State of Maine

Department of Marine Resources

2002 Brunswick Fishway Report

Maine Department of Marine Resources
Stock Enhancement Division
#21 State House Station
Augusta, ME 04333-0021

January 2003

ANADROMOUS FISH RESTORATION IN THE ANDROSCOGGIN RIVER WATERSHED

2002 Report on the Operation of the Brunswick Fishway FERC #2284

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INTRODUCTION

The Androscoggin River, with a drainage area of approximately 3,460 square miles, is Maine's third largest watershed. Historically, the Androscoggin provided access to a large and diverse aquatic habitat and supported great numbers of diadromous and resident fish species. For most species, the natural upstream migration barrier on the main stem of the Androscoggin River was Lewiston Falls, 22 river miles above tidewater. Although Lewiston Falls was an impassable barrier for most species, sea-run Atlantic salmon and American eel were able to ascend these falls and move upstream to Rumford, 80 river miles above tidewater. According to Atkins (1887), Rumford Falls was an impassable barrier to migrating salmon and excluded them from the New Hampshire waters of the Androscoggin River.

River herring were known to reproduce in lake and pond habitat throughout the Androscoggin and Little Androscoggin River watersheds below Lewiston Falls, while American shad reproduced in the riverine areas below Lewiston Falls. Atlantic salmon, which could ascend the earliest built low head dams at Brunswick, were caught at Lewiston as late as 1815; however, river herring and American shad were excluded from waters above Brunswick after 1807, when the first dam was built at head-of-tide. The Little Androscoggin River, which enters the main stem Androscoggin on the west bank just below Lewiston Falls, was noted for large runs of diadromous fish. Sea-run fish ascended this major tributary to Biscoe Falls, 35 miles above the river's confluence with the main stem Androscoggin. By the early 1930s, the construction of dams that lacked fish passage capabilities, in combination with severely polluted waters, virtually eliminated all opportunity for fish to live and reproduce in the main stem Androscoggin and most of its tributaries.

Since the early 1970s, substantial improvement in water quality and the provision of fishways at some of the dams have enhanced the potential for successful fish restoration within the lower Androscoggin River watershed. In 1982, the Brunswick vertical slot fishway and downstream fish passage were constructed at the first upstream dam on the river. In 1987, an upstream fish lift and downstream passage were provided at the Pejepscot Project, the second upstream dam on the river; in 1988, an

upstream fish lift and downstream passage were installed at the Worumbo Project, the third upstream dam on the river. Effective upstream fish passage at these three hydropower projects could potentially provide access for diadromous and resident species as far upstream as Lewiston Falls.

The restoration of native diadromous fish species to the Androscoggin River watershed has multiple benefits to the ecosystem and society. American shad and river herring provide important forage to other fish and wildlife species in both inland and coastal ecosystems. Restoring species to healthy habitat will allow individuals to utilize this valuable resource for recreational as well as commercial uses. The Androscoggin system has the potential to produce an annual sustained yield of 1,000,000 pounds of alewives and 500,000 pounds of American shad, valued at $132,000 and $206,000 respectively. The reestablishment of large runs of alewives and American shad could provide employment for a number of commercial fishermen, and large recreational fisheries for American shad could develop in the lower Androscoggin River. The 1,000,000-pound alewife harvest will increase long-term average statewide landings by 33% and provide a substantial source of bait for Maine's 6,700 licensed lobster fishermen. Efforts toward improved water quality, habitat, and fish and wildlife populations improve the overall health of the ecosystem and society.

The Maine Department of Marine Resources (DMR) provides an annual report on the operation of the Brunswick fishway to enhance its cooperative partnership with FPL Energy Maine Hydro LLC (FPLE) in the operation of the fishway and to assist the company in meeting its FERC reporting requirements. DMR's report is based upon daily data, records, and logs that are maintained by DMR biologists at the fishway. This includes information regarding daily inspections, fishway cleaning and condition, fish data collection, and operational activities throughout the season (typically May through November). The operation of the Brunswick fishway is one tool that is utilized in the implementation of the DMR fishery restoration program for the Androscoggin River. The goals and objectives of this program, along with any additional information not specifically associated with the actual operation of the fishway, are included in this report as a courtesy to provide FERC and FPLE with a broader perspective of the

purpose, role, and usefulness of the fishway in the DMR program. Several legal authorities and state and federal plans that guide state restoration programs include:

Legal Authorities

- Fish and Wildlife Coordination Act
- Federal Power Act
- Fish and Wildlife Act of 1956
- Federal Aid in Fish Restoration Act (Dingell-Johnson Act)
- Anadromous Fish Conservation Act
- Title 12 M.R.S.A. §6021, §6022, §6051, §6052, §7701, §7702
- Title 38 M.R.S.A. §630-636

Guidance Documents

- Fishery Management Report No. 35 of the Atlantic States Marine Fisheries Commission - Amendment 1 to the Interstate Fishery Management Plan for Shad and River Herring, April 1999.
- Maine Department of Marine Resources: State of Maine Recovery Plan for American Shad (*Alosa sapidissima*) and River Herring (*Alosa pseuodoharengus* and *Alosa aestivalis*) for Amendment 1 to the Interstate Fishery Management Plan for Shad and River Herring, May 1999.
- Maine Department of Marine Resources: American Shad Management Plan.
- State of Maine Statewide River Fisheries Management Plan, 1982.

- State of Maine Anadromous Alewife Restoration Program – A Report to the Joint Standing Committee on Inland Fisheries and Wildlife. Prepared by the Maine Department of Inland Fisheries and Wildlife and Maine Department of Marine Resources. February 1998.

GOAL AND OBJECTIVES OF THE RESTORATION PROGRAM

The State of Maine's Department of Marine Resources Fishery Restoration Program goal is to increase ecosystem health in the Androscoggin River watershed by restoring native diadromous fish species and their habitats. The primary focus is to restore river herring (alewives and blueback herring) and American shad to historic habitat areas in the Androscoggin and Little Androscoggin River watersheds, while increasing the restoration potential for other native fish species.

Objective 1: Increase the abundance, survival, and natural reproduction of pre-spawning adult river herring and American shad in historic spawning and nursery habitat areas.

Strategies:

1. Trap upstream migrating adults at the Brunswick fishway and distribute them into upstream habitat areas that are inaccessible due to the obstruction of passage by dams.
2. Conduct supplemental releases of adult American shad and river herring from other tributaries when necessary.
3. Conduct American shad fry stocking to increase juvenile abundance in nursery habitat areas.

Objective 2: Protect and enhance the health of the native fish community structure in support of river herring and American shad restoration efforts.

Strategies to characterize and assess the fish community structure:

1. Monitor and facilitate up- and downstream movement of native diadromous and resident fish species into historic habitat by the operation of the Brunswick fishway.
2. Collect biological data on all fish species captured at the Brunswick fishway.
3. Collect fish community data during the juvenile river herring surveys conducted upstream in Sabattus Pond and the lower Androscoggin River.
4. Collect fish community data during the adult river herring emigration assessment conducted in the Sabattus River at the outlet of Sabattus Pond.

Objective 3: Characterize the annual migration of adult river herring and American shad in the Androscoggin River watershed.

Strategies:

1. Assess the timing and magnitude and collect biological data from pre-spawning adult river herring and American shad captured at the Brunswick fishway.
2. Assess the timing and magnitude of the adult American shad migration upstream to the Brunswick fishway by conducting visual observations and underwater monitoring.
3. Assess the post-spawn adult river herring emigration timing, magnitude, and condition from Sabattus Pond sampling.

Objective 4: Assess the reproductive success of adult and productivity of juvenile alosids in the watershed.

Strategies:

1. Evaluate the juvenile river herring growth and emigration timing, habitat parameters, and fish community in Sabattus Pond, located in the upper Androscoggin River.
2. Evaluate juvenile alosids in the lower river by sampling at the Brunswick fishway and selected areas in the lower reaches of the Androscoggin River.

Objective 5: Increase the accessibility of historic habitat for native diadromous and resident fish species to increase the abundance, survival, and natural reproduction in historic habitat.

Strategies:

1. Provide oversight, review, and comments on required fish passage operation and downstream effectiveness study plans at hydropower dams.
2. Identify ineffective fish passage and the potential causes by conducting studies, collecting visual observations, and utilizing underwater monitoring data.
3. Provide effective up- and downstream passage for native diadromous fish species at dams currently without passage through the FERC process and non-regulatory partnerships.

Objective 6: Increase public awareness of the Androscoggin River program in order to encourage participation and support in river restoration initiatives.

Strategies:

1. Conduct outreach activities such as providing presentations on the program to public and scientific audiences.
2. Participate in the development and activities of the Androscoggin River Watershed Council.

2002 BRUNSWICK FISHWAY MAINTENANCE AND OPERATION

- DMR met with the Brunswick dam owner, FPLE, in the spring of 2002 to review Brunswick Station operations, problems occurring with the fishway, and maintenance issues that remained from the fall 2001 season that required resolution prior to the startup of the fishway in May 2002.

- The fishway was officially opened for its 20th consecutive season on May 6, 2002.

- Prior to the 2002 season, FPLE serviced the existing fish hoist. The foot valve was inspected and the electric motor that operates the hopper lift was recalibrated to provide the desirable lift height. A new distribution hose was installed and modifications were made to the distribution hose attachment. A heavy-duty hose lift was installed to replace the existing hose lift system. An additional electrical outlet was installed in the fishway control room. In addition, FPLE installed a supplemental oxygen delivery system to provide oxygen to two overhead fish distribution tanks. The new system allowed DMR personnel to increase the number of alewives that were held in the tanks prior to distribution. Supplemental oxygen was used to aerate water when Atlantic salmon and American shad were held in the overhead tanks. Routine maintenance was conducted in the lower section of the fishway; the diffusion chamber grates and baffles were cleaned, inspected and replaced if needed.

- Stop logs were placed and tested in the lower six pools of the fishway prior to fishway operation. The lower six pools of the fishway were modified to create a pool and weir fishway to improve American shad passage by FPLE on November 2001.

- During the first day of operation the isolation gates were not lowering to the bottom of the fish trap. Maintenance personnel corrected the problem later that day by adjusting the travel stop on the electric motor that operates the gate. As in 2001, one of the four wheels of the fish crowder remained sheared off. In 2001, a piece of pipe was welded onto the crowder in place of the wheel assembly. This modification

worked fine throughout the season but should be checked routinely. An assessment of the reasons why this keeps occurring should be conducted before a serious malfunction preventing daily use of the crowder occurs. The fish crowder is vital to the trap and truck stocking operation being conducted from the Brunswick fishway.

- The fishway was closed June 13 – 16 due to high river flows during this period. Over the four-day period river flows crested at 29,500 cfs. Average flows during this period range from 2,000 – 6,000 cfs.

- In June, FPLE constructed and mounted three staff gauges in the fishway to track water height in the fishway. Staff gauges were mounted in Pool 1, Pool 6, and at the top of the fishway in the vicinity of the fish trap.

- The fishway was closed August 22 for five hours (7:30 AM to 12:30 PM) to perform routine cleaning.

- The pneumatic gates in the fishway control room were inoperable on October 1, 2002 and fixed later that same day. The Fish Passage Weir Hoist also malfunctioned on October 1 and was inoperable for four days. The fishway was closed for the season October 28, 2002.

- The warning light on the Fish Attraction Intake Differential, which monitors the amount of attraction water being supplied to the fishway entrance, was tripped on 27.0% of the days the fishway was checked in June and July in 2001. The blowback system appeared to be working better in 2002. The Fish Attraction Intake Differential warning light, indicating clogged intake grates, was tripped on thirteen occasions during the 2002 season.

FISH PASSAGE

River Herring:

One of the statewide goals of the Maine Department of Marine Resources is to restore self-sustaining populations of river herring to their historic range. One benefit is the

restoration of native anadromous fish species to the Androscoggin River. A second benefit is that with the reestablishment of river herring populations to Maine rivers adult broodstock become available for restoration purposes in other Maine river systems. Since 1983, DMR personnel have distributed over 754,700 adult river herring captured at the Brunswick fishway into otherwise inaccessible habitat on the Androscoggin and Little Androscoggin Rivers. These stocking efforts continue due to the lack of fish passage at subsequent upstream dams on the Little Androscoggin and Sabattus Rivers that prevent access to river herring spawning and nursery habitat areas.

The maintenance crew of FPLE opened the Brunswick fishway May 6, 2002; DMR personnel began staffing the fishway the same day. River herring were captured at the fishway from May 10 through June 13. A total of 104,520 river herring were captured at the fishway in 2002. This was the largest number of river herring captured at the fishway since the inception of the restoration project in 1983. The run peaked May 31 through June 4. During this period 103,180 were captured and passed upstream or trucked to spawning habitats; these five days accounted for 99% of the total number of river herring captured during the 2002 sample season. On four occasions - May 31 and June 1-3 the number of captured adults exceed 2,000 fish (Table 1).

The number of river herring captured at Brunswick in 1999 (8,909), 2000 (9,551) and 2001 (18,196) were lower than the number captured in 1998 (25,189), but slightly higher than that of 1997 (5,540). The number of river herring trapped during the 2002 season ranked the highest out of the 20 seasons the fishway has been in operation. The total number of river herring captured in 2002 was well above the 20-year average of 37,900. The number of Androscoggin River adults captured for transport and release exceeded the amount of upstream spawning and nursery habitat currently available. The adult release target for the Androscoggin watershed was 27,358 river herring into 1,846 hectares of upstream habitat available for restoration. Due to the late river herring run on the Androscoggin and fears that this run would not meet stocking needs, 21,297 river herring were trucked from the Kennebec River to spawning habitat in the Androscoggin River watershed (Table 2). Of the 104,520 adults captured, 1,993 were transported upstream; 100,361 were released into the Brunswick headpond; 166 were sacrificed for

biological sampling and 2,000 were stocked outside of the watershed. A total of 123,651 adult river herring was released into the Androscoggin River watershed, 23,290 of which were released into nine upstream habitat areas totaling 1,644 hectares, excluding the main stems of the Androscoggin and Little Androscoggin (Table 3). River herring were distributed to Sabattus, Lower Range, Sutherland, Marshall and Taylor Ponds, Sabattus River, Bog Brook, Taylor Brook and the Brunswick headponds. All of these areas received the target number or reached the target stocking density of 14.83 fish per hectare (six fish/acre)(Table 4). Higher than average numbers of adult river herring captured in 2002 may have been a result of the high number of adults released into optimum spawning habitats during 1997-98 (Table 3; Figure 1). During this period, DMR was permitted to stocking alewives into prime spawning habitat at Sabattus Pond.

