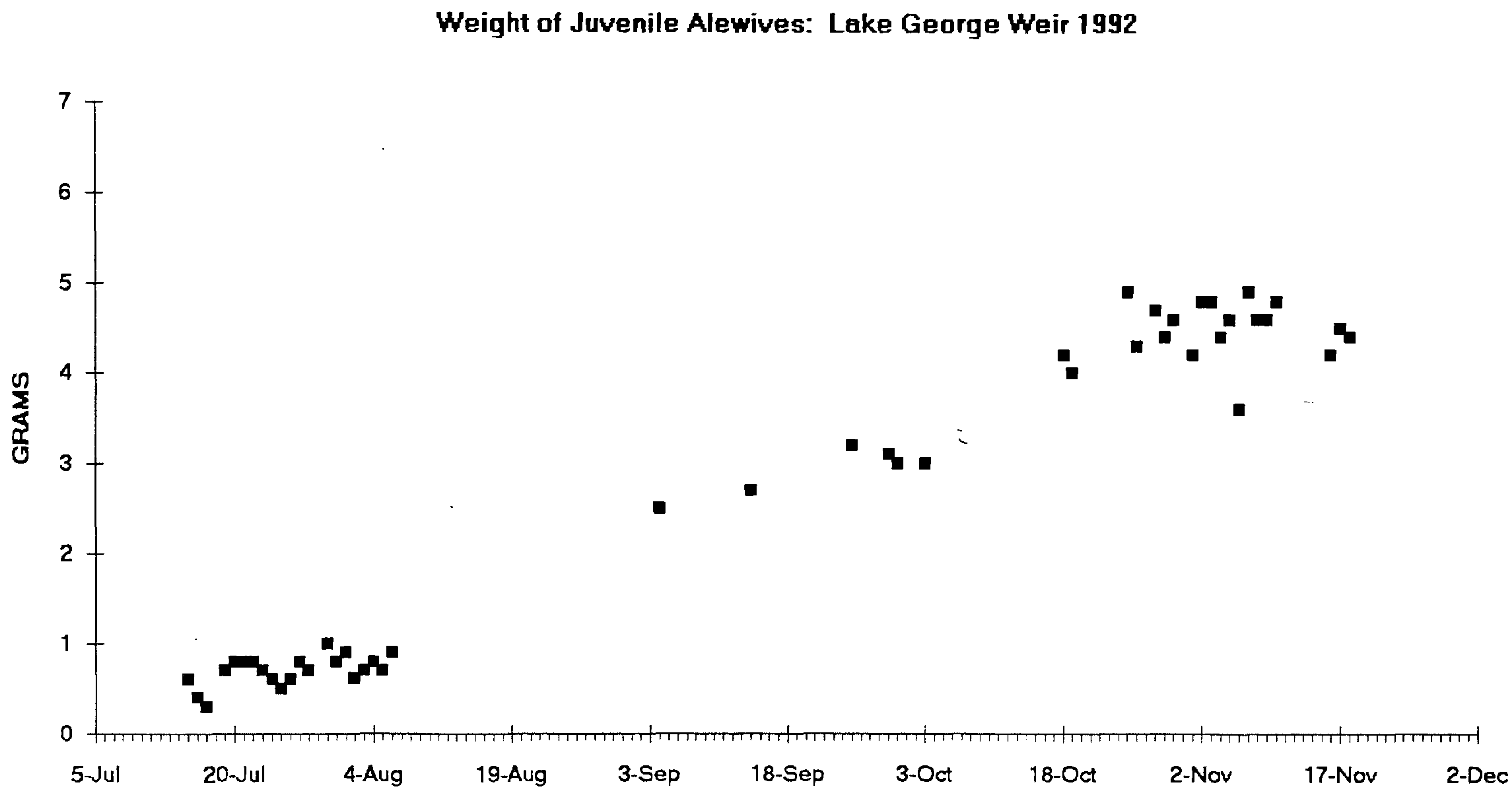

Weight of Juvenile Alewives: Lake George Weir 1991
GRAMS
7
6
5
4
3
2
1
0
5-Jul
20-Jul
4-Aug
19-Aug
3-Sep
18-Sep
3-Oct
18-Oct
2-Nov
17-Nov
2-Dec

FIGURE 7.


Weight of Juvenile Alewives: Lake George Weir 1992
GRAMS
0
1
2
3
4
5
6
7
5-Jul
20-Jul
4-Aug
19-Aug
3-Sep
18-Sep
3-Oct
18-Oct
2-Nov
17-Nov
2-Dec

APPENDIX I

Summary of Initial Work Done by IF&W at Lake George During the Spring of 1987

F-409. Inter-relationships of Anadromous Alewives and Freshwater Fishes, 1987.

F-409. Inter-relationships of Anadromous Alewives and Freshwater Fishes, 1988.

F-409. Inter-relationships of Anadromous Alewives and Freshwater Fishes, 1989.

F-409. Inter-relationships of Anadromous Alewives and Freshwater Fishes, 1990.

F-409. Inter-relationships of Anadromous Alewives and Freshwater Fishes, 1991.