During the run, the water temperature ranged between 9.7° and 18.3°C, averaging 15.5°C (Figure 2). The river flows ranged between 4,430 (cfs) and 29,700 (cfs), averaging 9,122 (cfs) (Figure 3). Alewives trapped at the Brunswick fishway were sampled on five different occasions. Of the 166 individuals sampled, 43% were female, while 57% were male. Females averaged 251 mm fork length and weighed 185 grams. Males averaged 243 mm fork length and 166 grams (Table 5). The proportion of females to males caught during the 2002 river herring run was similar to 2001 results. The lengths and weights of females were slightly lower than 2001, while males tended to be slightly larger and weigh more than in 2001.

The majority of the 2002 river herring run sampled at the Brunswick fishway were four-year old fish (76%). The three and five-year old age classes were 15% and 9% respectively (Table 6). River herring returns to the Androscoggin River are expected to increase in 2003 as a portion of the production from Sabattus Pond return as four and five-year olds.

There are several factors that can influence the adult river herring capture rates at the fishway. A few include environmental conditions affecting the size of any given year class of returning adults, temperature, river flows, operational activities of the hydropower facility, effectiveness of the fishway, and the number of adults released to

reproduce in upstream spawning habitat four to five years earlier. Returning adult river herring to the Androscoggin River are predominantly four years old when they are captured.

American Shad:

American shad captured at the fishway are passed upstream into the headpond to continue their upstream migration. Fish lifts at the next two upstream dams provide passage that allows shad to potentially migrate to Auburn, although the effectiveness of these lifts has not been evaluated. Production potential of the habitat within the range is estimated to be 2.3 adult shad per 100 square yards of water surface area. The shad habitat area of 10,217,391 square yards in the Androscoggin could result in a return of 235,000 adult shad annually. The number of pre-spawn adult shad currently captured in the fishway trap at Brunswick is inadequate for a successful restoration program. To increase the abundance, survival, and natural reproduction of adults, Merrimack or Connecticut River pre-spawn shad are obtained through a cooperative agreement with the Connecticut River American Shad Technical Advisory Committee (CRSTAC). These fish are released into spawning and nursery areas in the Androscoggin River at Auburn.

MODIFICATIONS MADE TO THE LOWER FISHWAY TO IMPROVE UPSTREAM SHAD PASSAGE:

In 2001, a cooperative effort between FPLE, US Fish & Wildlife Service and MDMR was made to modify the lower fishway to improve upstream shad passage at the Brunswick fishway. After consultation with the US Fish & Wildlife Service and FPLE, fishway design modifications were implemented to improve water flow through the lower fishway and increase the slot width between the first six pools in hopes of enhancing upstream passage. In November 2001, the existing 12-inch stub walls were removed and replaced with a 5-foot weir constructed from 2-inch angle iron 6-feet high and attached to the existing fishway wall and remaining stub wall and 6 X 24-inch timbers (Figures 16 – 17). As a result of these modifications, the opening between the lower six pools increased to 24 inches from 11 inches and the flow was modified from the existing serpentine flow to an inline flow running adjacent to the inside of the fishway wall. The US Fish & Wildlife Service observed water flow on two occasions during the shad run. On both occasions, water flow appeared adequate and was in general thought to be an

improvement over the existing design. During both these visits, water levels were high and provided adequate water flow over the weirs to provide upstream passage. During the first week of June, shad were observed passing upstream and downstream over the newly constructed weirs. However, throughout the season (May – October) there were several occasions when passage was not available because of inadequate flows from the headpond through the fishway. As a result, the opportunity for upstream passage for all species, including shad, were reduced from 2001 levels. The main reasons for the inadequate flow over the weirs were: 1) inherent problems in all weir fishways relating to their inability to function when water levels fall beyond design tolerances; 2) difficulties in maintaining stable water levels in the fishway due to debris collecting on the headpond trash rack, which FPLE cleans, and the fishway trash rack, which is MDMR's responsibility to clean; and 3) extreme tidal changes that affect water levels in the lower six pools of the fishway.

Additional efforts need to be made to ensure that both trash racks are kept free or debris.

Observed Shad:

Visual observations of adult shad at the Brunswick fishway during the spawning run have been noted since 1990. Visual observations between 1994 and 2002 documented 1,724 adult shad swimming in the river outside the entrance and in the lower portion of the fishway below the 180-degree turn halfway up the ladder. The majority of these sightings have occurred since 1998 (Table 7). Since 1994, a total of 225 have been captured in the trap at the top of the fishway. In 1998, the highest numbers of both observed and captured shad recorded were 30 and five respectively, until 1999, when 543 were observed and 87 were captured. This information led to a more intensive effort in 1999 to document shad activity at the fishway by making visual observations from the fishway walk and using underwater video equipment.

Detailed visual observations from the fishway walk were continued during the 2002 sample season. Selected pools (pools 0-6, 14, 23, 31, river) were monitored for 30-second intervals to standardize observations between individual pools and the river. All observations were made between 11:00 AM and 12:00 PM. Visual observations from

the walkway were conducted on 63 consecutive days beginning June 1 and continuing through August 2. On May 31, one shad was observed in the diffusion chamber (Pool 0) in the lower fishway accompanied by large numbers of alewives. This sighting was prior to the start of the visual observation data collection that began the following day. In June, a total of 103 shad were observed primarily in the lower half of the fishway and the river. Only one shad was observed in the upper fishway and viewing window. The water temperature when the shad were observed averaged 21.8°C and river flow averaged 6,383 (cfs) (Figures 8-9). In July, a total of 404 were observed in and around the fishway, one in the corner pool, 67 in the lower fishway, and 336 in the river adjacent to the fishway. During August, a total of four shad were observed in the river outside the fishway. Shad outside the fishway entrance were usually swimming up- and downstream along the concrete wall in a school. In the corner pool, they were usually holding a single position in a school or circling, but not moving up- or downstream. Shad were rarely observed in the upper fishway. During the first week of June, shad were observed passing upstream and downstream over the newly constructed weirs in the lower section of the fishway. These observations were independent of the daily shad observations made throughout the shad run. Shad appeared to have no difficulty passing over these weirs, either upstream or downstream, at that time.

Captured Shad:

In 2002, the number of American shad captured at the Brunswick fishway declined from highs of 87 and 88 captured during 1999 and 2000, respectively. A total of 11 adults were captured between June 5 and July 18, 2002 (Table 8). In 2002, 11 adult shad trapped at the Brunswick fishway were released into the main stem river between Brunswick and Auburn. The decreased catch was disappointing based upon the number of pre-spawn adults stocked upstream in 1997-1998 and the lack of returning adults ascending the fishway from previous stocking efforts (Table 9). Returns ranging from 884 to 1,547 pre-spawn adults were expected during the 2002 spawning migration based on adult returns and recruitment from the Columbia and Connecticut Rivers. Data were collected on 10 of the 11 shad captured in 2002, including length and sex. Scales were also collected for age determination and fin clips were collected for genetic analysis when additional funding becomes available for this study.

During the 2002 run, the water temperature ranged between 17.4° and 25.7°C, averaging 20.4°C (Figure 6). The river flows ranged between 1,750 (cfs) and 29,700 (cfs), averaging 6,477 (cfs) (Figure 7). Of the 10 adults trapped and sampled, five were male (50%), two were female (20%), and three were undetermined sex (30%). The average fork length was 433 mm and average total length was 483 mm (Table 10).

The condition of the shad varied, but all had at least some scale loss on the sides of the body. In general, the condition of these shad was better than in previous years. Hemorrhaging around the mouth and head, common during the 1999-2001 seasons, were not observed in 2002. This may be a result of the modifications made to the lower fishway in the fall of 2001. The vertical slots in the lower six pools were increased in width from 11 inches to 24 inches (Figures 16-17).

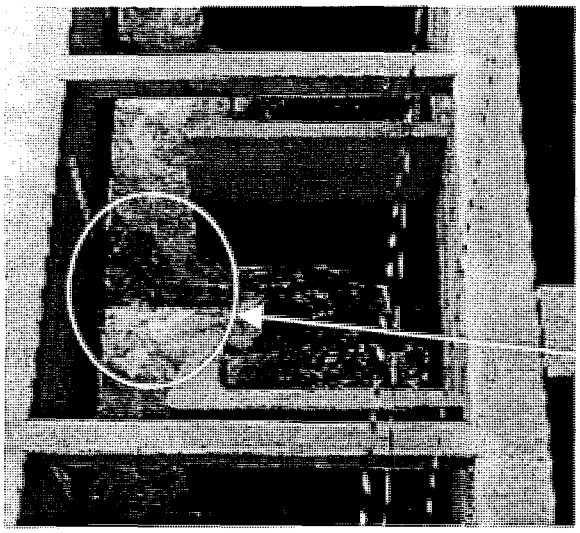

Figure 16. Modifications made by FPLE to increase the slot width and modify flow in the lower section (pools 1-6) of the Brunswick fishway to improve shad passage.

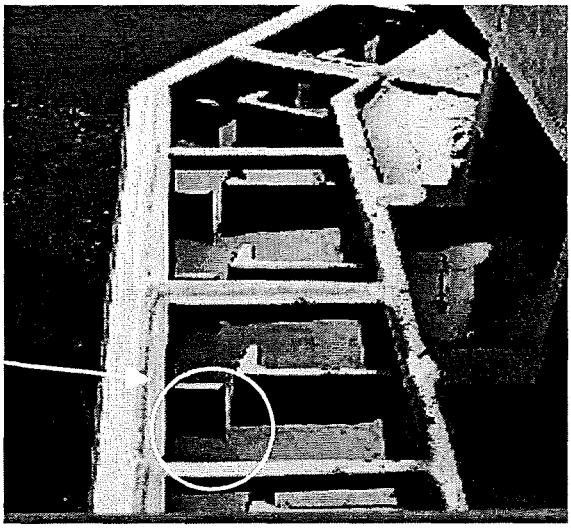

Figure 17. Existing fishway slot widths prior to modification by FPLE in November 2001.

In 2002, seventeen of the 130 (13.0%) juvenile shad caught in the fishway trap were kept for otolith analysis that would determine their origin (Table 11). Only one of the seventeen shad sampled was determined to be the result of hatchery production based

on otolith analysis. All hatchery fry were marked with oxytetracycline prior to release to create a fluorescing ring within the otolith when viewed under a mercury microscope.

Capturing juvenile shad at the fishway is difficult due to the 1.5-inch bar spacing in the grating that make up the trap. A large proportion of juvenile shad passing downstream pass undetected through the trap, downstream bypass, and the turbines.

The DMR considers collection of this data essential for the effective management of the species and participates as a member of the Atlantic States Marine Fisheries Commission, in which specific fishery independent monitoring programs for American shad are conducted.

Transported & Released Shad:

A statewide objective of the DMR is to restore self-sustaining populations of American shad to their historic range. A primary benefit of restoring shad to several rivers in Maine is that adult broodstock are available from several nearby Gulf of Maine sources and can be utilized for restoration purposes in other Maine rivers.

In 1999, the first American shad fry were released into the Androscoggin River. These were reared at the Waldoboro Hatchery and released on June 30 into the main stem at the Auburn boat launch. A portion of the 1999 fry stocking is expected to return as four-year olds to the Brunswick fishway in 2003. DMR continued to stock shad fry in the Androscoggin River during 2002 (Table 12).

Prespawn adult American shad were also transported from the Merrimack River and released into the Androscoggin River at Durham. A total of 259 shad were transported and released alive into the river. Eight shad were transport mortalities and discarded. The adult prespawn release program was resumed in 2002 after two years of difficulty in obtaining prespawn shad from southern New England rivers. Prior to 2000, prespawn shad were stocked in 1999 and 1985-1997 (Table 9).

Table 12. American shad fry released into the main stem Androscoggin River at Auburn, 1999- 2002

Date	Source	No. Released	Age	% Mortality	Loading Site Tem(C)	Receiving Site Temp. (C)	Marking Method
7/17/02	Merrimack	295,725	10-17 days	~1%	18.0	23.2	Tetra-cycline*
7/2/01	Merrimack	308,600	23-26 days	~1%	18.0	23.4	Tetra-cycline*
7/10/00	CT x Kennebec	529,000	7-10 days	~5%	18.7	25.0	Tetra-cycline*
6/30/99	CT x CT and CT x Saco	280,000	10-17 days	~2.4%	17.3	24.7	Tetra-cycline*

* Fry were exposed to a four-hour Tetracycline bath at the Waldoboro Hatchery

2001 – 2002 American Shad Study:

In 2002, six underwater video cameras were installed to observe American shad behavior, movement and numbers in the fishway. One camera was placed in the river to record shad behavior outside the fishway. The remaining five cameras were placed in the fishway entrance, Pool 1, Pool 6, Pool 23 entrance and Pool 23 exit. A time-lapse video recorder began recording at 6AM and stopped recording at 6PM each day, beginning June 1 and ending July 31. In 2002, approximately 4,392 hours of video were recorded using the six cameras. Project personnel have not reviewed videotape collected in the fishway and the river adjacent to the fishway. Videotape review will be conducted throughout 2003.

Results of the 2001 video data collected at the Brunswick fishway during the 2001 season.

American shad behavior recorded on the videotape was classified into three categories: shad movement upstream (US), downstream (DS), or other behavior (OB), which included circling and holding. A total of 126,033 behavioral observations were recorded during the 2001 spawning season, while 52,836 behavioral observations were recorded

at similar locations in 2000 over the same general time period. During 2001, the total number of observations recorded on the river camera (Camera 1) was 86,282. The camera in Pool 6, (Camera 4) and Pool 24 (Camera 6) recorded 8,325 and 237 respectively (Table 13). Several large schools of American shad were documented within 75 feet of the fishway entrance. Schools of over 100 shad were observed occasionally, while schools of 75 were common and easily recorded with the river camera. The large numbers of American shad documented recently at the Brunswick fishway are likely the result of extensive stocking of pre-spawn adult shad below Lewiston Falls and natural reproduction in the river below the Brunswick fishway. The American shad-stocking program began on the Androscoggin River in 1984 and continued in 2002. To date, a total of 6,355 adults and 1,413,225 fry have been released below Lewiston Falls at Auburn or Durham, above the Brunswick Hydropower facility. Prior to DMR's stocking program, American shad had not been documented using areas in or around the fishway from 1983 through 1990, and only ten adults were documented at this location through 1997. Historically, large numbers spawned in the Androscoggin River above Brunswick. Pollution and barriers preventing upstream passage on the Androscoggin reduced numbers of spawning fish to a fraction of historical levels. To date, there has been no recent evidence of American shad spawning naturally in the Androscoggin River below Brunswick although spawning is suspected to occur in the Androscoggin among individuals that were not able to ascend the fishway over the past four years.

In 2001, the predominant behavior recorded by Camera 1 (river camera) was for American shad in the river to move upstream towards the fishway entrance, 67% in June (Table 14). Unlike 1999 and 2000, a large percentage of the shad observed in the river in July (84%) were observed moving downstream, away from the fishway entrance. During this period, the large turbine located adjacent to the fishway entrance was shut down due to low river flows. This turbine supplies additional attraction flow at the fishway entrance and helps attract shad upstream to the fishway entrance. It is suspected that because this turbine was seldom operated in July shad may have had a difficult time locating the fishway entrance. Only 10% percent of the total number of observations recorded on the river camera was recorded in Pool 6, the last pool of the

fishway at river level. The number of shad attempts to move upstream (US) through Pool 24, the first pool above the corner pool, was 167, or 0.3%, of the total number of upstream observations recorded on the river camera. Shad attempted to climb the upper portion of the fishway 167 times, a decrease compared to 2000 numbers. Observations indicate 47 of those attempts resulted in shad moving downstream, leaving a net total of 120 attempts by shad to move upstream. A total of 11 American shad were captured at the top of the fishway during 2002.

Table 13. American shad behavior recorded by cameras 1-6 and classified by behavior displayed at the Brunswick fishway during 2001

Jun-01	Total No.	US	DS	OB
River Camera	78,977	53,110	25,791	77
Fishway Entrance	18,275	14,249	3,626	400
Pool # 1	10,899	6,380	1,825	2,694
Pool # 6	8,038	3,516	939	3,583
Pool # 23 Entrance	613	436	67	110
Pool # 23 Exit	157	117	30	10
Grand Total	**116,959**	**77,808**	**32,278**	**6,874**

Jul-01	Total No.	US	DS	OB
River Camera	7,305	1,146	6,072	87
Fishway Entrance	499	426	63	10
Pool # 1	400	276	77	47
Pool # 6	287	140	87	60
Pool # 23 Entrance	503	380	30	93
Pool # 23 Exit	80	50	17	13
Grand Total	**9,074**	**2,418**	**6,346**	**310**

Table 14. American shad behavior recorded by cameras 1-6, classified by percent behavior per camera, displayed at the Brunswick fishway during 2001

June-01	Total No.	US	DS	OB	%
River Camera	78,977	67.2%	32.7%	0.1%	100%
Fishway Entrance	18,275	78.0%	19.8%	2.2%	100%
Pool # 1	10,899	58.5%	16.7%	24.7%	100%
Pool # 6	8,038	43.7%	11.7%	44.6%	100%
Pool # 23 Entrance	613	71.1%	10.9%	17.9%	100%
Pool # 23 Exit	157	74.5%	19.1%	6.4%	100%

Grand Total	116,959

July-01	Total No.	US	DS	OB	%
River Camera	7,305	15.7%	83.1%	1.2%	100%
Fishway Entrance	499	85.4%	12.6%	2.0%	100%
Pool # 1	400	69.2%	19.2%	11.7%	100%
Pool # 6	287	48.8%	30.3%	20.9%	100%
Pool # 23 Entrance	503	75.5%	6.0%	18.5%	100%
Pool # 23 Exit	80	62.5%	21.3%	16.3%	100%

Grand Total	9,074

Circling and holding behavior were most commonly exhibited in Pool 6 (Camera 4) and accounted for 52% of this type of behavior recorded by all cameras in June and 19% in July. Only 1% of the behavior exhibited on Camera 1 (river camera) was classified as circling or holding. The effects of this behavior are well documented by Camera 6 (Pool 23 exit), which recorded a net of only 167 attempts by shad to move beyond the mid-point of the 40-foot vertical climb to the top of the fishway. The data clearly indicates that shad have returned to their natal river to spawn, but are unable to negotiate the fishway to access the spawning habitat above Brunswick into which pre-spawn and fry stockings have occurred. In fact, few shad moved beyond the halfway point in the 40-foot vertical climb to the fish trap.

Clearly, as with any study, visual observations of shad made from the fishway wall and through the use of video equipment have certain limitations that are considered when analyzing the data, such as the potential for overestimating (same fish counted more than once) or underestimating (limited visibility when looking down into the fishway/water) the number of fish actually present. The purpose of collecting this preliminary data was to first determine if there is a need to conduct more quantifiable studies that would require substantially more funds, staff, and equipment. Preliminary data clearly indicates the need for a quantitative study to focus on the numbers of fish in the river and the effectiveness of the Brunswick fishway in relation to American shad passage on the Androscoggin River.

Summary:

Based on three years of videotape data collected at the Brunswick fishway, it is clear that American shad are not utilizing the fishway to reach spawning habitat above Brunswick. Data recorded in 2001 indicates a very small percent (27.0%) of shad observed moving upstream within a 75-foot radius of the entrance are observed moving upstream at Pool 1. An even lower percentage (0.3%) was viewed exhibiting upstream behavior into Pool 24. The numbers of shad retained in the trap at the top of the fishway during the past three years verify that very few of the shad documented at the fishway entrance are successfully ascending the upper half of the fishway and making it into the fish trap. The majority of the behavior recorded by Camera 4 suggests fish are resting and holding in the lower section of the fishway.

Radio Tagging Study:

Beginning in 2002, a radio telemetry study was instituted to determine the effectiveness of the modifications made to the lowest six pools of the Brunswick fishway. The study was conducted in cooperation with the U.S. Fish & Wildlife Service and FLPE. The U.S. Fish and Wildlife Service purchased the ten Lotek internal radio tags that were used during this study. FPLE contributed four Lotek radio receivers and provided technical assistance in setting up the receiving stations by hiring Doug Royer of Normandeau Associates. DMR captured and tagged the shad used in the study and monitored the results on a daily basis.

The shad used for the telemetry study were captured in the tailrace of the Brunswick Hydropower Station. Shad were angled using a variety of shad darts and a dip net for landing the fish. Shad were removed from the line and tagged with an internal radio tag with a 67-day battery life. Tags were inserted into the shad's stomach using a plastic tube. The shad were then released into the tailrace of the hydropower station.

Receiver antennas were placed in the river adjacent to the fishway, at the fishway entrance, Pool 0, Pool 6, Pool 23 and at the entrance to the fish trap located at the top of the fishway. Four Lotek radio receivers, housed in the fishway control room, were used to record and store tag information. These receivers operated 24 hours per day throughout the study.

Radio telemetry equipment used during the 2002 American shad study was set up and tested on June 5, 2002. Doug Royer of Normandeau associates was hired by FPLE to set up and test the equipment prior to the study. The gain settings on the radio receivers were set low to avoid more than one receiver logging tag data from the same tag during the same time period. Also, by adjusting the receiver gains, we were able to define the coverage area relatively easily. Coverage outside the fishway was limited to an area 15' from the location of the river camera location and coverage at the fishway entrance was restricted to 15' in front of the fishway entrance. Antennas located in the fishway pools 0, 3, 6 and 23 were calibrated to pick up radio signals only in their respective pools.

Beginning June 5, the first two American shad were captured, tagged and released. Over the following two days, eight additional shad were tagged and released. A total of five males and five females were tagged over the three-day period. Immediately after a shad was tagged and released, tag data transmitted from the tag was received and recorded by the nearest radio receiver. Tagging was conducted in the area immediately adjacent to the antenna located in the river. Each tag was coded so that individual fish could be tracked and differentiated from other tagged shad. Shortly after each shad was tagged, the shad dropped out of the hydropower tailrace.

Over the next few days of the study, audible radio signals were heard on the radio receivers. Signal strength was not strong enough to be recorded on the receivers and we concluded that these fish had not migrated up into the study area; instead, these fish were holding downstream within a quarter mile of the hydropower station. At this point in the study, we believed that these fish were exhibiting drop-back behavior that is common in radio tag studies that investigate American shad behavior. Over the next few weeks of the study, heavy rain and high river flows were recorded on the Androscoggin River. The fishway was shut down for four days as the river flow increased to 29,500 cfs. Normal river flows during the shad run are expected to range from 1,500 – 6,000 cfs.

After the initial three days of tagging, radio signals for the tags were never picked up or recorded in the study area. On June 14, a mobile receiver was used to listen for signals at five locations down river. The river was divided into five one-mile sections and sampled once a week for three weeks. On two occasions, July 3 and July 16, a MDMR boat was used to try to locate tagged shad. On July 3, one tag was located 1.5 miles below the study area. The location of the tag was stationary and was believed to no longer be associated with a live shad. We believe that either the tag was regurgitated or the shad died. On July 16, the entire Merrymeeting Bay complex was surveyed using a mobile receiver. The Androscoggin, Cathance, Muddy, Kennebec and Eastern Rivers were searched without success.

High river flows and the stress of tagging likely caused the shad to drop back down the river system. This type of response is commonly observed in shad tagging studies and was not unexpected while planning this study. It is unknown why none of these fish returned to the study area. It is unlikely that mortality, as a result of tagging, was a major factor in this study. This tagging study used techniques employed routinely by researchers tracking shad movements/behavior in the Northeast. Nonetheless, it was discouraging to put so much time and effort into a study and receive so little information.

In addition to the ten radio tagged shad, 24 adult shad were tagged with a florescent orange spaghetti tag that contained a unique number and the Maine Department of

Marine Resources contact information. We are hopeful that these fish will return to the fishway in 2003 and be observed by fishway personnel.

Work Planned for 2003:

During the 2003 American shad run, six underwater cameras will be deployed in the fishway to record shad behaviors around the modifications made to the fishway in November 2001 by FPLE. If these modifications prove successful, then the same modifications will be made to additional pools. The USFWS may provide funds to purchase radio tags that will be used to track American shad in the tailrace and within the fishway as shad attempt to ascend into the Brunswick headpond. FPLE has agreed to contribute spare radio receivers to record the movements of radio tagged shad. In addition to radio tagging, visual tags will be applied to a number of shad caught in the tailrace of the fishway.

Atlantic Salmon:

An active Atlantic salmon restoration program is not in place for the Androscoggin River, other than providing upstream passage past the first three dams on the river. However, an average of 32 sea-run salmon are captured annually at Brunswick, although Atlantic salmon returns have been below six salmon annually since 1996 (Table 15). During the 2002 sample season, a total of two Atlantic salmon were passed into the Brunswick headpond. The mean fork length of adult salmon captured was 809 mm. There were no visible fin clips or other identifying characteristics observed on either of these fish (Table 16). The Maine Atlantic Salmon Commission determined that these salmon were the result of natural reproduction or fry stocking conducted in the Little River, a tributary to the Androscoggin or another river. The condition of the fins indicated that these fish were not raised in a hatchery and were not stocked as smolt. An analysis to determine the age and whether these salmon are sea-run or landlocked fish will be conducted by the Maine Atlantic Salmon Commission.

In June 1999, the Maine Atlantic Salmon Technical Advisory Committee (MSTAC) agreed to include the Androscoggin River in an ongoing genetic sampling program. Fin clips were collected from all salmon captured at the fishway during 2000-2002. Genetic

analysis may be conducted in the future to determine the origin of the salmon captured at Brunswick to provide more effective management in the watershed. Through participation in the MSTAC, it was discovered that 15 schools in the Androscoggin River watershed participated in the 2002 Fish Friends, Salmon-in-Schools and Adopt-a-Salmon Family Programs. In these programs, the U.S. Fish & Wildlife Service provides salmon eggs to schools in the spring for students to rear and release as fry into salmon nursery habitat identified in their watershed. In 2002, the fry from these programs were released into the Little River, a tributary that enters the Androscoggin between the second and third upstream dams. Atlantic salmon fry releases occurred in the same locations during the spring of 2000 and 2001.

Sea Lamprey:

Three sea lamprey were captured at the fishway in 2002. Several more sea lamprey were observed attached to the sides of the fishway throughout the months of June and July. Sea lamprey are released downstream and not allowed to pass above Brunswick.

American Eel:

Two American eels were captured in the fishway trap during July. However, they are rarely captured in the trap since upstream migrating juveniles may be small enough to pass through the trap grating. American eel released above the Brunswick dam may use the fish passage facilities located at the next two dams to reach and utilize upstream habitat. Upstream migrating juvenile eels utilize these habitat areas for an average of 20 years to grow to adulthood before emigrating to reproduce in the Sargasso Sea.

Striped Bass:

In 2002, eight striped bass were captured at the Brunswick fishway. None were captured or observed in the observation window/trapping area during the 2001 season.

Other Species:

From May 6 through October 28, 2002, fifteen fish species and 108,123 individual fish were captured or passed at the Brunswick fishway, including American shad and river

herring (Table 17). The most common species captured in May, other than river herring, was white sucker. In June, the most common species was smallmouth bass. Juvenile American shad adult smallmouth bass were the dominant fish species using the fishway from July - October

At the Brunswick fishway, three white catfish were captured in July. All white catfish were sampled and tagged with a spaghetti tag prior to release downstream; total length was recorded and the tag was applied posterior to the dorsal fin. Recapturing tagged fish will provide important information on growth and migration within the Androscoggin River/Merrymeeting Bay estuary. White catfish are a non-indigenous species unintentionally introduced into Maine waters and are not passed upstream. They were first discovered in the Eastern River, a tributary of the Kennebec, in 1997, and appear to be rapidly expanding their range. The exact rate and location of expansion and the potential effects on native fish communities are undetermined. A full summary of fish community data by month through October of the 2002 sample season is provided in Table 18.

Environmental Data:

Brunswick fishway air temperature, water temperature, and water flow data recorded from May through October 2002 are shown in Tables 19-24 and Figures 10-15.

Table 1. Adult river herring captured, water temperature and river flow at the Brunswick fishway, 2002

Date	Number	Temp. (C)	Water Flow (cfs)	% Total Run
10-May	68	12.0	7,420	0.03
13-May	279	12.0	7,080	0.27
16-May	18	11.0	16,900	0.02
19-May	14	9.7	13,600	0.01
29-May	28	15.0	4,530	0.03
30-May	516	16.0	4,430	0.49
31-May	8,483	17.5	5,590	8.12
1-Jun	58,305	17.5	5,659	55.80
2-Jun	26,245	17.8	6,060	25.12
3-Jun	8,700	17.9	6,870	8.33
4-Jun	1,447	18.1	7,180	1.38
5-Jun	395	18.3	7,190	0.38
9-Jun	6	16.9	8,460	0.01
11-Jun	12	17.7	6,160	0.01
13-Jun	4	15.7	29,700	0.00
02 Total/Ave.	**104,520**	**15.5**	**9,122**	**100.00**

Note: Flow Data from USGS Station 01059000 at Auburn, ME

Table 2. Adult river herring distribution in the Androscoggin Watershed by site, 2000-2002

Source: Androscoggin / Kennebec

Habitat	2000	2001	2002
Sabattus Pond	5,839 / 4,944	1,575 / 9,176	0 / 10,695
Little Sabattus Pond	-	344 / 0	-
Taylor Pond	0 / 3,801	0 / 4,099	1,477 / 3,018
Taylor Brook	-	126 / 0	0 / 200
Tripp Pond	-	-	-
Lower Range Pond	0 / 1,748	1,274 / 615	0 / 3,104
Androscoggin River	3,463 / 0	13,375 / 0	100,361
Sabattus River	0 / 2,050	0 / 3,587	0 / 2,000
Marshall Pond	0 / 612	612 / 0	0 / 1,881
Bog Brook	0 / 690	671 / 0	0 / 399
Durham Boat Ramp	-	13 / 0	-
Loon Pond/Curtis Stream	0 / 415	0 / 609	-
Sutherland Pond/Curtis Stream	0 / 315	0 / 758	516 / 0
TOTAL	**9,302 / 14,575 = 23,877**	**17,990 / 18,844 = 36,834**	**102,354 / 21,297 = 123,651**
Brunswick Headpond (passed upstream)	3,463 / 0	13,375 / 0	100,361 / 0
TOTAL PASSED OR STOCKED IN WATERSHED	**9,302 /14,575 = 23,877**	**17,990 / 18,844 = 36,834**	**102,354 / 21,297 = 123,651**

Table 3. Adult river herring habitat availability, number captured and number stocked in lakes and ponds within the Androscoggin River watershed, 1985-2002

Year	Habitat* (hectares)	Number Trapped At Fishway	Total Number Stocked (Androscoggin and Kennebec)	Ave. Fish/ Hectare
1982	723	0	2,326	1.3
1983	1,328	601	6,305	4.2
1984	1,328	2,650	8,359	2.6
1985	3,377	23,895	37,773	11.2
1986	2,678	35,471	17,763	6.6
1987	770	63,523	11,892	15.4
1988	887	74,341	13,183	14.9
1989	887	100,895	13,814	15.6
1990	887	95,574	11,725	13.2
1991	887	77,511	13,574	15.3
1992	887	45,050	12,351	13.9
1993	722	5,202	7,448	10.3
1994	887	19,190	14,549	16.4
1995	852	32,002	10,591	12.4
1996	747	10,198	14,288	19.1
1997	612	5,540	11,524	18.8
1998	1,299	25,189	20,805	16
1999	1,318	8,909	8,671	6.6
2000	1,318	9,551	20,414	15.5
2001	1,846	18,196	23,459	12.7
2002	1,846	104,520	23,290	12.6

* Habitat area does not include the Brunswick headpond.

Table 4. Adult river herring stocking densities, 2000-2002

Habitat	Hectares	2000 Densities (fish/hectares)	2001 Densities (fish/hectares)	2002 Densities (fish/hectares)
Sabattus Pond	723	14.9	14.9	14.8
Little Sabattus Pond	10	-	34.4	-
Taylor Pond	253	15.0	16.2	17.6
Taylor Brook	5	-	25.2	40
Tripp Pond	311	-	-	-
Lower Range Pond	117	14.9	16.1	26.5
Androscoggin River	-	-	-	
Sabattus River	111	18.5	32.3	18.0
Marshall Pond	41	14.9	14.9	45.9
Bog Brook	24	28.8	28.0	16.6
Durham Boat Ramp	202	-	0.1	-
Loon Pond	28	14.8	21.8	-
Sutherland Pond	21	15.0	36.1	24.6
Average		**15.3**	**21.8**	**25.5**
TOTAL	**1,846**			

Table 5. Adult river herring sampled at the Brunswick fishway during 2001 - 2002

Adult river herring sampled at Brunswick fishway, 2002.

Date	Sex	Number	Mean Fork Length (mm)	Mean Weight (g)
5/16/02	Female (41%)	21	258	220
	Male (59%)	30	248	185
6/2/02	Female (46%)	23	250	184
	Male (54%)	27	243	167
6/5/02	Female (43%)	21	242	169
	Male (57%)	28	240	163
6/11/02	Female (33%)	4	250	168
	Male (67%)	8	239	153
6/13/02	Female (50%)	2	253	-
	Male (50%)	2	245	-

Totals	Number	Mean Fork Length (mm)	Mean Weight (g)
Female	71	251	185
Male	95	243	166

Adult river herring sampled at Brunswick fishway, 2001

Date	Sex	Number	Mean Fork Length (mm)	Mean Weight (gm)
5/12/01	Female (32%)	8	256	213
	Male (68%)	17	241	171
5/18/01	Female (44%)	11	258	208
	Male (56%)	14	243	163
5/23/01	Female (44%)	11	253	196
	Male (56%)	14	239	164
5/30/01	Female (37%)	7	255	185
	Male (63%)	12	242	153

Totals	Number	Mean Fork Length (mm)	Mean Weight (g)
Female	37	276	201
Male	57	241	164

Table 6. Ages of alewives captured at the Brunswick fishway in 2002

	Number	Ave. TL (mm)	Ave. FL (mm)	Ave. Wt (g)	%M	%F	%U	% of Sample
Age 3 Alewives	25	286	254	158.5	64	36	0	15.0%
Age 4 Alewives	126	286	242	180.6	57	43	0	76.0%
Age 5 Alewives	15	293	258	212.3	53	47	0	9.0%

Table 7. American shad observations at the Brunswick fishway May 1 – August 31, 1997-2002

Year / Month	Viewing Window	Upper Fishway	Lower Fishway	Corner Pool	Outside Fishway	Total #	Mean Water Temp. (C)[1]
2002 May	0	0	0	0	0	0	-
June	1	0	31	3	68	103	17.4
July	0	0	67	1	336	404	23.6
August	0	0	0	0	4	4	24.3
2001 May	0	0	0	0	0	0	-
June	3	0	58	0	176	240	20.2
July	0	0	0	0	0	0	-
August	0	0	0	0	0	0	-
2000 May	0	0	0	0	0	0	-
June	21	17	169	106	22	335	18.7
July	3	4	6	4	0	17	22.5
August	0	0	0	0	0	0	-
1999 May	16	0	5	15	5	47	19.4
June	38	0	73	218	150	487	22.9
July	0	0	0	0	0	0	-
August	0	0	0	0	0	0	-
1998 May	0	0	0	0	0	0	-
June	1	0	6	0	0	9	17.8
July	0	0	0	0	20	21	23.8
August	0	0	0	0	0	0	-
1997 May	0	0	0	0	0	0	-
June	0	0	0	3	36	39	17.9
July	0	0	0	0	0	0	-
August	0	0	0	0	0	0	-

*Numbers for the 2000 and 2001 season are visual observations from the fishway platform and do not include numbers of shad observed using underwater video equipment placed in the fishway or river.

[1] Mean water temperature at the time of shad observations.

Table 8. American shad captured at the Brunswick fishway, 2000-2002

Date	No.	Water Temp. (C)	Flow (cfs)
6/5/02	6	18.4	7,190
6/7/02	1	17.3	8,740
7/18/02	4	23.1	3,220
Total #	**11**		
Av.		**19.6**	**6,383**
Min / Max	**1 / 6**	**17.3 / 23.1**	**3,220 / 8,740**
5/25/01	1	16.9	4,750
5/29/01	9	16.5	4,580
6/3/01	2	15.2	7,530
6/8/01	1	16.4	6,860
6/13/01	1	19.1	3,350
6/14/01	2	20.2	4,100
6/15/01	6	22.2	4,110
6/18/01	1	22.8	3,140
6/22/01	1	22.2	3,469
7/18/01	1	22.4	3,910
7/19/01	1	22.3	2,940
Total #	**26**		
Av.		**19.6**	**4,431**
Min / Max	**1 / 9**	**15.2 / 22.4**	**2,940 / 7,530**
6/3/00	1	17.0	4,890
6/5/00	4	16.9	4,490
6/9/00	3	17.9	4,490
6/12/00	4	16.0	4,470
6/14/00	1	16.8	5,870
6/19/00	60	19.0	3,600
6/20/00	9	18.9	3,260
6/21/00	2	19.0	4,040
6/22/00	2	19.5	2,680
7/1/00	1	23.0	1,910
7/3/00	1	22.0	3,430
Total #	**88**		
Av.		**18.7**	**3,921**
Min / Max	**1 / 60**	**16.0 / 23.0**	**1,910 / 5,870**

Table 9. Adult American shad distribution in main stem Androscoggin River at Auburn, 1985-2002.

Year	Number distributed		Source		Mortality during transport
		Androscoggin	Connecticut	Merrimack	
2002	278	11	-	267	2.8%
2001	26	26			25.0%
2000	88	88	-	-	N/A
1999	357	87	270	-	11.0%
1998	5	5	-	-	N/A
1997	221	2	219	-	13.0%
1996	312	2	310	-	37.8%
1995	1,090	3	1,087	-	9.8%
1994	707	1	706	-	38.0%
1993	580	1	579	-	20.0%
1992	566	-	566	-	15.0%
1991	357	-	357	-	31.0%
1990	354	1	353	-	21.0%
1989	414	-	414	-	25.5%
1988	513	-	513	-	1.2%
1987	92	-	-	92	11.0%
1986	224	-	-	224	17.0%
1985	115	-	-	115	35.8%
TOTAL	**6,299**	**227**	**5,374**	**698**	**Ave = 19.7%**

Table 10. Ages of adult American shad sampled at the Brunswick fishway, 2001- 2002

2002 sample season

	Number	Ave. TL (mm)	Ave. FL (mm)	%M	%F	%U	% of Sample
Age 3 Shad	*	*	*	*	*	*	*
Age 4 Shad	3	433	387	66	*	33	30.0%
Age 5 Shad	4	494	446	50	25	25	40.0%
Age 6 Shad	2	515	459	50	0	25	20.0%
Age 7 Shad	*	*	*	*	*	*	*
Age 8 Shad	*	*	*	*	*	*	*
Age 9 Shad	1	527	470	0	100	0	10.0%
Age 10 Shad	*	*	*	*	*	*	*
Undet. Age	*	*	*	*	*	*	*

2001 sample season

	Number	Ave. TL (mm)	Ave. FL (mm)	%M	%F	%U	% of Sample
Age 3 Shad	*	*	*	*	*	*	*
Age 4 Shad	*	*	*	*	*	*	*
Age 5 Shad	6	482	437	17	33	50	37.5
Age 6 Shad	8	497	448	50	25	25	50.0
Age 7 Shad	2	501	454	0	100	0	12.5
Undet. Age	*	*	*	*	*	*	*

Table 11. Juvenile American shad sampled at Brunswick fishway, 2002

Date	Total Length (mm)	Fork Length (mm)	Weight (g)	Water Temp (c)	River Flow (cfs)
5-Sep	85	75	-	21.2	1,590
5-Sep	88	78	-	21.2	1,590
6-Sep	88	79	-	20.4	1,580
6-Sep	86	76	-	20.4	1,580
11-Sep	101	90	7.8	22.6	1,560
11-Sep	88	79	5.3	22.6	1,560
11-Sep	86	74	4.3	22.6	1,560
18-Sep	106	93	8.8	19.5	2,310
18-Sep	100	89	7.6	19.5	2,310
18-Sep	104	92	7.7	19.5	2,310
18-Sep	97	86	7	19.5	2,310
20-Sep	109	95	9.1	19.6	1,830
20-Sep	105	92	8.6	19.6	1,830
20-Sep	91	81	5.3	19.6	1,830
Average	95.3	84.2	7.2	20.6	1,839.3
1-Oct	130	115	17.1	17.8	2,660
2-Oct	90	80	5	18.6	1,910
8-Oct	125	110	13.4	16.3	1,860
Average	115.0	101.7	11.8	17.6	2,143.3

Table 12. American shad fry released into the main stem Androscoggin River at Auburn, 1999-2002

Date	Source	No. Released	Age	% Mortality	Loading Site Tem(C)	Receiving Site Temp. (C)	Marking Method
7/17/02	Merrimack	295,725	10-17 days old	~1%	18.0	23.2	Tetra-cycline**
7/2/01	Merrimack	308,600	23-26 days old	~1%	18.0	23.4	Tetra-cycline*
7/10/00	CT x Kennebec	529,000	7-10 days old	~5%	18.7	25.0	Tetra-cycline*
6/30/99	CT x CT and CT x Saco	280,000	10-17 days old	~2.4%	17.3	24.7	Tetra-cycline*

* Fry were exposed to a four-hour Tetracycline bath at the Waldoboro hatchery.

Table 13. American shad behavior recorded by cameras 1-6 and classified by behavior displayed at the Brunswick fishway during 2001

Jun-01	Total No.	US	DS	OB
River Camera	78,977	53,110	25,791	77
Fishway Entrance	18,275	14,249	3,626	400
Pool # 1	10,899	6,380	1,825	2,694
Pool # 6	8,038	3,516	939	3,583
Pool # 23 Entrance	613	436	67	110
Pool # 23 Exit	157	117	30	10
Grand Total	**116,959**	**77,808**	**32,278**	**6,874**

Jul-01	Total No.	US	DS	OB
River Camera	7,305	1146	6,072	87
Fishway Entrance	499	426	63	10
Pool # 1	400	276	77	47
Pool # 6	287	140	87	60
Pool # 23 Entrance	503	380	30	93
Pool # 23 Exit	80	50	17	13
Grand Total	**9,074**	**2,418**	**6,346**	**310**

Table 14. American shad behavior recorded by cameras 1-6, classified by percent behavior per camera, displayed at the Brunswick fishway during 2001

June-01	Total No.	US	DS	OB	%
River Camera	78,977	67.2%	32.7%	0.1%	100%
Fishway Entrance	18,275	78.0%	19.8%	2.2%	100%
Pool # 1	10,899	58.5%	16.7%	24.7%	100%
Pool # 6	8,038	43.7%	11.7%	44.6%	100%
Pool # 23 Entrance	613	71.1%	10.9%	17.9%	100%
Pool # 23 Exit	157	74.5%	19.1%	6.4%	100%
Grand Total	**116,959**				

July-01	Total No.	US	DS	OB	%
River Camera	7,305	15.7%	83.1%	1.2%	100%
Fishway Entrance	499	85.4%	12.6%	2.0%	100%
Pool # 1	400	69.2%	19.2%	11.7%	100%
Pool # 6	287	48.8%	30.3%	20.9%	100%
Pool # 23 Entrance	503	75.5%	6.0%	18.5%	100%
Pool # 23 Exit	80	62.5%	21.3%	16.3%	100%
Grand Total	**9,074**				

Table 15. Number, origin and lengths of sea-run Atlantic Salmon caught on the Androscoggin River at the Brunswick fishway, 1983-2002

	Sea-Run Hatchery				Sea-Run Wild				Av. Length (mm)	Total
Age	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat		
Year										
1983	1	16	0	0	0	3	0	1	*	21
1984	4	79	1	0	0	7	0	0	*	91
1985	1	18	0	0	0	2	0	0	*	21
1986	0	72	1	0	0	8	0	0	*	81
1987	2	20	3	0	0	1	0	0	729	26
1988	2	11	0	0	1	0	0	0	723 (TL)	14
1989	1	17	0	0	0	1	0	0	712 (TL)	19
1990	6	168	0	1	1	9	0	0	706	185
1991	0	9	0	0	0	12	0	0	759 (TL)	21
1992	2	9	0	0	1	3	0	0	658	15
1993	1	33	0	0	1	9	0	0	727	44
1994	2	16	0	1	0	6	0	0	707	25
1995	2	12	0	0	0	2	0	0	710	16
1996	2	19	1	0	1	16	0	0	708	39
1997	0	0	0	0	0	1	0	0	*	1
1998	0	4	0	0	0	0	0	0	737	4
1999	1	1	0	0	0	1	2	0	700	5
2000	1	3	0	0	0	0	0	0	769	4
2001	1	4	0	0	0	0	0	0	718	5
2002									809	2
Total	**29**	**511**	**6**	**2**	**5**	**81**	**2**	**1**		**639**

Data source: U.S. Atlantic Salmon Assessment Committee Annual Report 1998/10

SW - # Sea Winters/number of years at sea length
Repeat - repeat spawner
- 2001 data collected from May – June 2001.

TL - total length measured; all others are fork

* - Data unavailable

Note: 1998 average fork length differs from Table 10 because total length data were used where fork length data were not available.

Table 16. Atlantic salmon passed upstream on the Androscoggin River at the Brunswick fishway, May – October 2002

Date	Fork Length (mm)	Total Length (mm)	Clips/Marks	Water Temp. (C)
6/3/02	790	826	None	15.1
10/28/02	828	864	None	8.4
Total	**2**			
Average	**809**	**845**		
Min. T° (C)				**8.4**
Max. T° (C)				**15.1**

Atlantic salmon passed on the Androscoggin River at the Brunswick fishway, May – June 2001

Date	Fork Length (mm)	Total Length (mm)	Clips/Marks	Water Temp. (C)
6/8/2001	804	833	None	16.4
6/13/2001	723	-	None	19.2
6/20/2001	724	731	Dorsal punch	21.9
6/20/2001	744	756	None	22.3
7/10/01	594	603	Elastimer tag	22.7
Total	**5**			
Average	**718**	**731**		**20.5**
Min. T° (C)				**16.4**
Max. T° (C)				**22.7**

Table 17. Numbers of fish captured by month at the Brunswick fishway during the 2002 sample season

	May	June	July	August	September	October	Species Total
American Eel (*Anguilla rostrata*)			2				2
American Shad (*Alosa sapidissima*)		7	4		81	49	141
Atlantic Salmon (*Salmo salar*)		1				1	2
Brown Trout (*Salvelinus trutta*)		1	1				2
Largemouth Bass (*Micropterus salmoides*)			1				1
Pumpkinseed Sunfish (*Lepomis gibbosus*)			11	1	2		14
River Herring (*Alosa aestivalis*)(*Alosa pseudoharengus*)	9,471	95,115	1,402	1,061	14	679	107,742
Smallmouth Bass (*Micropterus dolomieu*)	12	13	20	8	10	1	64
Spottail Shiner (*Notropis hudsonius*)	2	1	11				14
Striped Bass (*Morone saxatilis*)		1	4	3			8
White Catfish (*Ictalurus catus*)			2				2
White Perch (*Morone americana*)			1				1
White Sucker (*Catostomus commersoni*)	113	1					114
Unidentified Fry			16				16
Monthly Totals	9,598	95,140	1,475	1,073	107	730	Yearly Total 108,123

Table 18. Fish community by month at the Brunswick fishway for the 2002 sample season

Summary of Fish Community at BFW: May, 2002

Species	Total #	Destination	Mean Total Length (mm)
Alewife	51	Sample	286
Alewife	516	Sutherland Pond	
Alewife	8,904	Head Pond	
Spottail Shinner	2	Head Pond	
Smallmouth Bass	12	Head Pond	356
White Sucker	113	Head Pond	380
Total Number	9,598		
Mean Water Temperature:	11.8 C		

Summary of Fish Community at BFW: June, 2002

Species	Total #	Destination	Mean Total Length (mm)
American Shad	7	Head Pond	471
Atlantic Salmon	1	Head Pond	826
Alewife	115	Sample	276
Alewife	2,000	Highland Lake	
Alewife	93,000	Head Pond	
Brown Trout	1	Head Pond	424
Smallmouth Bass	13	Head Pond	317
Spottail Shiner	1	Head Pond	115
Striped Bass	1	Head Pond	398
White Sucker	1	Head Pond	264
Total Number	95,140		
Mean Water Temperature:	17.4 C		

Summary of Fish Community at BFW: July, 2002

Species	Total #	Destination	Mean Total Length (mm)
Juvenile Alewife	1403	Downstream	56
Juvenile Alewife	17	Sample	56
American Eel	2	Downstream	663
American Shad	4	HeadPond	501
Brown Trout	1	HeadPond	420
Largemouth Bass	1	HeadPond	312
Smallmouth Bass	20	HeadPond	169
Spottail Shiner	11	HeadPond	33
Striped Bass	4	Downstream	559
Pumpkinseed Sunfish	11	Downstream	67
White Catfish	2	Downstream	358
White Perch	1	HeadPond	N / A
Unidentified Fry	16	HeadPond	N / A
Total Number	1493		
Mean Water Temperature:	23.5		

Summary of Fish Community at BFW: August, 2002

Species	Total #	Destination	Mean Total Length (mm)
Juvenile Alewife	1059	Downstream	
Juvenile Alewife	2	Sample	69
Smallmouth Bass	8	Downstream	252
Striped Bass	3	Downstream	420
Pumpkinseed Sunfish	1	Downstream	94
Total Number	1073		
Mean Water Temperature	24.0		

Table 18 continued. Fish community by month at the Brunswick fishway for the 2002 sample season

Summary of Fish Community at BFW: September, 2002

Species	Total #	Destination	Mean Total Length (mm)
Alewife Juvenile	14	Sample	110
American Shad Juvenile	14	Sample	95
American Shad Juvenile	67	Downstream	
Smallmouth Bass	10	Downstream	82
Pumpkinseed Sunfish	2	Downstream	50
Total Number	107		
Mean Water Temperature	20.9		

Summary of Fish Community at BFW: October, 2002

Species	Total #	Destination	Mean Total Length (mm)
Alewife Junenile	651	Downstream	
Alewife Junenile	28	Sample	100.2
American Shad Juvenile	46	Downstream	
American Shad Juvenile	3	Sample	115
Atlantic Salmon	1	Downstream	863
Smallmouth Bass	1	Downstream	280
Total Number	730		
Mean Water Temperature	16.0		

Summary of Fish Community at BFW: November, 2002

Species	Total #	Destination	Mean Total Length (mm)
Closed for the season			

Summary of Fish Community at BFW: December, 2002

Species	Total #	Destination	Mean Total Length (mm)
Closed for the season			

Table 19. Brunswick fishway air and water temperatures/headpond levels, May 2002

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow (cfs)
1	-	-	-	10,000
2	-	-	-	11,100
3	-	-	-	10,800
4	-	-	-	10,400
5	-	-	-	10,100
6	18.7	9.3	41.0	9,310
7	11.5	9.9	39.8	8,850
8	11.4	10.6	40.3	8,760
9	12.7	11.3	40.4	8,380
10	14.7	11.7	39.5	7,420
11	9.9	12.5	39.0	7,250
12	-	-	-	6,690
13	6.2	12.1	39.4	7,080
14	8.9	11.2	41.8	11,000
15	8.4	11.1	41.8	16,800
16	13.6	10.6	41.8	16,900
17	18.2	9.9	42.0	15,300
18	5.2	9.4	42.5	15,200
19	8.3	9.1	41.6	13,300
20	10.8	10.1	41.9	12,700
21	12.1	10.4	41.5	11,600
22	12.9	11.1	41.0	9,400
23	16.4	11.6	40.0	7,630
24	18.1	12.3	39.0	6,740
25	12.4	12.3	39.1	6,260
26	11.7	13.0	39.0	5,870
27	15.6	13.0	39.0	5,750
28	18.9	15.0	39.0	5,740
29	15.9	15.4	39.0	4,530
30	15.5	16.1	38.3	4,430
31	17.6	16.9	39.0	5,590
Mean	**13.0**	**11.8**	**40.3**	**9,390**

Table 20. Brunswick fishway air and water temperatures and headpond levels, June 2002.

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow (cfs)
1	23.5	18.0	39.0	5,659
2	17.6	18.2	39.0	6,060
3	16.4	18.0	39.0	6,870
4	15.1	18.4	39.3	7,180
5	15.9	18.4	39.1	7,190
6	17.2	17.6	39.0	7,770
7	14.9	17.3	40.4	8,740
8	16.9	17.3	40.5	8,800
9	17.8	17.0	40.5	8,460
10	20.2	17.4	39.0	6,740
11	14.2	17.6	39.0	6,160
12	10.7	16.6	39.0	10,300
13	16.4	15.9	41.3	29,700
14	14.2	14.5	41.8	28,499
15	11.8	13.0	42.0	19,400
16	12.4	12.4	42.0	14,700
17	14.5	13.8	41.5	14,800
18	14.2	14.1	41.5	12,900
19	21.3	14.8	40.4	11,400
20	20.0	15.5	41.0	9,530
21	24.9	17.5	39.3	6,969
22	21.4	17.7	39.0	6,060
23	17.2	17.2	39.0	5,930
24	25.2	18.4	39.3	5,540
25	21.0	18.6	39.0	5,170
26	24.7	20.0	39.0	4,280
27	28.5	21.1	39.0	5,679
28	25.7	21.9	38.5	4,700
29	21.4	21.3	38.3	4,380
30	24.2	22.7	39.0	4,950
Mean	**18.6**	**17.4**	**39.8**	**9,484**

Table 21. Brunswick fishway air and water temperatures and headpond levels, July 2002.

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow (cfs)
1	25.1	22.8	39.0	5,090
2	23.5	22.6	38.8	5,870
3	28.1	23.6	38.8	5,990
4	32.2	25.7	38.5	5,940
5	-	-	-	6,020
6	22.8	24.3	37.8	2,470
7	23.5	23.6	37.8	2,700
8	27.0	23.0	37.5	4,160
9	23.5	24.4	38.0	4,240
10	21.7	25.3	37.8	4,089
11	18.7	23.9	38.3	3,550
12	21.3	23.1	38.5	4,200
13	24.7	23.5	38.0	1,820
14	23.7	23.7	38.5	2,610
15	22.9	24.2	39.0	3,300
16	20.4	23.9	38.5	1,900
17	20.6	32.2	38.5	3,300
18	23.1	23.1	39.0	3,220
19	17.8	23.1	38.0	1,790
20	19.6	22.9	38.5	1,750
21	23.1	22.8	38.5	1,880
22	21.9	22.4	39.0	3,620
23	26.1	24.1	38.0	3,590
24	20.5	24.0	38.3	2,590
25	20.2	23.3	39.0	2,970
26	15.8	22.7	38.5	3,000
27	17.4	22.7	39.0	1,890
28	-	-	-	1,930
29	20.9	22.0	38.0	2,950
30	23.9	22.5	38.5	3,150
31	27.1	23.6	38.5	2,720
Mean	**23.1**	**23.5**	**38.4**	**3,367**

Table 22. Brunswick fishway air and water temperatures and headpond levels, August 2002

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow (cfs)
1	26.5	24.3	39.0	2,701
2	21.9	24.5	38.5	3,200
3	-	-	-	2,080
4	27.0	24.4	38.0	2,340
5	29.5	25.5	38.0	2,200
6	18.7	24.7	37.5	2,110
7	21.1	23.6	38.5	3,870
8	20.9	22.7	38.0	2,930
9	21.9	22.7	38.5	3,280
10	-	-	-	2,700
11	20.5	23.5	38.5	1,900
12	27.0	23.8	38.5	2,030
13	25.9	24.3	38.5	2,010
14	30.2	25.1	38.5	2,039
15	26.6	25.3	39.0	1,999
16	24.5	25.5	38.0	1,980
17	28.7	25.8	37.5	2,000
18	-	-	-	1,990
19	26.3	25.6	38.0	1,990
20	19.3	25.4	39.0	1,880
21	24.1	24.8	38.8	1,880
22	18.6	24.2	37.5	2,000
23	17.8	23.8	37.5	1,980
24	-	-	-	2,010
25	22.0	24.2	38.5	2,020
26	23.9	23.0	39.0	2,000
27	24.3	23.2	39.0	1,870
28	16.7	23.0	38.5	2,000
29	19.7	23.0	38.0	1,830
30	18.3	22.3	39.5	1,790
31	-	-	-	1,640
Mean	**23.8**	**24.3**	**38.4**	**2,220**

Table 23. Brunswick fishway air and water temperatures and headpond levels, September 2002

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow(cfs)
1	9.3	21.4	38.5	1,640
2	-	-	-	1,630
3	17.6	21.7	38.5	1,710
4	18.2	21.5	38.0	1,540
5	21.0	21.2	39.0	1,590
6	18.5	20.4	39.0	1,580
7	-	-	-	1,650
8	-	-	-	1,560
9	27.4	21.3	38.0	1,550
10	28.7	22.1	38.5	1,510
11	23.8	22.6	38.0	1,650
12	15.9	21.2	39.0	1,690
13	-	-	-	1,570
14	-	-	-	1,620
15	-	-	-	1,870
16	14.2	19.2	38.5	2,440
17	17.1	20.9	39.0	2,020
18	12.9	19.5	39.5	2,310
19	15.1	19.5	38.5	1,950
20	16.5	19.6	38.5	1,830
21	-	-	-	1,719
22	-	-	-	1,680
23	19.7	20.7	38.5	2,260
24	13.3	20.6	39.0	1,590
25	13.5	20.1	39.5	1,660
26	11.3	19.7	39.0	1,680
27	13.1	19.1	38.0	2,460
28	19.8	19.4	38.3	2,020
29	-	-	-	1,800
30	15.3	17.7	39.5	2,770
Mean	**17.2**	**20.4**	**38.7**	**1,815**

Table 24. Brunswick fishway air and water temperatures and headpond levels, October 2002

Day	Air Temp (°C)	Water Temp (°C)	Headpond Level	Flow (cfs)
1	17.5	17.8	38.5	2,660
2	17.7	18.6	39.0	1,910
3	13.5	19.2	39.5	1,890
4	5.9	18.1	39.5	2,270
5	-	-	-	1,880
6	11.5	16.7	38.0	1,620
7	13.9	16.4	39.0	1,670
8	7.3	16.4	38.5	1,860
9	7.3	15.0	39.0	1,690
10	-	-	-	1,760
11	12.7	14.5	39.0	1,930
12				1,870
13				1,810
14	9.1	14.5	39.0	2,280
15	5.3	13.2	39.2	1,850
16	4.9	12.8	39.5	2,050
17	9.1	12.2	39.5	2,700
18	6.5	11.9	39.0	3,439
19	-	-	-	3,380
20	7.5	10.9	38.5	2,760
21	6.5	10.7	39.0	2,400
22	1.8	10.1	39.5	2,859
23	-	-	-	2,180
24	4.7	9.1	39.0	1,830
25	4.0	9.0	39.0	1,870
26	-	-	-	1,640
27	-	-	-	1,719
28	6.6	8.4	39.5	1,729
29	Fishway	Closed For	Season	-
30	-	-	-	-
31	-	-	-	-
Mean	**8.7**	**13.8**	**39.1**	**2,125**

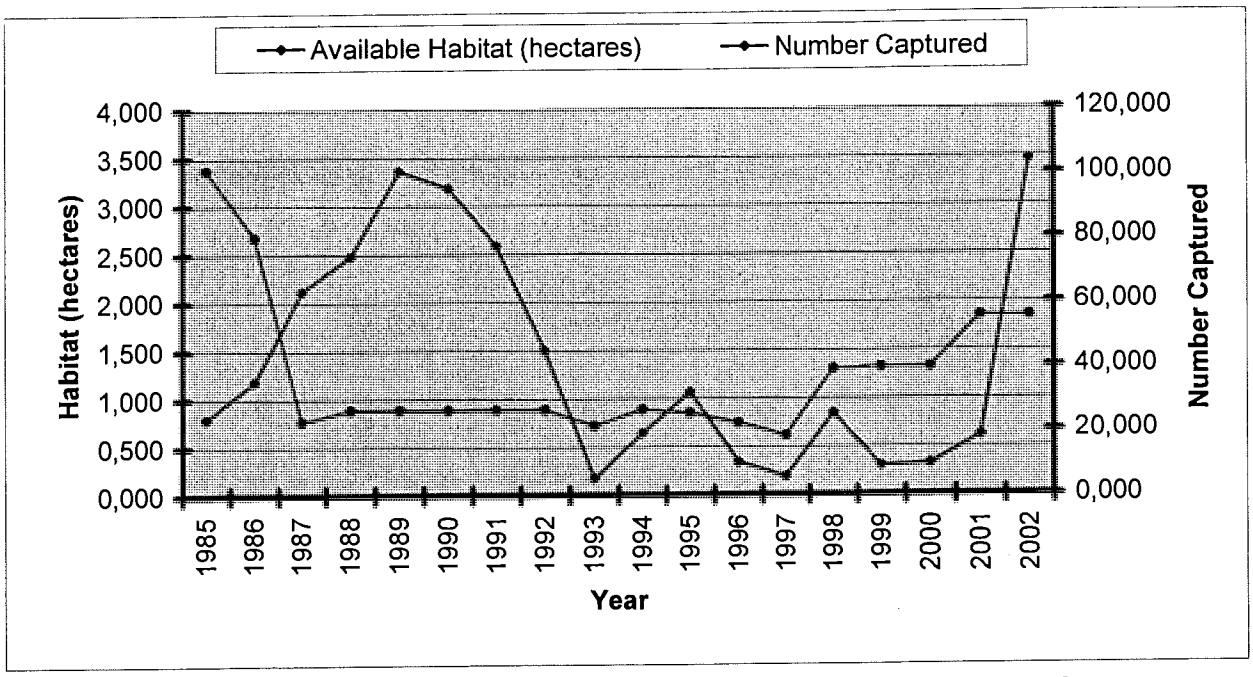

Figure 1. Adult alewife captured and habitat availability in the Androscoggin River watershed, 1985-2002

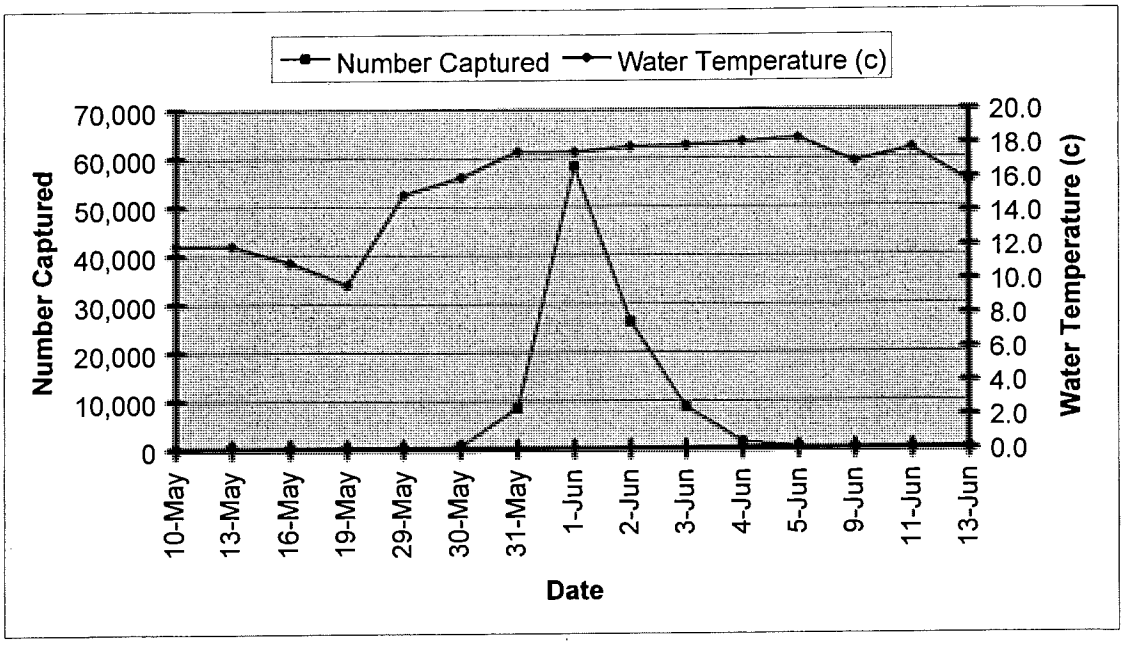

Figure 2. Number of adult river herring captured vs. water temperature at the Brunswick fishway, 2002

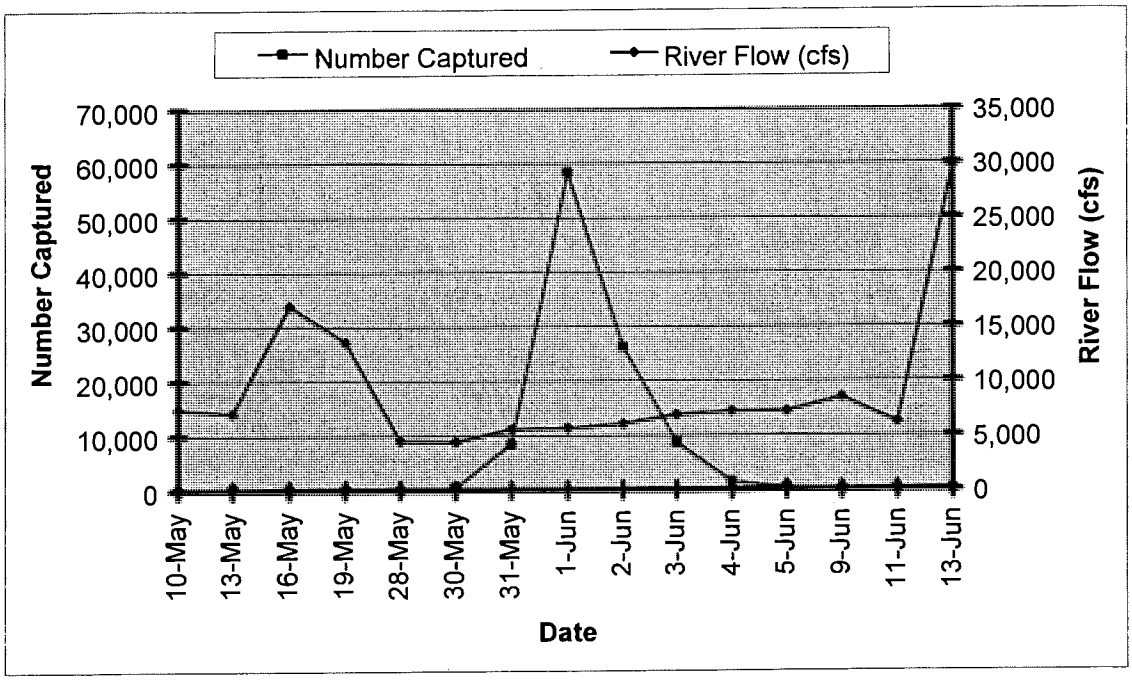

Figure 3. Number of adult river herring captured vs. river flow at the Brunswick fishway, 2002

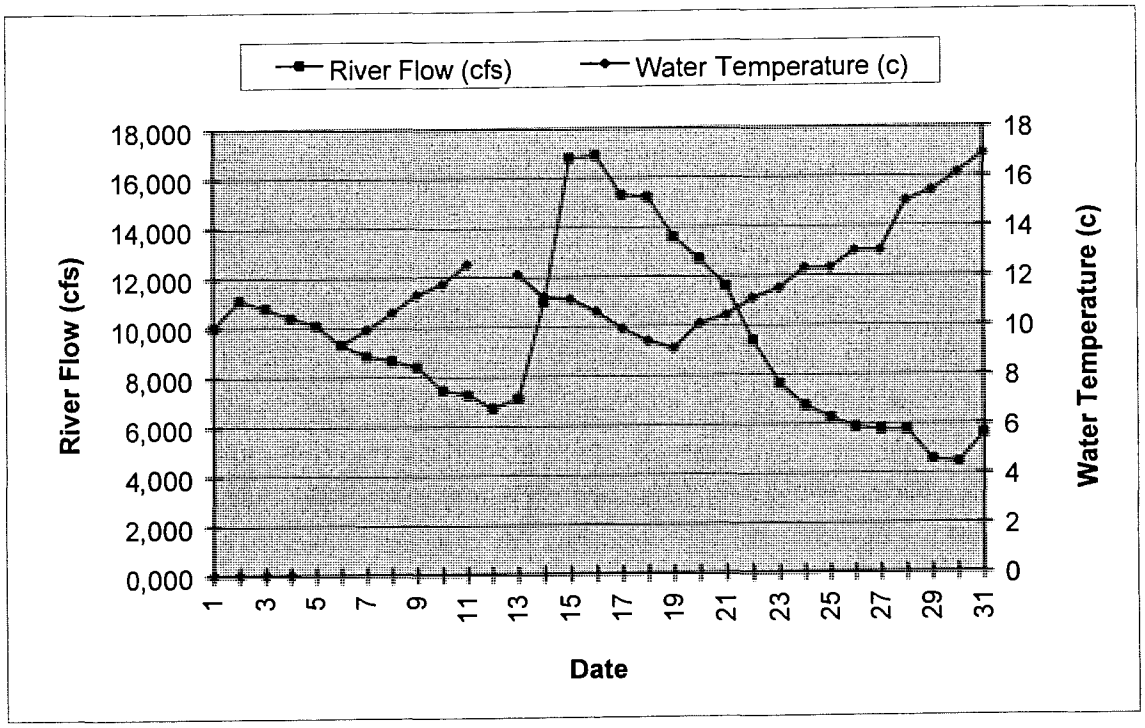

Figure 4. Brunswick fishway water temperatures and river flows - May, 2002

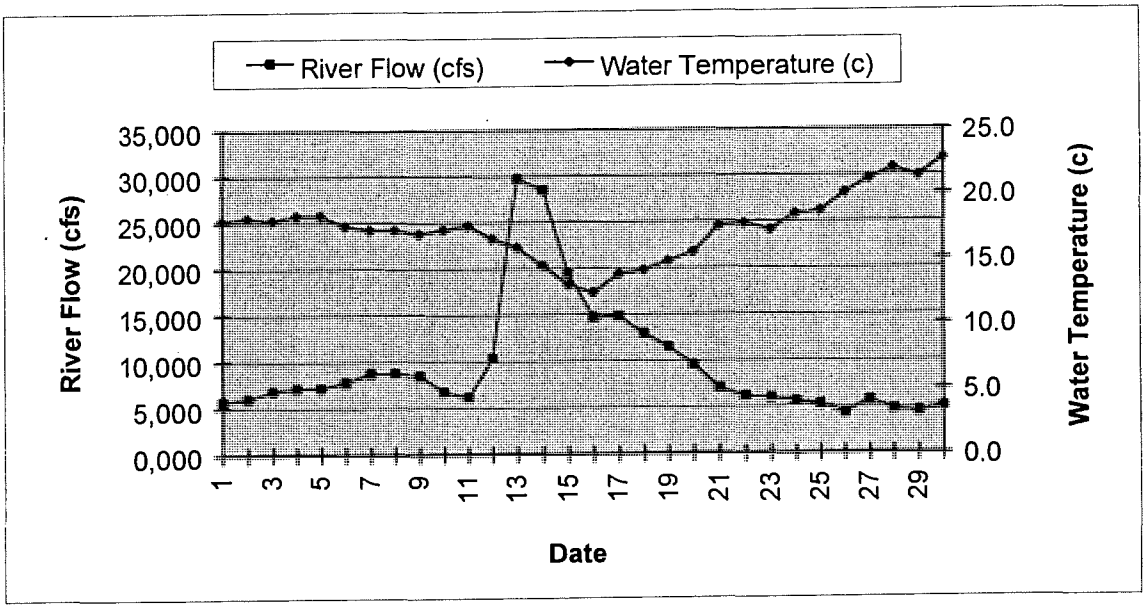

Figure 5. Brunswick fishway water temperatures and river flows – June, 2002

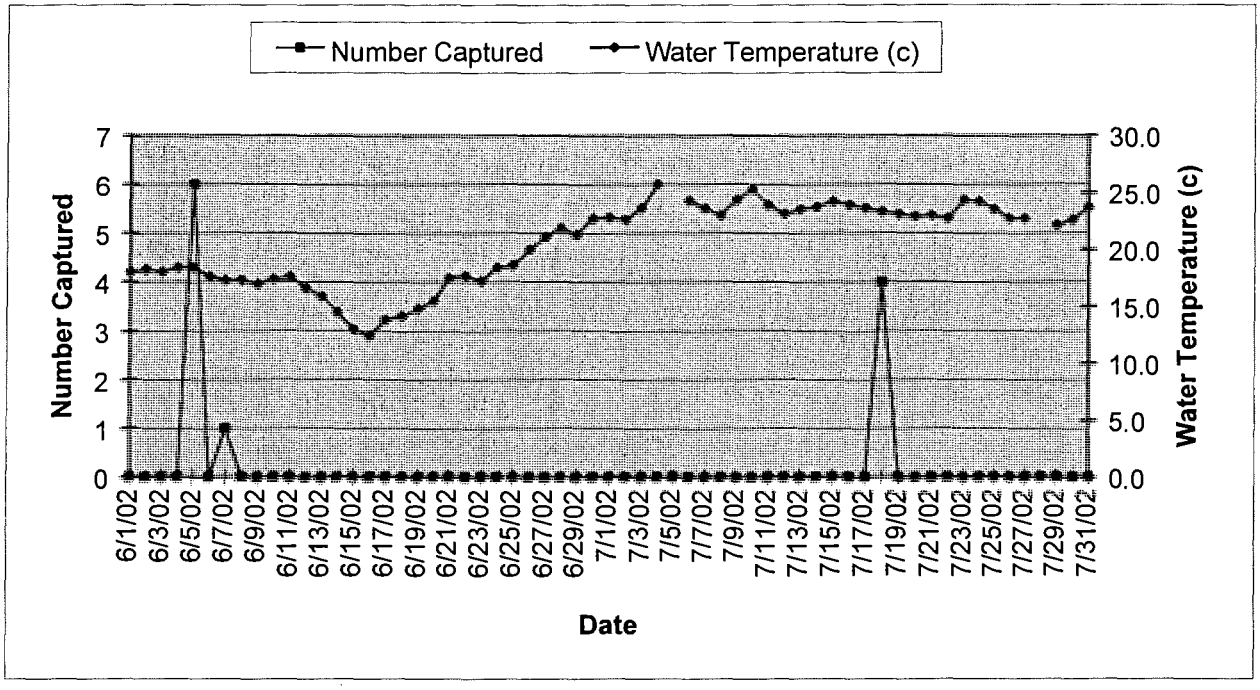

Figure 6. Number of adult American shad captured vs. water temperature at the Brunswick fishway during June – July, 2002

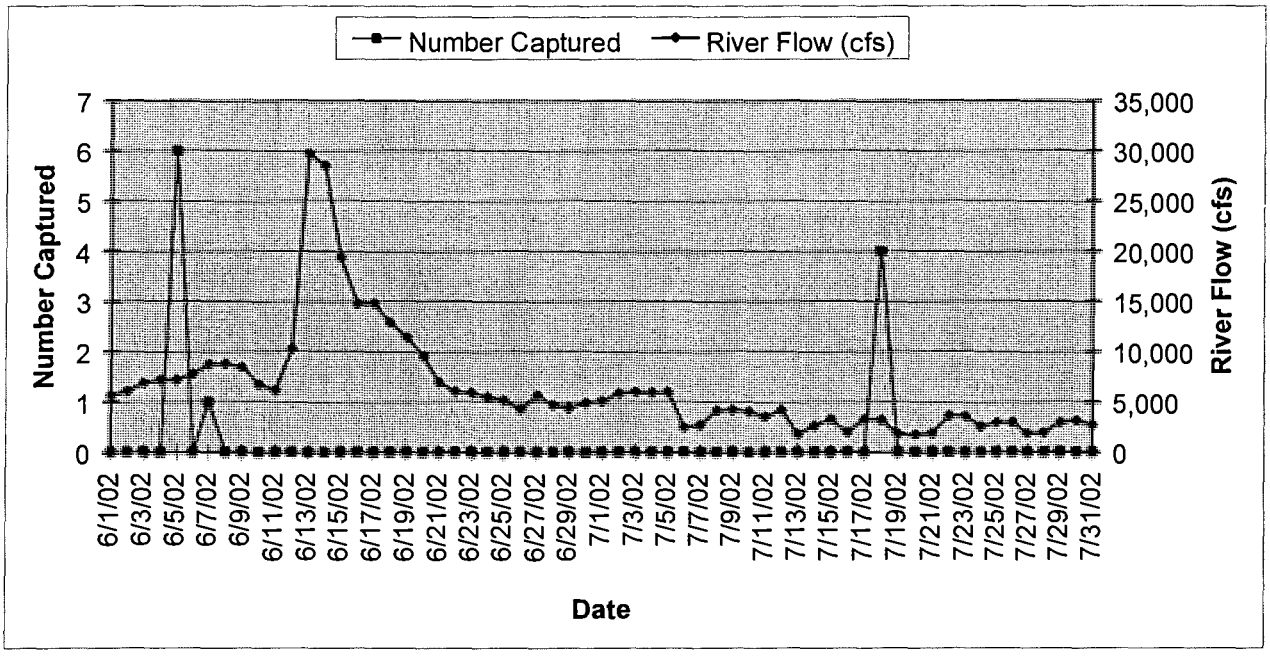

Figure 7. Number of adult American shad captured vs. river flow at the Brunswick fishway during June – July, 2002

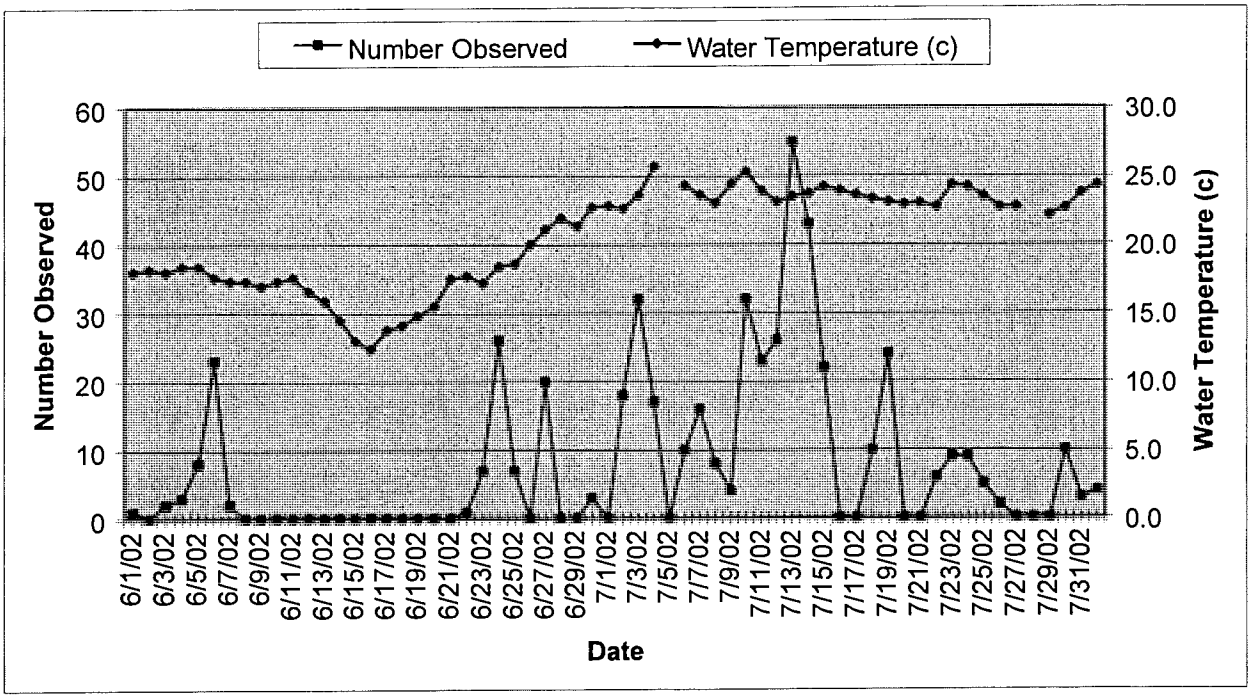

Figure 8. Number of American shad observed vs. water temperature at the Brunswick fishway, June – August 2002

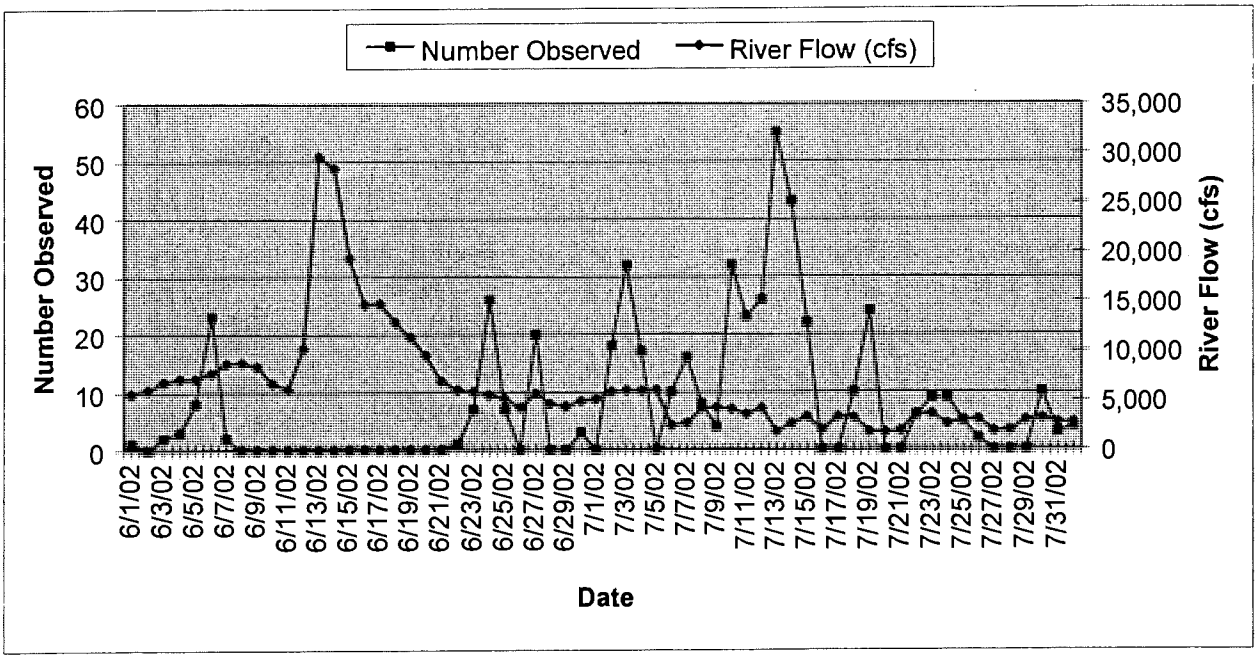

Figure 9. Number of American shad observed vs. river flow (cfs) at the Brunswick fishway, June - August, 2002

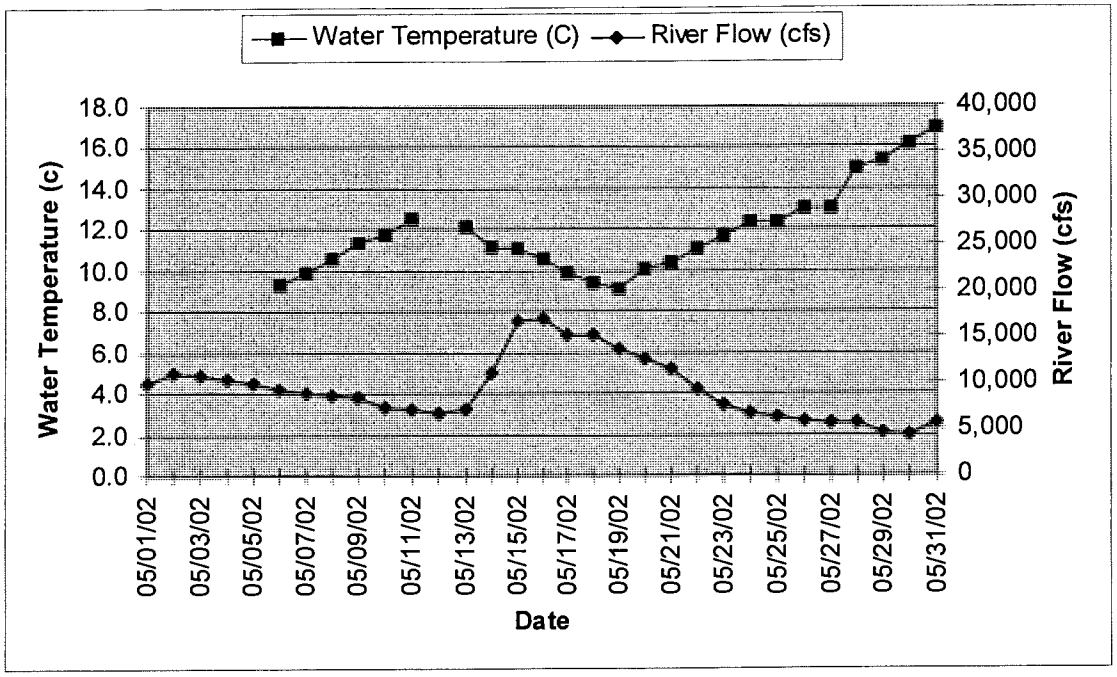

Figure 10. Water temperature and river flow recorded at the Brunswick fishway in May, 2002

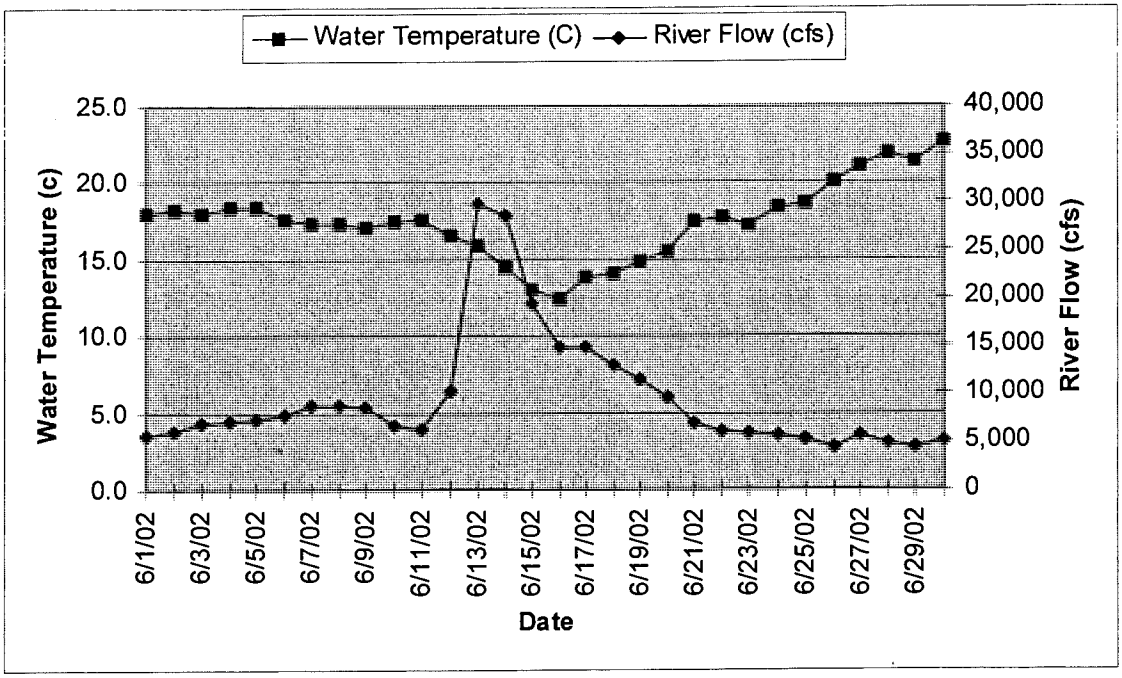

Figure 11. Water temperature and river flow recorded at the Brunswick fishway in June, 2002

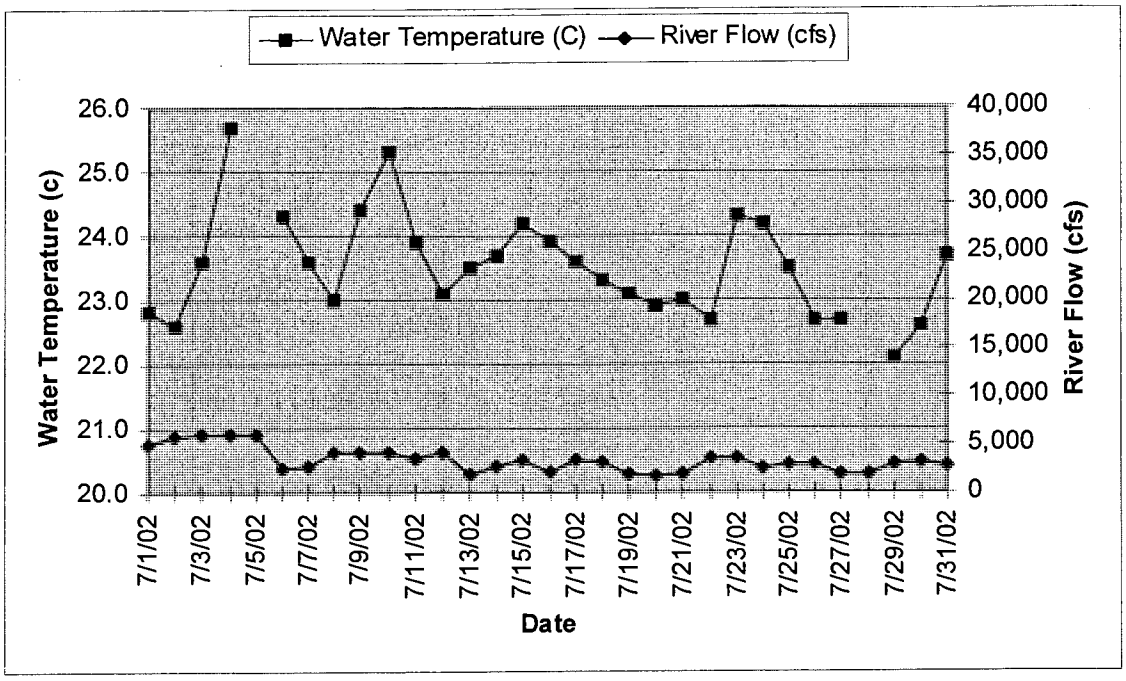

Figure 12. Water temperature and river flow recorded at the Brunswick fishway in July, 2002

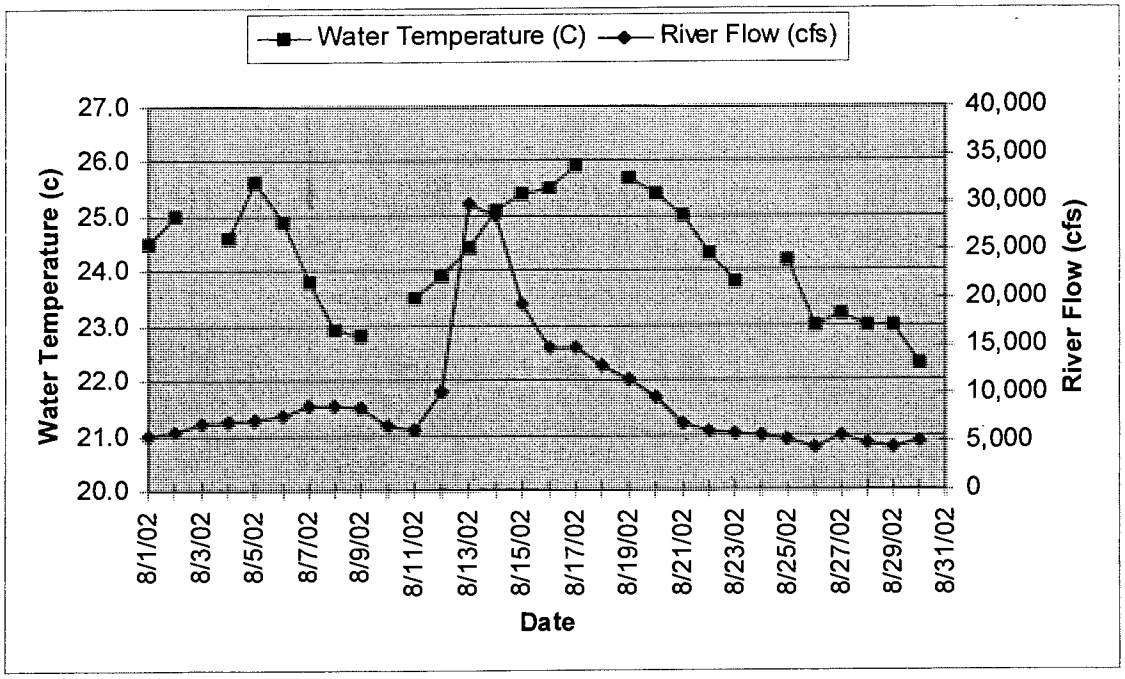

Figure 13. Water temperature and river flow recorded at the Brunswick fishway in August, 2002

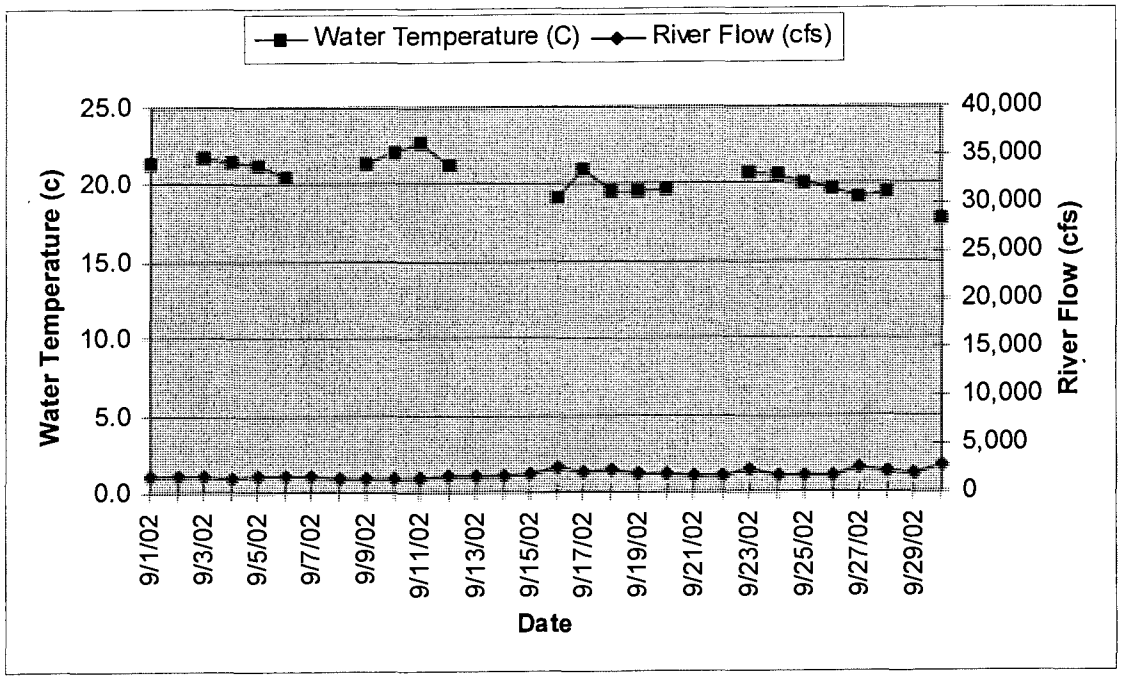

Figure 14. Water temperature and river flow recorded at the Brunswick fishway in September, 2002

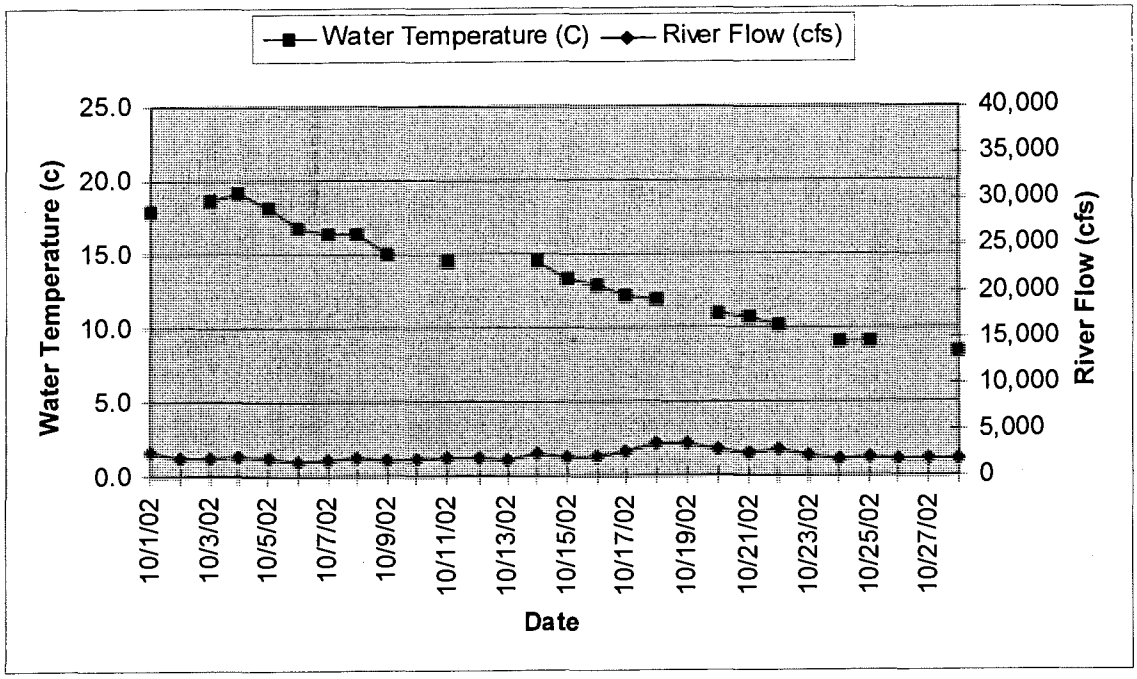

Figure 15. Water temperature and river flow recorded at the Brunswick fishway in October, 2002

Brunswick Fishway Specifications

Type:	Vertical Slot
Description:	Reinforced concrete w/precast baffles
Overall Length:	570' +/-
Floor Elevations:	Elevation 34.0 at fishway exit
	Elevation -5.0 at fishway entrance
Floor Slope:	1 on 10
Pool Size:	8'-6"W x 10'-0"L with 11" wide slot
Drop per Pool:	12"
Design Populations:	85,000 shad per year
	1,000,000 alewives per year
Fishway Operating Range:	Maximum headwater elevation 43.0
	Maximum tailwater elevation 7.5
	Q = 30,000 CFS
	Normal headwater elevation 39.4
	Normal tailwater elevation 2.5
	Q = 4,400 CFS
	Minimum headwater elevation 37.4
	Minimum tailwater elevation -1.0
	Q = 0 CFS
Design Flow:	30 CFS
Supplementary Attraction Flow:	70 CFS (gravity)
Total Attraction Flow:	100 CFS
Fishway Entrance Jet Velocity:	4.0 FPS to 6.0 FPS
Tailrace Velocity:	5.0 FPS maximum

Appurtenances:

Gates:

1 - 7' x 10' motorized & instrumented sluice gate at fishway exit. This gate to be closed when pond level reaches elevation 43.0+

1 - 4' x 10' motorized & instrumented sluice gate at entrance to downstream

Appurtenances, cont.:

Gates:	Migrant passage on north side of powerhouse
	2 - 27" diameter motorized & instrumented sluice gates at intake of supplementary attraction flow system
	2 - pneumatic trap gates at fish trap
	Stop logs at fishway entrance & exit
	Trash rack: 1 10' x 12' at fishway exit with 5 3/4" clear bar spacing
Fish Crowder	1" x 4" grating on motorized trolley at fish trap
Fish Hopper	500-gallon capacity with electric hoist at fish trap

Related Work:

Existing Overflow Spillway	Addition of flashboards (120 L.F.) to elevation 42.0 to prevent discharge into tailrace at river flow 20,000 CFS
Fish Barrier Wall	Reinforced concrete semi-gravity type with top at elevation 21.0 to prevent discharge into tailrace at river flows up to 20,000 CFS
Overall Length	170' +/-
Maximum Height	30' +/-
Appurtenances	Sluice gate for dewatering intermediate pool

Species Observed Using The Brunswick Fishway 1983-2001

Brook trout

Brown trout

Smallmouth bass

Largemouth bass

White sucker

Striped bass

American shad

Coho salmon

Carp

Sea lamprey

Rainbow trout

Chinook salmon

White perch

Yellow perch

Atlantic salmon

American eel

Landlocked salmon

Sunfish (Bluegill)

Sunfish (Pumkinseed)

Pumpkinseed Sunfish

Creek chub

Golden Shiner

Common Shiner

White catfish

Spottail Shiner

Rainbow Smelt

Crayfish